

**REPORT**  
**OF**  
**THE SALT EXPERTS COMMITTEE**

**NEW DELHI**  
**1950**

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## CHAPTER I

### INTRODUCTION

#### 1. Appointment of the Committee.

1.1 The Salt Experts' Committee was constituted by the Government of India in Resolution No. Salt 18(1)I&S/48, dated the 15th April 1948, with the following personnel:

Sri P. A. Narielwala	Tata Industries Ltd.	<i>Chairman</i>
Dr. K. L. Moudgill	Director of Research, Travancore (now Deputy Director, Indian Standards Institution, Delhi).	<i>Member</i>
Sri M. D. Mithal	Director, Irrigation, Central Water-power, Irrigation and Navigation Commission, New Delhi (now Chief Engineer, Irrigation, Rajasthan).	<i>Member</i>
Shri Shiv Charan Das	Salt Controller, Government of India (since retired, Collector of Central Excise).	<i>Member</i>
Dr. B. Shah	Assistant Development Officer, Directorate General of Industries and Supplies (now Assistant Salt Controller).	<i>Secretary</i>

#### 2. Terms of Reference.

2.1 The Committee was set up in order to advise Government on the measures necessary to place the Salt Industry in India on a sound footing. The terms of reference were:

- (i) to examine the existing methods of salt production in Government and private-owned salt works, and to make recommendations as to what steps should be taken to increase production, to improve quality and reduce costs; where possible to give an estimate of the costs involved in increasing production and improving quality;
- (ii) to indicate the areas in which new salt works may be established with advantage and the technical standards which should be prescribed for these works;
- (iii) to examine and report on the best method of enforcing minimum standards of quality of salt offered for sale and methods to prevent wasteful production of salt below such quality;
- (iv) to report on the necessity and/or usefulness of model factories to guide production and to give concrete proposals for their establishment;
- (v) to report on the character and extent of the technical assistance and supervision which must be provided to private salt works to enable them to increase the quantity and improve the quality of production. Should Government itself maintain a permanent technical staff for this purpose; if so, what should be the qualifications and experience of such staff;
- (vi) to report on the desirability and possibility of establishing whether under state control or otherwise, modern installations for the production of salt otherwise than by solar evaporation, particularly for the manufacture of high quality edible salt, salt for industrial use and by-products of salt. For this purpose an assessment should be made of the industrial requirements of salt and

the proportion of such requirements which the consuming industries can economically buy from outside sources.

2.2 Apart from these terms of reference, the Committee were consulted from time to time by the Salt Controller, Government of India, on various matters connected with salt and its by-products. These points were separately attended to by the Committee and the more important ones have been incorporated in the report.

### 3. Previous Enquiries.

3.1 In 1926, the Taxation Enquiry Committee of the Government of India reported that if India could be made self-sufficient in salt by the granting of a purely temporary advantage to the local manufacturers, it would be a desirable end to achieve and they recommended that an enquiry should be made into this matter by the Tariff Board. The recommendation was examined by the Central Board of Revenue who, however, came to the extraordinary conclusion that, on the evidence available, a reasonable probability that India could be made self-supporting in salt could not be regarded as established.

3.2 About the same time, *i.e.*, in 1926, almost simultaneous efforts were made both in Kathiawad and Karachi to set up salt works in order to produce good white salt that would be acceptable to the Bengal market which then entirely depended upon foreign sources. When the shipments of salt from Kathiawad and Karachi began to be accepted in Calcutta, the importers of foreign salt made a determined bid to thwart the existence of the new salt factories by cutting down prices to an unremunerative level. The Indian factories had to struggle for their existence and when they found it impossible to continue to manufacture salt against this onslaught they appealed to the Government of India for protection. In 1929, Government referred the case for protection to the Tariff Board who, after a detailed enquiry, recommended that Tariff protection should be granted to the Indian Industry. The Board also expressed their conviction that fine, white crushed salt of the purity demanded by Bengal could be produced in India in sufficient quantities and at a reasonable price. They, therefore, recommended that the Government of India should undertake a thorough enquiry into the potentialities of the various salt sources in India, particularly with a view to determining how soon the country could be made independent of foreign imports.

3.3 The recommendation of the Tariff Board led to the appointment of the Salt Survey Committee in 1930, with Sir Chunilal V. Mehta as Chairman. This Committee confined its enquiry to the salt works of Bombay, Sind, Kathiawad and Rajputana only. It came to the conclusion that India had all the facilities for manufacturing salt of first class quality and becoming self-sufficient within a reasonable period of time, provided adequate assistance and protection were granted to the industry. Government of India thereupon accepted the recommendations of the Tariff Board and levied a protective duty of Rs. 7-10-6 per ton (Re. 0-4-6 per maund) on imports of all foreign salt. During the period of protection, private enterprise in India made a notable effort to increase the salt production in the country, particularly in Kathiawad and Kutch, where new salt works were established, helping considerably to reduce the imports of foreign salt.

3.4 Since 1930, except for departmental surveys and local investigations in Bengal and Orissa no exhaustive enquiry has been held on the development and growth of the Indian Salt Industry as a whole or of the causes which have hitherto prevented the country from becoming completely self-sufficient.

3.5 In 1946, Shri Shiv Charan Das was appointed Salt Adviser, Government of India, and after visiting the important salt works in the country he submitted a report to the Central Board of Revenue, suggesting ways and means for the

expansion and the control of the salt industry. Very soon after India achieved independence, shortage of salt was noticed in various parts of the country. Government set up an Inter-Departmental Committee under the chairmanship of Mr. H. M. Patel, then the Cabinet Secretary, to report on the measures necessary to overcome this shortage, and to recommend steps for securing a higher production and a better method of distribution in order to eliminate as far as possible the periodic complaints of shortage. This Committee submitted, within two months, a report to Government containing several short term proposals to overcome the shortage of salt. It also came to the conclusion that the Indian salt industry needed a closer examination of its production and quality, and recommended the setting up of an Experts' Committee to go into these questions more thoroughly and in all its aspects. The Government of India accepted the recommendation of the Patel Committee which led to the appointment of our Committee.

#### 4. Enquiry of the Salt Experts' Committee.

4.1 Our committee started work soon after its formation and we visited 25 important salt producing areas in the country, viz., the Marine Salt Works, on the sea board of India, the Inland Salt works in Rajasthan and other areas, and the Rock Salt Mines in Mandi. The places visited by the Committee are noted below:

Place	State	Character of the works.
Astrang	Orissa	Marine
Adirampatnam	Madras	"
Contai	West Bengal	"
Covelong	Madras	"
Cape Comorin	Travancore	"
Ennore	Madras	"
Gokurkuda	Orissa	"
Huma	"	"
Jamnagar	Saurashtra	"
Kandla	Kutch	"
Lavanpur	Saurashtra	"
Mithapur	Kathiawad	"
Naupada	Madras	"
Porbandar	Saurashtra	"
Sumadi	Orissa	"
Surla	"	"
Tuticorin	Madras	"
Vodranyam	"	"
Velan	Kathiawad	"
Didwana	Rajasthan	Inland
Kharaghoda	Bombay	"
Kuda	Saurashtra	"
Pachbadra	Rajasthan	"
Sambhar	"	"
Mandi	Himachal Pradesh	Mines

4.2 The visits of the Committee to the different producing centres had to depend upon the season and were arranged during the fair weather so as to coincide with their period of manufacturing operations. The labours of the Committee have in consequence taken a somewhat longer time than was originally anticipated. In view, however, of the urgency of increasing the production in the country as quickly as possible, the Committee submitted two *Interim* Reports to the Government of India, the first in June 1948, and the second in January, 1949, to enable Government to adopt immediate remedial measures where necessary. The recommendations made in these reports have been incorporated in this report and the interim reports are not reproduced in the present text.

4.3. In order to collect full and up-to-date information on the salt industry, the Committee issued a detailed questionnaire (Appendix A) to all the salt factories, the State Governments and Associations of salt manufacturers. A considerable amount of useful information has been gathered which shows

that whilst the salt production in the country has increased considerably since 1931, the industry with a few fortunate exceptions is backward in many respects, even to the point of being characterised as primitive. The Committee is constrained to observe that the poor quality of Indian salt is to some extent due to the policy followed in the past by the Government of India. Until the advent of the National Government, the salt industry was looked upon solely as a source of revenue. Stringent rules were devised to collect the revenue as effectively as possible, without any regard or consideration being paid to the quality of the salt produced. Even in Government salt works sufficient attention was not paid to improvements in the method of manufacture. Such progress and improvement as have been noticed in Government salt works or in private factories have been due to the zeal of individuals, despite the fact that incentive was lacking. If a little more attention, properly directed, had been given to these improvements, the Indian industry would have been in a better state, producing not only a superior quality of salt but enough quantity to make India self-sufficient and perhaps exporting salt instead of importing it as at present. We are glad to note that in recent months the policy has undergone a radical change and Government are now regulating the imports by integrating them to the production within the country thus preventing indiscriminate imports of large quantities which would otherwise have detrimental repercussions on the indigenous production.

4.4. We cannot emphasise too strongly the importance of achieving self-sufficiency in the supply of such an important commodity as salt. It would have been possible for undivided India to attain it almost immediately by an expanded programme of production at all the existing works. By the partitioning of the country in 1947 most of the valuable and extensive rock salt deposits in the Punjab and the marine salt works in Sind have gone to Pakistan. Nonetheless, India still possesses a number of large works and, after our visits to them, we believe that large potentialities exist at all of them for an immediate and appreciable increase in production. To bring about this increase we had recommended in June 1948 as an interim measure, the issue of a directive by Government to all the salt works in the country, whether Government or privately-owned, urging them to increase their production, in the ensuing manufacturing season, by at least 10 per cent above the maximum production reached during the three years ending 31st March 1948. We were confident that even without any special effort or extension of the existing works, an increase in production could be achieved to this extent. We are glad to record that this recommendation was immediately accepted and acted upon by Government with the result that the production for the year ending 31st March 1949 has shown a substantial increase.

4.4.1 The production of salt in the India of today (*i.e.* after the partition of the country) has increased from 12,65,000 tons (3,44,00,000 mds.) in 1930 to 18,85,000 tons (5,13,10,000 mds.) in 1947; an increase of nearly 50 per cent. This increase has taken place principally in Kathiawad, Kutch, Madras, Sambhar and Travancore. In Kathiawad and Kutch, the expansion has been phenomenal; from a bare 14,700 tons (4,00,000 mds.) it has increased to 3,17,000 tons (86,29,000 mds.). In Madras production has risen from 3,64,000 tons (99,08,000 mds.) to 6,35,000 tons (1,72,85,000 mds.). Sambhar has shown an increase from 2,09,000 tons (57,00,000 mds.) to 3,67,000 tons (1,00,00,000 mds.). Travancore, where there was hardly any production in 1930, now contributes 60,000 tons (16,33,000 mds.) annually. Even with this increase, the production has not yet caught up with the consumption in the country which also continues to increase from year to year and which at present is over 22,50,000 tons (6,12,45,000 mds.) thus showing a shortage of 3,65,000 tons (99,35,000 mds.). This gap has to be met by import of foreign salt which is regrettable and which should be stopped as early as possible. Since the consumption of salt in the country is likely to increase progressively with the increasing

population and the growing industrial and agricultural demands merely filling up this gap would not be sufficient.

## 5. Report.

5.1 In the preparation of this report we have kept in view the fact that the present state of the salt industry in India requires a comprehensive discussion of the technical aspects of the industry in simple language in order to give information of the conditions that prevail in different parts of India and to suggest methods within the reach of the manufacturers by which the quality and yield of salt can be improved. The report has of necessity become long and contains repetitions at places which have been advisedly allowed to remain because we feel that the reader should be in the possession of a complete and easily understandable account of each aspect of the industry. The report starts with a general discussion of the technique of salt manufacture followed by a detailed account of the conditions that prevail in the chief producing regions of India. We have attempted to give an estimate of the potentialities of production at the various centres and how best they could be utilised. We have also dealt with the costs of production and the selling prices with suggestions for reducing the cost and improving the quality. We have further indicated the manner in which the Salt Department of the Government of India should function and the help it would render the industry particularly in areas where it is urgently needed, by establishing model factories and research stations. We have discussed also the need for laying down proper standards of quality for edible salt and the stages by which these standards could be reached and enforced. A summary of our recommendations is given at the end of each chapter.

5.2 Considerable confusion arises in Indian literature on salt because figures of production are expressed sometimes in tons and at others in maunds. While the figures in tons are important from the point of view of international trade, the practice in India has been to give them in maunds, chiefly because the maund was the unit on which the duty on salt was collected. We have, therefore, adopted the practice of giving the figures in tons and their equivalents in maunds, within brackets, using the conversion factor 1 ton = 27.22 mds. and rounding off to the appropriate significant digit in converting from one unit to the other. In expressing the results of analyses of samples of common salt, brines, etc., we have adopted the practice of giving figures on a dry basis so that the data may be directly comparable.

## 6. Acknowledgements.

6.1 We gratefully acknowledge the assistance that we have derived from the available literature on salt on which we have drawn freely. In order to avoid making frequent and repeated references to the original sources in the body of the report we have listed in the Bibliography the more important publications which we have consulted and used. We also wish to thank the Government of India and the State Governments for the assistance they have rendered us during the inspection of the salt works and for the courtesy and hospitality extended to us. We wish to express our appreciation and satisfaction at the promptness with which many of our interim recommendations have been acted upon by the Government of India. This is to a large measure due to the personal interest that the Hon. Dr. Syama Prasad Mookerjee, Minister for Industry and Supply, Government of India, has taken in the work of the Committee. We place on record our gratitude to him for the encouragement and kindness we have received at his hands.

6.2 The Committee acknowledge the valuable assistance they received from salt manufacturers and their trade associations. They record with appreciation the work of Dr. B. Shah, the Secretary, who collected and placed before the Committee valuable information which was of great assistance in presenting this report.



## CHAPTER II

### OCCURRENCE, PRODUCTION AND USES OF SALT

#### I. Occurrence.

1.1 Common salt or Sodium Chloride is an inorganic substance which is very widely distributed on this earth. It is found in varying concentrations in all rocks and clays in the earth's crust; in all animal and vegetable life; in all waters in rivers, springs, lakes and the sea. In rich concentrations it occurs in sea water, in inland saline lakes and in saliferous earths; and in the massive form as rock salt.

1.2 The main source of common salt is the sea. The continuous cycle of evaporation of water from the sea leading to rainfall on the land continents and its return to the sea, laden with the dissolved salt, extracted from the earth, has built up the salinity of the sea. The total quantity of all salts present in the sea is computed to be sufficient to cover the entire sea bottom of 131 million square miles to a thickness of 196 feet of which 155 feet would be sodium chloride or common salt alone. Sea water is an inexhaustible source of common salt and its analyses from widely separated seas, as shown in Table I, will indicate that the composition of the dissolved salts is fairly constant.

TABLE I—ANALYSES OF SEA WATER FROM DIFFERENT SOURCES.

	Suez Canal	Atlantic Ocean	Gulf of Mexico	Contal Coast (Bengal)	Madras Coast	Bombay Coast
	(Percent on dry basis)					
Calcium carbonate . . .	0.02	0.30	0.11	0.36	..	0.10
Calcium sulphate . . .	3.57	4.31	4.08	3.65	4.06	3.05
Sodium chloride ] . . .	79.25	78.00	78.2	} 80.02	81.50	{ 78.0
Potassium chloride . . .	1.22	2.01	2.01			
Magnesium sulphate . . .	6.44	6.01	5.76	6.90	5.64	7.5
Magnesium chloride . . .	9.29	9.15	9.64	8.82	8.77	9.1
Magnesium bromide . . .	0.14	0.22	0.20	} 0.25	9.30	{ 0.08
Rest . . . . .	0.07	..	..			
	100.00	100.00	100.00	100.00	100.00	100.00

1.2.1 Along the sea shore, where shallow depressions occur, sea water comes in intermittently at high tides and gets evaporated leading to the formation of saline earths or the enrichment of the subsoil waters below. These earths and subsoil brine also form an important source. The salt marshes and swamps on seaboard caused by tidal inundations from the sea are to be found on the Red Sea Coast of Eritrea, in the Nile Delta and on the Black

Sea Coast. In India, the Great and Little Rann of Kutch and the swamps at Vedaranyam on the East Coast are typical and important examples.

1.3 The other sources of common salt are the widely distributed pockets which have been formed through geologic times by the transgression and recession of the sea through periodic land movements; or by the evaporation of salt lakes in arid regions. The total quantity of salt in such deposits is, however, small as compared with the salt available in sea water, but they nonetheless constitute an important source of supply.

1.3.1 The rock salt deposits of the world come under the first category. These massive formations are the hoarded wealth of the past geological ages and are an important source of common salt of great economic value to the countries in which they are found. In America and Europe they are fairly extensive and cover hundreds of miles. They are often protected by dolomite, gypsum or impervious clay and have thus withstood erosion by rain water. In Asia, rock salt occurs in Iran, Siberia, Tibet and Pakistan. In India the Mandi rock salt deposits situated in the Himalayan ranges are the only hitherto known source, but they are comparatively small and yield salt of inferior quality.

1.3.2 In the second category come the lake deposits of the world. They occur in dry and arid areas and are formed by the leaching out of salts in the surrounding territories during rains; the basin into which the flood water drains forming a salt lake. The salt lakes of California and Utah, the Dead Sea, and the Rajputana deposits in India, are formed in this manner and are situated in regions of dry climates. It is stated that the whole area of the Rajputana deposits is sprinkled with salt every year by the dust storms from the Rann of Kutch bringing salt laden dust which is washed into the lakes at Sambhar and Didwana.

## 2. Production.

2.1 Salt is produced in almost all the countries of the world. Its consumption is an index of the industrial progress of a nation. The production and consumption of salt have been increasing steadily for the last several years owing to growth in population and larger and larger use in industries, particularly the chemical industry. In 1939 the total world production of salt was reported to be 36 million tons (980 million mds.). The last World War gave a fillip to the production, increasing it by nearly 20 per cent. In 1946, the latest year for which figures of world production are available, the output had risen to 42 million tons (1143.24 million mds.).

2.2 The largest amongst the world producers is the United States of America which manufactured 13.51 million tons (367.74 million mds.) in 1946. The next biggest producer is the United States of Soviet Russia where the production is said to exceed 4.5 million tons (122.50 million mds.) followed by Great Britain and China where the production is more than 3 million tons (82 million mds.). Before the War, Germany was also a big producer of salt and in 1942 its total production exceeded 4.5 million tons (122.50 million mds.); figures of recent production are not available, but owing to restriction on its industrial activity after the War, the present production must have fallen considerably. In undivided India the production in 1946 was 2.18 million tons (59.34 million mds.), but calculated for the India of today it would correspond to 1.80 million tons (48.99 million mds.) which gives India the sixth place amongst the world producers. Considering that in point of population this country ranks as second in the world, its backwardness in salt production becomes quite apparent. Table II shows the production of salt in various countries of the world in 1946; some of these figures are reported to be approximate, but by and large they may be taken as sufficiently representative.

TABLE II—WORLD PRODUCTION OF SALT IN 1946

Country	Millions (In millions)	Maunds (In millions)
(a) NORTH AMERICA . . . . .	14.71	400.40
1 Canada . . . . .	0.47	12.79
2 Mexico . . . . .	0.73	19.87
3 United States . . . . .	13.51	367.74
(b) SOUTH AMERICA . . . . .	1.05	28.58
1 Argentina . . . . .	0.39	10.61
2 Brazil . . . . .	0.45	12.25
3 Columbia . . . . .	0.12	3.27
4 Venezuela . . . . .	0.09	2.45
(c) EUROPE . . . . .	17.90	437.24
1 Austria . . . . .	0.17	4.63
2 Czechoslovakia . . . . .	0.17	4.63
3 France . . . . .	1.19	32.39
4 Germany . . . . .	4.50*	122.49*
5 Great Britain . . . . .	3.23	87.92
6 Greece . . . . .	0.10	2.72
7 Hungary . . . . .	0.34	9.26
8 Italy . . . . .	1.50	40.83
9 Netherlands . . . . .	0.15	4.08
10 Poland . . . . .	0.60	16.33
11 Portugal . . . . .	0.25	6.80
12 Rumania . . . . .	0.35	9.53
13 Russia . . . . .	4.50	122.49
14 Spain . . . . .	0.76	20.69
15 Switzerland . . . . .	0.09	2.45
(d) ASIA . . . . .	6.94	188.91
1 Aden . . . . .	0.11	2.99
2 China . . . . .	3.00	81.66
3 India (including Pakistan) . . . . .	2.18	59.34
4 Indo-China . . . . .	0.20	5.44
5 Indonesia . . . . .	0.20	5.44
6 Japan . . . . .	0.40	10.89
7 Korea . . . . .	0.30	8.17
8 Manchuria . . . . .	0.20	5.44
9 Siam . . . . .	0.13	3.54
10 Turkey . . . . .	0.22	5.99
(e) AFRICA. . . . .	0.76	20.69
1 Egypt . . . . .	0.50	13.61
2 Eritrea . . . . .	0.14	3.81
3 Union of South Africa . . . . .	0.12	3.27
(f) AUSTRALIA . . . . .	0.17	4.63
(g) REST . . . . .	0.47	12.79
TOTAL . . . . .	42.00	1143.24

\*1942

2.2.1 A distinction has to be made between the types of salt in the solid form or in the form of concentrated solution produced in different countries, viz., brine salt, rock salt, or salt obtained by solar or artificial evaporation. The

total world production of about 42 million tons (1143.24 million mds.) is made up as follows:

	Tons (in millions)	Maunds (in millions)
(a) Brine and artificially evaporated salt . . . . .	18.18	494.86
(b) Solar salt . . . . .	9.81	267.03
(c) Rock salt . . . . .	9.51	258.86
	<hr/>	<hr/>
	37.50	1020.75
(d) Soviet production (varieties unknown) ] . . . . .	4.50	122.49
	<hr/>	<hr/>
	42.00	1143.24

It will be noticed that the production of brine and artificially evaporated salt is almost as much as the combined total rock salt and solar salt.

### 3. Uses.

3.1 The principal uses of salt can be classified broadly under three heads:

- (a) Food,
- (b) Industries, and
- (c) Agriculture.

3.2 SALT AS FOOD OR ALIMENTARY SALT.—The use of salt in the food of mankind constitutes its major demand. It is an indispensable part of both human and animal diet. Natural foodstuffs of man and of animals contain salt. It is believed that man started to use salt admixed with his food when he gave up eating raw meat and raw vegetables. Raw meat contains about 0.5 per cent. of sodium chloride, but 70 per cent. of it is lost in boiling. Similarly vegetables and cereals in which the salt content is lower than in meat also lose salt on boiling but not to the same extent as meat. The need to add salt artificially to cooked food arose in order to replace the salt washed out of the food during the process of cooking. Salt was at one time looked upon merely as a condiment to give taste to food but in recent years it has gained special notice as a medicinal aid to man, as the lack of it led to deterioration of the health of communities which could not obtain it in sufficient measure.

3.2.1. The most important function of salt is through the gastric juices which contains free sodium chloride and hydrochloric acid, the total chlorides forming about 90 per cent. of the dissolved solids in the juice. Without these juices the assimilation of food is hindered. In prolonged privation, during their sojourn to places where salt was not available, persons accustomed to cooked food have suffered intensely because of the reduced intake of sodium chloride. Slow, imperceptible starvation of salt also leads to loss of health and vitality of a community and it is as important a social obligation of Government to supply the requisite quantity of salt as a part of diet as the supply of food and other auxiliary food factors such as vitamins.

3.2.2 The serum of human blood contains about 5.5 parts per thousand by weight of sodium chloride and apart from other functions salt preserves the osmotic balance in the body fluids and keeps the body in a condition of good health. In deep hot mines, metallurgical works and in other places where workers are liable to excessive perspiration and consequent loss of salt from the body, a small quantity of salt taken with water restores the salt balance and prevents heat cramps to which they are prone. Salt also forms a useful vehicle for making up deficiency of other ingredients in human metabolism. For example, salt is iodised by inclusion of minute quantities of potassium iodide, about 0.02 per cent., to prevent certain types of goitre which are caused by thyroid gland deficiency. Similarly, salt medicated with phosphates or other ingredients is prescribed to regulate other deficiencies in the human system.

3.2.3 Salt is an important item in food processing industries, fish curing, meat packing, dairy products and fruit and vegetable canning. It is as essential to livestock as it is to human beings. In an agricultural country like India, the use of salt for livestock should occupy the next position after food for man, but unfortunately the consumption of salt by livestock is comparatively small. Salt licks are an ancient institution in certain parts of India, especially where massive rock salt can be obtained. Charitably disposed persons have made it a practice to purchase large lumps of salt and leave them on the roadside in towns and villages for cattle to lick. Salt is also added, together with other mineral matter, to the feed of cattle in all modern dairy practice. In places situated near the sea, stray cattle are seen congregating near the seashore imbibing salt with the spray which is carried landward by the breeze. The deficiency of salt in cattle feed may be partly responsible for the poor quality of Indian cattle and for the low yield of milk. For a long time to come the economy of India will be linked with the welfare of its livestock as a source of supply of milk, hides and skins. It is, therefore, imperative that salt is supplied to cattle to their fullest requirements.

#### 4. Industrial Salt

4.1-The importance of salt in industries comes only next to food. The needs of the chemical industry form a large proportion of the industrial consumption of salt particularly in the manufacture of heavy chemicals, like soda ash, caustic soda, chlorine, sodium sulphate, etc. Soda ash is required largely in the manufacture of caustic soda, glass, textiles, paper, silicates, bichromates, etc. Caustic soda is used extensively in soap making, in the rayon industry, in paper manufacture and in textile processing. Chlorine, which is obtained from salt, is used for sterilization of water; in the manufacture of synthetic resins for the plastic industry, and organic solvents for dry cleaning; in the production of bromine which is so important in the drug and dyestuff industries, chlorinated rubber, refrigerants, etc. Salt is also used in leather processing and has many other industrial uses such as the salting out of soap from saponified fats; for the glazing of pottery and ceramics; in dye baths as a fixative for dyes; and for regenerating sodium zeolite in water softening plants. It is evident that salt is directly or indirectly associated with the production of a number of articles of daily use. In recent years, it has been found that *kutch* roads can be consolidated by the addition of salt to the clay used in surfacing. This gives the road a hard surface to withstand the damage caused by heavy traffic and inclement weather. New uses are found for salt each year. For instance, a method is reported for using salt in ice to make thin ribbons of ice of an eutetic composition of 23.3 per cent. salt and 76.7 per cent. of water, with a melting point about 38°F. below that of ordinary ice. Two and half pounds of ice are claimed to have the same refrigerating effect as one pound of solid carbon-di-oxide or "dry ice". In the United States of America salt seasoning of timber is being studied and the results of tests obtained so far have been promising. Soaking green wood in an aqueous solution of common salt combined with sodium sulphate is reported to hasten the seasoning greatly and also overcomes cracking, thus yielding usable timber from many trees hitherto deemed unsuitable for structural uses.

#### 5. Agriculture

5.1 In agriculture salt is used as a fertilizer for certain classes of crops. Peas, potatoes, turnips and beet-roots improve in their quality and yield if salt is added to the manure. Salt is also found beneficial for fruit trees. Coconut palm which grows naturally in abundance on the sea coast requires manuring with salt when it is grown inland. The improvement that is noticed when salt is used as a fertilizer is also attributed to its property of releasing potash in the soil which might not be available otherwise to the plant. Thus salt forms a constituent of many fertilizers.

## CHAPTER III

### TECHNOLOGY OF SALT MANUFACTURE

#### 1. Methods of Manufacture

1.1 The different methods by which common salt can be produced are:—

- (a) by solar evaporation of either sea water, natural brine from lakes or wells, or brine obtained by lixiviation of salt earth;
- (b) by artificial evaporation of brine in open pans either by direct fire or by steam, or in vacuum evaporators;
- (c) by freezing of sea brine which results in saturated brine and separation of salt. This method of manufacture is in use in countries of North Europe having excessive cold climates;
- (d) by mining rock salt either by dry mining methods or in the form of saturated brine by injecting water through tubes sunk into the deposits of salt. From the saturated brine, salt is recovered by artificial evaporation.

1.1.1 These methods are utilised to different degrees depending upon the prevailing climatic conditions, the geographical location of the sources, and the advancement of technical knowledge and its application. In the Western Hemisphere, where prolonged dry weather is uncommon, solar evaporation of either sea water or natural brine is not so feasible and salt is produced by dry mining of salt deposits or by artificial evaporation of brine. In tropical countries on the other hand where long dry periods exist the manufacture by solar evaporation is resorted to. In the United States of America which is today the largest producer of salt in the world, the production of salt by solar evaporation constitutes less than four per cent. of its total annual production of 13.5 million tons. Notwithstanding the technical advancement in artificial methods of evaporation, manufacture by solar evaporation is still in use in California. Likewise, in some of the European countries like Spain, Italy and France where a long dry season exists on the coastal areas, salt is produced by solar evaporation of sea water. In India the entire production of about 2 million tons, with the exception of the negligible quantity of rock salt produced at the Mandi mines, is obtained by solar evaporation, as nature has endowed India with an extensive seaboard with long periods of dry weather which aid natural evaporation. In fact nature has so designed its climate for India that the manufacture of salt by solar evaporation in one or the other part of the country is possible in almost all the 12 months of the year.

#### 2. Physical Factors

2.1 The theoretical aspects which are of significance in the manufacture of salt are dealt with below. For India, the solar evaporation method is of greater importance than artificial evaporation and mining. The technology of salt manufacture depends largely on the physical laws of evaporation, solubility and crystallisation.

2.2 **EVAPORATION.**—Evaporation is the chief operation involved in the concentration of a weak brine to a stage at which it is saturated with respect to the salts dissolved in it. This evaporation can be carried out either by the heat of solar rays or by heat obtained by the burning of fuel or by both. The factors which affect evaporation are

- (a) Vapour pressure and temperature
- (b) Dissolved solids
- (c) Wind velocity and
- (d) Surface of exposure.

**2.2.1 Vapour Pressure and Temperature.**—Over every liquid there is a certain amount of its vapour, the pressure of which is known as the vapour pressure. It depends upon the temperature and it rises with temperature. When it is equal to the atmospheric pressure the liquid begins to boil and evaporates freely. The tendency of a liquid to evaporate is gauged by its vapour pressure, and the factors which increase or decrease the vapour pressure increase or decrease the evaporation of the liquid. Atmospheric air has always a certain amount of water vapour in it. At any given temperature, there is a limit beyond which air will not absorb more water vapour. When air comes into contact with an aqueous solution it takes up more water vapour till the limit for that temperature is reached. The extent of evaporation depends upon the margin of difference between this limit and the water vapour content of the air. The higher the vapour content or humidity of the surrounding air the lower will be the amount of water getting into the vapour phase and hence lesser the evaporation.

**2.2.2 Dissolved Solids.**—The presence of a salt in solution alters the vapour pressure of a liquid and when the salt does not itself exert any pressure or is not volatile, it lowers the vapour pressure of the solution. The rate of evaporation, therefore, decreases with rise in concentration of the salts in solution. Weak brine evaporates and loses its water more readily than a strong brine.

**2.2.3 Wind Velocity.**—When a breeze is blowing over brine, the layer of air in contact with the liquid surface changes constantly and more and more water evaporates to attain an equilibrium with each fresh layer of air with which it comes into contact. In other words the rate of evaporation is higher when the velocity of the wind increases, and it drops considerably when there is no breeze.

**2.2.4 Surface of Exposure.**—As evaporation takes place only from the surface, the larger the exposed surface for any given bulk of brine the greater is the rate of evaporation. A shallow layer of brine will, therefore, concentrate more rapidly than a deeper layer.

**2.2.5** To summarise, evaporation of brine increases with rise in temperature, wind velocity and surface of exposure and decreases progressively with the rise of humidity of the surrounding air and the concentration of brine.

## 2.3. SOLUBILITY.

**2.3.1 Saturated Solution.**—When soluble salt is brought into contact with a solvent, say water, it begins to dissolve and gives a homogeneous solution. As more and more salt dissolves, the capacity of the water to take up further quantities of salt goes on diminishing and a stage is reached when no further quantity would go into solution at the same temperature, no matter how long the salt is kept in contact with the solvent. Such a solution is known as *saturated solution*. The solubilities of different salts are different and there are two common ways of expressing solubility. It is either expressed as the number of parts by weight of the salt dissolved in 100 parts of the *solvent* to yield a saturated solution or in 100 parts by weight of the *solution*. For example, the saturated solution of sodium chloride at 30°C contains 36.03 parts of the salt dissolved in 100 parts of water (solvent) or 136.03 parts of the solution and the solubility is stated to be 36.03 in terms of the first definition

and  $\frac{100 \times 36.03}{136.03} = 26.48$  in terms of the second. It was not possible for us

to adopt either one or the other definition exclusively because both the systems of expression are adopted in the literature on the subject and while reproducing the data, conversion from one basis to the other would have entailed its complete reconstruction. To avoid confusion we have, therefore, stated the basis of expression in the course of this report wherever necessary.

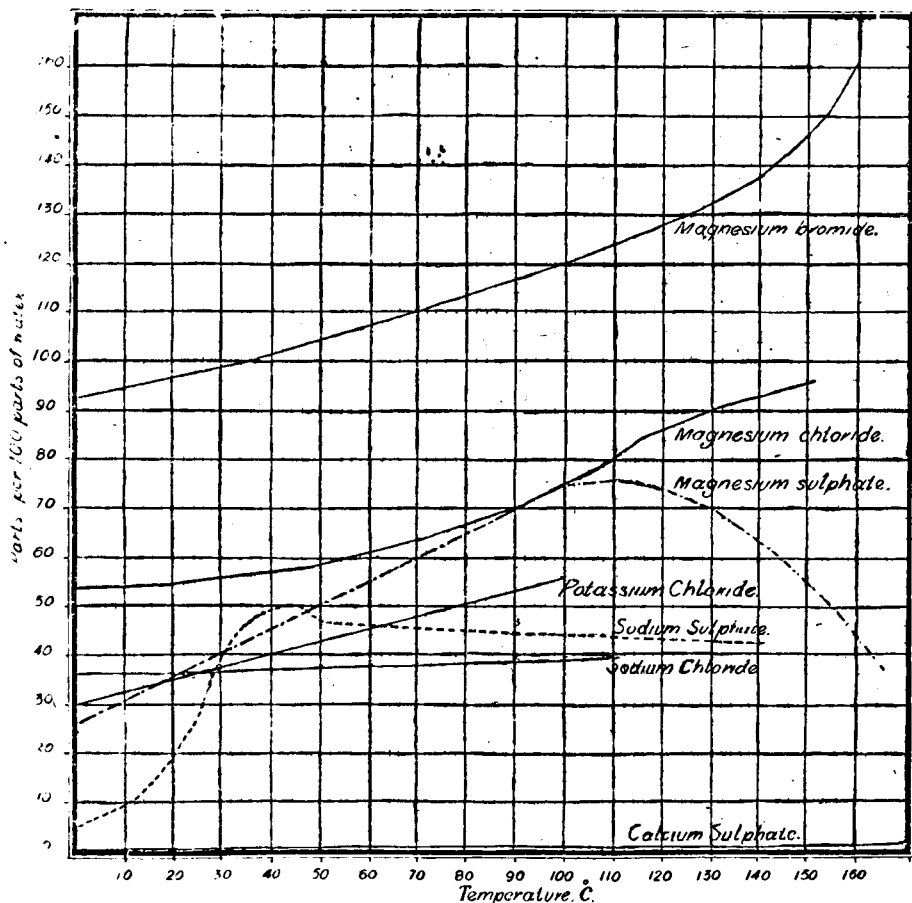
2.3.2 *Solubility and Temperature.*—As a general rule the solubility of a solid in a liquid increases with rising temperature. The rate of increase differs widely for different substances. The solubility of common salt is, however, fairly constant in water from 0°C to 100°C (32°F to 212°F), the increase in solubility for this range of temperature being of the order of only 1.5 per cent. If we examine the solubility at the temperatures which prevail in salt producing areas, which do not go below 10°C (50°F) or rise above 45°C (113°F), the range of variation is only 0.5 per cent. Table III gives the solubilities at 30°C (86°F) of the common components of brine.

TABLE III SOLUBILITY AT 30°C (80°F) OF THE COMMON COMPONENTS OF BRINE

Salts	Parts in 100 parts of water
Calcium sulphate ( $\text{CaSO}_4, 2\text{H}_2\text{O}$ ) . . . . .	0.27
Sodium chloride ( $\text{NaCl}$ ) . . . . .	36.03
Sodium carbonate ( $\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}$ ) . . . . .	105.88
Sodium sulphate ( $\text{Na}_2\text{SO}_4, 10\text{H}_2\text{O}$ ) . . . . .	92.80
Magnesium chloride ( $\text{MgCl}_2, 6\text{H}_2\text{O}$ ) . . . . .	127.93
Magnesium sulphate ( $\text{MgSO}_4, 7\text{H}_2\text{O}$ ) . . . . .	81.34
Potassium chloride ( $\text{KCl}$ ) . . . . .	37.35

The solubilities of different salts in water at different temperatures vary so much that, not infrequently, one salt which has a higher solubility than another, at any stated temperature may have a relatively lower solubility at another, higher or lower, temperature. A clear picture of this can be obtained from the graphs given in Fig. 1 which show the solubilities of the more common components of sea water at different temperatures.

**Fig. 1 Solubilities of different salts in water.**





2.3.3 *Solution of Mixtures.*—Sea water is not a solution of only one salt; though sodium chloride preponderates in sea water, other salts are also present. This is also true of other brines. It is, therefore, necessary to remember that when more than one salt is present in a solution their solubilities interfere mutually to a certain extent. The influence of any salt on the solubility of one or more other salts present in a solution can be explained only on the basis of the principles of the Phase Rule. It would perhaps be inappropriate to discuss the theoretical aspect of Phase Rule in detail in this report, but in Appendix 'B' are shown the mutual solubilities at different temperatures of certain pairs of salts which are commonly found together in salt manufacture at one stage or another.

## 2.4. CRYSTALLISATION.

2.4.1 *From a solution of a single salt.*—When a solution of a single salt is evaporated, the volume of the liquid gradually diminishes and the concentration of the dissolved salt progressively increases. This continues till the point of saturation is reached for the particular temperature after which the dissolved substance separates out of the solution or crystallises out. The separation of crystals keeps pace with the removal of water owing to evaporation, the status of saturation of the solution being maintained.

2.4.2 *From a solution of a mixture of salts.*—When more than one salt is present in a solution, the one which reaches the point of saturation earlier crystallises out earlier. Thus if a solution of two salts is evaporated, the one with a lower solubility starts separating out earlier than the one of higher solubility. It should, however, be explained that the crystallisation of one of the salts is not entirely over before the crystals of the other salt appear. This is of fundamental importance in the manufacture of common salt and has to be well understood by every manufacturer.

## 3. Control of Operations

3.1 In any manufacturing operation, the quality of production can be controlled easily if there is a ready and convenient method of measuring the degree of changes that take place. A chemical analysis for ascertaining these changes progressively would be a laborious process which cannot be used conveniently in a manufacturing operation. As is shown below, the density of salt solutions varies directly with the concentrations or in other words, the changes of concentration can be assessed from a determination of its density. The changes in density thus give a very good indication of the progress of evaporation and how the resulting solution can be expected to behave if these changes were allowed to continue.

3.2 **CHANGE IN VOLUME ON DISSOLUTION.**—When a salt is dissolved in water, the weight of the solution is always equal to the sum of the weights of the water and the dissolved salt. The resulting volume is, however, not equal to the sum of the volumes of the water and of the salt dissolved in it. As the particles of a dissolved salt distribute themselves uniformly in the water, the volume of the latter is altered only slightly. The extent of the slight variation is different with different salts. The volume of aqueous solutions of sodium chloride at different concentrations and temperatures are shown in Table IV.

TABLE IV.—VOLUMES OF AQUEOUS SOLUTIONS OF SODIUM CHLORIDE AT DIFFERENT CONCENTRATIONS AND TEMPERATURES

*(Volume at 19.5°C = 1,00000)*

Temperature Degrees Centigrade	Quantity of salt in 100 parts of water					
	4.7	10.0	15.4	20.5	26.3	31.4
10	0.99783	0.99715	0.99674	0.99644	0.99620	0.99604.
19.5	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
30	1.00327	1.00381	1.00410	1.00410	1.00435	1.00468
40	1.00710	1.00790	1.00840	1.00878	1.00910	1.00928.
50	1.00150	1.01246	1.01309	1.01353	1.01391	1.01412
60	1.01646	1.01748	1.01817	1.01860	1.01898	1.01919.
70	1.02201	1.02303	1.02364	1.02400	1.02431	1.02454
80	1.02809	1.02889	1.02945	1.02971	1.02993	1.03006
90	1.03466	1.03525	1.03560	1.03576	1.03581	1.03591
100	1.03179	1.04209	1.04217	1.04214	1.04211	1.04190

It will be noticed that the overall change in volume due to rise in temperature does not exceed 4.5 per cent. for any concentration. Since the prevailing temperatures in the salt works in India vary only between 15°C (59°F) and 45°C (113°F) the change is narrowed down to less than 1.5 per cent. We may, therefore, assume that for all practical purposes the volume and the density for any given concentration are not affected by fluctuations of temperature.

3.3 HYDROMETERS.—The density of brine is measured by different types of hydrometers, which are graduated according to certain conventions. The types commonly used in the salt industry are (a) the salimeter and (b) the Baume hydrometer.

3.3.1 In the salimeter the zero point is determined by immersion in distilled water and the other point in a saturated salt solution<sup>1</sup> at 20°C (68°F). The distance between these two points is graduated into 100 equal parts. The salimeter is not of much practical value in India where, invariably, the Baume hydrometer is in use. In mining by means of brine wells, the salimeter is preferred, because it gives a more direct reading of the salt content in the brine.

3.3.2 The Baume hydrometer was designed specially to study the changes of density of solutions of common salt at various concentrations. It is of great assistance to the salt manufacturer because it tells him how the evaporation of the brine is progressing and what changes are taking place in it. Though its graduation is based on the changes in the density of a solution of sodium chloride to the exclusion of other salts in water, it gives within limits a fair indication of the sodium chloride content of solutions which contain other salts besides sodium chloride.

3.3.2.1 It is necessary to give a brief account of the graduation on the Baume hydrometer so that the limitations of the instrument may be understood. The zero point of the hydrometer is determined by immersing it in distilled water at 15.5°C (60°F) and is fixed at the position on the instrument to which the hydrometer sinks. The other fixed point is determined by immersing the hydrometer in a solution of 15 parts of sodium chloride by weight in 85 parts by weight of water at the same temperature. This point is given the number 15 to indicate that 100 parts of the solution contain 15

parts of salt. The distance between these two fixed points is graduated into 15 equal divisions and each is called a Baume (Be') degree. The graduation is carried beyond 15°Be' mark up to 40°Be', by extrapolation. Baume hydrometer readily gives an indication of the composition of solutions of sodium chloride. A reading of 24°Be' means that the solution contains 24 parts of sodium chloride by weight dissolved in 76 parts of water; or in other words the composition of the solution is 31.6 parts by weight of sodium chloride in 100 parts by weight of water. It must be understood clearly that the readings of the Baume hydrometer are correct only with regard to the temperature of graduation *viz.* 15.5°C (60°F). As was shown in Table IV, the range of changes in density for any concentration of salt over the range of temperatures ordinarily prevalent in India is less than 1.5 per cent. The standard hydrometer is, therefore, fairly correct under Indian conditions. It would, however, be desirable to calibrate the hydrometer for use in India at a temperature which represents a fair average of the prevailing temperatures. This calibration might be carried out at a temperature to be selected in the range 27°+2°C (80°+4°F) which has been recently prescribed by the Indian Standards Institution as a standard atmospheric temperature and which corresponds more correctly to Indian conditions.

3.3.3 The salt manufacturer in actual practice has to deal with more complex solutions than the type for which the Baume hydrometer is graduated. As the effect on density of the saturated solution increases with the concentration of other salts in solution it is not correct to assume that a 20°Be' brine necessarily contains 20 parts by weight of sodium chloride in 80 parts by weight of water or in other words it is a 25 per cent. solution of sodium chloride. Its reading approximately connotes that 20 parts by weight of soluble salts are dissolved in 80 parts by weight of water or the total salt content of the solution is 25 per cent. Considering, however, that sodium chloride preponderates in all brines used in salt manufacture, the Baume hydrometer is truly the best friend of the salt manufacturer, provided that these limitations set out above are remembered in the finer calculations and conclusions. Table V below gives the specific gravity of pure solution of sodium chloride corresponding to the divisions and degrees of Baume hydrometer. To convert the hydrometer readings into specific gravity the following formula may be employed!—

$$\text{Specific gravity of brine} = \frac{145}{145-n}$$

where n=reading on Baume's hydrometer

TABLE V—DENSITY OF SODIUM CHLORIDE SOLUTIONS AT DIFFERENT TEMPERATURES.

Parts (by weight) of salt in 100 parts of solution	10°C		25°C		40°C	
	Sp. gr.	Be'	Sp. gr.	Be'	Sp. gr.	°
1	1.007	1.00	1.004	0.72	0.999	..
2	1.014	2.00	1.011	1.44	1.006	0.72
4	1.029	4.00	1.025	3.54	1.020	2.84
8	1.059	8.00	1.054	7.56	1.048	6.91
12	1.089	12.00	1.083	11.36	1.077	10.12
16	1.120	15.54	1.114	14.96	1.106	13.78
20	1.152	18.91	1.145	18.36	1.137	17.25
24	1.185	22.64	1.177	21.60	1.170	21.07
26	1.202	24.17	1.194	23.66	1.186	22.64

#### 4. Evaporation of Brines.

4.1 We shall now proceed to discuss the process of evaporation of sea and other brines with the help of solar and artificial heat.

4.2 SOLAR EVAPORATION OF SEA WATER.—Sea Water provides an unfailing material for the manufacture of salt. Other sources are subject to depletion, they vary from time to time and from place to place. Greater emphasis and importance have, therefore, to be attached to production from marine sources than from sources such as saline earths, subsoil water, swamps, and the like.

4.2.1 When Sea water is subjected to solar evaporation the concentration of the various salts contained in it increases until it reaches saturation with respect to any of them. At that stage such component starts separating out. On the sea coast, where the climate is fairly equable, and with little variations between night and day temperatures, the order of separation of salts by solar evaporation does not vary much. The variation, if any, is within narrow limits. In Table VI is shown the progressive separation of salts on solar evaporation from sea water on the Mediterranean Coast.

TABLE VI—SEPARATION OF SALTS ON PROGRESSIVE EVAPORATION OF SEA WATER  
(MEDITERRANEAN)

°Be/at 21°C	Volume on evapora- tion in litres	Quantity Separated (in grams)									Cumulative Total	
		Iron Oxide (Fe <sub>2</sub> O <sub>3</sub> )	Calcium Carbo- nate (CaCO <sub>3</sub> )	Gypsum (CaSO <sub>4</sub> · 2H <sub>2</sub> O)	Common Salt (NaCl)	Magne- sium Sulphate (MgSO <sub>4</sub> )	Magne- sium Chloride (MgCl <sub>2</sub> )	Sodium Bromide (NaBr)	Potassium Chloride (KCl)	Total separated	Separated	In Solution
3.50	1.0000	..	..	..	..	..	..	..	..	..	0.0000	38.4472
7.10	0.5330	0.0030	0.0642	..	..	..	..	..	..	0.0672	0.0672	38.3800
11.50	0.3160	..	Traces	..	..	..	..	..	..	Traces	0.0672	38.3800
14.00	0.2450	..	Traces	..	..	..	..	..	..	Traces	0.0672	38.3800
16.75	0.1900	..	0.0530	0.5600	..	..	..	..	..	0.6130	0.6802	37.7670
20.60	0.1445	..	..	0.5620	..	..	..	..	..	0.5620	1.2422	37.2050
22.00	0.1310	..	..	0.1840	..	..	..	..	..	0.1840	1.4262	37.0210
25.00	0.1120	..	..	0.1600	..	..	..	..	..	0.1600	1.5862	36.9610
26.25	0.0950	..	..	0.0508	3.2614	0.0040	0.0078	..	..	3.3240	4.9102	33.5370
27.00	0.0340	..	..	0.1476	9.6500	0.0130	0.0356	..	..	9.8462	14.7564	23.6908
28.50	0.0390	..	..	0.0700	7.8960	0.0262	0.0434	0.0728	..	8.1084	22.8648	15.7624
30.20	0.0302	..	..	0.0144	2.6240	0.0174	0.0150	0.0358	..	2.7066	25.5714	12.8758
32.40	0.0230	..	..	..	2.2720	0.0254	0.0240	0.0518	..	2.3732	27.9446	10.5026
35.00	0.0162	..	..	..	1.4040	0.5382	0.0274	0.0620	..	2.0316	29.9762	8.4709
Total separated		0.0030	0.1172	1.7488	27.1074	0.6242	0.1532	0.2224	..	29.9762		
Remainder in solu- tion in 0.0162 litres.		..	..	..	2.5885	1.8545	3.1640	0.3300	0.5339	8.4709		
Total content in one litre.		0.0030	0.1172	1.7488	29.6959	2.4787	3.3172	0.5524	0.5339	38.4471		

It will be seen from the above table that sodium chloride is not the only salt that separates out on evaporation of sea water, but it predominates in the salts that crystallise out during certain densities. In actual practice the separation of the salts does not always follow quantitatively the table owing to slight differences in chemical composition of the brine and physical factors affecting evaporation.

4.2.2 In an experiment conducted by the late Mr. Kapilram Vakil on the solar evaporation of sea water obtained from the west coast of India the following observations were recorded:

- (a) When the density of sea water has risen to 10° Be' the original volume is reduced to 37 per cent. and the salt that separates out during this concentration is mainly calcium carbonate.
- (b) On further concentration to 17° Be' the original volume of the sea water is reduced to about 20 per cent. and the remaining calcium carbonate separates out completely. Calcium sulphate in the form of gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ) begins to separate in appreciable quantity at this concentration. The crystals of gypsum float at first on the surface of the liquid as a thin grey film, but when these grow in size they settle to the bottom. By the time the brine reaches 25° Be' and is reduced to 12 per cent. of its original volume, about 84 per cent. of the gypsum present in sea water gets separated out, the balance 16 per cent. continues to crystallise out along with sodium chloride as will be seen below:

Degree Be'	Gypsum deposited (Per cent.)
3.5	
25.0	83.8
28.5	99.1
32.4	100.0

- (c) A solution of pure sodium chloride is saturated at 24° Be' when the percentage of salt in the solution is about 26.5. For every hundred parts of water evaporated from the saturated solution, about 36.5 parts of sodium chloride are thrown out. Owing, however, to the presence of other salts in the solution the saturation with respect to sodium chloride occurs at 23.5° Be' and sodium chloride begins to separate out as soon as this density is reached. The brine remains between 25° and 26° Be' for a very long time as the rise in density due to separation of the dissolved sodium chloride is not appreciable, but it begins to rise above 26° Be' when over 50 per cent. of the dissolved sodium chloride has crystallised out. As the concentration increases, more and more salt is thrown out of the solution till the brine reaches a density of 32.4° Be' by which time 86 per cent. of the sodium chloride separates out as shown in Table VII.

TABLE VII.—SEPARATION OF SODIUM CHLORIDE FROM SEA WATER

Degree Be'	Quantity in solution	Total separated	Percentage separated
3.5	29.606	Nil	Nil
23.0	29.696	Nil	Nil
28.5	8.889	20.807	70
32.4	3.993	25.704	86

(d) The volume of residual brine at 29° Be' is only about 2 per cent. of the original and if the concentration is carried further the sodium chloride which continues to separate out gets progressively contaminated with other salts as shown in Table VIII.

TABLE VIII.—COMPOSITION OF SALTS OBTAINED FROM BITTERNS OF DIFFERENT CONCENTRATIONS

Concentration		(On dry basis)					Remarks
from Be'	to Be'	NaCl	Mg Cl <sub>2</sub> (in percent)	KCl	MgSO <sub>4</sub>	Total	
29.75	31.70	92.63	4.65	..	2.72	100.00	Density drops from 36 to 35° Be'
31.70	33.80	93.14	3.54	..	3.32	100.00	
33.80	35.00	68.42	8.15	..	23.43	100.00	
35.00	36.25	38.76	7.76	0.08	53.50	100.00	
36.25	37.00	14.11	6.94	34.30	44.65	100.00	
37.00	34.75	..	8.45	29.58	61.97	100.00	
34.75	35.50	14.17	25.02	27.34	33.47	100.00	
35.50	36.00	24.25	21.24	27.88	26.63	100.00	
36.00	38.25	8.02	49.21	25.35	17.42	100.00	
38.25	39.25	12.00	31.71	12.00	44.29	100.00	
39.25	40.00	2.82	69.29	1.73	26.16	100.00	Density drops from 40 to 37.5° Be'
37.50	40.50	..	97.82	..	2.18	100.00	

4.2.3 It will be clear from the foregoing that in order to obtain common salt of as great a purity as possible by solar evaporation its manufacture should be strictly regulated so as to eliminate the other salts present in the original sea water. The importance of regulating the density of brine to a correct point for the recovery of a high grade of common salt will be easily appreciated from Tables VI and VIII. It cannot be emphasised too strongly that correct appreciation and application of the Phase Rule should govern the separation of salts from brine.

4.2.4 It may be noted that apart from common salt, the other salts present in the brine can also be recovered in separate fractions economically. Calcium sulphate or gypsum separates before common salt, while the other salts like magnesium sulphate, potassium chloride, magnesium chloride, etc. can be obtained with no great difficulty from the residual brine or mother liquor commonly known as the bitterns. After the brine has reached a density of 30° Be', the bitterns start depositing a succession of complex salts in the following order at ordinary temperatures.

(i) Magnesium sulphate (MgSO<sub>4</sub>).

(ii) Magnesium sulphate (MgSO<sub>4</sub>) and kainite (MgSO<sub>4</sub>), KCl, 3H<sub>2</sub>O)

(iii) Magnesium sulphate Hexahydrate (MgSO<sub>4</sub>, 6 H<sub>2</sub>O)

(iv) Kieserite ( $MgSO_4 \cdot H_2O$ ) and kainite.

(v) Kieserite and carnallite ( $MgCl_2 \cdot KCl \cdot 6H_2O$ ).

(vi) Kieserite, carnallite and bischofite ( $MgCl_2 \cdot 6H_2O$ ).

By simple solar evaporation it is not easy to recover these salts in a pure condition and carefully designed plants have to be employed for their recovery and refining.

#### 4.3 SOLAR EVAPORATION OF OTHER BRINES.

4.3.1 Brines may be obtained from sources other than the sea. They may occur as such in inland lakes, salt springs, backwaters and swamps or they may be obtainable from subsoil sources in shallow pits and wells or by tube wells sunk to greater depths. Sometimes brines are also produced by lixiviation of saline earths or by forcing water into pockets of rock salt. The composition of these brines is not so constant as that of sea water because it is influenced by the physical and chemical changes that are brought about owing to prolonged contact with the soil and the biochemical changes brought about by micro-organisms. The composition of the dissolved solids in the brines obtained in the inland lakes and from wells and marginal deposits is not only peculiar to each locality, but even at the same locality it varies from time to time and at different depths at the same time. The differences in composition between sea, lake and well brines at the different salt works in India is indicated in Table IX.

TABLE IX.—COMPOSITION OF INDIA SEA, LAKE AND WELL BRINES  
(On dry basis)

	Sea Brine	Lake Brine	Well Brine			
		Sambhar	Khara- ghoda	Kuda (Dhranga- dhra)	Didwana	Pach- badra
			(Per cent)			
Calcium carbonate	0.345		0.060	0.073	..	..
Calcium sulphate	3.600		2.120	1.961	..	2.970
Sodium chloride	77.758	87.300	70.800	72.342	77.190	85.660
Sodium sulphate	..	8.650	..	..	20.650	..
Sodium carbonate	..	3.870	..	..	0.600	..
Sodium bi-carbonate	..				1.560	..
Magnesium sulphate	4.737	..	2.313	2.320	..	9.440
Potassium chloride	2.465	0.129	2.000	1.250	..	..
Magnesium chloride	10.878	..	22.360	21.795	..	1.930
Magnesium bromide	0.217	0.051	0.347	0.259	..	..
	100.000	100.000	100.000	100.000	100.000	100.000

4.3.2 The evaporation of these brines is subject to the same physical principles as the evaporation of sea brine, but because of their different chemical compositions and the variations that occur in them, the technique of manufacture, though very similar to that employed in the production of sea salt, has to be adapted to local conditions. In India these brine sources are of considerable importance and will be dealt with in detail when the production of salts in different areas is described.



## 5. Artificial Evaporation of Brine.

5.1 A large quantity of salt is produced in the world by artificial evaporation of brines from different sources, using the heat obtained by the burning of fuel to effect rapid evaporation. Artificial evaporation has not been practised in India hitherto except in the primitive small scale production of salt of inferior quality in the villages in Bengal and Orissa, but during recent years there have been frequent proposals for introducing it. It is desirable that the technique and potentialities of artificial evaporation are discussed here briefly. This evaporation may be carried out either under the ordinary atmospheric pressure in open pans or under reduced pressure in vacuum pans heated either by steam or by electricity.

5.2 OPEN PAN EVAPORATION.—Except in India, the direct fire open pan evaporator is now more of historical than topical interest. It represents the first stage in the evolution of the modern evaporators and is now practically extinct, having been considered wasteful of heat consumption and labour. The consumption of fuel, in these direct fired pans using coal or wood, is estimated at  $1\frac{1}{2}$  lbs. of coal or 3 lbs. of fuel wood per pound of salt and is becoming increasingly uneconomical because of the rising prices of fuel. In the open pan system, brine is evaporated in iron kettles of 3 to 6 ft. in diameter. The kettles are heated by open fire and the salt is lifted out by means of a drain board. In subsequent improvements, pans were set over brick flues to obtain improved heat economy and the fuel used was changed from wood to coal and then to gas. In more recent years and in progressive countries the open pan method has been replaced by vacuum evaporation.

5.2.1 Two methods are in use in India which employ open pan evaporation, namely the *Punga* process and the Burma process. The *Punga* process is practised by small scale producers in Bengal and Orissa. Saline earth is scrapped from swamps and other tracts where salt comes to the surface by efflorescence. This earth is heaped together over bamboo mats and lixiviated with water and the resulting brine, which may reach a concentration of  $20^{\circ}\text{Be}$  is evaporated by boiling in earthenware pots or iron pans over open hearths in which firewood, twigs, straw, dry leaves, or whatever else is available as fuel, is burnt. No attempt is made to carry out fractional crystallisation. The moist residue is tied up in cloth and placed under ashes which absorb the mother liquor leaving behind salt of inferior quality. The colour of the salt obtained is white, and the salt is of small grain. These account for the preference which the people of Bengal have for small grain and white colour in the salt they use.

5.2.2 The Burma process is a combination of solar and artificial evaporation. The sea brine is concentrated by solar evaporation and it is then evaporated in open pans in which, it is claimed, salt of different grades and of greater purity is obtained by regulating the temperature of crystallisation. The Bengal Government secured the services of an expert from Burma to advise them about the feasibility of introducing the Burma method in Bengal and the Committee were able to inspect this process in operation at Contai, but, as is discussed at a later stage, there is little to recommend the introduction of this method in India.

5.2.3 *Grainer Pans*.—The grainer pan is the next step in the development of evaporators after the open pan. No plants adopting the grainer process are in use in India. In construction it is similar to the open pan, but it is heated by steam with pipes extending the full length of the grainer. The original grainers were made of wood and the salt was raked out manually, but wooden grainers were replaced by shallow steel pans. Mechanical scrapers are now used to remove the salt. The crystals formed are uniformly developed and the process is flexible and adaptable for producing different grades, from fine grained salt to flaky and hopper-shaped hollow crystals. In the best plants

using the grainer system one quarter pound of salt is made per pound of steam condensed; this represents a lower heat economy compared with vacuum evaporators.

**5.3 VACUUM PAN EVAPORATORS.**—The largest proportion of salt produced by artificial evaporation is obtained from vacuum evaporators. Concentrated brine of 23 to 24°Be' density is evaporated with closed steam pipes in an evaporator which is subjected to vacuum. As has been stated earlier in this chapter a liquid begins to boil when its vapour pressure is equal to the external pressure. If this external pressure is reduced, the boiling takes place at a lower temperature. These evaporators may be in single units or, the hot vapours escaping from one may be used as the source of heat in the second unit, if the pressure in the latter is lower than in the first. Further evaporation takes place in this second effect and there can be three or four such effects connected in series. With increase in the number of effects, the heat economy is improved, but, since the pressure of steam falls with each effect, the number of effects in any unit is limited by the amount of pressure drop that can be maintained between the first and the last effect. Each evaporator is a separate unit, operating under a vacuum, which increases from unit to unit. The evaporators vary in size and may be 18 to 22 ft. in diameter by 36 to 45 ft. in height. The first evaporator is fed with low pressure process steam and the water evaporated is used as the heating steam in the second effect. This process continues until the last effect. Besides economy in fuel, the vacuum evaporator yields pure salt of uniformly fine quality containing 99.5 per cent. of sodium chloride. The salt is removed from the evaporators either through a salt box or as a slurry which is either centrifuged or passed over a rotary vacuum filter to produce dry crystals. The heat economy obtained by increasing the number of effects is shown below:

No. of effects	Pounds of coal per pound of salt	Pounds of steam per pound of salt
1	0.45	4.00
2	0.22	2.00
3	0.15	1.33
4	0.11	1.00

**5.4 THERMO-COMPRESSION.**—This name is given to a new technique of vacuum evaporation. In a multiple effect evaporator, the vapours given out from the first effect are utilised for heating the subsequent effects, but these vapours can be utilised again to heat the same effect provided they are compressed to the pressure of the heating steam. Greater heat economy is obtained by this method than in a multiple effect evaporator, but the consumption of power in compressing the steam has to be considered against the saving in fuel brought about by this heat economy. The cost of fuel saved compared with the cost of power consumed is the deciding factor in the adoption of thermo-compression. It is of special advantage where cheap hydro-electric power is available and coal is comparatively costly. Thermo-compression is claimed to provide other advantages also namely; simplicity in working, maintenance of uniform boiling pressure in the evaporators and lesser attention than in multiple effect evaporators.

**5.5 FLASH EVAPORATION (ALBERGER PROCESS).**—A system of evaporation by flashing is employed in the United States of America for the production of salt by what is known as the Alberger Process. Although unpurified brine is used as the raw material, the process is so devised that it produces calcium sulphate in one part of the cycle and common salt in another. The evaporation

of the brine is carried out in a closed circuit. It is first heated to a temperature of about  $143^{\circ}\text{C}$  and then passed through a cylindrical vessel, packed with stones, called the "graveler". As the solubility of calcium sulphate is lower than that of common salt, calcium sulphate is deposited on the stones and the super-heated brine is then passed on to vapour flashers which are arranged in a series of three. The salt crystallises out in the third flasher and is taken away from it in the form of a slurry into a circular open pan where surface evaporation occurs. The slurry is then centrifuged and the brine used again in the system. The purity of salt obtained by the Alberger Process is said to be 99.95 per cent., but this process is reported to be expensive in operation and is used only when granular salt of high purity is required.

## 6. Freezing Method.

6.1 If brine is refrigerated, the ice that separates out is free from salt. Advantage is taken of the naturally prevailing low temperatures in Norway to use this principle for the production of salt from sea brine. In Japan, where there is a scarcity of salt this process was developed during the Second World War. In the latter country sea water is passed through a machine called "powder ice machine" which is cooled by ammonia refrigeration to  $-20^{\circ}$  to  $-30^{\circ}\text{C}$  when ice floats on the water and the salt is retained in the brine below. The ice is removed and the concentrated brine is evaporated artificially for the recovery of salt. This process cannot strictly be called a process for manufacture of salt as the quantity of ice produced is about 30 times the quantity of salt. Provided that there is a large demand for powdered ice for fish preservation and other like purposes, this method would provide common salt as a byproduct.

## 7. Mining.

7.1 Rock salt is extracted or won either by the dry mining method or by the brine well method which is based on injecting water through tubes into the salt bearing strata to obtain concentrated brine for subsequent artificial evaporation. The method of working is largely determined by the quality of the salt in the deposits and the depth at which it occurs. The open dry mining method is the cheapest where a deposit is on the surface, but, where it is at some depth, the brine well method is preferred. The latter method is economical, conserves the salt resources and prevents the abuses to which dry mining methods are subject. The bulk of the salt production in U.S.A. is obtained by means of brine wells and this is being increasingly followed in other countries also, largely because the salt deposits are too far below for economic dry mining operations or they are dispersed in several layers with layers of shale, mud, etc. intervening.

7.2 The removal of rock salt from the solid underground deposits by the method of brine wells makes the use of the solubility of salt in water. The water may be pumped through tubes drilled down into the salt deposit and the resulting brine allowed to flow up through a central pipe, an outer casing being sunk to the stratum of salt to seal off all natural water unless it is to be utilised for dissolving the salt from the deposits. If, however, the drill hole passes through a water bearing strata, the water is allowed to flow down into the salt layer and the brine raised to the surface by an air lift, worked with compressed air. The inlet pipe for pumping the water into the deposit and the outlet pipe for the brine are set concentrically inside the casing. As the salt from the deposits gets dissolved, the insoluble impurities are left behind in the mine and a cavity is formed in the salt strata. If a sufficient thickness of the salt layer is not left over the cavity in the form of an arch, the strata above the salt deposit, which is usually not rigid enough to support itself, might cave in. To prevent this, compressed air is pumped along with the water to form a cushion over the brine and protect the upper strata of salt from dissolution. Thus a protective arch is left at the top and an undercut

obtained giving a cylindrical cavity with as much as 300 ft. diameter in the strata of salt. A close control over the shape of the cavity formed is, therefore, necessary to prevent the failure of wells. To control the shape of the cavity, it is necessary to cut off the surface water and subsoil water from overlying strata. To obtain a proper yield from a well the shape of the cavity should be such as to ensure the greatest rate of solution. Care has also to be taken to prevent the insoluble matter left behind from blocking the flow of water or blanketing the salt surface.

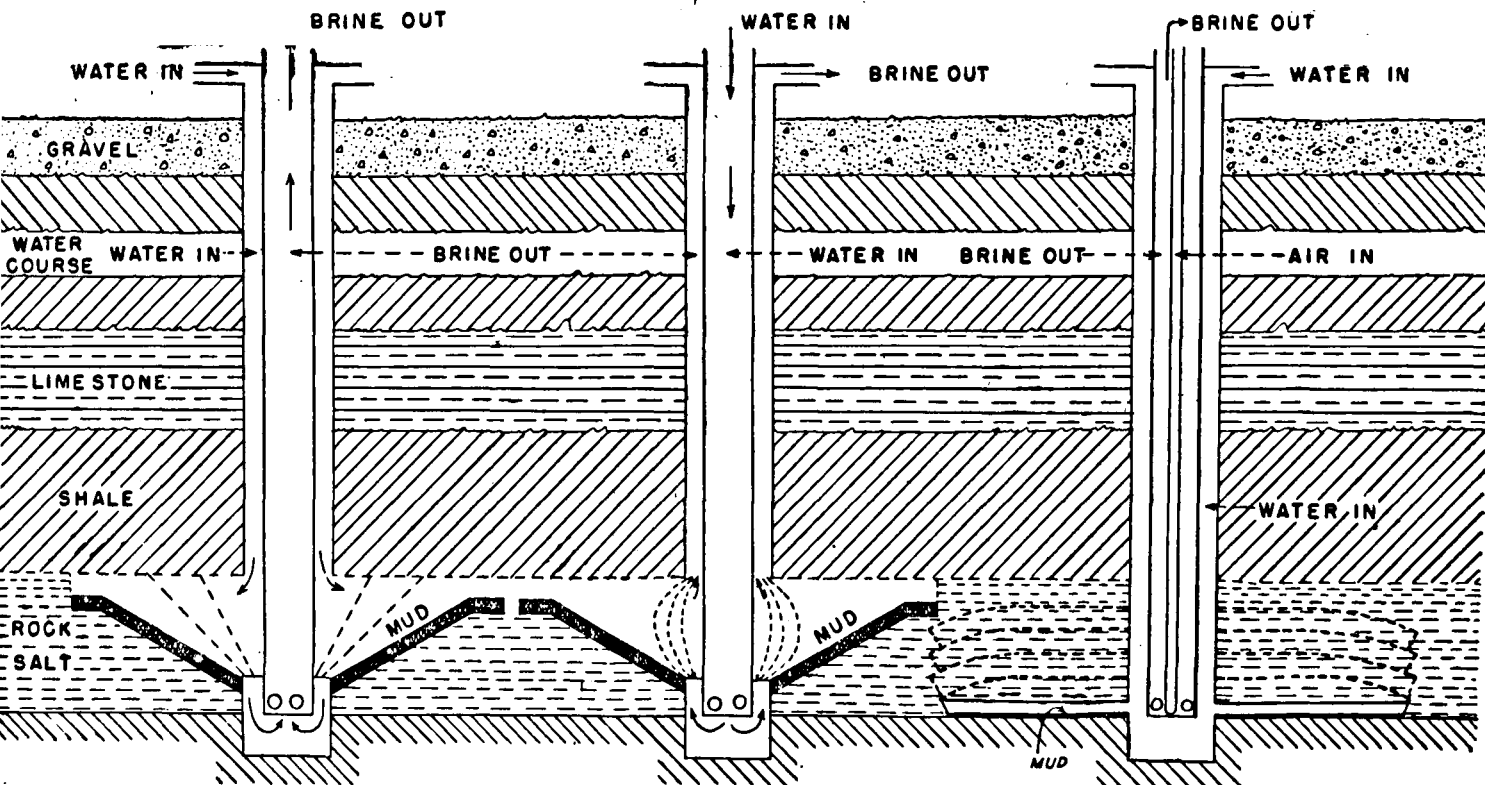
7.2.1 The brine wells vary in depth from several hundred to several thousand feet; on an average they are two thousand feet deep. Figure 2 shows three different types of brine wells in use in America. The brine obtained from the tube wells is either used directly for industrial purposes or evaporated artificially, after purification if necessary to produce high quality salt.

### 8. Summary of Recommendation.

(a) It would be desirable to calibrate the Baume hydrometer for use in India at a temperature which represents a fair average of the prevailing temperatures falling within the range  $27^{\circ} + 2^{\circ} 80^{\circ} + 4^{\circ} \text{F}$  (3.3.2.1).

Fig. 2

# SKETCH SHOWING DIFFERENT TYPE OF BRINE WELLS IN USE IN AMERICA.



NEW YORK METHOD  
USED FOR THIN SALT BEDS

DETROIT SYSTEM  
APPLICABLE TO BEDS  
OVER 150 ft. THICK.

TRUMP UNDERCUT  
METHOD, USED FOR IMPROVED  
YIELD IN SALT BEDS OF ANY  
THICKNESS.

## CHAPTER IV

### FACTORS AFFECTING PRODUCTION OF SOLAR SALT

1. Except in Maudi, where rock salt is obtained by dry mining method, salt is produced in India almost exclusively by solar evaporation. The process has been evolved over several centuries and apart from local variations in some of the details, it does not differ widely from place to place. The practices followed in India are also similar to those in other countries, but, unfortunately, the technique does not always conform to scientific principles and often goes contrary to them. The sites have also not been selected with proper regard to the economic advantages that accrue from considerations of the various factors which determine the success of a solar salt works. The principal factors to be considered are (a) initial density of brine, (b) continuity of brine supply, (c) rainfall distribution, (d) temperature, (e) relative humidity, (f) wind velocity, (g) surface of exposure, (h) impermeability of soil, and (j) security against floods and dust storms.

#### 2. Initial Density of Brine.

2.1 As mentioned in the previous chapter, sea and other brines have to be reduced in bulk by the evaporation of water till the point of saturation is reached. Sea water of 3.5° Bé has to be reduced in bulk to one tenth of its original volume before it deposits any crystals of sodium chloride; on the other hand with brine of 7° Bé the reduction in its volume will be only one-fifth whilst for brine of 17° Bé the reduction will be less than half. Other things being equal, brine of a higher concentration is, therefore a more profitable raw material.

2.2 The layout of a salt works depends upon the initial concentration of the brine. When it varies, as it might even in marine salt works owing to the flow into the sea of fresh water streams after the monsoon, or other causes such as more rapid evaporation during the hot dry months, care has to be taken to adjust the areas reserved for the concentration of brine prior to its admission before saturation into the crystalliser bed in which the salt separates out.

#### 3. Continuity of Brine Supply.

3.1 Marine salt works present no problem in the matter of supply of brine, but it is of importance in those places where the brine is taken from pits or wells or as at Sambhar Lake where the brine is obtained by the dissolution of salt by rain water. The production at Sambhar often fluctuates because of the failure of brine supply in years of scanty rainfall. At Kharaghoda some of the wells dry up whilst the supply in others diminishes as the season progresses. A hydrographic survey can however reveal the character and other details of the water table and any scarcity of brine can be avoided by supplementing it from deeper sources to ensure continuity of supply.

#### 4. Rainfall Distribution.

4.1 The occurrence of rainfall is of vital importance in the manufacture of solar salt. If it occurs during the manufacturing season, it interferes by diluting the brine and reducing evaporation. In India, there are two rainy seasons, but the extent of rainfall in the two monsoons is not equally intense in different parts of the country. Intensity varies appreciably from place to place, and even within a few miles, there may be a difference of several inches in the rainfall. Such differences are also not constant, so that the locality which has less rainfall in one year may have more in another. It is essential, therefore, that

in any salt works data of rainfall is regularly collected by installing rain gauges instead of obtaining information from the rain gauge stations situated at considerable distances. Installation of a rain gauge is both easy and cheap and the recording should not be difficult or irksome.

4.2 The location of a salt works should preferably be in an area which would give fairly long periods of fair weather which is so essential in the manufacture of salt. A heavy downpour, even if occasional, causes serious interruption and affects the production for the season. Interruption during heavy showers is largely cost by the excessive dilution of the brine in the crystallisers where the brine is of high concentration. This can be reduced if steps are taken to remove the rain water, which mostly remains at the top, as an overflow without allowing it to mix completely with concentrated brine. There is an indirect consequence of heavy rainfall, viz., spoilage of the crystallising beds which sometimes retards the output. This can, however, be rectified by proper design and preparation of the beds. Light showers are, however, no real hindrance to the manufacturing operations. When the precipitation of rains during occasional showers is small, the effect of it is rectified during the succeeding days of clear weather.

4.3 Table X gives the rainfall data for some of the important areas in which salt is or can be manufactured in India.

## 5. Temperature.

5.1 As evaporation depends upon the temperature, the average daily temperature during the entire manufacturing season determines the amount of evaporation and, in consequence, affects the output of salt. A regular recording of temperature serves to give much useful information which when taken over a number of years helps the manufacturer to ascertain what he can expect during different periods of the manufacturing season.

## 6. Relative Humidity.

6.1 The air above the brine in a salt works is not always saturated with moisture but only contains a certain percentage of the quantity required to saturate it. This percentage is known as the relative humidity. When the humidity at a place is 70, it means that the vapour pressure actually present is 70 per cent. of that required to saturate the air at the temperature then prevailing. The evaporation of water is directly proportional to the factor  $(100-x)$  where  $x$  is the relative humidity. Table XI gives the average relative humidity at different centres in India during the twelve months of the year.

TABLE X. AVERAGE MONTHLY RAINFALL

(In inches)

Month	Bengal Contai	Orissa Sumadi	Madras				Bombay		Kathiawad Mithapur	Rajasthan Sanbhar
			Naupada	Covelong	Vedaranyam	Tuticorin	Bombay	Kharaghoda		
January .	0.59	0.80	0.59	1.56	2.65	0.81	0.23	0.09	0.03	0.70
February .	0.54	Nil.	0.59	0.24	1.53	0.97	0.04	Nil	0.70	0.34
March .	0.96	Nil.	0.78	1.39	0.84	1.35	0.03	Nil	Nil	0.23
April .	1.67	Nil	0.87	0.96	3.74	2.32	0.25	0.52	Nil	0.14
May .	4.53	0.33	2.03	1.40	4.03	0.83	0.65	Nil	0.40	0.34
June .	10.82	5.29	4.50	2.12	1.12	0.40	16.82	0.74	1.16	1.36
July .	12.85	7.37	4.55	3.22	2.20	0.02	26.30	2.95	10.94	5.85
August .	17.66	8.68	5.86	4.78	1.28	0.06	15.18	4.75	4.93	6.75
September .	11.33	7.40	6.80	6.19	4.67	0.42	10.15	2.38	0.67	3.60
October .	11.72	4.93	8.26	9.94	10.36	3.84	1.78	0.81	Nil	0.18
November .	0.72	8.28	2.16	12.79	22.16	7.88	1.23	1.09	Nil	Nil
December .	0.36	9.32	0.67	7.77	9.50	4.90	0.09	Nil	0.01	0.09
TOTAL .	73.75	52.40	37.66	52.36	64.08	23.81	73.75	13.33	18.84	19.58



TABLE XI.—RELATIVE HUMIDITY  
(Average of daily means per cent.)

	January	February	March	April	May	June	July	August	September	October	November	December	Year
Bombay .	72.0	71.4	75.4	76.6	76.1	83.3	87.4	87.2	85.9	81.4	72.8	71.8	78.5
Madras .	79.2	77.7	73.1	77.7	70.2	66.1	68.1	73.2	76.7	82.7	84.1	82.1	76.3
Calcutta .	69.6	66.0	67.0	69.5	75.0	83.4	87.3	88.2	86.4	81.8	74.2	70.5	76.6
Balasure* .	75.0	72.0	70.0	72.0	73.0	80.0	83.0	85.0	81.0	81.0	74.0	73.0	77.0
Cuttack .	65.5	61.9	60.8	66.2	66.4	71.4	79.8	80.9	73.6	74.0	69.5	66.2	69.7

\* The figures for Balasure are based on observations for four years.

6.2 In the case of brine which has a vapour pressure lower than that of water at any given temperature the evaporation is not dependent upon the factor  $(10C-x)$  but upon  $(y-x)$  where  $y$  is the ratio between the vapour pressure of the solution to that of water at the same temperature expressed as a percentage. For example a saturated solution of sodium chloride which has a vapour pressure approximately equal to 80 per cent. of that of water at the same temperature ceases to evaporate further on exposure to air with a relative humidity of 80. If the relative humidity exceeds 80, not only further evaporation ceases but the solution starts absorbing moisture. This has a special bearing on salt manufacture where solutions, with progressively increasing concentration and hence of a continually decreasing vapour pressure, are being dealt with. A record of relative humidity should be maintained at salt works as it would help in determining the rate of evaporation and therefore the yield of salt per acre of works.

## 7. Wind velocity.

7.1 Wind velocity is of importance for promoting evaporation, but it must be noted that beyond a certain speed of say 3 to 4 miles per hour the quick replacement of the air above the liquid does not result in a proportional increase in evaporation. A wind of uniform velocity is more favourable than occasional spurts of high velocity winds with periods of calm air. The drier the wind the greater is its capacity to absorb moisture. In most marine salt works, there is a daily alternation between sea breeze and land breeze. The land breeze is invariably drier and where it blows for a longer spell than the sea breeze the evaporative capacity of the locality is higher and it is found to be better suited for the manufacture of salt than the place where the opposite conditions prevail. It should, however, be understood that sea breeze is not usually saturated with moisture and is, therefore, not unfavourable for salt manufacture. If a regular record of direction and velocity of wind is maintained it comes of great value to the manufacturers.

7.2 There is an indirect effect of wind which can be favourable to evaporation though it may not be always favourable to crystallisation. If the wind velocity is high, the surface of the water is thrown into ripples which may develop into waves if the depth of the brine is adequate and there is a sufficient expanse of water. These effects increase the surface of exposure and as such improve evaporation. But such waves disturb the accretion of the crystals and may cause formation of small sized crystals. When the depth of the brine in the crystallising pans is shallow and the size of the pans is small the wave effect is little but the ripples do not affect the size of the crystals.

## 8. Surface of Exposure.

8.1 Evaporation is increased substantially by allowing brine to flow over a wide area with a gentle gradient. In this manner the brine keeps turning over so that a fresh surface is exposed each time leading to a higher rate of evaporation than if it were stationary. Sometimes this effect is also produced artificially by lifting the brine to a high level and allowing it to fall in a stream but the expense involved in lifting is not compensated by adequate increase in evaporation. Another method is to throw up the brine in sprays so that the droplets which form the spray during its rise and fall may produce a larger surface of exposure and evaporation. This procedure, however, involves considerable additional cost and the results obtained so far are not encouraging.

## 9. Impermeability of Soil.

9.1 Since brine has to be concentrated by long exposure over extensive areas it is imperative that it should not be allowed to percolate through the soil, and necessary precautions should be taken to prevent such leakage. Brine increases in value as the concentration rises because of the money, time and solar energy spent on it and loss of this brine volume for volume, means a much greater loss of its salt content. The prevention of leakage becomes increasingly more important with the rise in concentration of the brine and, therefore, greater care has to be taken to prevent leakage in the crystallising beds than in the earlier stages.

9.2 The suitability of the clay depends upon the composition of the soil. The soil must be impermeable, but where it is not so it must be made impervious by artificial treatment such as a top dressing of plastic clay. Such treatment is particularly necessary in marine salt works which are laid on permeable sandy soil. The ancient and timehonoured method of preparing clay beds and tamping and consolidating them periodically, as practised in India, has stood the test of time and has proved satisfactory. When a bed is newly laid notwithstanding its top dressing and careful tamping it is apt to be permeable, but its pores get filled up by the clay which is carried down by the percolating liquid and are sealed in the course of 2 to 3 years. The composition of the brine also plays an important part in consolidating the beds. The salts dissolved in the brine react both chemically and mechanically on the clay and the sand. Some of the less soluble components such as carbonates, sulphates, etc. get deposited as slush and partly soak into the bed of sand. A certain amount of inter-locking of crystals of these salts also takes place in the inter-spaces of the sand bed and both the upward and downward seepage is thus progressively reduced.

9.3 It is not possible to prescribe an optimum chemical composition or physical texture of an ideal impermeable clay for use in the making of beds. Texture of clay is not dependent upon its chemical composition and any attempt to co-relate the two would not be fruitful. Where salt manufacture has been going on for a number of years the selection of suitable clay and its effective treatment have been developed by traditional methods which have been found to yield satisfactory results.

9.4 The quality of the soil and its character are of significance in another respect. Salt is made to crystallise out on the clay beds. These crystals are first heaped on the pathways and ridges to drain away the adhering mother liquor. The salt is then lifted to the storage platforms where again it is heaped on a clay bed. At each handling the crystals come into contact with the soil and tend to pick up impurities. It is, therefore, important that the soil at the factory site should be such that it does not impart colour to the brine or to the crystals. It is also necessary to ensure that the soil gets consolidated readily under semi wet conditions which prevail in all the factories and is not picked up by the crystals during their frequent handlings. Much

can be done by tamping the beds, the ridges and the storage platforms, but in some places the nature of the soil is such that even washing the salt does not completely remove the colour or the impurities which are picked up during crystallisation or handling.

9.5 The other danger which is equally serious and should be guarded against is the dilution of brine by upward or lateral infiltration of water or weak brine which might nullify the effect of evaporation. While dilution can be prevented if the beds are made impermeable it is the practice in some places to dig protective percolation channels to a depth of 5 to 6 feet below the bed level of the condensers and crystallising pans. This channel, which is sometimes called a "ring channel" rings off the beds from the effect of any lateral flow of sub-soil water. It affords some protection also from the rising water table, but if the upward thrust directly below the salt pans in high the ring channel does not offer adequate protection. In such cases, the impermeability of the bed is the only protection that is possible. The need for a ring channel depends upon the nature of the soil, the type of beds that have been laid, the character of lateral currents of subsoil water and the water table. No hard and fast rule can be laid down on this point, but emphasis has to be laid on the fact that percolation is a serious threat to the success of the manufacturing operations. It has to be closely watched and when noticed has to be combated.

9.6 There are other factors leading to loss of water by leakage which may also be stated briefly. Ordinary vegetation cannot thrive in brine, but there are certain weeds which grow in it and their roots are a serious threat to the non-permeability of the evaporating bed. This vegetation must be rooted out and when a new bed is laid, any vegetable matter such as roots, twigs, leaves, etc., which may be found in the soil, must be removed, as, otherwise, they would lead to leakage and prevent the formation of a suitable impermeable bed.

9.7 Crabs, worms and other forms of life which can thrive in brine upto  $46^{\circ}$  Be are also factors to be considered. Many sites have proved unsatisfactory and uneconomical because crabs and worms burrow through the bed and cause holes through which considerable loss takes place by leakage. These holes are easily detected and it is possible not only to fill them but also to bring them round in order to get the enclosed brine more highly concentrated so that in its seepage through the hole it kills the burrowing worm.

9.8 In the United States of America it has been found that the best floor for a crystalliser is a layer of salt. Where the accretion system of manufacture is in practice, the first layers of crystals of salt form an impermeable bed on which successive layers of salt are allowed to accrete. - In India, however, such beds of salt cannot be formed in places of frequent rainfall where crops of salt have to be lifted at short intervals. Even in such places, it is a matter of common knowledge that as the manufacturing season advances the bed becomes more and more leak proof due, apparently, to the interlocking of salt crystals in a magma of slush and clay.

9.9 Suggestions have been made from time to time that concrete or clay beds coated with asphalt would offer a satisfactory solution to the problem of seepage and percolation. Experiments have been made with such artificial beds but they proved unsatisfactory and were abandoned because they did not provide uninterrupted protection that was sought. Cement beds blister because of contact with brine and fissures appear in them owing to exposure to heat and cold alternately. Asphalt beds on the other hand swell out due to unequal expansion and the asphalt layer gets detached from the surface on which it is laid and develops cracks through which the brine is sucked up by the loose bed below and is lost. If ideal conditions could be attained and beds made from an asphalt of a suitable ductility and softening point they might give more satisfactory service, but this ideal has yet to be reached.

9.10 As magnesium chloride is present in large quantities in the bitterns and can be recovered in a fairly pure state, it is possible that it could be utilised by mixing it with magnesia (MgO) to form oxychloride cement beds for crystallisers. This cement has many advantages over ordinary cements; it has a strength three to five times that of Portland cement, sets much more rapidly, bonds perfectly with many materials and resists the action of salts present in brine. Magnesium oxychloride has, however, one disadvantage in that it is easily hydrolysed forming magnesium chloride which is removed when subjected to continuous action of water. Recent investigations have, however, shown that this can be completely prevented by the addition of 10 per cent. of finely divided copper to the oxychloride cement. During the period of the setting of the cement, copper is converted to "Atacamite" which acts as an additional binding material and increases the strength and resistance of the floor and at the same time prevents its erosion by water. Trials with such artificial floors are worth investigation and might be tried out in the proposed research stations dealt with in the chapter on Model Factories and Research Stations.

## 10. Security against Floods and Dust Storms.

10.1 Salt Works are generally located at a lower level than the surrounding land and during the rainy season are liable to floods. These floods are actually a blessing if they occur in moderation because they flush out during the off season the soluble impurities which are the refuse of the manufacturing operations and thus prevent a progressive deterioration of the quality of salt produced. As the intensity of rainfall varies from year to year the magnitude of floods also varies. Provided the showers are not too heavy, normal and periodical floods need not be looked upon as a source of danger, as they are easily controlled with protective embankments.

10.2 There are some places where floods are caused by cyclones, and as a cyclone comes without much warning, it is devastating in character. The rise of water in such cases is so rapid that human agency can neither guard against it nor combat it and the entire works including stocks of salt, platforms, factory buildings and installations are liable to be washed away. This is a major problem of flood control and can only be combated on a more general basis by Government. The coast of Bengal and to a lesser extent that of Orissa is notorious for these periodical ravages, and the location of salt factories in areas subject to cyclones must be settled with due regard to the possible loss to the works due to floods.

10.3 To a lesser extent, dust storms and sand storms also affect the manufacture of salt. These storms are more frequent in places of high temperature and low rainfall which factors are suited to the production of large compact heavy crystals of salt. They generally occur during the hot summer months when production is at its maximum. The fine sand and dust which blow in, sometimes without warning, contaminate the salt in all stages of production, *viz.*, in the crystalliser beds, on the ridges and on the storage platforms. It is impossible to prevent this contamination. It is difficult to wash away dust and fine sand from hollow crystals, nor is it possible to remove it by sieving or other forms of grading. Settled dust could, however, be washed from heavy, regular crystals. Unlike the damage done by cyclones and excessive floods, the loss due to dust storms can be mitigated if the production is adjusted and the process so regulated as to yield large compact solid crystals of salt so that even if they are contaminated, the damage can be rectified easily. Magnesium salts are a common impurity in salt; they are hygroscopic and absorb moisture causing the salt to sweat. In such cases the dust sticks to the salt and is difficult to remove. As the quality of salt is of importance the damage done by dust storms can be easily remedied if the technique of manufacture is adapted to produce good quality salt.

## 11. Summary of Recommendations.

- (a) Rain gauges should be installed in salt works wherever possible to maintain a regular record of rainfall. (4.1)
- (b) The crystalliser beds should be so designed as to enable the removal of rain water which mostly remains at the top of the concentrated brine, and thus reduce interruptions in manufacture during heavy showers. (4.2)
- (c) The following daily records should be maintained at the salt works :— .
- (i) maximum and minimum temperature . . . . . (5.1)
  - (ii) relative humidity . . . . . (6.2)
  - (iii) wind direction and velocity . . . . . (7.1)
- (d) The beds of crystallisers and high density condensers should be made impervious by use of plastic clay. (9.3)
- (e) Ring channels should be provided wherever required to prevent lateral infiltration of water or weak brine. (9.5)
- (f) Experiments should be conducted in the research stations on the utility of oxychloride cement as a lining for crystalliser beds. (9.10)
- (g) In areas subject to cyclones location of salt factories must be settled with adequate regard to the possible loss to the works due to floods. (10.2)
- (h) In areas subject to dust storms wastage should be reduced by regulating the process of manufacture so as to yield large compact crystals of salt. (10.3)

## CHAPTER V

### MANUFACTURE OF SALT IN INDIA

#### 1. Production

1.1 The manufacture of salt is an ancient industry in India. As far as can be gathered India was self-sufficient in salt till the beginning of the 19th century when import of salt was actively encouraged for the first time by the British rulers for the benefit of manufacturers of Liverpool and Cheshire. Salt has also been a source of revenue to all the rulers of India. The early empires, the Moghuls, the Maharathas and their successors, the British, levied various forms of taxes on salt, treating it as a monopoly article. The British collected the excise duty in a more organised and systematic manner and as it was more convenient for them to levy their taxes at places of entry of salt into India they used the excise duty as an instrument for promoting the interests of the manufacturers in England.

1.2 The economic aspects of salt manufacture and trade in salt are discussed in subsequent chapters. It is necessary to review in this chapter the present production and methods of manufacture in the country so that suggestions for improvement may be correlated with the existing conditions. The manufacture of salt in India is almost exclusively by solar evaporation and is to a large extent in the hands of small licensees or lessees of absentee proprietors. Many of them are ignorant of the correct technique of manufacture of salt and their main interest is in making quick money rather than producing good quality salt. The methods of manufacture continue to be ancient and primitive and the artisans being conservative are suspicious of new innovations. Though illiterate and left without guidance they have displayed considerable amount of ingenuity in producing salt in spite of defective layout and design of the works. The quality of salt produced is, therefore, poor in several centres of production, but in better designed works, where there is some scientific control, the quality stands comparison with the best that is produced anywhere else in the world by solar evaporation. With a change over to a more scientific technique, the quality and yield of salt can be improved immeasurably.

1.3 The principal producing centres of salt in India are (a) the *inland sources* of Rajasthan, Kharaghoda and Dhrangadhra, (b) the *marine salt works* in Bombay, Kathiawad, Kutch, Madras, Orissa and Travancore and (c) the *rock salt mines* in Mandi. In 1930-31, when the Salt Survey Committee enquired into the position of the Indian salt industry, the production was as shown in Table XII.

TABLE XII.—INDIAN PRODUCTION IN 1930-31

	(Tons)	(Maunds)
(a) Inland Works :	4,38,000	1,18,94,000
(i) Sambhar . . . . .	2,73,000	74,30,000
(ii) Didwana . . . . .	20,000	5,34,000
(iii) Pachbadra . . . . .	45,000	12,20,000
(iv) Kharaghoda . . . . .	1,00,000	27,10,000

	(Tons)	(Maunds)
(b) Marine Works :	7,70,000	2,09,54,000
(i) Bombay . . . . .	3,82,000	1,04,02,000
(ii) Kathiawad . . . . .	25,000	6,76,000
(iii) Madras } . . . . .	3,63,000	98,76,000
(iv) Orissa }		
(c) Rock Salt Mines :		
(i) Mandi . . . . .	4,000	1,22,000
Total . . . . .	12,12,000	3,29,70,000

(N.B.—No account has been taken of the production in those parts of India which now constitute Pakistan.)

In this same year the import of foreign salt at Calcutta amounted to as much as 5,84,000 tons (1,45,47,000 mds.) valued at nearly one crore of rupees. It came from Europe and the Middle East countries and was imported chiefly into Bengal where white salt of good quality has always been in demand.

1.4 Since then the industry has made considerable progress and new salt works have come into existence in Kathiawad, Kutch and Travancore. In Kathiawad the first of the many salt works to be established was at Mithapur (Okhamandal) by the late Mr. Kapilram H. Vakil whose pioneering work led to the establishment of a large number of new works in this area. As the salt manufacture in Kathiawad by purely solar evaporation method began to be accepted in Calcutta market the nascent industry in Kathiawad came up against the powerful importing interests and would have gone under were it not for the tariff protection that it began to receive in 1931 from the Government of India. This protection continued until 1939 but the Indian industry fully established itself only in the second World War when imports of foreign salt were considerably curtailed for lack of shipping. The War also forced home the important lesson of self-sufficiency in the supply of an essential commodity like salt.

1.5 The progress made by the Indian industry since 1930-31 will be seen from the figures of production for the calendar year 1948 when it reached the maximum of 23.3 lakh tons (634.8 lakh mds.) which is the highest on record. Table XIII shows the production for that year.

TABLE XIII.—INDIAN PRODUCTION IN 1948

	(Tons)	(Maunds)
(a) Inland Works :	6,27,000	1,70,80,000
(i) Sambhar . . . . .	3,16,000	86,15,000
(ii) Didwana . . . . .	47,000	12,90,000
(iii) Pachbadra . . . . .	70,000	19,05,000
(iv) Kharaghoda . . . . .	1,36,000	36,91,000
(v) Dhrangadhra . . . . .	58,000	15,79,000

	(Tons)	(Maunds)
<b>(b) Marine Works :</b>	<b>17,00,000</b>	<b>4,62,86,000</b>
(i) Bengal (West) . . . . .	1,000	32,000
(ii) Bombay . . . . .	4,50,000	1,22,45,000
(iii) Kathiawad . . . . .	2,93,000	79,87,000
(iv) Kutch . . . . .	65,000	17,57,000
(v) Madras . . . . .	8,10,000	2,20,56,000
(vi) Orissa . . . . .	20,000	5,45,000
(vii) Travancore . . . . .	61,000	16,64,000
	<hr/>	<hr/>
<b>(c) Rock Salt Mines :</b>		
(i) Mandi . . . . .	4,000	1,14,000
	<hr/>	<hr/>
<b>Total . . . . .</b>	<b>23,31,000</b>	<b>6,34,80,000</b>
	<hr/>	<hr/>

The quantity of foreign salt imported into India during this same period was 2,98,000 tons (81,12,000 mds.) which gave the total consumption of the country at 26,29,000 tons (7,15,92,000 mds.).

1.6 In our first Interim Report we had recommended an immediate increase of 10 per cent in the production at all the salt works in the country to reduce the deficit to less than half. After visiting the salt works throughout the country, we have come reluctantly to the conclusion that a mere increase in production at all the works will not yield the desired results, largely because the quality of salt produced in Bombay, Madras and Travancore is unacceptable to the Bengal market. In recent months, the Tuticórin salt manufacturers are reported to have made some efforts to improve their quality and if they maintain this improvement in quality they could reduce the deficit to some extent. It is also possible for the works in Bombay to do likewise. The immediate possibility of increase in production of good salt, therefore, rests largely with Kathiawad and Kutch where, favourable conditions and facilities exist for the manufacture of solar salt. Our visit to this region has convinced us beyond doubt of its potentiality to make the country self-sufficient within a short period.

## 2. Sources of Brine

2.1 According to the source of brine employed, the salt works in India have been classified as

- (a) Inland using
  - (i) subsoil brine and
  - (ii) lake brine
- (b) Marine

In the marine salt works the brine is obtained from the sea whilst in inland works it is either obtained from salt lakes or tapped from sub-soil sources by means of shallow wells or deep tube wells, pits and percolation canals. Another source of brine is by the ancient method of lixiviating the saline earths. The above classification of the works is somewhat loose because in several places marine salt works use sub-soil brine also, whilst at Sambhar the lake brine is augmented by supplies from percolation canals which tap the subsoil sources.



2.2 The brine for the marine salt works being obtained from the sea, its initial density is of the order of  $3^{\circ} \text{Be}$  though it varies slightly from place to place. The relative composition of the dissolved solids in the sea brine is, however, uniform and the quality of the salt produced in marine works should not, therefore, vary much provided the lay-out is based on scientific lines and the operations are controlled properly. Unfortunately the quality of marine salt produced in India varies from centre to centre owing to ill-conceived layout and unregulated methods of manufacture.

2.3 The subsoil brine is tapped at depths which vary from place to place as also in the same place during different parts of the manufacturing season. The saline stratum which gets lixiviated by the percolating rain water varies in composition from place to place and depth to depth. The extent of lixiviation depends upon the porosity of the soil and the downward flow of this percolating water. As a consequence of these two factors the concentration of the subsoil brine varies from  $2.5^{\circ}$  to  $19^{\circ} \text{Be}$ . Its composition also varies as shown in Table IX.

2.3.1 Usually the subsoil brine is lifted from wells or pits with manual labour, but draught animals are also employed. In Travancore it is also obtained from tube-wells which vary from 60 to 180 ft. in depth. Tube-wells are a valuable source of concentrated brine, but without a hydrographical survey to determine the quality and the quantity of brine that may be expected at different strata, their utility is limited. The density of tube well brine in Travancore is reported to vary with the depth which may be due to a number of causes which have not yet been determined. Whether this is due to the variation in concentration of subterranean pockets of brine or to the greater dilution by percolating water of the top layers of subsoil brine is at present a matter of conjecture. In places where high rainfall occurs and sea brine is subject to dilution, the tube-well method of tapping subterranean brine is worth investigation. But the wells should be sunk with proper regard to the quality and quantity of the brine available and its rest level in the tube-well.

2.3.2 The salt obtained from subsoil brines is apt to vary in quality owing to the variations in their composition, and though adjustments are necessary in the method of manufacture to correspond to these fluctuations, such adjustments are not made in any of the works in India. Such little regard is paid to the relative composition of the dissolved solids in these subsoil brines that data regarding their composition are not known or maintained at many of the salt works.

2.4 The only substantial source of lake brine for salt manufacture is at Sambhar Lake in the Rajasthan Union. This brine has been in use for several centuries and the reserves are apparently enormous. The brine results from the dissolution of efflorescent salt and lixiviation of the superficial salt stratum of the lake bed during the rains. Whilst a major portion of the production of salt at Sambhar depends upon the lake brine, some subsoil brine obtained from percolation canals is used as an auxiliary to the lake brine.

### 3. Reservoirs

3.1 The brine obtained from different sources is either fed directly into condensers or, more often, especially when sea brine is used, it is let in by sluice gates at high tides through creeks into low level reservoirs, or small lagoons which serve as a storage of brine. The reservoir should be of a fairly large capacity and capable of holding, if not the whole season's requirement, at least a substantial part of it. Natural depressions near the sea coast are often utilised as reservoirs and an arm of an estuary or a silted basin can be banked off and isolated to form a reservoir; but where they are constructed artificially, their

alignment and protection are carried out with due regard to the contours of the land. As it is seldom possible to locate the reservoir at a level higher than the rest of the factory, brine has often to be pumped up to a high level storage from where it flows by gravity through long winding channels into condensers. The cost of lifting brine is, however, an important item in the manufacturing cost of salt and should not be overlooked.

3.1.1 The reservoirs are an indispensable feature of marine salt works, but they are not considered necessary in the case of pit or well brine which is generally free from suspended impurities and which is also of a higher concentration. They also serve a useful purpose in some inland salt works as at Sambhar Lake. A certain amount of evaporation inevitably takes place in the reservoirs and the concentration of the brine rises but their main function is to store enough brine between high tides. They help also to bring about a sedimentation of the suspended impurities in the brine. Unfortunately the reservoirs are frequently used also as an outlet of the outgoing bitterns with the result that the waste effluent of the salt works is allowed directly to contaminate the incoming raw material resulting in a progressive deterioration of the quantity of salt produced at these works. This is an undesirable practice which cannot be too strongly condemned; the reservoirs should be protected from contamination by bitterns.

#### 4. Condensers

4.1 Condensers are an integral part of all solar salt works. They are intended to serve two purposes, namely, the raising of the concentration of brine and the precipitation and sedimentation of impurities. In many of the salt works in India both these functions are served indifferently at present. The undissolved impurities consist of mud and organic matter in suspension; as the brine is allowed to settle, these separate out in the form of slime which forms a slush with the small quantities of calcium carbonate which also gets precipitated at the early stages of evaporation. When the concentration is allowed to go high enough to permit crystallisation of gypsum, this useful material also goes into the slush and is rendered irrecoverable. Sea and lake brines contain considerable quantities of algal matter which separates out as the concentration increases. The extent of removal of suspended impurities can be judged by visual examination; a properly settled brine should be clean and transparent. The rise in concentration takes place only as a result of evaporation and the extent of evaporation is largely determined by the areas and the course the brine takes in its passage from one condenser to another. The size of the individual condensers varies from works to works and is immaterial, provided that the total condensing area is adequate for raising the concentration of the brine to 22° Be'. The earlier stages of concentration 14° Be' may be carried out anywhere, *i.e.*, either in the reservoirs or condensers, because the materials separating out upto this stage are not of any economic value and are not recoverable; the layout and preparation of the later series of condensers in which the brine is raised from 14° to 22° Be' are important and require special attention. In several marine salt works, particularly in the Madras area, there is one condenser to one crystalliser and the size of the two is the same. In this area the condensers and the crystallisers are both known as pans; the condenser is sometimes called the *male pan* and the crystalliser the *female pan* and the density of the brine led into the crystalliser seldom exceeds 14° Be'. In the Bombay Presidency, the brine on reaching 5° Be' in the reservoirs is led into condensers called *tapavanis* where it is further concentrated till it reaches 10° to 12° Be', when it is led into the crystallisers. In Kathiawad where greater attention has been paid to the relative area of condensers and crystallisers, the concentration of the brine is progressively carried out in a series of condensers and it is allowed to flow into the crystallisers only when the density exceeds 20° Be'.

4.2 The condensers ought to be so planned that the brine in the last condenser should leave it at about  $22^{\circ}\text{Be}'$ ; for sea brine it means an evaporation of 9/10th of its water content. In actual practice in works other than those in Kathiawad the condenser area is seldom more than the crystalliser area and frequently is even less. This means that impurities which should be removed in the condensers find their way into the crystallisers where they separate out along with the salt and contaminate it. There is sometimes a mistaken notion that the yield depends only upon the crystalliser area and the allocation of adequate space for condensers is considered unnecessary and wasteful. It is, however, not appreciated that salt will not separate out unless the required evaporation is affected. The preliminary concentration upto  $22^{\circ}\text{Be}'$  should be carried out in the condensers before the brine is let into the crystallisers so that calcium sulphate may crystallise out in the condensers as much as possible. This would not only lead to greater purity of the product but, with properly designed condensers, the gypsum which separates out largely between  $14^{\circ}$  and  $23^{\circ}\text{Be}'$  could be collected as a profitable byproduct. A proper layout of the salt works demands that the relative areas for condensers cum reservoirs and crystallisers should be fixed with due regard to the density of the initial brine used.

## 5. Crystallisers

5.1 The area of the condenser determines the area of the crystallisers. As the sea water is reduced to one-tenth of its volume during concentration from  $3^{\circ}$  to  $24^{\circ}\text{Be}'$ , and assuming that there is no loss of brine by percolation the area of the crystalliser should be normally only one-tenth of the area under reservoir and condensers. However, as the rate of evaporation falls appreciably with increase in density it is necessary to provide for more than one-tenth of the reservoir cum condenser area for the crystallisers. We have discussed this at length in the chapter on model factories and research stations. In very few factories in India is the proper ratio maintained. An unnecessarily large crystallising area is provided under a mistaken notion that the output of salt depends upon its area, with the result that low density brine is taken into crystallisers, leading to formation of salt, largely contaminated with gypsum. As the crystallisers need special attention both in their layout and maintenance, the cost of laying out the works and their maintenance become high when this area is made unnecessarily large.

5.2 The crystallisers are lined with a prepared bed of clay which is consolidated by puddling and tamping. This operation is well understood in India. The clay is first loosened and brine is let into it till it forms a soft mud. It is puddled by treading till it is so dry that the foot ceases to make an impression on it. It is then allowed to dry and harden but when it shows signs of cracking, fresh brine is let in and the bed again puddled till it is firm when it is allowed to dry and harden. It is then tamped with wooden rams or mallets, sand being sprinkled, if necessary, to prevent the clay from sticking to the ram. Crystalliser beds are given this treatment at the commencement of each season, but sometimes if the surface gets pitted or broken with rainfall, it becomes necessary to repair the beds in the course of the season. If the bed is not properly levelled it leads to difficulties in the collection of salt and its effect on the appearance of the salt collected is easily noticed. The beds, therefore, require a fair amount of attention.

5.3 The crystallisers should be situated at a level lower than the condensers to allow a natural flow of brine into them. The crystallisers are best located together to facilitate easy collection and storage of salt. The location of the crystallisers with respect to the direction of the land winds is also an important factor. Winds that blow over an expanse of water become humid and do not aid evaporation of the denser brine in the crystallisers. On the other hand, if

the wind blows directly from the land a good deal of dust might be carried into the crystallisers contaminating the salt. It is, therefore, advisable to have a small area of condensers intercepting the land breeze before it reaches the crystallisers.

5.4 The size of the individual crystallisers is of great importance as the salt deposited in it is collected with manual labour. The optimum size depends upon the ease with which the crop is harvested from the pathways without the labourers having to step into the beds or walk through them. Apart from the discomfort to the men of having to work in concentrated mother liquor in the crystallisers, frequent treading loosens the bed and renders it pervious. The loose clay also tends to find its way into the crystals and makes the salt dirty. In places where showers are likely to fall during the manufacturing season, and the crop of salt is not allowed to accumulate or accrete, but is raised as soon as each charge of brine deposits it, the size of the crystalliser is small. In many of the marine salt works in Bombay and Madras provinces the size is generally about 20 feet square or one cent. i.e. one hundredth of an acre. In places of low rainfall where the crop is not raised after each charging, and the crust is allowed to grow in thickness, the size of the crystalliser is much larger, running into half an acre in some works or several acres in Sambhar.

5.4.1 There is one other aspect which has a bearing on the optimum dimensions of the crystallisers. At present in most of the works in India the mother liquor in the crystalliser is not drained away before the crop is raised. It is desirable that the mother liquor should be removed before the crop is harvested as otherwise the soluble impurities in it get deposited on the salt on drying. To do this there should be a gentle gradient in the crystalliser bed so that puddles of mother liquor are not left behind. Both these considerations point to the need for small size crystallisers. The chief objection to making small pans is that pathways and partitions have to be provided to give access to them and they are expensive to make and maintain and also take up much space. This can be obviated to a certain extent if the crystallisers are made long and narrow. The width may be fixed at 35 feet to 40 feet so that all parts of the pan can be reached with the help of wooden scrapers from the partitions. A satisfactory gradient can also be given breadth-wise without introducing a big difference in the bed levels and the bitterns can be discharged into channels running along the length of the crystallisers. If this is done the length of the crystallisers may not matter and can be determined solely by local convenience.

5.5 The partitions around the crystallisers have also to be prepared with care. They are used both as a pathway and as ground for heaping the salt, after it is scraped from the pans, with a view to draining off the adherent mother liquor as far as possible, before removing the salt to the drying ground and storage. It is, therefore, essential that these partitions should be firm and set well above the brine level so that they do not give way and the salt heaped on them does not pick up soil as an impurity. The width of the pathways varies with the size of the crystallisers; usually it is 3 to 6 feet in width and about 6 to 12 inches above the bed level. In most of the salt works these partitions were found to be both narrow and low and they were not given a proper slope to the bed level of the pans. This slope is important for all pans and more so when they are large in size when it should be properly constructed and pitched and given a correct angle of repose so that the wave action of the brine does not continually wash away the edges and damage the partitions.

## 6. Channels

6.1 Brine is fed either by gravity or by pumping through channels to the reservoirs and from reservoirs to the condensers and thence to the crystallisers.

The bitters left in the crystallisers are led out through bittern channels. Where the lie of the land and the layout permit, brine channels, besides serving as conduits for the brine, help also to raise its concentration. Mud on the sides of the channels is frequently washed away by erosion, causing the channels to get silted, the flow to be impeded and the brine to become muddy. Like the condensers and crystallisers the channels are also liable to leak and the loss by leakage, especially of the concentrated brine, must be prevented. It is, therefore, desirable that channels which convey concentrated brine should be short and stone pitched or lined with impermeable clay to reduce leakage and cost of maintenance. Sometimes, however, long channels are necessary for the layout of the works to conform to the contours of the land and to save expenditure on unnecessary levelling and earth work. In an ideal layout in which the condensers and the crystallisers are laid contiguously, there should be little need for lengthy channels, the brine being led directly from a low density condenser to a condenser of the next higher density till it approaches  $22^{\circ}\text{Be}$  when it could be charged through short channels into the crystallisers.

6.2 Bittern channels are meant to remove the mother liquor, but their position in most of the salt works is very unsatisfactory because they run generally very close to the feeding channels of the crystallisers. Since the condensers and crystallisers are usually arranged in all kinds of juxtaposition the bitters from these channels tend to find their way by leakage or seepage into the condensers or the crystallisers, thus spoiling the quality of the salt. It has also to be recorded that in many of the salt works, the bittern channels are not put to proper use. The bitters are often thrown into them and allowed to stagnate because there is no proper outlet for draining them. At places, the same channel is being used alternatively for the letting in of the condensed brine and the letting out of the bitters, with the result that the other salts present in the bitters soak into the channel beds and are picked up by the incoming brine, thus getting back into circulation. This practice must be stopped if the quality of salt in India is to improve.

## 7. Removal of Bitters

7.1 As sodium chloride crystals begin to separate out, the composition of the brine alters and it becomes richer in other salts which are more soluble than sodium chloride and which separate out only at higher densities. The general belief in the Indian salt works is that salt can be allowed to separate out till the brine reaches  $30^{\circ}\text{Be}$ . This belief is derived from the rule laid down in Government salt manuals, which requires that the density of the brine should not exceed  $30^{\circ}\text{Be}$ . This has become a convention and considerable importance is attached to it. This rule was apparently fixed as an outside permissible limit of concentration. We consider it too high as it reduces the purity of salt. It is often stated that until the brine has reached a concentration of  $30^{\circ}\text{Be}$  much of the salt does not get deposited. It is even advocated, that in the early part of the manufacturing season when the evaporation is slow, the bitters should be allowed to mix with the brine to raise its density and to "hasten" the separation of salt. The bringing in extraneous impurities into the crystallisers, merely with a view to raising artificially the concentration of the brine and thus "promoting" the production of salt is utterly indefensible.

7.1.1 In places where a crop is raised after each charging, a further permissible rule was introduced in the salt manuals directing that the bitters must be discharged from the crystallisers, after a collection of 3 to 5 crops of salt. Even this direction is not followed and in several places the bitters are never discharged at all. It is difficult to understand why such a measure should ever have been permitted, as it has gone a long way to lower the quality of the salt produced in the salt works. Bitters undoubtedly contain some common salt

but it is not understood by the manufacturers that the common salt contained in the bitterns will not separate out at 30° Be. with succeeding crops, no matter how often the bitterns are subjected to evaporation after replenishing with fresh brine. With the removal of salt after each harvesting the accumulating bitterns become increasingly more concentrated, with regard to other salts and are, therefore, a progressively increasing source of contamination. Moreover, by allowing the mother liquor to remain in the crystallisers, the volume of fresh brine which can be conveniently let into the crystallisers, during the second and successive charges, is reduced. Not only is the sodium chloride content progressively lowered, but the output of salt also suffers. We recommend that this practice be given up if the quality and the yield of salt are to show an improvement.

7.2 In America and in other parts of the world, the bitterns are utilised for the recovery of the byproducts. In India, except at Mithapur, Kharaghoda and Dhrangadhra no recovery of the byproducts has been attempted and large quantities of useful salts like magnesium sulphate, potassium chloride, sodium sulphate, calcium sulphate, magnesium chloride are consequently running to waste. A substantial portion of these salts goes back to the sea, but in some places (and in India these places are many) where there is no adequate removal of the bitterns, these salts soak into the crystallising pans and progressively lower the quality of the common salt manufactured.

7.3 On a purely theoretical consideration for the production in 1948 of 23.3 lakh tons (634.8 lakh mds.) of common salt, the corresponding quantities of byproducts that could have been recovered are given in Table XIV.

TABLE XIV.—CALCULATED RECOVERY OF BYPRODUCTS (1948)

(In tons)

	Common Salt	Byproducts						
		CaSO <sub>4</sub>	MgSO <sub>4</sub>	Na <sub>2</sub> SO <sub>4</sub>	KCl	MgCl <sub>2</sub>	Na <sub>2</sub> CO <sub>3</sub>	Bromine
Marine salt works	17,00,439	95,593	1,48,076	..	76,849	3,39,804	..	5,755
Kharaghoda & Dhrangadhra	1,93,606	6,757	9,024	..	7,812	87,399	..	1,180
Sambhar	3,16,495	..	..	44,799	668	..	20,043	229
Didwana	47,391	..	..	18,076	..	..	8,588	..
Pachbadra	69,985	2,938	11,018	..	..	2,253	..	..
Total	23,27,916	1,05,288	1,68,118	62,875	85,329	4,29,456	28,631	7,164

The above figures have been calculated on the composition of the different brines used in different centres of manufacture and on the assumption that 70 per cent. of the common salt, 85 per cent. of the gypsum and 100 per cent. of the other salts are available for recovery. In practice, however, the quantity that can be recovered will be of a lower order depending on the methods of recovery adopted and their efficiencies.

## 8. System of Irrigation

**8.1 SINGLE IRRIGATION SYSTEM.**—The charging of brine into the crystallisers is spoken of as irrigation. In marine salt works where there is a threat of interruption by showers of rain, in the midst of the manufacturing season, the crystallisers are charged with brine to a shallow depth of  $1\frac{1}{2}$  to  $2\frac{1}{2}$  inches and the crop of salt is scraped periodically once or twice a week, when the density rises to  $30^{\circ}\text{Be}'$ . This method of manufacture is known as the single irrigation system. After the crop is harvested, the bitterns are allowed to remain in the crystallisers into which more condensed brine is let in to raise the density of brine and force a quicker deposition of salt in the second and subsequent chargings. There is an erroneous impression that common salt present in the mother liquor is deposited in the succeeding crops. This is against the physical laws of solubility. Provided the second scraping is done also at  $30^{\circ}\text{Be}'$  the mother liquor of the previous crop has absolutely no chance of depositing crystals of common salt in the succeeding crop. On the other hand the mother liquor, because of its high density, artificially boosts up the density of the second charge so that the density of  $30^{\circ}\text{Be}'$  is reached in succeeding evaporations progressively earlier than the previous one with the result that instead of more, less and less of sodium chloride gets deposited in each succeeding crop. There is another drawback which deserves mention. When the crystals of salt are scraped out they carry with them a certain amount of the mother liquor; at  $30^{\circ}\text{Be}'$  this is rich in magnesium salts and adds to the impurities in the common salt.

**8.2** As has been stated previously, occasional small showers are no hindrance to evaporation. As long as the weather is clear, it should be possible to leave the salt in the bed after the bitterns have been drained away and charge the beds with fresh concentrated brine so that the layer of salt may grow as a result of successive deposition. The Indian manufacturers in different areas are, however, so scared of rain that they cannot see the advantages of allowing this accretion from successive charges. The Committee would draw the attention of the salt manufacturers to this method of manufacture. Except when interruption through rainfall is imminent they should allow the crust to grow so that the scraping operations are simplified. Some manufacturers also persist in the method of quick and frequent scraping because they can thus obtain light and flaky salt. This is an objectionable practice which has to be stopped in any case. As the crystalliser beds have to be prepared with care and tamped frequently because of the damage they suffer during scraping, it follows that if the number of scrapings is reduced, the cost of maintaining the crystallisers would also be reduced besides giving a cleaner crop of crystals.

**8.3 MULTIPLE IRRIGATION OR ACCRETION SYSTEM.**—In some places in India concentrated brine is charged into the crystallisers and periodically replenished to make up for the evaporation and to allow the crust of salt to grow into a layer varying in thickness from 3 to 9 inches. Care is taken that at no stage the concentration of the brine in the bed rises above a stipulated maximum density, which is generally below  $30^{\circ}\text{Be}'$ . This is known as the multiple irrigation system. In this system brine is charged to a greater depth than in the single irrigation system and the crystals of salt are well-developed and compact, yielding the heavy type of salt. In this manner, 2 to 4 crops of salt are raised from the crystallisers in the course of manufacturing season depending on the length of the season and other local conditions. In the inland salt works at Sambhar and Kharaghoda, the crust is allowed to grow till towards the end of the season when the crop from all the crystallisers is lifted in one continuous operation during a period of about three months. The multiple irrigation system is also known as the accretion system. Sometimes these two terms are used as if they can note two different operations which in essence are identical, the difference, if any, being one of minor detail and of local practice and not of principle.

8.3.1. In the multiple irrigation system as followed in India, the mother liquor is not drained out at each charging, with the result that the content of salts other than common salt continues to rise in the bitterns and the succeeding crops of common salt separate out with more of the other salts present in the brine. If the bitterns were drained more frequently all successive crops of salt that separates out would be of uniform purity because they would crystallise from a solution of uniform composition.

8.3.2 The multiple irrigation system is undoubtedly more economical than the single irrigation system and the salt obtained is cleaner. In the latter system at each crop, a certain amount of mud from the bed remains attached to the salt which is difficult to remove. Frequent scrapings also add to the cost of lifting. The cost of maintenance also rises because the bed of the crystallisers is disturbed by frequent scrapings requiring greater attention.

## 9. Varieties of Salt

9.1 There is a great deal of variety in the physical characteristics of the solar salt produced in India. In the marine salt works of Bombay and Madras the single irrigation system is in vogue and two varieties of salt are produced; one called "heavy" and the other "light". In Bombay the heavy grade of salt is known as *vajni* and the light grades as *mapi* and *kuppa*. In the salt works at Kathiawad and Kutch where the multiple irrigation or accretion system is employed, only the heavy type of salt with well formed crystals of uniformly good quality, known as *Kurkutch* is produced. Likewise in the inland salt works of Kharaghoda and Dhrangadhra, the variety produced is also of the heavy type and known as *baragara* meaning 'big lump'. This variety is produced by periodical raking and spreading out of the crystals which are thus helped to grow uniformly on all sides. At Sambhar three varieties of salt are produced of which two *viz.*, *kjar*, and *pan* are heavy and the third, *reshta* is light and flaky. *Reshta* is produced by wind action on the brine. Crystals of salt that get formed on the surface of the brine are blown by the wind towards the sides of the pans where they collect in tiny light crystals.

9.2 The light variety of salt is produced in two or three grades in Bombay, Madras and Travancore. Tuticorin particularly excels in producing this variety. The formation of light variety of salt is aided by charging the crystalliser with weak brine of 10° to 12° Be' to shallow depths and collecting the crop frequently before the salt grows into compact dense crystals. As calcium sulphate present in the brine does not separate out in the condensers, it deposits along with the salt and helps in the formation of light hollow crystals. The salt is scraped in thin layers and contains a large percentage of magnesium and calcium salts and an appreciable amount of insoluble impurities. There is an erroneous impression that the single irrigation system of manufacture yields only the light variety of salt and for producing the heavier variety, multiple irrigation is necessary. This is not so. It is possible to produce the heavy variety by the single irrigation system by having a proper layout which enables the removal of gypsum from the brine before it is fed into the crystallisers.

9.2.1 The *mapi* salt of Bombay is similar to the light variety produced in Madras and Travancore. The *kuppa* variety is however different and is obtained by an ingenious method. Strings of coir are stretched across the crystallising beds just touching the surface of the brine. The evaporating surface is thus subdivided into small sections so that the breeze does not create a strong wave action on the brine. Thin flakes of salt, which are formed on this calm surface, float on the top at first till by the increase of their weight, they slowly sink to the bottom of the crystallisers. Because of their flaky form, crystals of *kuppa* salt do not pick up mud from the crystalliser floor nor retain the bitterns to the



same extent as the hollow crystals of *mapi salt*. While no objection can be raised to the production of *kuppa salt* on the score of its quality, it has to be mentioned that the floating crystals reduce the surface of evaporation and the yield of this salt by weight is lower, for a given evaporating area, than that of heavy salt.

9.3 The multiple irrigation system yields only the heavy variety of salt. In order to produce the heavy variety the beds of the crystallisers are tamped fairly hard and the crystallisers are fed with brine of 16° Be' and above. The crystals are allowed to grow over a long period and they agglomerate into dense compact crystals. The heavy variety can be produced by the single irrigation system also if brine of high density (18° Be' and above) is fed into the crystallisers. This is in fact done in Bombay where the *vajni salt* which is comparatively free from calcium sulphate is obtained.

9.4 The light variety of salt like *mapi* of Bombay contains only 88 to 92 per cent. sodium chloride and its content of calcium sulphate contributes largely to the hollow character of its crystals. The magnesium salts from the mother liquor are also retained in these crystals and are not drained away easily because of their hollow shape. Moreover, this variety of salt picks up soil and other impurities at each handling because of its moist character. The *kuppa* variety though flaky and light has a high sodium chloride content of 95 to 97 per cent. Similarly the *reshta salt* of Sambhar has about 98 per cent. sodium chloride content and, in fact, is purer than the heavy *kyar* and *pan salt* produced at Sambhar. The *vajni* variety contains between 94 to 96 per cent. sodium chloride and is comparatively free from calcium sulphate and insoluble impurities. It also contains, appreciable quantities of magnesium salts which could be avoided by a proper control of the manufacturing operations. The insoluble impurities consisting of clay and dirt could also be reduced by more careful method of collection and handling.

9.5 The heavy variety of salt is better in all respects than the light varieties but the retail merchants, who buy the salt from the manufacturers or wholesale dealers by weight prefer the light varieties in areas where salt is sold by measure because they can obtain weight for weight a larger number of measures. This is tantamount to a fraud on the public, as one maund of light variety salt in Madras gives 63 padi as compared with 42 padi of the heavy variety. Similarly in Bombay a maund of *mapi salt* gives 15 to 16 *payalis* and of *kuppa* 18 to 19 *payalis* as compared with 10 to 11 *payalis* of the *vajni* variety.

One Madras padi = 85.0 c. in.

One Bombay payali = 236.7 c. in.

The manufacturers however continue to produce the light varieties of salt and there is a keen competition between them to produce lighter and still lighter salt because of this preference by the retail dealers. They have however repeatedly stated that they would undertake the manufacture of heavy salt exclusively if the sale of salt by measure were banned by Government. We have stressed the importance of stopping the sale of salt by measure in subsequent chapters.

## 10. Artificial Evaporation

10.1 The manufacture of salt by artificial evaporation by direct fire in open pans is practised by cottage workers in Bengal and Orissa but the quality of the product obtained is very inferior and the product cannot compete in price with solar salt. Attempts have also been made in Bengal to combine solar with artificial evaporation by evaporating concentrated brine in metal pans over open fire but here too the attempt has not met with success. The use of the vacuum evaporators has not been introduced in India, except for the alkali works at Dalmianagar, which uses multiple effect evaporation for refining the salt required for the manufacture of caustic soda. At Mithapur, however, a large capacity quadruple effect evaporator plant to produce 6 tons of salt per hour is under erection.

This plant is also intended to produce 75,000 gallons of distilled water per day to relieve the shortage of good quality soft water for the boilers at these works.

**10.2 FUEL ECONOMY.**—The artificial evaporation of brine depends more on the cost of fuel on any other factor. It is, therefore, of advantage to ensure the supply of cheap fuel before any question of setting up artificial evaporation plants in India is considered seriously. Apart from considerations of cost, it is now increasingly realised that no country can afford to dissipate its accumulated resources of mineral or forest wealth. Where the sun is bountiful as in India and showers its energy in abundant measure from day to day it is in the national interest to see that such operations as can be carried out with the help of solar energy should not be conducted by artificial heat. The conservation of fuel is a matter of supreme importance to any country, but more so to India which is not particularly well endowed in this respect. Proposals have been advanced from time to time suggesting the adoption of artificial evaporation as a solution of the problem of deficiency of salt in the land. Attractive schemes, more often fanciful than realistic, have been advanced advocating the manufacture of salt by this method. The Committee are strongly of the opinion that all alimentary salt and a good proportion of industrial salt can be manufactured economically by solar evaporation at most of the sources of brine supply in India. Artificial evaporation should be resorted to only to obtain special grades of high quality salt which are not directly obtainable by solar evaporation, or when solar evaporation is likely to be beset with such difficulties as lack of level land and short duration of fair weather conditions. In the tropics and countries like India where a fairly long period of dry weather prevails it is of the utmost importance that the solar evaporation method of manufacture should continue to be utilised in preference to artificial.

## 11. ROCK SALT

**11.1** The main source of rock salt in undivided India were the Khewra deposits in the Sulaiman range. The only known source now left in India is the Mandi rock salt which is mined in small quantities and its sale is confined to a small area. As a rule, rock salt varies in colour from red to deep mauve and is fairly free from insoluble matter. The Mandi rock salt is, however, dark grey in colour and might be easily mistaken for a lump of rock. It is very impure and has a sodium chloride content of less than 74 per cent. the rest being insolubles like silica, lime and traces of calcium sulphate. In America and other places rock salt is generally used directly for cattle and agricultural purposes, but when it is required for edible purposes it is subjected to a process of refining and recrystallisation in vacuum evaporators.

## 12. INDIVIDUAL CENTRES OF PRODUCTION

**12.1** In the foregoing paragraphs we have dealt with the general aspects of manufacture of salt in India. The conditions of manufacture vary from one centre of production to another and it is necessary to deal at length with the practices followed in the individual centres, the problems that confront them, the contribution that they can make in furthering the programme of self-sufficiency for India as a whole, and our recommendation for their improvement. This has been attempted in the chapters that follow which deal with the inland salt works, followed by the salt mines of Mandi and last of all the marine salt works.

## 13. SUMMARY OF RECOMMENDATIONS

(a) In places where rainfall is high and sea brine gets diluted the alternative method of tapping subterranean brine by tube well should be investigated.

(2.3.1)

(b) Bitterns should be prevented from draining into the reservoirs which should be used only for the storage of brine. (3.1.1)

(c) The relative areas of crystallisers and reservoir *cum* condensers should be fixed with due regard to the density of the initial brine used. (4.2)

(d) In marine salt works, the crystallisers should be located together, to facilitate easy collection and storage of salt and should be so placed as to have the benefit of the land breeze. It is advisable to have a small condenser area intercepting the land breeze before it reaches the crystallisers. (5.3)

(e) The crystallisers should, as far as possible, be large in area, but where single irrigation system is followed, the width may be fixed at 35 to 40 ft. so that all parts of the pans may be within reach of the wooden scrapers. A gentle gradient should be provided in the crystalliser beds so that the bitterns can be drained effectively into the bittern channels and puddles of mother liquor are not left behind. (5.4.1)

(f) The partitions in the crystalliser area should be given a proper slope to the bed level of the pans. In large crystallisers they should be pitched and given a correct angle of repose so that the wave action of the brine does not continually wash away the edges and damage the partitions. (5.5)

(g) Separate channels should be provided for the incoming brine and the outgoing bitterns. (6.2)

(h) Bitterns should be discharged before the harvesting of each crop. (7.1.1)

(j) Even where the single irrigation system is followed, an attempt should be made to allow the crust to grow by accretion during the fair weather. (8.2)

(k) The sale of salt by measure should be banned by law. (9.5)

(m) Artificial evaporation in open direct fired pans should be discouraged. All alimentary salt and a good proportion of industrial salt should be manufactured economically by solar evaporation only. When salt of high grade purity is required and is not directly obtainable by solar evaporation, artificial evaporation by vacuum evaporators is recommended. (10.2)

## CHAPTER VI

### SAMBHAR LAKE

#### 1. DESCRIPTION

1.1 In the inland salt works of India, the Sambhar Lake works are the most important. The Lake is situated east of the Aravali Hills (75°E and 27°N) on the common border of the former States of Jodhpur and Jaipur which are now in the Rajasthan Union. The lake is nearly 20 miles long and 2 to 5 miles wide, covering a total area of 90 square miles. The lake gets filled up during the rains only and is fed by four main streams with a number of feeders. Being shallow, the depth of water varies from 18 to 36 inches depending upon the rains. As the dry season advances the water in the lake recedes to its deeper parts, leaving the major portion of the lake bed practically dry. A spongy crust of salt nearly 6 inches in thickness forms on the dry lake bed and is caused by the salt in the clay rising to the top by capillary action. Salt has been manufactured from this source since ancient times.

1.2 The bed of the lake consists of a stratum of saliferous black clay which increases gradually from a depth of a few feet at the edges of the lake to about 60 ft. at the centre. The soluble compounds of this mud consist largely of sodium chloride mixed with appreciable quantities of sodium sulphate and sodium carbonate. The analysis of average samples of lake mud at the surface and at depths of 1 foot and 2½ ft. is shown in Table XV.

TABLE XV.—COMPOSITION OF LAKE MUD AT DIFFERENT DEPTHS  
(On air dry basis)

	at surface	at 1 ft. depth	at 2½ ft. depth
	(Per cent.)		
Sodium chloride . . . . .	16.02	4.97	6.66
Sodium sulphate . . . . .	5.15	1.22	1.49
Sodium carbonate . . . . .	0.66	0.53	0.27
Sodium bicarbonate . . . . .	0.11	0.21	0.42
Insolubles (mainly inorganic) . . . . .	74.46	89.18	87.21
Moisture . . . . .	3.60	3.89	3.95
	100.00	100.00	100.00

A complete analysis of the mud at greater depths was not available, but its sodium chloride content was reported to remain fairly uniform upto a depth of 12 ft. as will seen from the following figures:

Depth in feet.	Sodium chloride con- tent Per cent.
4 . . . . .	6.45
6 . . . . .	6.78
12 . . . . .	6.50

It is estimated that the top 12 feet of the lake mud contains 550 lakh tons (nearly 15,000 lakh mds.) of common salt.

1.2.1 A geological section of the Sambhar Lake is shown in Fig. 3. This is built up on the data collected by sinking a few bores going to the rock level which in the deepest portion is as low as 65 ft. below the bed level. We consider that a more detailed geological survey of the lake bed going down considerably into the primary rock (micaceous schists) is necessary. In fact, an investigation to determine the real origin of salt and the extent of its reserves not only in Sambhar, but in the whole of Rajasthan is wanted. Advantage might be taken of this investigation to ascertain also the character and the quantity of the subsoil and subterranean brine available in the lake bed. As the quality and quantity of the brine available vary from place to place such a survey would enable the sources to be tapped at the right places in order to obtain an abundant supply of suitable brine. There is a common belief at Sambhar that the subsoil brine towards the edges of the lake contains more sulphates and carbonates than the brine at the centre of the lake bed. If this can be confirmed by a proper investigation, it would then be possible to re-locate the position of the percolation canals in the lake to obtain brine of optimum suitability.

1.2.2 Salt is also extracted at Didwana and Pachbadra which are about 40 and 150 miles from Sambhar lake, in the north-west and south-west directions respectively. The brine that is available for salt manufacture at all these three sources differs in its composition. For instance, the brines at Sambhar and Didwana are more closely akin than the brine at Pachbadra. Calcium sulphate and magnesium chloride are present along with sodium chloride at Pachbadra whilst in the former they are absent and sodium sulphate and sodium carbonate are found instead. These brines are also entirely different in composition from sea brine and the proportion of sodium chloride to the rest of the salts is higher than in sea brine. Table XVI will show this more clearly.

TABLE XVI.—COMPOSITION OF SAMBHAR, DIDWANA, PACHBADRA AND SEA BRINES

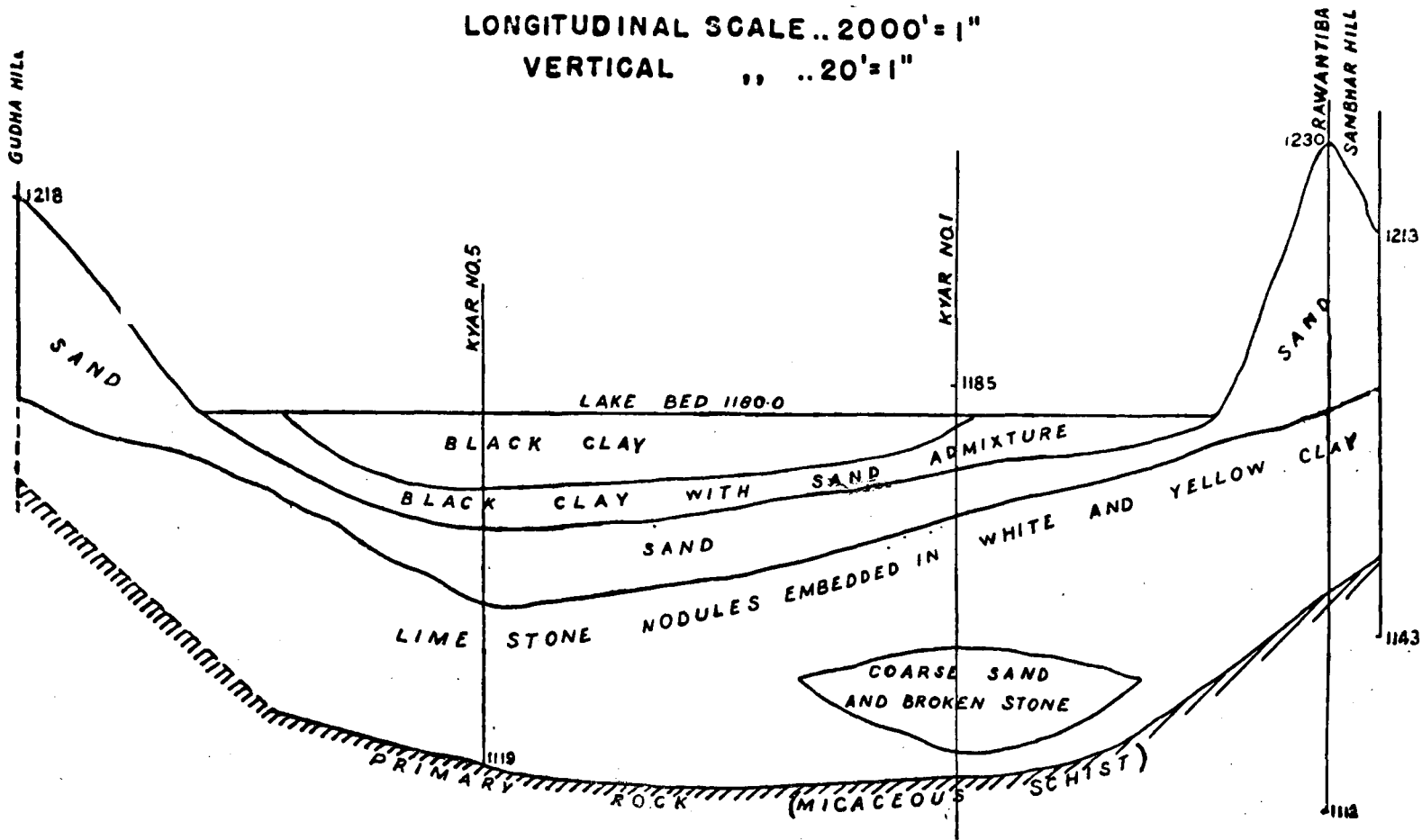
(On dry basis)

	Sambhar	Didwana	Pachbadra	Sea
		(Per cent)		
Calcium carbonate	..	..	..	0.345
Calcium sulphate	..	..	2.970	3.600
Sodium chloride	87.300	77.190	85.660	77.758
Sodium sulphate	8.650	20.650	..	..
Sodium carbonate	3.870	0.600	..	..
Sodium bicarbonate		1.560	..	..
Magnesium sulphate	..	..	9.440	4.737
Potassium chloride	0.129	..	..	2.465
Magnesium chloride	..	..	1.930	10.878
Magnesium bromide	0.051	..	..	0.217
<b>TOTAL</b>	<b>100.000</b>	<b>100.000</b>	<b>100.000</b>	<b>100.000</b>

FIG. 3 GEOLOGICAL SECTION OF SAMBHAR LAKE FROM SAMBHAR HILL TO GUDHA HILL.

LONGITUDINAL SCALE .. 2000' = 1"

VERTICAL ,, .. 20' = 1"



A detailed investigation to account for the presence of these salts and the difference in the composition of the brines should be carried out alongside the geological survey.

1.3 The accumulation of these salts is attributed to various streams which drain into the lake the rain water from a catchment area of over 2000 sq. miles carrying in solution the salts from the surrounding area. As compared with other fresh water streams which normally do not contain more than 5 parts per million of sodium chloride, these streams carry considerable amount of salt as will be seen from the salt content in the water of three of the principal feeder streams:

Name of stream	Sodium chloride (Parts per million)
Mandha . . . . .	1395
Kharia . . . . .	665
Rupnagar . . . . .	72

The approximate catchment areas of Mandha, Kharia and Rupnagar are 850, 450 and 530 sq. miles respectively. The monsoon rainfall in these areas averages about 16 in. The runoff from these catchment areas into Sambhar lake may be taken as 10 per cent. of the monsoon rainfall. On this basis the salt that can be expected to reach the lake in a year of average monsoon would be

		Tons	Mds.
Via Mandha . . . . .	$\frac{850 \times 1395 \times 16 \times 5280 \times 5260 \times 62.4}{2240 \times 12 \times 10 \times 10^6} =$	1,22,950	33,47,000
Via Kharia . . . . .	$\frac{450 \times 665 \times 16 \times 5280 \times 5280 \times 62.5}{2240 \times 12 \times 10 \times 10^6} =$	30,960	8,42,800
Via Rupnagar . . . . .	$\frac{530 \times 72 \times 16 \times 5280 \times 5280 \times 62.5}{2240 \times 12 \times 10 \times 10^6} =$	3,957	1,07,700
		<u>1,57,867</u>	<u>42,97,500</u>

Apart from the quantities of salt received annually with the surface runoff, a larger amount is received with the sub-surface runoff, thus accounting for the almost inexhaustible nature of the Sambhar source.

1.4 ORIGIN OF SALT.—Several theories have been advanced to explain the presence of this large proportions of sodium chloride and other sodium salts in the water. According to one of the theories, these salts are the products of chemical weathering of the rocks on the Aravali hills where the felspars and allied minerals on decomposition give rise to soluble sodium salts which are leached out by the rain water. The semi-arid conditions prevailing in these areas are believed to help in their deposition in the basin. In other parts of the world similar salt lakes and deposits of soluble sodium salts exist in indential climatic condition. The nitre deposits of Chile, the sodium sulphate deposits of

Arizona, the salt lakes of California and Nebraska, the great salt lake of Utah and the Dead Sea are well known examples of lake salt deposits in other countries. Another theory is that the spontaneous salt which forms in the Rann of Kutch is blown by the wind on to the catchment area of the lake and is dissolved by the rain water and carried into the lake, this is an annually recurring event and would further support the view that the salt resources of Sambhar lake are inexhaustible.

## 2. Manufacturing Rights.

2.1 The lake was jointly owned by the Jaipur and Jodhpur States, but the Jaipur interests in the lake were leased to the Government of India under two agreements of 1869 and 1878 and those of Jodhpur under two agreements executed in 1870.

2.1.1 *Jaipur Agreements.*—According to the 1869 agreement entered into by the Government of India with the Jaipur State, the former undertook—

- (a) to pay an annual compensation of Rs. 2,75,000 for the surrender of commercial rights in the Lake and a royalty at 20 per cent. on the sales realisation of all salt in excess of 30,310 tons (8,25,000 mds.) per annum, and
- (b) to supply, free of excise duty,
  - (i) 6,320 tons (1,72,000 mds.) of salt for the consumption of the public in the State, and
  - (ii) 260 tons (7,000 mds.) for the use of the Durbar.

The second agreement executed in 1879 provided for the stoppage of the manufacture of salt in all the subsidiary salt works in the State on payment to the State of an annual compensation of Rs. 13,310. Further, the annual supply of 6,320 tons (1,72,000 mds.) of duty free salt to the State provided in the previous agreement was commuted to an annual cash compensation of Rs. 4 lakhs.

2.1.2 *Jodhpur Agreements.*—In the 1870 agreement with the Jodhpur State the Government of India undertook.

- (a) to pay an annual rent of Rs. 1,25,000 and a royalty at 20 per cent. of the price of salt sold from Sambhar in excess of 30,310 tons (8,25,000 mds.) per annum, and
- (b) to supply 260 tons (7,000 mds.) of salt free of charge for the use of the Durbar.

By a second agreement of the same year, the Works at Nawa, Ghuda, etc. were also leased to the Government of India on an additional rent of Rs. 3,00,000 and a royalty at 40 per cent. of the price of salt sold in excess of 33,100 tons (9,00,000 mds.) per annum from this area.

2.2 To simplify the assessment of royalty, it was later agreed by the two States that the royalties be calculated at 40 per cent. on the price of salt sold in excess of 63,400 tons (17,25,000 mds.) out of the entire production of the Sambhar area and shared in the proportions of 3:5 between Jaipur and Jodhpur. In 1947 the amount of royalty paid to the two States was Rs. 3,22,271 and Rs. 5,37,119 respectively.



## Manufacturing Process.

3.1 KYAR SALT.—Of the total area of 90 sq. miles of the lake, the area under salt manufacture is 1,803 acres (about 2.82 sq. miles). The salt works are situated on the sides of the lake and are laid out in the form of six separate units, locally called *kyars*. They are—

- (a) Main Line Kyar
- (b) Deodani Kyar
- (c) New Kyar
- (d) Gudha Kyar
- (e) Jhapog Kyar
- (f) Nawa Kyar.

Each *kyar* is complete with its own set of small reservoirs, condensers and crystallising pans. Their area as also the yield per acre is shown in Table XVII.

TABLE XVII.—AREA OF KYARS AND YIELD PER ACRE

Name of Kyar	Reservoir	Condenser Crystalliser (Area in acres)		Total	Yield per acre	
					(Tons)	(Mds.)
Main Line . . .	46	55	137	238	201	5471
Deodani . . .	317	48	285	650	141	3838
New . . .	78	72	109	259	117	3185
Guhda . . .	104	34	72	176	146	3974
Jhapog . . .	142	20	68	210	105	2858
Nawa . . .	90	90	90	270	82	2232
TOTAL . . .	777	319	761	1803	Average 133	3593

The crystallisers are the largest we have seen anywhere in India; they measure from 3 to 7 acres each and in many respects they could easily lend themselves to mechanical harvesting instead of the present method of manual litting. The ratio of the areas of reservoirs and condensers to that of the crystallisers varies from 0.8:1 to 2:1.

3.2 The production at Sambhar depends mainly on the rainfall and there is no other source of water which can be utilised for the extraction of salt. The annual rainfall is 20 in. and is mainly confined to the three months of July to September. There are slight showers in the months of December and January, but they are of no significance. In years of lean rainfall, the production is reduced considerably whilst rainfall in excess of 30 in. also affects it adversely. Being in the middle of a desert, the rate of evaporation at Sambhar is very

high viz., 60 to 65 in. per annum. In order, therefore, to conserve enough brine to last for the whole manufacturing season a dam has been built across the deepest portion of the lake, enclosing an area of 5 sq. miles to serve as Main Reservoir. At either end of the dam, pumps have been installed for transferring the brine from the lake into the reservoir after it attains a density of 3° to 5° Bé. As the depth of the brine in the reservoir is 18 in. to 24 in. the evaporation is slower than it would have been had the brine been left in the lake. During years of normal rainfall the brine is barely sufficient to last the entire manufacturing season and the deficiency is made up by supplementing the supply from the subsoil sources which are tapped by percolation canals. When the brine in the main reservoir has reached 5° to 7° Bé it is again transferred by pumps to the small reservoirs attached to the different kyars. From there, the brine is taken into condensers where it gets concentrated to about 15° to 20° Bé before it is fed into the crystallising pans. During the rains the crystallisers get a preliminary flushing after which the rain water is allowed to accumulate in the pans in order to dissolve the salt embedded in the beds. As soon as the density of this water reaches about 20° Bé it is transferred to a smaller number of pans for the deposition of salt. By this time the brine in the condensers has reached a density at which it can be charged into the crystallisers.

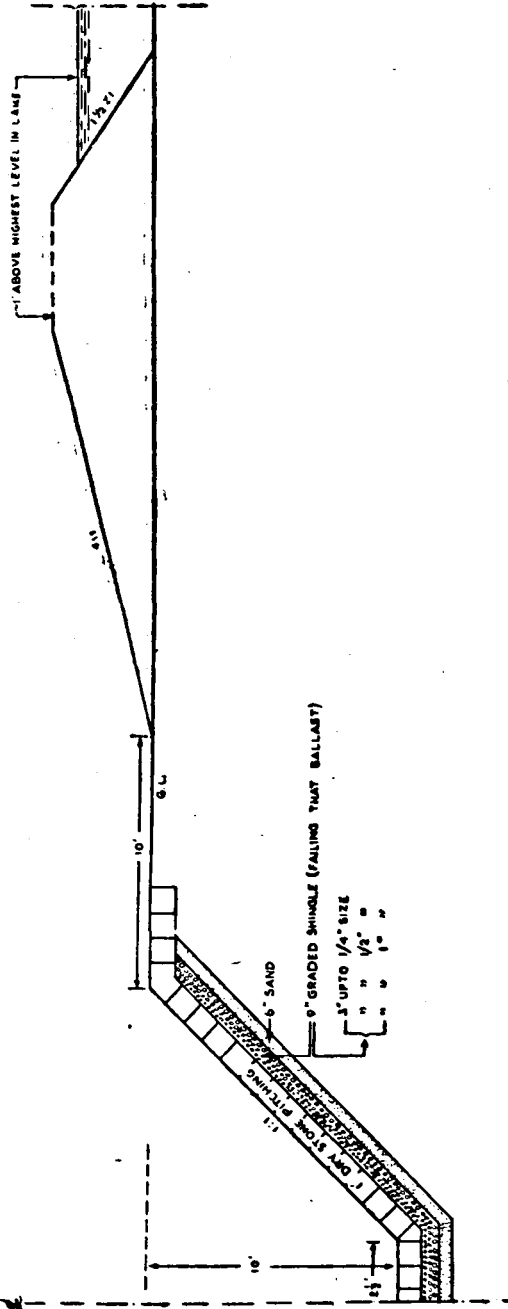
3.3. PERCOLATION CANALS.—In the previous paragraph we have mentioned that the supply of brine to the crystalliser is supplemented by brine from the percolation canals. This is either when the density of brine in the main reservoir is not high enough or when the supply in the reservoir threatens to fall short of the requirements for the manufacturing season. There are three percolation canals, situated on the edges of the lake; one of them is six miles long while the other two are a mile or less in length. The canals are designed to slope towards the *kyars*, but being on a lower level than the *kyars* the brine has to be pumped up from them. The density of the brine in the canals varies from 8° to 19° Bé depending upon their location, the seasonal variations and the extent to which the brine is drawn from them. The composition of the brine from the percolation canals differs from that of lake brine. As will be seen from Table XVIII the canal brine is inferior in sodium chloride content and contains appreciable quantities of sodium sulphate and sodium carbonate.

TABLE XVIII.—COMPOSITION OF LAKE AND CANAL BRINES

	Lake Brine	Canal Brine	
		Deodani	Nawa
Density . . . . .	3.5° Bé	22° Bé	12.5° Bé
	(Per cent on dry basis)		
Sodium chloride . . . . .	87.30	80.61	84.60
Sodium sulphate . . . . .	8.65	12.81	9.27
Sodium carbonate and bicarbonate . . . . .	3.87	4.12 2.46	2.53 3.60
Undetermined . . . . .	0.18	..	..
Total	100.00	100.00	100.00

3.3.1 We found that the percolation canals had silted to the point of extinction. The cost of maintaining the canals at present is high and the canals have been grossly neglected. This is due partly to the lack of proper maintenance and partly to the faulty design of the canals. We were informed that these canals have been used frequently as sumps for the storage of brine from the main reservoir for drawing into the condensers and crystallisers. This is a serious misuse of the function of the canals and has aggravated the deposition of silt. We have proposed a modified type of protection for the percolation canal as indicated in Fig. 4. The main functions of this design are

**Fig 4. PROPOSED DESIGN FOR PERCOLATION CANAL**  
SCALE : 8' = 1 INCH



- (a) to prevent the falling or caving in of the sides of the percolation canals which results in rapid chocking up, and
- (b) to provide a transverse flow filter which will hold back the soil particles but allow the subsoil brine to percolate through and reach the canal.

The adoption of this design would substantially reduce the maintenance cost and keep the canal in a serviceable condition long enough to compensate the heavy initial outlay. Commenting on this design the General Manager at Sambhar drew our attention to the possibility that after some lapse of time, the entrapped slime below the water level may completely seal off the seepage and the flow of the brine into the canal. Whether this sealing off would or would not take place, and even if it does, how long the canal would continue to be serviceable, are matters which can be finally decided only after a large scale trial. We are, however, confident that our design would prove satisfactory for a long enough period.

3.4 Salt begins to deposit in the crystallisers when the density of the brine rises above 26° Bé. When the density reaches 29° Bé, the crystallisers are replenished with fresh brine from the condensers, care being taken to see that the density in the pans does not fall below 26° Bé; nor is it allowed to go above 29° Bé. Salt is thus deposited without interruption and only one crop is raised each year, commencing about the end of March or beginning of April. The salt is first excavated with iron spades and made into heaps on the crystalliser beds and it is then washed with the bitterns. This washing is resorted to in order to remove the mud and other adherent impurities from the surface of the crystals. The bitterns are rich in chemical impurities like sodium sulphate, sodium carbonate, etc., and while removing the insoluble impurities from the heaps, they contaminate the salt and the sodium sulphate and sodium carbonate contained in them get deposited on the crystals on drying. This is, therefore, not a satisfactory practice. In all good manufacturing practice, the salt on collection should be carried from the beds on to the ridges at the sides of the crystallisers and heaped there to permit the adherent bitterns to drain out. This, however, is not at present possible in Sambhar where the crystallisers are of large size and the area of the ridges is not adequate to heap all the salt from each crystalliser. The only chance of removal of the contaminating sodium sulphate and sodium carbonate is by the washing which the salt gets in the storage yards during the rains. As the rain water does not evenly percolate through the mounds of salt measuring several lakhs of tons, this vicarious washing by rain water is not at all effective and the impure salt containing the sulphate and carbonate continues to be marketed. If the bitterns were removed from the crystalliser beds before the collection of salt, it would be possible to heap the salt in the crystalliser beds to allow the adherent bitterns to drain away. The quality of salt would improve thereby to an appreciable extent.

3.4.1 When we discussed this matter at the site, certain difficulties that might be encountered in carrying out the above suggestions were brought to our notice. It was pointed out that the crystallisers could not be completely drained of the bitterns as their floor was uneven and the bitterns would remain behind in pools in places, thus probably increasing the contamination of the salt by drying up during the process of collection. It was further urged that the floors of the crystallisers were not hard enough with the result that some clay which at present was being eliminated by washing the heaped salt with the bitterns would remain in the salt. If, the crystallising pans were properly maintained by a periodic removal of the slush and the floor was well levelled and tamped before the manufacturing season commenced, these difficulties could be obviated. The large size of the crystallising pans at Sambhar would permit the collection of salt by mechanical harvesters for the operation of which

a hard level bed and a complete draining of the bittersns would be essential. The anticipated difficulties should not, therefore, deter the works from adopting our suggestion. We should like to observe that the crystallising beds have at present a layer of 3 to 9 in. of a slushy material consisting largely of mixed salts, organic matter and mud. An appreciable quantity of salt remains in the slush and cannot be collected. The removal of this slush is essential in order to permit a substantial improvement in the quality and a larger output of salt per crystalliser. There has been a general complaint that the quality of salt produced at Sambhar has been deteriorating steadily both as regards its sodium chloride content and appearance. We believe these defects are due to the accumulating of slush and the presence of sodium sulphate and organic matter. In our opinion the cleaning of the crystallisers is an urgent task and it should be undertaken at an early date in order to achieve an increase in production and improvement in quality. It is regrettable to mention that the cleaning and/or maintenance of the crystallisers which have to be done systematically each year have not been done as far as we can gather for the past 20 years or more, with the result that to put them into proper order now considerable amount of expenditure will be required during the next three to five years. This expenditure is inevitable and until it is incurred the quality and yield of salt will continue to suffer. Definite instructions should also be issued to the works that in future the cleaning and maintenance operations of the crystallisers should be done each year and necessary staff should be provided for this purpose so that the works are not allowed to deteriorate and do not need a heavy outlay all at once.

3.4.2 To avoid the contamination of salt with the bittersns we suggest that at the time of lifting, the procedure, in the order given below, be followed:

- (a) the mother liquor should be drained away from the pans;
- (b) the condensed brine which is very nearly saturated with respect to sodium chloride should be let into the crystallisers; and
- (c) the salt crust should be raised as is done now and washed in the brine.

By collecting salt in this manner the crystals would be wetted with a liquor of which the sodium sulphate and carbonate contents are much lower than that of the bittersns.

3.5. We understand that each year several lakh maunds of salt are left behind in the beds as they cannot be extracted before the onset of the rains. The quantity that was expected to be left behind when we visited the works in June 1948 was estimated to be 17,000 tons (4.63 lakh mds.) This was reported to be due to the inadequate number of wagons being available for transporting the salt to the central stores. We recommend that steps should be taken to see that all available salt is extracted from crystallisers before the outbreak of the rains. Even if immediate transport facilities are not available for the removal of the salt from the crystallisers to the stores, the salt could be heaped in the crystallisers and along the railway track for removal as soon as transport is made available.

3.5.1 It was pointed out to us that it may not be possible to carry out the suggestion in the preceding paragraph with the present method of payment to labour at Sambhar. The prevalent method is to entrust the work of lifting the salt and delivering it to the stores to a group of contractors who then engage the labour for the work. Payment is made to the contractors only after the salt is delivered to the central stores. To obviate this difficulty and in fairness to labour we suggest that the payment to the contractors (if the contract system is to be continued at all) be split into two parts, the first being for the extraction of salt from the beds and heaping it and the second for its loading

into wagons and delivery at the central stores. If this system is adopted, labour working in the crystallising beds will be assured of payment for the quantity of salt they extract and heap but which could not be removed owing to transport difficulties, whilst the labour who load the wagons at the crystallisers and unload them at the central stores will receive their part of the payment when transport is arranged. If this could be arranged, the production at Sambhar is likely to be increased by at least 10 per cent. without any extension of the Works.

**3.6 RELATIVE AREAS OF CONDENSERS AND CRYSTALLISERS.**—In the Chapter on Model factories and Research stations we have discussed in detail the optimum ratio between the areas of reservoirs and condensers on one hand and the crystallisers on the other for different densities of raw brine. At Sambhar, however, the supply of brine varies in quantity according to the rainfall and the optimum ratio which is applicable to marine salt works cannot be applied here. It is difficult to fix a rigid ratio for Sambhar in view of the conditions peculiar to the place. Nevertheless we consider that the crystallising area is in excess of what is required or desirable and the present ratio is unsatisfactory and needs to be rectified. If a part of the present crystallising area which requires the maximum of attention could be reduced and converted into condensers as conditions warrant, the output will not, in any way, be affected. On the contrary, it will not only facilitate the lifting of salt but will help to keep out much of the algal contamination which now finds its way into the salt, because brine of as low a density as 18° Be' is at present being fed into the crystallisers. The crystallisers will thus remain relatively free from silt and their maintenance and cleaning will be made easier. We have observed elsewhere that considerable amount of salt which could not be extracted before the onset of the rains is left behind in the present extensive crystallising beds. If the area under crystallisers is reduced it would facilitate the collection of most of the salt and perhaps even avoid the necessity of heaping it on the ridges of the crystallisers for removal after the rains. It is desirable that the brine should be fed into the crystallisers as near saturation as possible. If adequate condensing area is available such a procedure would be made easier: of adoption at Sambhar. We have also recommended in 3.4.2 that the crop of salt should be given a wash in the crystallisers with saturated brine to remove the adherent bittern. For this purpose it is necessary that saturated brine should be always available and this would be made possible if the condensing area is proportionately increased. In 6.3.1 we deal with the recommendation of the Works to partition the main reservoir and convert a portion of it into condensers. This large addition to the condensing area will, in our opinion, improve the overall efficiency of the Works. The present yield of salt per acre in the different *kyars* varies at present from 82 tons (2,232 mds.) at Nawa to as much as 201 tons (5,471 rids.) per acre in the Main Line *kyar*. This is partly due to the varying ratios between the reservoirs and condensers and crystallisers and, if the condensing area in each *kyar* is adequately increased, we believe that the yield per acre in any given year in all the *kyars* will be more uniform and not show such wide fluctuations.

**3.7 BITTERNs.**—The bitterns from the crystallisers are drained into four separate areas which are isolated from the lake by embankments. The largest of this area is known as the East Lake Bitterns Area and measures 1,280 acres. The other three are located in the vicinity of the Ghuda, Jhapog and Nawa *kyars* each covering 50 to 60 acres. The bitterns, as drained out from the crystallisers, are at a density of 30° to 32° Be' and they contain a good percentage of common salt as well as sodium sulphate and sodium carbonate. Apart from the collection of some reshta salt no attempt is made to recover any of the products and all that is done is to remove the bitterns into the areas set apart for them, where they are allowed to dry up. This accumulation of bitterns over several decades is a potentially rich source of sodium chloride and other salts.

The system of throwing away bitterns over a large area and allowing them to evaporate is, in our opinion, very inadvisable as it is likely to affect the source of brine and contaminate it sufficiently enough to affect seriously the production of salt in future. To improve the quality of salt as also to increase the production it would be preferable to harvest two grades of salt one between 26° and 29° Be' and another between 29° and 32° Be' instead of the present methods of obtaining one grade only. This can be done by transferring the brine as soon as it has reached a concentration of 29° Be' in one set of crystallisers to a separate set for the further deposition of salt up to 32° Bé. If this procedure is adopted the salt which would deposit upto 29° Bé would be purer and contain less of sodium sulphate than at present. The two grades can be marketed separately depending on the requirements of the consumer. These limits are arbitrary, but the correct limits for the different qualities of brine available at the works could be determined by systematic investigation. The limits can best be arrived at by preparing a chart showing the progressive separation of salts on the evaporation of the different qualities of brine available and co-relating it with the rise in density and reduction in volume. This would also help in guiding the general manufacturing operations at the works. As there are wide differences in temperature and humidity during various seasons, the rate of evaporation and the manner of separation of salts fluctuate to a considerable extent with these changes. It often happens that on cold wintry nights sodium sulphate crystallises out along with the salt. This could be avoided if the manufacturing operation is adjusted to counter the effect of seasonal variations. These variations at different periods of the year could be determined and precautionary measures devised for the different seasons to prevent a fall in production or contamination of the common salt produced. We recommend that this work should be taken in hand systematically and made a part of the routine records and reports of the Works.

3.8 The rain water that collects in the East Lake Bitterns Area dissolves a part of the crust of bitterns salts and rises in density due to subsequent evaporation. It has been suggested that this should be used for augmenting the brine supply to the Works when it has reached a density of 20° Be'. If this brine is to be utilised the modified method of extracting salt as recommended by us in the previous paragraph will become necessary as otherwise it will not be possible to produce salt of an edible quality. It has, however, been reported to us that the sewage of Sambhar town drains into this area and there may be sentimental objections to preparing salt out of this brine. Even though the sodium chloride status of this brine is inferior to the canal or lake brine as will be seen from the following comparative statement, this brine is a potentially rich source of salt and we suggest that a suitable method of disposal of this sewage be examined at an early date:

	Lake brine	Canal brine	East lake Bitterns. Area brine
	(Per cent. on dry basis)		
Sodium chloride . . . . .	87.30	78.90	75.30
Sodium sulphate . . . . .	8.65	14.30	15.60
Sodium carbonate & bicarbonate . . . . .	3.87	6.80	9.10
Undetermined . . . . .	0.18	..	..
	100.00	100.00	100.00

3.9 PAN SALT.—Salt is also manufactured at Sambhar in small size crystallisers from brine obtained from shallow wells by a method similar to that adopted in the main salt works in Bombay and Madras. There are at present 353 crystallising pans and they are all situated at Ghuda. Formerly there were pans at Deodani and Nawa also, but they were abandoned and steps are now being taken to revive them. The brine supply is from the subsoil source, but unlike the percolation canals the wells do not get silted up to the same extent. Occasionally when the brine supply gets reduced the well is abandoned and a new one dug nearby. The brine is lifted from the wells in earthen pots tied to a counter-poised bamboo lever system, worked by manual labour. The depth of the wells is barely 8 to 10 ft. and the density of the brine is 15° to 22° B<sub>é</sub>. For each well there is one condenser of 25' x 25' and two crystallisers each of 150' x 50'. The brine is first let into a condenser, but as the condenser area is only 1/25th of the crystalliser area it could not possibly play any part in regulating the density of the brine let into the crystallisers. The condenser area is even too small to serve as a catchment for the suspended silt in the well brine. Though with the density varying from well to well and from time to time in the same well, a fixed proportion between the areas of the condensers and crystallisers cannot be laid down, and a mutual adjustment between the relative areas has to be made. If the incoming brine is 15°, the ratio may be maintained at 1:1, but where the density is higher, a part of the condensing area can be converted into an additional crystalliser; the condenser can be so designed as to make this possible. The crystallisers are shallow and the accretion method is followed, but the salt is harvested at irregular intervals.

3.9.1 The manufacture of salt in pans is not directly under Government control, but a group of pans (varying from 2 to 3) is leased out to local contractors, known as 'Bandewals' who are required to sell the salt to Government at a price which is fixed at the beginning of each season. As the working of the pans is left to persons who follow primitive and traditional methods, the layout and the operations are primitive and the quality of the salt is also not dependable. Considering that this system of production is free from silting and the complications due to algae as in other parts of Sambhar are absent and as brine of high density is available, we feel that this important supplementary source of salt should be extended on a large scale with improved methods of lifting brine, i.e., by pumping and by proper layout of condensers and crystallisers and operating these pans on a scientific basis under direct Government management.

3.10 RESHTA SALT.—Another form of salt produced at Sambhar and which until recently had been neglected is the wind swept salt known locally as '*reshta*'. It forms in the crystallising pans as well as in the bitterns area. In the pans the salt that crystallises on the surface of the brine is blown to the edges where it collects as tiny crystals; in the bitterns area the salt separates out from a brine formed by the dissolution of the bittern salt by the rain water which collects there. There are no proper facilities for transporting the *reshta* salt from the bitterns area to the storage yards and the collection has been consequently handicapped. The works estimate to collect every year as much as 55,000 tons (about 15 lakh mds.) of *reshta* salt from the bitterns area in the eastern portion of the lake, if a permanent track is laid to convey the salt to the stores. We recommend that this be arranged as expeditiously as possible in order to take full advantage of the natural separation of sodium chloride which takes place from the large accumulations of bittern salts in this area.



3.11 TRANSPORT AND STORAGE.—From the crystallisers the salt is carried in tipping wagons of 2 ft. gauge or by meter gauge trucks to two central stores of which one is situated at Sambhar and the other at Ghuda. The wagons are drawn up a ramp several feet high and the salt is dropped down the sides to the ground until a long heap is formed. For each trip the deadweight of the locos and the wagons has to be hauled up which adds to the cost of storage. Moreover, in harvesting season over 3,000 tons (81,660 mds.) of salt are handled every day in this manner involving the employment of a large labour force. As the salt is stored in the open, a little of its impurities gets washed away during the rains, but this washing is inadequate to bring about any appreciable improvement in the quantity of the salt. This method of storing of salt will have to be reconsidered and mechanical means devised to simplify and cheapen the cost. This question is, however, linked with the question of a provision of a washery to be installed at Sambhar which is dealt within a subsequent paragraph. In the stores the salt remains invariably for nearly a year before it is sold; this in many respects is advantageous as it permits of a permanent cushion against the very wide variations in the annual production that we have noticed at Sambhar and which might otherwise lead to speculative fluctuations in the price of Sambhar salt.

3.11.1 The despatching and bagging of salt is done manually involving against the employment of a large labour force. Many types of bulk handling devices are now available to carry out this work more efficiently and economically and we recommend that the question of mechanical bagging and loading be investigated. As almost the entire production at Sambhar is despatched only in bags it is obvious that mechanical bagging and handling will bring about a substantial reduction in the labour employed on this work and may effect a considerable economy.

#### 4. Annual Production and Quality.

4.1 PRODUCTION.—The total annual output of salt at Sambhar of the three different varieties for the years 1946 to 1948 is given in Table XIX.

TABLE XIX.—PRODUCTION AT SAMBHAR 1946-48

Years.	Kyar salt		Pan salt		Reshta salt		Total	
	Tons	Maunds	Tons	Maunds	Tons	Maunds	Tons	Maunds
1946 .	2,77,833	75,62,620	20,155	5,48,620	37,077	9,27,580	3,32,065	90,38,820
1947 .	3,54,090	96,38,340	20,282	5,52,100	22,723	6,18,520	3,97,095	108,08,960
1948 .	2,78,382	75,77,580	15,934	4,33,720	22,162	6,03,250	3,16,478	86,14,550

4.2. QUALITY.—The analyses of the three varieties of Sambhar salt, *viz.*, *kyar*, *pan* and *reshta* of representative samples drawn by us during the time of our visit are given in Table XX. Of the *kyar* salt we drew separate samples and the results of these two are given separately. The *reshta* salt samples were drawn from the *kyars* as also from the East Lake Bitterns Area and the analyses of these two samples are also shown separately. We have also given for purpose of comparison, the analysis of a sample of *kyar* salt after it had been washed in its own brine in the laboratories of Tata Chemicals Ltd. at Mithapur.

TABLE XX.—ANALYSES OF SAMBHAR SALT

	Kyar salt		Pan salt	Reshta salt		Washed Kyar salt
	Sample 1	Sample 2		From kyar	From Bitterns Area	
		(Percent ,	on dry basis)			
Sodium chloride .	96.67	95.50	95.25	97.69	97.63	98.54
Sodium sulphate .	2.34	2.17	1.23	1.25	0.69	0.52
Sodium carbonate .	0.53	0.26	0.60	0.34	0.32	0.15
Sodium bicarbonate .	0.09	..	1.10	0.12	0.59	..
Insolubles .	0.30	1.68	1.82	0.60	..	0.36
Undetermined .	0.07	0.39	..	..	0.77	0.43
	100.00	100.00	100.00	100.00	100.00	100.00

It will be noticed that the sodium chloride content of Sambhar salt (unwashed) varies from 95.25 per cent. in the case of *pan* salt to 97.69 per cent. in the case of *kyar reshta*. The sodium sulphate, sodium carbonate and bicarbonate between them are nearly 3 per cent. in the case of the *kyar* salt, but they go down to 1.6 per cent. in the case of the *reshta* from the bitters area. The insolubles are also high in the *pan* salt and in one of the samples of *kyar* salt. The insolubles are largely composed of mud and dirt and the remains of algal matter which could be reduced by a more careful handling of the crust during lifting and reducing the number of handlings wherever possible. The *reshta* salt is distinctly better in all respects than the *kyar* or *pan* salt. It has not only a higher sodium chloride content but also a lower sodium sulphate content and is whiter in colour. This salt is particularly suitable for use in chemical industries which require salt of good quality.

4.2.1 It is our considered opinion that the *kyar* and *pan* salts could be substantially improved in quality by washing and brought up to a standard of 98 per cent. and more of sodium chloride content. This improvement can be effected by subjecting the salt to a process of mechanical washing either in its own brine or with fresh water if a sufficient supply were available. The analysis of the washed sample shows the great potentialities for raising the percentage of sodium chloride and reducing those of sodium sulphate, sodium carbonate and the insolubles. The colour and appearance of the salt had also improved appreciably. Although this experiment was carried out on a small scale, we believe that the results could be reproduced on a large scale with equal, if not better, efficacy and we recommend that washing arrangements be installed at Sambhar.

## 5. ALGAE

5.1 Several types of algae develop and flourish in the lake brine and interfere with manufacturing operations by imparting both an offensive smell and a pink to rust red colour to the salt; in extreme cases the algae turns the brine into a gelatinous fluid from which well developed crystals of salt cannot be formed and recovered. These algal growths are locally called *neel*. They are easily recognised in their different stages of life and decay by their distinctive colours which vary according to the concentration of the brine. From 5° to

17° Be' the colour of the growth is green, but it turns yellowish brown and then pink which develops into rust red with a further rise in density above 20° Be'. The red colour is attributed to the bacteria which develop and feed on the dead or dormant algae. The colour differences also vary slightly from *kyar to kyar* and it would appear that several micro-organisms are responsible for this phenomenon.

5.2 The late Professor S. N. Ghosh of the Government College, Lahore, had carried out a preliminary investigation into the origin, life history and the possibilities of removal of this algae. He had reported that the organic matter the spores and other reproductive bodies of different algae are supplied to the lake water by the various riverine sources and that the elimination of algae in the entire area of 90 square miles of the lake is well nigh impossible. It is not so much the living algae which causes nuisance as the decaying matter resulting from their dead bodies which remains suspended or are in colloidal solution. This creates the chief difficulty in the manufacturing operation and, in extreme cases, turns into a gelatinous fluid from which crystallisation of salt becomes impossible. It is, therefore, necessary to devise ways and means to eliminate the dead algae and the putrefying bacteria. Dr. Ghosh had, therefore suggested

- (a) the addition of calcium hypochlorite (bleaching powder) in the proportion of 60 lbs. to a million gallons of brine at 22° Bé to prevent the putrefaction of dead algae and to facilitate its removal as a scum and
- (b) the filtering of the brine through sand and ballast before taking it into the crystallising beds.

He had further suggested a detailed investigation of the problem at the spot over a period of three years by a trained algologist, particularly the life habits of all micro-organisms involved.

5.2.1. The treatment with calcium hypochlorite was tried on an experimental scale but proved a failure. As could have been anticipated the calcium was precipitated as calcium carbonate and perhaps as calcium sulphate and added to the complex character of the brine system while the available chlorine proved inadequate to deal with the algae effectively. Some slight improvement in the colour of the salt was noticed but even if this experiment had proved a complete success we do not think it would have been possible to apply it to the vast quantities of brine to be treated. The suggestion of filtering the brine was also tried but found impracticable. It is, however, not understood why the most important suggestion of Dr. Ghosh of a detailed investigation by an algologist was not carried out. The problem is so complicated and of such great consequence to the Sambha: Works that no large scale remedy could be tried without an exhaustive investigation and we strongly recommend that this suggestion be adopted without delay. The solution of the problem may take even longer than 3 years but that should not be allowed to stand in the way of these investigations.

5.3. The area highly infected with algae is the eastern portion of the lake which lies adjacent to the bitterns area. It is a natural depression about 1000 acres in extent in which the water from the Khandel stream and the rain water from the neighbouring areas gets collected. It gets progressively enriched by the dissolution of the salt in the bed, but because the brine is highly infested with algae which exists in it as a thick suspension it is not utilised for the manufacture of salt, but is allowed to dry up forming a gelatinous mass 9 to 12 in. thick consisting of dry algae impregnated with salt. The average depth of the brine in this area when it has reached a density of 3° to 5° Bé is about 18 in. which would yield about 44,000 tons (12 lakh mds.) of salt. This area is isolated from the rest of the lake by embankments so that the algae infected

brine may not contaminate the rest of the lake brine. In the opinion of the Committee efforts should be made to reclaim this area, for which two suggestions have been made by the Works. The first is to dig up this gelatinous mass and dump it away from the lake. The second is to transfer the algae infested brine on to the bitterns area where it is expected that it would decompose due to the high concentration of the bitterns. The area might improve by a continuous repetition of either of these two operations but we would not venture to recommend the first since, obviously, it would involve heavy capital expenditure for providing only a temporary remedy. Unless the remains of the algae could be effectively removed entirely outside the catchment area of the lake, it would ultimately find its way back into the lake bed and what is now a localised affair may become a widespread nuisance. It occurs to us that a weed killer like sodium chloride may be tried more effectively in the localised area, but before any such action is taken a study by an algologist and a chemist is necessary.

## 6. RENOVATION AND EXTENSIONS

6.1 When we visited the Works a programme of expenditure for the renovation and extension of the Works and their service departments was placed before us together with a statement of the estimated increase in production that would be achieved therefrom. In these estimates there was a provision for an expenditure of nearly Rs. 7 lakhs for converting the existing 2 ft. gauge system at the Works into 2½ ft. gauge. We have omitted this item from our calculations because if any modification in the internal transport system is at all to be carried out it should be into the meter gauge system. The cost of such a conversion will be so prohibitive that we hesitate to recommend it at the present stage. For convenience of discussion the rest of the estimates has been retabulated by us and is given as Table XXI.

TABLE XXI—PROGRAMME OF RENOVATION AND EXTENSIONS  
PROPOSED BY SAMBHAR

No.	Particulars	Estimated Cost		Estimated increase in output	
		Rs.	Rs.	Tons	Mds.
<b>A. REPAIRS &amp; MAINTENANCE—</b>					
(a)	Deodani Kyar . . . . .		5,14,000	20,200	5,50,000
1.	Cleaning of 2 miles of percolation canal . . . . .	98,000			
2.	Cleaning of crystallising pans Nos. 7, 8, 9 & 10 . . . . .	4,16,000			
(b)	Gudha Kyar . . . . .	..	1,00,000	7,350	2,00,000
3.	Cleaning of 2000 ft. of percolation canal . . . . .	19,000			
4.	Cleaning of 12 pans . . . . .	81,000			
(c)	Jhapog Kyar . . . . .		1,62,000		
5.	Cleaning of 24 pans . . . . .	93,000			
6.	Cleaning of Jhapog Sambhar channel from Sulzer pumps to pump No. 1 . . . . .	69,000			
(d)	Main Line Kyar . . . . .		2,35,000		
7.	Cleaning of kyar Nos. 3 to 6 . . . . .	2,35,000			
(e)	Nawa Kyar . . . . .		2,58,000	11,000	3,00,000
8.	Cleaning of one mile of percolation canal . . . . .	42,000			
9.	Cleaning of 60 pans . . . . .	2,16,000			
<b>TOTAL</b>			<b>12,69,000</b>	<b>38,550</b>	<b>10,50,000</b>

or say Rs. 13,00,000

TABLE XXI—*contd.*

No.	Particulars	Estimated Cost		Estimated increase in output	
		Rs.	Rs.	Tons	Mds.
<b>B. CAPITAL EXPENDITURE—</b>					
(a)	Deodani Kyar . . . . .		1,44,000	11,000	3,00,000
1.	Construction of masonry wall at two ends of the canal . . . . .	9,000			
2.	Construction of 2 tributary percolation canals each 2000 ft. in length . . . . .	1,02,000			
3.	Conversion of Reservoir No. 7 to a set of condensers . . . . .	8,000			
4.	Bifurcation of pans 5 to 12 . . . . .	25,000			
(b)	Gudha Kyar . . . . .		51,000	5,500	1,50,000
5.	Construction of a tributary percolation canal 2000 ft. in length . . . . .	51,000			
(c)	Nawa Kyar . . . . .		9,46,000	14,700	4,00,000
6.	Restoration of dam . . . . .	1,32,000			
7.	Construction of second reservoir about 90 acres in area . . . . .	72,000			
8.	Construction of one set of condensers 90 acres in area . . . . .	67,000			
9.	Layout of 2 ft. gauge transport system . . . . .	3,73,000			
10.	Purchase of Rolling stock and a loco for the above transport system . . . . .	25,000			
11.	Electrifying pumping plant . . . . .	1,05,000			
12.	Purchase of additional pumping plant . . . . .	30,000			
13.	Construction of a Central Stores . . . . .	1,42,000			
(d)	Main Line Kyar . . . . .		1,59,000	29,400	8,00,000
14.	Deepening of Ghuda Sambhar channel . . . . .	1,59,000			
(e)	East Lake Bitterns Area . . . . .		1,80,000	44,100	12,00,000
15.	Formation of banks and laying of a permanent track . . . . .	1,80,000			
(f)	General . . . . .		23,47,000	18,400	5,00,000
16.	Partitioning of Main Reservoir at Sambhar . . . . .	7,86,000			
17.	Installation of washing plant at Sambhar . . . . .	5,00,000			
18.	Weighbridge at Sambhar . . . . .	25,000			
19.	Automatic filling and bagging plant for Sambhar . . . . .	1,00,000			
20.	Remodelling of Power House & purchase of Engines at Sambhar . . . . .	7,00,000			
		C.O.	43,27,000	1,23,100	33,50,000

TABLE XXI—*contd.*

No.	Particulars	Estimated Cost		Estimated increase in output	
		Rs.	Rs.	Tons	Mds.
<b>B. CAPITAL EXPENDITURE—<i>contd.</i></b>		<b>B.F.</b>	<b>43,27,000</b>	<b>1,23,100</b>	<b>33,50,000</b>
<i>(f) General</i>					
	<b>b.f.</b>	<b>21,11,000</b>			
	21. Equipment for Sambhar workshop . . . . .	31,000			
	22. Construction of Central Store at Sambhar . . . . .	1,45,000			
	23. Extension of water supply services at Ghuda and Sambhar . . . . .	2,50,000			
	24. Construction of bungalows and staff quarters . . . . .	2,35,000			
	25. Laboratory extensions . . . . .	75,000			
	<b>TOTAL</b>		<b>43,27,000</b>	<b>1,23,100</b>	<b>33,50,000</b>

say Rs. 44,00,000

The capital cost of this estimate comes to about Rs. 44 lakhs whilst the expenditure on renovations is estimated to cost about Rs. 13 lakhs. No indication was given in the programme of either the period or the order of priority in which it should be carried out. These estimates have been examined by us carefully and we are generally in favour of this programme of work being undertaken, subject to the following observations.

6.2 REPAIRS AND MAINTENANCE.—In view of the unsatisfactory state of maintenance at the works, we recommend that the expenditure of about Rs. 13 lakhs on the cleaning of condensers, crystallisers and the percolation canals should be given the first priority and completed within 2 years. These estimates were prepared on the presumption that the work will be done by manual labour; we are afraid that the time taken may extend to well over four years and some part of the work may not even be done satisfactorily. The removal of silt which has collected for several years in the percolation canals is a very uncongenial job and it is difficult and costly to get it done by manual labour. The progress of work will in any case be slow and the cost may ultimately greatly exceed the estimated amount. We, therefore, recommend that mechanical scrapers be purchased not only to carry out this work but for the regular maintenance of these canals in future. Dragline tractors which can work from the embankments of the canals might be suitable for this purpose and their usefulness should be investigated with the assistance of competent engineers, experienced in this type of work. These excavators will also be useful in cutting new canals or making extensions. If delay in obtaining such an equipment is encountered, assistance of the Indian Army be sought as they have such equipment and the necessary personnel to use it. We should also like to observe that the estimate for the cleaning of the canals was prepared before we had suggested a change in the design of the canal. In 3-3-1 we have given a sketch of this and if it is adopted, these estimates will have to be reviewed in order to provide for the modification of the canals to the new design. We

recommend that the work on cleaning and modification of the canals as also the deepening of the canals should be taken up simultaneously and the necessary funds be provided so that the work may be completed in two years. As a result of this expenditure the production at Sambhar is expected to increase by about 38,550 tons (10.5 lakh mds.) a year. This, in our opinion, is to some extent an under-estimate, particularly because no account has been taken of the increase in production which would result from the cleaning of the crystallisers at Jhapog and Main Line kyars.

6.3 CAPITAL WORKS.—As regards the capital expenditure, there are four times of major importance. The total increase in output is estimated to be about 123,100 tons (33.5 lakh mds.) and the total expenditure is taken at Rs. 44 lakhs which also includes the provision for service departments like water supply, electric power, residential quarters, etc. We consider that all this expenditure will be fully justified by the large increase in production.

6.3.1. We recommend that the undermentioned order of priority be followed to carry out these capital works and they be completed within five years:

- (a) the deepening of the Ghuda Sambhar channel and the modification of the East Lake Bitterns areas, because they would produce quick results; (Items B14 & 15 of Table XXI).
- (b) the partitioning of the main reservoir. This is necessary to conserve the brine for a longer period and supply it to the different reservoirs in the kyars. At present the brine pumped into the main reservoir is distributed to the smaller reservoirs in different kyars, but during the later part of the season the level of the brine in the main reservoir falls low and even when there is some concentrated brine left, it cannot be fed into the condensers and is dissipated by evaporation in the reservoir itself. By partitioning the main reservoir one of the sections will be converted into a deep reservoir which would conserve the available brine for a longer period. The rest of the main reservoir could be converted into additional condensers which would help to establish a better ratio between the condensing and crystallising areas (Item B16);
- (c) the remodelling of Nawa kyar. The cleaning of Nawa canals as well as crystallisers and condensers will take considerable time, and will not show quick results which would normally be expected. As soon as positive results materialise from the first two items the extensive but necessary modifications at Nawa should be undertaken. Items 9 and 10 for the transport system at Nawa and the provision of rolling stock and locos for it were based by the Works on the 2½ ft. gauge system. As the rest of the track at Sambhar is either in 2 ft. gauge or meter gauge (which is also the Railway gauge in the locality) we see no purpose in introducing yet a new gauge and, we recommend that the estimate for this expenditure be recalculated for laying the track in the prevailing 2 ft. gauge. There is an additional advantage in this inasmuch as it will provide interchangeability of tipping wagons and locomotives between Sambhar and Nawa and common servicing facilities. By the introduction of a new gauge we do not expect any reduction in the cost of transport nor do we think any further improvement is likely to arise thereby. The existing 2 ft. gauge could give all the facilities that are required by proper maintenance and attention. (Items B6 to 10 and 12).

6.3.2 With regard to the other items on the programme of capital works, we consider that work on constructing tributary percolation canals at Deodani and Gudha kyars (Items B2 and 5) should not be undertaken until the trial bores

in the lake beds have been sunk to determine the best location for obtaining subterranean brine. Item 11 refers to the electrification of Nawa kyar. This work may be deferred until this question is fully examined. At present the pumping of brine is done at Nawa by means of Diesel engines and we do not see any justification for an immediate change over to electricity. When the other expenditure on Nawa has been incurred, *viz.*, building of a dam, reservoirs and condensers (items 6 to 8) the problem of electrification might assume some importance and could then be considered. Items B13 and 22 refer to the construction of Central Stores at Nawa and at Sambhar. This expenditure may also be deferred in view of the fact that we have included in item 19 the installation of a washery at Sambhar costing Rs. 5 lakhs. Until a decision is taken on its construction and location, no expenditure should be incurred on creating additional stores. It is likely that with the installation of a washery the future stores may have to be designed on an entirely different line from the one now contemplated and this expenditure on new stores should, therefore, be held over.

6.3.3 *Washery*.—Another important item of improvement affecting the entries system of production of common salt in Sambhar which was alluded to by the Works in their programme of improvements was the installation of mechanical washing plant. (Item B17). We consider this an important item of expenditure which should be incurred with the least possible delay. In our opinion the time has come for Government to set an example to the salt manufacturers in India in the direction of setting up a high standard of purity for all the salt produced in Government-owned works. Unless Government are prepared to take a lead in this matter, we feel that private manufacturers will continue to produce inferior salt and exploit the consumers. We understand that designs and estimates are being obtained for erecting a washing plant of a modern type. We have already stated that the laboratory experiment carried out on the washing of Sambhar salt in its own brine showed that the sodium chloride content of the salt goes up from 95/96 per cent. to 98 per cent. and above. We have every reason to expect that when these operations are repeated on a large scale, the laboratory results would be reproduced, if not bettered. Also the washing will be more effective if the salt were washed soon after it is raised in order to remove more easily and satisfactorily the impurities due to the adherent mother liquor. When the washery is installed, each year's production should be washed during that year itself, and salt should be stored only after it has been washed. On the location of the washery will depend the location of the future stores and the method of storage. This question should be examined by the Works in conjunction with the design of the washery.

6.3.4. The workshop at Sambhar appears to be fairly well equipped and a good deal of repairs and maintenance as also new work such as the manufacture of tipping wagons could be undertaken in it. A provision has been made for additional equipment for the workshop to enable it to function more economically and efficiently (Item B21). The maintenance of the mechanical and electrical equipment at the Works leaves much to be desired. This was reported to be due to lack of adequate number of technical staff and skilled workers. We recommend that the technical staff at the Works should be strengthened and improved so that the workshop and the power house are able to function at a high level of efficiency, particularly as the purchase of a new power plant has been approved of by us in the programme of expenditure. If the workshop is fully equipped and properly staffed, particularly with skilled and semi-skilled workers like lathe-men, fitters, turners and machinists, we are confident that in addition to the maintenance of the Works, it can turn out 40 to 50 new tipping wagons annually. They will go towards the replacement of those that become unserviceable by heavy wear and tear which is inevitable in all salt works due to



6.3.5 Work on items B1, B3, B4 and B18 do not involve much expenditure and there should not be any difficulty in completing them quickly. They should be taken up according to the convenience of the manufacturing operations. Items B23 and B24 relate to water supply and quarters for staff. Usually there is a tendency to look upon such items as luxuries and to postpone them; but we would emphasise that living conditions in Sambhar are trying and that in the interest of efficiency it is necessary to provide these necessities. No priority has been fixed for them, because the works can be taken up independently of the manufacturing programme. We would recommend that this be done as early as possible. Item 19 relates to the installation of an automatic filling and bagging plant which we have fully discussed and recommended under 3.11.1.

6.3.6 At present the power house supplies energy for running the pumps and other installations in the Works, and the surplus is made available to the public of Sambhar town. With the extensions suggested by us, the present capacity of the power house will not be able to cope with the extra load and additional equipment will have to be provided. Situated as the Works are at considerable distance from any other source of electrical power, the power house could, with profit, make itself more serviceable to the town. By so doing, it would reduce the overhead cost of energy for the manufacturing side of the works and also increase its efficiency. It should be possible to stagger the load on the electric supply in such a manner as to dovetail the requirements of the Works with those of the rest of the public with benefit to both. It is not necessary to fix a relative priority for this work because every item of increase in the productive capacity of the salt Works will make additional demand for electrical energy. This work, therefore, deserves to be taken up immediately.

6.3.7 At present there is a small laboratory at the Works, but it is so poorly equipped and scantily staffed that it cannot carry out either any research or keep a control on the quality of the brine or the bitterns or the salt produced. It is also supposed to render routine services to the Didwana and Pachbadra Works. There is no separate staff of chemists provided for this laboratory and the work that is now being done is only in the nature of a spare time activity of the officers working on the manufacturing side. A well equipped laboratory with a suitable staff should be provided for carrying out the routine control tests and the investigations of day to day problems. To start with we suggest the appointment immediately of the following staff and laboratory equipment.---

- 1 Chemist in charge who should have the minimum qualifications of M.Sc. with experience of research in inorganic and physical chemistry.
- 2 Assistant Chemists.
- 1 Laboratory Attendant.

The existing laboratory building should also be extended. Provision for this extension and the necessary equipment have been shown in Table XXI. We strongly recommend that this proposal be sanctioned immediately and the necessary funds provided. It should be stated that the function of this laboratory will be to attend to routine work connected with the manufacturing operation and that separate provision will have to be made for research work. This aspect is dealt with separately in the Chapter on Model Factories and Research Stations.

## 7. Other Improvements.

7.1 In paragraph 3.4.1 we have made a passing reference to the possibility of collecting salt with the help of mechanical harvesters. The extent of the Works and the size of the crystallisers are such that it would pay to use mechanical devices for collecting the salt. No such mechanisation has been done in any of the salt works in India, but there is no other salt works of the

size of the Sambhar Works. We have seen references in American journals to salt being collected by mechanical harvesters in solar works in that country, and we recommend that enquiries be made in America of the possibilities of installing suitable sized harvesters at Sambhar. As we have no direct knowledge or experience of the operation of mechanical harvesters, we are unable to indicate the consequential reduction in labour that may follow. It is, however, likely that a mechanical harvester raising about 100 tons of salt per day of 8 hours could do the work of at least 60 men and will need, perhaps, only two or three men to operate it, thus saving 57 man-days for every 100 tons of salt extracted. This proposition becomes all the more attractive when we recollect that the most uncongenial part of the work that labour is required to do in a salt works is that connected with the harvesting of salt. In 3.5 we have also drawn the attention of the large quantity of salt which remains uncollected and is left over in the crystallisers owing to shortage of transport facilities. The mechanical harvesters will be able to help in the solution of this problem too as due to the speed with which it operates it will be able to collect all the salt from the crystallisers before the rains start.

7.2 In 3.9.1 we have recommended the extension of the pan works. We have not included this as an item in the estimates of expenditure under 6. This question will have to be considered in the light of

- (a) laying down additional wells, condensers and pans, and
- (b) providing pumping facilities on all the wells.

In the first instance, we would suggest that pumps be fitted up on the existing wells to determine to what extent the output from the existing pans could be increased by their installation and the economy that could be effected in the manufacturing cost. Only thereafter should steps be taken to extend this method of production on a large scale. The installation of pumps will have to be considered also in relation to the number of wells that could be served by each pump. This can be determined only by trial and experiment and we suggest that a trial may be started at an early date with half a dozen pumps, grouping the existing wells in the manner suggested by us in the Chapter on Kharaghoda.

7.3 The existing provision of tipping wagons and locomotives on both the 2 ft. and meter gauge lines is grossly inadequate for Works of this magnitude. After our visit to the Works we had recommended an immediate purchase of at least 100 tipping wagons and 4 locomotives of 2 ft. gauge to help in the raising of the salt quickly. We understand that this recommendation has been accepted and orders placed for both the locomotives and the tipping wagons. The supply of these extra wagons and locomotives, alongside the rolling stock for Nawa kyar and the new extensions as well as replacements would partially ease the transport problem at the Works. In future, after suitable extension of the workshops which has been dealt with under 6.3.4, the tipping wagons needed at Sambhar could be manufactured locally.

## 8. Research.

8.1 There are a number of problems of a technical nature awaiting urgent solution at Sambhar, the most important being the removal of sodium sulphate which occurs in the brine, in a fairly large percentage (8 to 10 per cent. of the total salts). Along with the sulphate, sodium carbonate and sodium bicarbonate are also present in appreciable proportions (3 to 4 per cent. of the total salts). If sodium sulphate could be removed systematically from the brine either before or after the deposition of salt or both, there would be considerable improvement in the yield as well as the quality of salt produced. In the present

practice the crystallisers are replenished with fresh brine from time to time and the density of the brine in them is kept below 30° Be' till, at the close of the season, the entire crop of salt which has crystallised out from brine of progressively decreasing sodium chloride content is harvested. The result is that in the later stages of crystallisation, the brine leaves behind more and more of its sodium sulphate with the crystals of common salt. Further, by the method adopted of collecting and "washing" the salt with bitters, more contamination is added to the salt by the consequential evaporation of the bitters adhering to the salt crystals. The bitters which have by then reached a density of 30° to 32° Be' are discharged into the bitters area and allowed to dry up carrying away with them substantial quantities of sodium chloride which is rendered irrecoverable together with the valuable byproducts contained in them. These problems have not received the attention they deserve and there is a mistaken notion that the presence of these other salts does not constitute any serious impurity in common salt. Also, hitherto, no standards for purity of common salt have been laid down and salt of 90 per cent. sodium chloride content has been considered acceptable. In the light of this loose conception of standard of purity, Sambhar salt was considered a salt of exceptionally good quality, because its sodium chloride content was 95/96 per cent. This is, however, a delusion which needs to be dispelled.

8.2 As the problem of removal of sodium sulphate from the brine or bitters stage is of great importance, the question deserves to be studied thoroughly and investigations should be carried out simultaneously both in the laboratory and in the field. In the Chapter dealing with Model Factories and Research Stations we have recommended the establishment of an experimental research station at Sambhar. This station should concern itself, in the very first instance, with the investigations on the removal of sodium sulphate and the other salts that are found in the brine in order to improve the quality of the salt and also to devise steps for the recovery of these byproducts. We understand that this question is also receiving the attention of the Salt Research Committee set up in 1949 by the Council of Scientific and Industrial Research and that a programme of research work is being chalked out by this Committee. It should be possible to avoid duplication in the work carried out at Sambhar and that planned by the Salt Research Committee if it is clearly understood that the latter will devote its attention to the fundamental chemical aspects of the work and arrange for it to be done in Universities and other Research Institutions. There should be no difficulty in providing field facilities through the research station at Sambhar for field trials for results of a practical nature that may be obtained in University laboratories. We recommend that the Salt Research Committee should work in close co-operation with the experimental research unit proposed for Sambhar and the Sambhar Works should render every assistance in this respect.

8.3 We have learnt that during the last few years representatives of several business firms have visited Sambhar to examine samples of the mixed salt in the bitters area with a view to their exploitation. Now that the Salt Research Committee is investigating this question and we have recommended that the Works should be provided with a research laboratory, speculative examination of the problem of recovery of the byproducts from bitters by private parties should be discouraged, particularly by persons who have no knowledge or experience of such work. When the study of the problems is completed, the Works at Sambhar should themselves be in a position to exploit these deposits and recover all the salts that are now being wasted and which are successively lowering even the quality of common salt. These deposits are the accumulation of many decades and they constitute a potential source of wealth and should be conserved for proper exploitation after a method has been devised after adequate research.

## 9. Staff and Organisation.

9.1 The organisation at Sambhar for the management of the Works consists of

- (a) General Manager.
- (b) Deputy General Manager, who is also the Chief Electrical and Mechanical Engineer
- (c) Assistant General Manager
- (d) Chief Accountant

and a clerical staff numbering 60. For the field operations there are

- (a) 6 Superintendents
- (b) 2 Deputy Superintendents
- (c) 20 Inspectors.

There are no full-time Chemists at the Works, but we understood that one or two of the superintendents are graduates in Chemistry, who devote a part of their time in the laboratory for carrying out routine analyses. There is also no Civil Engineer to take care of the maintenance of these extensive works. The other superintendents and deputy superintendents and inspectors have no technical qualifications, but have gained practical experience in the manufacture of salt during the course of their service.

9.2 For Works of this size, which are the biggest in India, this set up of both administrative and technical staff is, in our opinion, inadequate. Under the General Manager, who may or may not possess a technical qualification there should be on the staff

- (a) One Chief Chemist
- (b) One Chemical Engineer,
- (c) One Chief Electrical and Mechanical Engineer and,
- (d) One Chief Civil Engineer.

They should have under them an adequate number of technically qualified assistants. We further recommend that the superintendents and the deputy superintendents should be technically qualified *i.e.*, they should have a basic technical qualification either in Chemistry or Engineering including Chemical Engineering. We do not wish our recommendation to imply that the existing experienced staff should be replaced by a newly recruited technical staff, but we suggest that when additional staff is appointed to meet the requirements of expansion, or to fill vacancies that may arise by retirement, only technically qualified personnel possessing the basic qualification we have outlined above should be recruited. The existing number of superintendents, deputy superintendents and inspectors may be considered adequate for the present Works, but when the proposed expansion of the Works is undertaken the number of field staff will have to be correspondingly increased. There should be under the Chief Accountant two separate branches of Accounts, one to look after the normal routine administrative accounts and another a cost accounts' branch which must have a qualified Cost Accountant as its head.

## 10. Labour.

10.1 The labour force employed at the Works, both permanent and temporary, comes to about 3,350. Of this 850 are permanent hands consisting of 100 skilled and 750 unskilled workers, and the remaining 2,500 are unskilled, who are engaged for about four months from the beginning of March to the end of June

f each year for the extraction and storage of salt. The unskilled labour is drawn mostly from the nearby villages within a radius of about 25 miles whilst the skilled labour is both local and imported. The permanent labour is engaged by the Works themselves, but the temporary labour for the lifting of salt and its storage is engaged by certain recognised contractors to whom the work is entrusted.

10.2 The rates are fixed at the beginning of each season by inviting tenders from these contractors. This system may facilitate the work of the administration, but is open to many abuses. When we were at the Works we heard complaints from the labourers that the contractors were trying to beat them down in their wages and allowances. In paragraph 3.5.1 we have pointed out that payment to the contractors is made for the combined work of lifting the salt and its storage at an inclusive rate. Before the last War this rate was Rs. 13-9-0 per 1,000 cubic ft. of salt, but it has now increased to Rs. 52-1-0. (1,000 c.ft. = 29.39 tons or 800 mds.). From this rate certain deductions at fixed rates are made for the use by the contractors of the locomotives and wagons. This deduction was Rs. 4-2-0 per 1,000 c.ft. during 1938-39 and is now Rs. 9-3-0. If the nature of this work is examined it will be seen that in reality there are three different categories of operations, viz.

- (a) raising the salt and heaping it,
- (b) loading it into wagons at the crystallisers, and
- (c) unloading it at the stores.

In the interests of labour, we consider that the composite rate should be split up and two rates be fixed, one for raking the salt from the crystallisers and heaping it on the ridges and another for loading it into wagons and unloading at the stores. Working in the crystallising pans in the heat of the day is not only a tiresome operation but an unpleasant task. Standing in high density bitterns is an uncongenial operation carrying with it a certain amount of industrial hazard. The work of lifting and heaping should, therefore, be paid for at a higher rate than the work of loading and unloading. The latter rate should be exclusive of the charge for the use of locomotives, wagons, etc. We further recommend that in the interest of Government themselves the employment of contractors on manufacturing operations be gradually eliminated. A contract system for this type of work is open to many abuses and should be discouraged in Government works. There is also the grave objection that the contractors are not responsible for, nor can they be expected to care for the works. We, therefore, suggest that labour be engaged for the manufacturing operations directly by the Works and it should work under the immediate control and supervision of the management. The additional supervisory staff that we have recommended in the previous paragraph should be able to cope with this change. We should make it clear that we are not opposed to the principle of getting the work done by labour on a piece rate basis, but we do not approve of a system which depends so largely on middlemen. We recognise that to change a system which has been in vogue for many decades may be beset with difficulties, but with the growing class consciousness of labour it is advisable to take necessary steps to revise the system of employment before any serious unrest is created. We would also point out that if the Works are to be progressively mechanised, the labour force at Sambhar particularly temporary labour, is bound to be reduced. With mechanical harvesting and washing and storage of salt, a great deal of unskilled labour will be rendered superfluous, but it would be necessary to increase the strength of the skilled and semi-skilled labour.

## 11. Capital Block.

11.1 From the records placed before us we learnt that the Capital Block at the Works was assessed in 1923-24 at Rs. 49 lakhs, and its present cost is estimated to be Rs. 60 lakhs without any deduction for depreciation. In other

words, if the depreciated value of the Works were to be taken, the net cost of the capital block today might be much lower than Rs. 49 lakhs. We consider that for Works of this dimension its capital cost is very low and if a new works of similar size were to be laid down today its cost would exceed Rs. 200 lakhs. While we do not wish to suggest an inflation of the capital assets at the present scale of values, we strongly feel that a careful, itemised revaluation of the total assets at the Works be carried out under the following heads:

- (a) Land.
- (b) Civil works, viz. reservoirs, condensers, crystallisers, canals, roads, bridges, buildings, etc.
- (c) Plant and machinery including power plant, pumps, motors, workshops and other mechanical equipment.
- (d) Railway track, locomotives and wagons (both meter gauge and narrow gauge).
- (e) Residential buildings.
- (f) Water works.
- (g) Stores.
- (h) Furniture and fixtures.

This revaluation should be based on the original cost of each item plus cost of additions and deductions, if any, due to the items being rendered unserviceable or thrown out of use.

## 12. Cost of Production.

12.1 We have examined the cost of production of salt at Sambhar. Before we discuss the individual items of cost we should like to make a general observation that the method of costing employed and as shown to us is unscientific and out of date. Proper costing methods are being increasingly introduced in all manufacturing operations and their importance recognised in determining the efficiency with respect to economies in labour and cost of materials. In modern costing methods, the cost is distributed under different categories of operations, each operation being separately costed with regard to the expenditure incurred on raw material, labour, power, stores and repairs and maintenance. In salt manufacture the costing should be done from the stage the brine is led into the reservoirs till the salt is bagged and despatched. A model cost form should provide costing under the following heads:

- (a) cost of pumping brine into the reservoirs, condensers and crystallisers;
- (b) manufacturing cost, i.e. cost of operating the condensers and crystallisers and lifting salt;
- (c) cost of washing the salt (if washing is adopted including loss during washing);
- (d) haulage to store;
- (e) cost of bagging and despatch, including storage and other losses;
- (f) cost of services like electricity, water, workshop charges, etc.;
- (g) works administration charges, including the salaries of the administrative and ministerial staff, office expenses and the cost of free medical attention;

- (h) overheads, including expenses of supervision by the office of the Salt Controller and the Central Audit;
- (j) laboratory charges;
- (k) interest;
- (m) depreciation calculated at standard income-tax rates on (i) civil works, (ii) plant and machinery, (iii) traction, *i.e.* rails, locomotives and wagons, (iv) buildings, (v) housing colony and (vi) service department.

If any charges are incurred on the sale and distribution of salt they should also be shown under a separate head. The total of all these items will give the final cost of salt produced.

12.2 From the figures of cost placed before us we have reconstructed the cost per ton (27.22 mds.) under different headings of the three varieties of salt produced at Sambhar. This is shown in Table XXII.

TABLE XXII—COST OF PRODUCTION OF KYAR, RESHTA AND PAN SALT AT SAMBHAR, 1946-47

	Kyar and Reshta Per ton (in rupees)	Pan Per ton (in rupees)
(a) Cost of obtaining brine into reservoirs	1.49	3.17
(b) Labour		
(c) Power and fuel	0.54	0.54
(d) Maintenance (including repairs and betterment)	0.14	0.14
(e) Supervision	0.80	0.80
(f) Overheads	0.22	0.22
(g) Royalty and rents	4.07	4.73
(h) Interest at 4%	0.64	0.64
(i) Depreciation	0.10	0.10
(j) Any other miscellaneous charges	0.01	0.01
	8.01	10.35
Less recoveries from sale of power, etc.	0.77	0.77
	7.24	9.58
	or Re. 0.4-3 per md.	or Re. 0.5-7 per md.

12.2.1 ROYALTY.—From an examination of this cost we notice that by far the largest item is that of royalty and rents. On the other hand, excluding unclassified items which are put under miscellaneous charges, the smallest incidence of cost is for depreciation. We have shown the royalties that are being paid to the Jaipur and Jodhpur States (now to the Rajasthan Union). When the agreements with these States were drawn up the political and fiscal conditions were materially different from what they are today. We consider that these treaty rights should be revised on the basis of the changed political structure of India and also the fact that salt is no longer a source

of excise revenue for the Central Government and for which compensation could be claimed by any of the component States. Instead of a royalty agreement it might be more equitable to arrive at an understanding with the Rajasthan Union under which they become co-partners with the Government of India in the working of all the salt sources in Rajasthan. We shall deal with this question in a subsequent chapter.

12.2.2 DEPRECIATION.—We were given to understand that until 1939, depreciation for the whole of Sambhar Works used to be provided on a percentage of the capital assets, but this healthy practice was given up and an *ad hoc* meagre figure of Rs. 37,200 per annum was fixed as depreciation for costing purposes and set aside as contribution to the Renewal Reserve Fund. This amount was arrived at on the basis of the average annual cost on renewals and replacements during the previous five years. Such a procedure is difficult to understand and is unwarranted, and is opposed to established business practice, because,

- (a) it gives a false picture of the cost of salt produced at Sambhar and
- (b) the assets of Government which are public assets are as much a trust as any assets of any other public importance and should be conserved and maintained at a proper level.

In paragraph 11, we have indicated that the present capital assets of the Works are valued at Rs. 60 lakhs. Calculating the average depreciation at only 5 per cent. of this value it would amount to Rs. 3 lakhs per year which in our opinion would be the minimum depreciation that should be provided and taken for purposes of costing. If the further capital expenditure of Rs. 45 lakhs is incurred the annual depreciation would then exceed Rs. 5 lakhs which in terms of the estimated increased production would work out at a depreciation charge of Rs. 1 per ton (Re. 0.036 per md.) of salt produced. We do not consider that this is an unreasonable amount to be provided in the cost of production. In preceding paragraphs we have shown the condition of neglect to which the Works have been reduced and if depreciation is regularly provided on this revised basis a considerable reserve could be built up and spent usefully for the proper maintenance of the Works.

12.2.3 The other items in the costs to which we would draw attention are the costs of manufacture and labour which in the case of *pan* works salt is more than double that of *kyar* and *reshta* salt. This high figure is understandable, when one examines the extensive manual operations that are in vogue at the *pan* works. If pumps are introduced, as we have recommended already, we have not the least doubt that the cost of *pan* salt will come down and will bear a reasonable comparison with that of *kyar* and *reshta* salt. In fact the cost of labour for *kyar*, *pan* and *reshta* salt could be further reduced by the adoption of labour saving devices to which we have drawn attention in previous paragraphs.

12.3 PROFIT.—We understand that salt from Sambhar is being sold at cost plus a nominal profit. It has been argued that as Government was recovering an excise duty of Re. 1-9-0 per md. (Rs. 42.53 per ton) there was no justification for making a further provision for profit. Even after the removal of the excise duty, salt from Sambhar continues to be sold without adequate profit. If other Government departments like Railways, Posts and Telegraphs, Telephones, can be treated as commercial ventures and allowed to make profit, a part of which goes towards the General Revenue, there is no reason to treat Government-owned salt works as non-profit making. Since the abolition of duty Government charge a cess of Re. 0-3-6 per maund (Rs. 5.98 per ton) on the salt produced at Sambhar. This is to cover certain debits which were previously set off against the excise duty. The amount recovered as cess exceeds these debits and the excess might be looked upon as profit.



The cess at present goes to the General Revenue of the Central Government and its individuality as an income from salt sources is lost. At present Government provide separate grants for all projects for improvements to or expansion of Government salt works, but it is likely that these projects, no matter howsoever essential or profitable, may be starved of funds during periods of financial stringency. This would be detrimental to the interest of the works and we suggest, therefore, that a fair margin of profit be included in the selling price of salt at Government salt works. The Tariff Board, when they made their enquiry on the salt industry in 1930 considered that a charge of 10 per cent. on the capital invested would be a reasonable margin of profit. On a capital block of Rs. 60 lakhs for Sambhar, as shown at present, profit at 10 per cent. will work out to Rs. 6 lakhs per annum. The selling price of Sambhar salt will then be placed on a comparable footing with privately-owned salt works.

12.3.1 Recent announcements made on behalf of Government seem to suggest that future State undertakings are to be managed as far as possible on the basis of independent public corporations. We recommend that this policy be applied to the Government salt works also and their capital structure as also their management should be aligned to conform to this principle. We deal with this question in the Chapter on General Observations. Pending the establishment of a Statutory Corporation we recommend that the salt works be treated as a commercial venture and the profits that accrue from them be distributed in the ratio of 50 per cent. to the General Revenue of the Central Government and 50 per cent., towards creating a Reserve Fund to be utilised for future expansion and modifications.

### 13. Sales and Distribution.

13.1 The sale of salt at Sambhar is done through ten companies who are recognised by Government as registered brokers. The indents for salt are placed on these companies by nominees of districts where Sambhar salt is sold. These companies, in turn, place the indents on the salt works on behalf of the indentors making full payment in advance. They also supply the necessary bags for filling the salt. Lest these companies charge for the bags a price higher than the rate prevailing on the day of supply, a check on the cost of the bags is maintained by the Works Manager. The work of filling, stitching and marking the bags is done departmentally through a contractor who also arranges for the despatch of the salt bags to the various destinations. For this work a fixed charge of Rs. 2-2-0 per ton (Re. 0-1-3 per maund) is added to the selling price. The registered companies are authorised by the Works to charge a maximum of Rs. 1-11-3 per ton (Re. 0-1-0 per maund) as commission for their services to the indentors. The final selling price of Sambhar salt to an indenter (exclusive of the cost of the bags) is as under:—

	Per ton	Per maund
	Rs. a. p.	Rs. a. p.
Issue price . . . . .	8 8 1	0 5 0*
Cess . . . . .	5 15 3	0 3 6
Filling and despatch charges . . . . .	2 2 0	0 1 3
Commission of registered companies . . . . .	1 11 3	0 1 0
	<hr/>	<hr/>
	18 4 7	0 10 9

\* The price has since been enhanced by 0-7-0.

13.2 This system of making sales is subject to several abuses. The registered brokers have practically a monopoly of the salt trade, and the commission they charge is not commensurate with the services they render. Moreover, the indentors are not given the choice to select the brokers through whom they

can place the indent, but they are directed by the General Manager of the Works to go to a particular registered company. The indentors also cannot indent for the salt directly on the Works. In our opinion, the indentors should be given the choice of selecting their own registered brokers and if they so desire they should be free to place their indents directly on the Works without the agency of brokers. Prior to the zonal system the registered companies acted more or less as sole distributors of salt and had their own distributing arrangements in various markets. Even this method of distribution had its abuses. It created a vested interest and a kind of monopoly in the hands of a few parties, who after they had taken delivery of the salt could manipulate the prices to their own advantage. The intention of the Works in changing over to the present system was perhaps to prevent a sudden disruption of the recognised channels of distribution as also to ensure the facility of dealing with only a limited number of known companies or brokers. Taking all factors into consideration, we do not consider that the present method is sound or healthily conceived. We can understand that where the indentors are unable to furnish ready cash at the time of taking delivery, the services of a broker may become necessary, but where an indentor is prepared to pay cash and also arrange to supply the bags for filling the salt, no lot or hindrance should be placed in his way to indent directly on the Works. For a wide distribution of a commodity like salt, there should be no limitation to the number of dealers. The greater their number, the less chances there are for adoption of unsocial practices. At present interested parties and unsocial elements do not hesitate to stoop to create scarcity of stocks, leading to panic and black market conditions, if supplies were made available freely to as large a number of dealers as possible the chances of malpractices will be reduced. As there is no overall price control or rationing of salt, the best means of maintaining a fair price is to distribute salt on as wide and free a basis as possible.

#### 14. Summary of Recommendations.

A. A detailed geological survey of the Lake bed at Sambhar going down into the primary rock (the micaceous schist) should be carried out. Investigations to ascertain the origin of salt in the different deposits in Rajasthan and the causes for the difference in the composition of the brines should also be undertaken. (1.2.1 and 1.2.2)

B. The modified design of the percolation canal shown in Fig. 4 should be tried on a large scale. It is expected to reduce the maintenance cost and keep the canal in a serviceable condition long enough to compensate the initial cost. (3.3.1)

C. (i) The crystalliser beds should be drained of the bitterns before the collection of salt. The beds should be levelled and tamped hard so that the bitterns do not remain behind in puddles. As the beds have a layer of 3 to 9 in. of slush its removal is essential for improving the quality of salt produced. (3.4.1)

(ii) The mother liquor should be drained, condensed brine, nearly saturated, should be let into the crystalliser and the salt crust should be washed in brine before raising. (3.4.2)

(iii) All available salt should be extracted from the crystallisers before the outbreak of the rains. Even if it cannot be removed to the stores before the rains it should be heaped in the crystallisers and along the track and transferred to the stores as and when transport is available. (3.5)

(iv) To prevent any salt being left over in the pans, the method of payment to labour may be modified. (3.5.1)

(v) The present crystallising area should be reduced and converted into condensers as conditions warrant. This will reduce the cost of maintenance of crystallisers and facilitate the collection of salt. It will help in increasing the yield of salt and lower the cost of production. (3.6)

(vi) Two grades of salt should be harvested, one between 26° and 29° Be and another between 29° and 32° Be. The exact limits should be determined for the different qualities of brine available by preparing a chart showing the progressive separation of salts on evaporation and co-relating it to the density and reduction in volume. This work should be done systematically and form part of the routine records and reports of the Works. (3.7)

D. The rain water that collects in the East Lake Bitterns Area and dissolves out the bitterns salts is a potentially rich source of common salt and should be exploited. A suitable method of disposal of the sewage of Sambhar town should be worked out to prevent its draining into this bitterns area. (3.8)

E. The production of salt in pans, utilising the brine from wells, should be undertaken under direct Government management on a large scale. Improved methods for lifting the brine by pumps should be used and the pans should be laid out on more scientific lines. We also suggest that trials may be made by grouping a number of wells by a single pump. (3.9.1 and 7.2)

F. A permanent track should be laid from the bitterns area to the stores to convey the *reshla* salt. (3.10)

G. The present method of storing salt should be modified. Mechanical means should be employed for storing, bagging and loading salt in order to simplify the operations, reduce the labour employed and cheapen the cost. (3.11 and 3.11.1)

H. As washing experiment with Sambhar salt has shown the possibilities of bringing about an improvement in the quality, further experiments on a larger scale should be conducted with a view to introducing washing as a part of the manufacturing operations. (4.2.1)

J. A detailed investigation of the algal problem, as suggested by the late Dr. S. N. Ghosh, should be carried out at Sambhar by a trained algologist and a chemist. (5.2.1 and 5.3)

K. (i) Among the programme of maintenance of works shown in Table XXI the cleaning of crystallisers, condensers and the percolation canals should be given the first priority. Mechanical scrapers should be purchased to clean the percolation canals. Dragline tractors which can work from the embankments of the canals might be suitable for the purpose and their usefulness should be investigated. These excavations will also be useful in cutting new canals. (6.2)

(ii) In the programme of Capital Works shown in Table XXI the following order of priority should be given among works of major importance and should be completed in the course of five years:

- (a) the deepening of the Gudha Sambhar channel and the modifications of the East Lake Bitterns area;
- (b) the partitioning of the main reservoir;
- (c) the remodelling of Nawa. (6.3.1)

(iii) Expenditure under items 9 and 10 which relate to the provision of a 2½ ft. gauge track in Nawa and the necessary rolling stock should be recalculated for the prevalent 2 ft. gauge track. If any modification in the initial

transport system is contemplated it should be to the meter gauge system, but such a step is not recommended at this stage as the cost of conversion would be prohibitive. (6.3.1)

(iv) Out of the programme of Capital works shown in Table XXI, Items B2 and B5 which relate to the construction of percolation canals should be deferred until trial bores in the lake bed have been sunk to determine the best location for obtaining subterranean brine is carried out. Items B13 and B22 which relate to construction of stores should also be deferred until a decision is taken on the construction and location of a washery, as the future stores will have to be designed on entirely different lines. Item B11 which relates to the electrification of Nawa should be closely examined and undertaken only after satisfying its essentiality. (6.3.2)

(v) A mechanical washing plant should be installed without delay. The salt should be washed soon after it is raised in order to remove the impurities more easily and satisfactorily and stored only after it has been washed. (6.3.3)

(vi) A well equipped laboratory with a suitable staff should be provided for carrying out the routine control tests and investigations of day to day problems. (6.3.7)

M. The size of the crystallisers at Sambhar lend themselves easily for mechanical harvesting and the possibility of using them at Sambhar should be investigated. (7.1)

N. Additional tipping wagons and locomotives should be provided to ease the transport problem at the works. The tipping wagons should be manufactured in future at the workshop at Sambhar after suitably increasing the equipment and the staff. (7.3)

P. (i) The problem of removal of sodium sulphate from the brine or the bitters should be subjected to a thorough study and investigations carried out simultaneously both in the laboratory and at the works in the field. (8.2)

(ii) The mixed salt in the bitters area constitutes a potential source of wealth and should be properly conserved for exploitation after a method has been devised for the recovery of their components. (8.3)

Q. The administration and the technical staff at the Works is inadequate and under the General Manager, the following technical staff should be provided:

- (a) Chief Chemist, (b) Chief Chemical Engineer, (c) Chief Electrical and Mechanical Engineer and (d) Chief Civil Engineer.

A cost accounting branch should be added to the Accounts section. (9.2)

R. In the interest of labour the composite rate for raising the salt and loading and unloading it should be split up into two different rates. The employment of contractors on manufacturing operations should be gradually eliminated and the labour should be engaged directly by the Works. (10.2)

S. A careful itemised re-valuation of the assets of the Works should be carried out under different heads. (11.1)

T. (i) In the items of cost the largest item is the royalty and rents paid to the States of Jaipur and Jodhpur. They should be revised on the basis of the changed political structure of India and also as salt is no longer a source of excise revenue. (12.2.1)

(ii) Proper rate of depreciation should be provided in the cost and reserves built up which can be spent usefully for the proper maintenance of the Works. (12.2.2)

(iii) Costs of salt will be reduced by the employment of pump wherever needed and the introduction of mechanical appliances. (12.2.3)

(iv) The salt works should be treated as a commercial venture and a fair margin of profit at 10 per cent. of the capital block be allowed in arriving at the selling price. 50 per cent. of the profits that may accrue should be paid to the General Revenue of the Central Government and 50 per cent. towards building a Reserve Fund to be utilised for future expansion and modifications of the Works. (12.3 and 12.3.1)

U. The present practice of marketing the salt through a limited number of registered companies is not sound or healthily conceived. Salt should be distributed as widely as possible and no restriction should be placed in the way of the indentors getting their supplies direct from the Works if they so desire. (13.2)

## CHAPTER VII

### DIDWANA

#### 1. Description

1.1 The Didwana Salt Works are situated in a depression 40 miles to the north west of Sambhar Lake in the same desert belt and within the territory of the former State of Jodhpur. The depression covers about 6 square miles and is about 4 miles long and  $1\frac{1}{2}$  miles wide. The rainfall varies between 12 to 24 inches and the average may be taken at about 15 inches. The rain water from the surrounding area collects in the shallow basin, but unlike Sambhar no salt is manufactured from the resulting surface brine, because the water either percolates below or evaporates very rapidly. The area is subject to severe fluctuations in temperature. From November to February the minimum night temperature varies from  $50^{\circ}$  to  $34^{\circ}$ F. whilst from the middle of March to the end of June the maximum temperature varies from  $100^{\circ}$  to  $120^{\circ}$ F.

1.2 The soil of the basin consists of black silt as in Sambhar and extends to a depth of 10 to 15 feet. No record, as far as we could gather, is available of the character of the different strata of soil below the silt. We recommend that as at Sambhar a detailed study of the strata up to the basic rock be carried out in order to determine not only the nature of the strata but also the extent and origin of the salt bearing stratum.

1.3 The brine for the manufacture of salt is tapped from the subsoil source in the central portion of the basin, by means of wells which are 14 ft. deep and 5 to 6 ft. in diameter. There are 140 wells at present and for every well there are 2 to 3 crystallisers. The wells are renovated each year and the brine is drawn in earthen buckets by manual labour. The brine varies in density from  $15^{\circ}$  to  $23^{\circ}$ Be' and is rich in sodium chloride and sodium sulphate as will be seen from the analysis given in Table XXIII. The presence of these salts in the brine is attributed to the same factors which enrich the brine at Sambhar Lake.

TABLE XXIII—ANALYSIS OF DIDWANA BRINE

	(Percent, on dry basis)
Sodium chloride . . . . .	65 to 77
Sodium sulphate . . . . .	31 to 19
Sodium carbonate . . . . .	2
Sodium bicarbonate . . . . .	2

1.4 We have referred in Chapter II to the occurrence of salt lakes in other parts of the world under arid conditions similar to Didwana. Of the various lakes mentioned, the salt lakes of California show a great resemblance to the lakes in the Rajputana Desert. The resemblance between the Didwana Lake and the Dale Lake in California is particularly remarkable. The Dale Lake is also a subterranean lake, covering an area of 1,500 acres with brine containing mainly sodium chloride and sodium sulphate in the ratio of about 75 to 25. For three or four months each year, the day temperature at Dale Lake ranges from  $100^{\circ}$  to  $140^{\circ}$ F whilst during the winter months the night temperature is always below  $50^{\circ}$ F. Advantage is taken of these variations in temperature by the Desert Chemical Company of California for effecting the separation of the two salts from the Dale Lake brine. Sodium sulphate is first allowed to separate out during the cold months and the residual brine is made to yield

sodium chloride by solar evaporation during the hotter months. By this process as much as 50,000 tons of sodium sulphate are produced every year in addition to a large quantity of common salt. In Didwana unfortunately the manufacture of salt is carried on by traditional and primitive methods and advantage is not taken of the changes in temperature to bring about the separation of the two salts. The manufacture is in the hands of *Deshwals*, a clan who claim hereditary rights to the manufacture of salt at Didwana, who dig the wells and lay out the crystallising pans at their own expense.

## 2. Manufacturing Rights

2.1 By a treaty concluded in 1879, the four salt sources *viz.* Didwana, Pachbadra, Falodi and the Luni tract of the then Jodhpur State were leased to Government who undertook:

- (a) to pay the State annually a rent of Rs. 3,76,000/- and a compensation of Rs. 1,60,392/- for the stoppage of the manufacture of salt by the State and
- (b) to supply free of excise duty
- (i) 8,270 tons (2,25,000 mds.) for the use of the people of the State and
- (ii) 370 tons (10,000 mds.) free of all charges for the use of the Durbar.

## 3. Manufacturing Process.

3.1 The Salt Works are divided into two sectors, *viz.* South Dariba Mata and North Dariba Bore measuring 248 acres and 15 acres respectively. The area under salt cultivation is about 263 acres made up as under:

	acres
Crystallising pans . . . . .	151
Platforms . . . . .	100
Storage yards . . . . .	12
Total . . . . .	263

The total number of crystallising pans is 388, but all of them are not brought into use each year. Only about 349 pans are in use at present. This is partly due to the fact that several of the pans have heavy deposits of sodium sulphate and they have been handed over to the Jodhpur Government (now Rajasthan Union) for the extraction of sodium sulphate. The pans vary in size from 50 ft. x 120 ft. to 60 ft. x 180 ft. In the old section of the Works they not only vary in size, but are also irregularly laid out which is not conducive to a convenient and economic recovery of salt. Steps will have to be taken to realign these pans to a standard size with a width not less than 40 ft. and a length of 100 ft. or more. Steps should also be taken to provide the necessary pathways to facilitate the collection and removal of the salt.

3.2 The manufacturing operation does not start till the end of February, because of the fear that the sodium sulphate present in the brine will deposit in the crystallising pans along with the sodium chloride during the cold nights. Since the density of the brine is high, no condensers are provided and the brine is charged directly into the crystallising pans to a depth of 2 inches and replenished daily to make up for the loss by evaporation. The hard crust of sodium sulphate which forms naturally during the process of manufacture constitutes the floor of the crystalliser and the common salt that deposits on this floor is raked by wooden scrapers into ridges to prevent the crystals from attaching themselves firmly to the floor. When the quantity of salt formed in the pan increases and the ridges take up more of the space in the pan, the

lifting of the salt is started. The first crop is taken out after a period of 30 to 40 days from the initial charging of the brine. As the season progresses, the succeeding crops are extracted at intervals of 20 days or even less. As the bitterns are not eliminated from the pans, the quality of salt deteriorates progressively as shown in the following Table XXIV.

TABLE XXIV—ANALYSIS OF DIDWANA SALT  
(Crop by crop)

	1st	2nd	3rd	4th	5th
	(Percent,	on dry	basis)		
Sodium chloride . . . . .	90.69	87.57	86.66	83.37	85.56
Sodium sulphate . . . . .	7.25	9.90	10.49	12.39	11.69
Sodium carbonate, sodium bi-carbonate etc. . . . .	2.06	2.53	2.85	4.24	2.75
	100.00	100.00	100.00	100.00	100.00

3.3 GRADES.—The salt is graded into 3 varieties depending on its quality; the first grade usually consists of the 1st crop, the second grade of the 2nd and 3rd crops and the third grade of the subsequent crops. The three grades are paid for by Government at different rates which are fixed each year at the beginning of the manufacturing season. For the season 1947-48 they were as follows:

	1st Grade	2nd Grade	3rd Grade
	Rs. A. P.	Rs. A. P.	Rs. A. P.
Per ton . . . . .	4 4 0	3 15 6	3 10 9
Per maund . . . . .	0 2 6	0 2 4	0 2 2

In our opinion the quality of all the grades is poor and the salt is unfit for human consumption; at best it can be used as cattle feed. In order to prevent this salt from being sold for human consumption we suggest that it be cast into blocks for use as salt licks for cattle. This should be quite easy, because of the high content of sodium sulphate and sodium carbonates which would help the salt to set into hard blocks. A quick and easy market for these blocks can be found in the Punjab (India) and western parts of U.P. where rock salt was formerly in demand as salt licks.

3.4 From the crystallising pans the salt is carried by head loads or on pack animals to the storage yards which are situated at a distance of about half a mile from the pans. This mode of haulage is costly and can be considerably cheapened by providing a 2 ft. gauge track for internal transport to the storage. It was pointed out to us that the track may be submerged under water during the rains and its life would be considerably reduced. This difficulty can be got over by a proper embankment. As in Sambhar, the salt produced in any year is sold only in the succeeding year. From the storage yards the salt is carried by bullock carts or on camels to the nearest railway station of Italia which is  $1\frac{1}{2}$  miles away.



#### 4. Annual Production

4.1 The production of salt for the past three years is as under:—

	Tons	Maunds
1946 . . . . .	27,000	7,34,000
1947 . . . . .	32,000	8,61,000
1948 . . . . .	47,400	12,90,000

The average yield per acre of crystallising pans works out to about 185 tons (5,000 mds). Notwithstanding the high density of the brine available the yield per acre is small because the manufacturing season is restricted to only about four months. Were the operations commenced earlier, the yield per acre could be much higher. The manufacturing operations start at present about the end of February or the beginning of March largely due to two apprehensions

- (a) that the brine wells and the crystallising pans cannot be got ready for manufacture till the accumulated flood water after the rains has dried up, and
- (b) that the sodium sulphate present in the brine will separate out in large proportions with common salt in the cold season if the manufacturing operations were started earlier.

4.1.1 With regard to the former apprehension, our own information is that the percolation of water at Didwana is so rapid that it is only during very heavy rains that the wells and the crystallising pans get flooded out. Normally there should be no difficulty in drawing the brine early in the season. If, however, it is found that this is not possible, an easy solution of the problem could be found by constructing a small bund round these wells and crystallising pans which would keep out the flood water and permit an earlier start of the manufacturing operations. As regards the latter, it could be obviated to a large extent if the brine from the wells is transferred to a condenser and not directly fed into the crystallising pans as at present and allowed to concentrate till it gets saturated with respect to sodium chloride. Owing to the low temperature of the cold weather, especially in the nights, an appreciable quantity of sodium sulphate present in the brine will separate out by the time the brine is saturated with respect to sodium chloride.

4.2 In 1948 the production reached the peak figure. The Works have proposed to raise this output still further to about 73,500 tons (20 lakh maunds) per annum by increasing the number of brine wells and crystallising pans. There is, however, not enough demand for this salt due to its poor quality and it is found difficult to dispose of even the present production. There is, therefore, no point in increasing the production without improving its quality or finding a wider market for it as salt lick.

#### 5. Improvement of Quality

5.1 The improvement in quality can be effected by carrying out a preliminary separation of sodium sulphate from the brine. A double advantage will be gained *viz.* a valuable byproduct will be recovered and the quality of salt obtained as a result of it will be fit for human consumption. This separation can be carried out by taking advantage of the natural fluctuations in atmospheric temperature at Didwana. Even now without any conscious effort in this direction, sodium sulphate (anhydrous) is depositing on the floor of the crystallising pans in successive layers which, in some of the old pans, have grown to a thickness of 6 to 24 inches. The present method of manufacture needs, therefore, a radical revision.

5.2 Appendix B gives the mutual solubility of sodium chloride and sodium sulphate at different temperatures. A solution containing about 22 per cent. sodium chloride at 50°F can hold in solution only about 8 per cent. sodium sulphate decahydrate which is equivalent to 3.5 per cent. of the anhydrous salt. When the brine at Didwana is concentrated and reaches the point of saturation with respect to sodium chloride, its sodium sulphate content will have risen to 6 to 11 per cent. and this brine on cooling to 50°F or below will have deposited an appreciable quantity of its sodium sulphate. The residual sodium sulphate remaining in the brine will be then too small to get deposited with common salt when the latter starts separating. Small quantities that may be deposited during the night will get redissolved during the day.

5.2.1. As no attempt has hitherto been made to condense the Didwana brine to saturation point before charging it into the crystallisers, the exact density of the brine of this status will have to be determined to guide the manufacturing operations. As a first step, therefore, one of the crystallising pans near to each well should be converted into a condenser and charged with brine towards the end of October. The actual size of the condenser will depend on the density of the brine available, which varies from 15° to 23° Bé. As the density is quite high, we do not think that any large area will be required for the condenser. One crystalliser out of a set of two or three which are at present provided for each well should be sufficient for the purpose. It should be emphasised that the brine in the condensers should be allowed to reach a density of 23° Bé in order to permit the maximum separation of sodium sulphate, and as the evaporation progresses, fresh brine should be let into the condenser so that it is kept fully charged. The condensed brine can then be taken into the crystallising pans where salt of high purity will separate out on further evaporation. The salt may be allowed to remain in the pan and to grow by accretion. Care will have to be taken to see that the brine is fed only in the early hours of the day to take full advantage of the low temperatures reached during the night and to prevent any sodium sulphate redissolving into the brine with the increase in temperature during the hotter part of the day. The saturated brine in the crystalliser should not be allowed to rise in density above 28° to 29° Be' and the bitterns should be eliminated periodically. To ensure that the bitterns carry away with them as much of the remaining sodium sulphate as possible, this elimination should also be carried out during the hottest part of the day.

5.3 This procedure would entail an appreciable difference between the quality of salt obtained during the colder parts of the year and that obtained during the summer months. In an ideal plan, the entire brine should be subjected to a precooling in condensers, but this would involve many radical changes in the design and the layout of the works at Didwana. For the present, therefore, we recommend that the manufacture of salt be started as early as possible and as much brine as possible be lifted during the cold season and subjected to this pre-cooling to allow sodium sulphate to get deposited. When the temperature rises and the pre-cooling is no longer effective even during the coldest part of the night, the efficiency of elimination of sodium sulphate will be reduced and the salt obtained under these conditions will not attain the quality reached during the earlier part of the season. We, therefore, further recommend that the crops obtained from the winter operations should be harvested separately by the end of February and marketed as edible salt. Even though the subsequent crops would be better than the quality obtained at present they may not be of edible quality and may be cast as salt licks as recommended in 3.3. If as a result of this modification the improvement in the quality of even the hot weather crops is substantial it may be possible to instal washing arrangements at Didwana, as suggested in the case

of Sambhar, to improve the quality still further. This may not be immediately feasible owing to the paucity of water.

5.3.1 As a considerable portion of the sodium sulphate will be removed by the process outlined above, the composition of the bitters obtained from the crystallisers at 28' to 29' Be' will be very similar to that of the bitters at Sambhar. The observations made with regard to the disposal of the bitters of Sambhar will hold good for the Didwana bitters also. No attempt is made at present at Didwana to remove the bitters, and, therefore, the sodium sulphate and sodium carbonate associated with the sodium chloride remain as impurities in the salt. When the practice recommended in the previous paragraph is followed, it will also be necessary to provide a separate pan for the discharge of the bitters where they may be allowed to collect and evaporate until a method is evolved at Sambhar for the recovery from them of the residual sodium chloride as also sodium sulphate and sodium carbonate.

5.4 Harvesting of Sodium sulphate—Unlike common salt which will have to be harvested in at least two crops during a year and which may be raised oftener if the conditions of the crystallisers demand it, the collection of sodium sulphate will have to be left over to the end of the manufacturing season when it can be raised from the condensers. Though the sodium sulphate will be deposited during the winter as a decahydrate ( $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ ) it will lose its water of crystallisation on exposure to the heat of the summer months and get converted into the anhydrous state in which form it is usually marketed. If necessary, the recovered sodium sulphate can be left in the open for a wash during the monsoon to free it from mud and any contamination with sodium chloride. An analysis of the different layers of the deposits of sodium sulphate locally known as *rohr* which are being excavated at present from the abandoned crystallisers, is shown in Table XXV.

TABLE XXV—ANALYSIS OF ANHYDROUS SODIUM SULPHATE  
(Percent on dry basis)

	Bottom Layer	Middle Layer	Top Layer
Sodium Sulphate . . . . .	93.75	97.56	98.31
Sodium chloride . . . . .	1.57	1.20	1.14
Sodium carbonate . . . . .	0.32	0.14	0.12
Insolubles . . . . .	4.36	1.10	0.43
	100.00	100.00	100.00

It will be seen that sodium sulphate is separating out in a fairly pure condition and its quality will be comparable to any of the commercial, imported grades of sodium sulphate, if only contamination with insoluble impurities like clay etc. is avoided during its separation. A very much improved yield and a better product will be obtained by conducting this separation on scientific lines as suggested in the preceding paragraph.

5.5 We suggest that this modified method of manufacture be tried out immediately, if not in the entire Didwana area, at least in one of the two sectors where manufacturing operations are now carried out. If the results of this trial prove convincing, and we have no doubt that they will be successful, the question will then have to be considered for a complete relaying of the Didwana salt area on the lines of the process followed at Dale Lake in California. It may be pointed out that the area under salt production at present at Didwana

is barely 151 acres which is about one-fourth of a sq. mile as against the total area available of 6 sq. miles. We are satisfied that the manufacture of salt on a much larger scale than hitherto is possible at Didwana, provided

- (a) the quality of the salt is improved and
- (b) an increasing demand is created for it.

In addition to an increase in the output of salt a large scale recovery of sodium sulphate is also possible. From the quality of brine available at Didwana, we believe that for every ton of salt produced it will ultimately be possible to recover  $\frac{1}{4}$  to  $\frac{1}{3}$  of a ton of sodium sulphate.

5.6 The proposed modifications may be resisted by the Deshwals who may not be amenable to a radical departure from their traditional practices. Whilst we have no desire to throw this clan of workers out of employment, we recommend that their claim to any hereditary rights be examined in the context of present day conditions. If these claims are to be recognised it should only be on the understanding that they undertake to adopt the modified method of manufacture. This method will in fact give them employment for a much longer period than hitherto and they can further augment their earnings by recovering the sodium sulphate that will be depositing in the condensers.

## 6. Extensions to the Works

6.1 The General Manager, Sambhar Works, placed before us a proposal to spend Rs. 15 lakh at Didwana in order to increase the production from about 29,400 tons (8 lakh maunds) to about 73,500 tons (20 lakh maunds). We have already mentioned that without an improvement in the quality of salt, which can be brought about only by a radical revision in the method of manufacture, there will be no purpose in increasing the production at Didwana. No detailed estimates as to how Rs. 15 lakhs were to be spent were placed before us but the only indication given was about the following two items:

- (a) erection of a central stores near the Balia Railway Station and
- (b) provision of a 2 ft. 6 in. gauge rail track from the Works to Balia together with the necessary rolling stock.

6.1.1 We are not satisfied about the necessity of having a central stores near the railway station as we do not see any advantage in it. There is sufficient space in Didwana itself for additional storage yards as and when the production increases, whereas by providing the stores at Balia additional expenditure will have to be incurred in engaging watch and ward and supervisory staff to look after the stores. With regard to the need for improvement in haulage and transport, we are in agreement with the Works that mechanical traction should be provided. We have already suggested in 3.4 the construction of a 2 ft. gauge rail track for haulage within the Works itself as it will be considerably cheaper than the  $2\frac{1}{2}$  ft. gauge track suggested by the Works. For transporting the salt from the storage to the railway station of Balia we suggest that Government should ask the Railway Board to construct a metre gauge railway siding from the Station to the Works, as that would facilitate the despatch of salt and economise in the cost of transport. This, in our opinion, will be a better course to follow than providing a 2 ft. 6 in. gauge line from the Works to the Railway station.

6.2 In the Works proposal no mention was made for the cost of digging new wells or increasing the number of pans, as it was presumed that the present practice of allowing the Deshwals to do this work would be continued. We are not in favour of this practice and any modifications that are to be made to

the layout of the Works should be carried out by Government at their own expense, the Deshwals being only allowed to conduct the manufacturing operations on a lease or licence. If our recommendations are accepted, the cost of re-laying the Works may probably go into several lakhs of rupees for which careful estimates will have to be drawn up, with the help of a civil engineer.

6.3 No labour saving devices have been adopted at Didwana nor recommended by the Works. If, instead of drawing brine by manual labour or with the help of draught animals as at present, pumps were provided, the cost of lifting would be greatly reduced. A number of wells grouped together, could be served by a single pump. As electric power is not available, and we see little likelihood of any being provided in the near future, these pumps will have to be driven by diesel oil.

## 7. Staff and Organisation

7.1 The present staff at Didwana consists of:

- (a) One Superintendent,
- (b) Two Inspectors, and
- (c) the necessary clerical staff.

As the wells and the pans are owned by the Deshwals the labour at the Works is engaged by them. The total labour strength is about one thousand and is drawn from the surrounding villages within a radius of 10 miles. The field operations are supervised by the Superintendent and the Inspectors. The entire staff works under the general direction and control of the General Manager at Sambhar whose office also looks after the accounts side of the Works.

7.2 The existing staff will be inadequate to carry out the modified procedure we have suggested and will have to be augmented. The modified system of manufacture to become a success will need a close chemical control of the operations and the presence of a full time Chemist at the Works will be necessary. A laboratory for conducting routine analysis and other control operations will also be needed. The chemist will work under the technical direction of the Chief Chemist, we have suggested for Sambhar Lake, who will have to be held responsible to see that the chemical control is correctly executed. A Civil Engineer should also be appointed to carry out the modification and he will work under the direction of the Chief Civil Engineer at Sambhar. Although the office at Didwana may continue to work under the general supervision of the General Manager at Sambhar, we believe that, in the interests of efficiency, Didwana should have its own Accounting staff to keep a closer control over the expenditure incurred at the Works.

## 8. Capital Block

8.1 The capital invested by Government at the Didwana Works is on the works, office and residential buildings. Their original cost was estimated at Rs. 24,000 in 1923-24 and stands today at about Rs. 23,000. As the Works are laid out by the Deshwals at their own cost, no capital cost of the Works is taken into account. If our recommendations are accepted and the Works are relaid by Government considerable capital expenditure will be necessary and at that stage the capital block of the entire Works should be

## 9. Cost of Production

9.1 Due to the peculiar system prevailing of purchasing salt from the Deshwals, no itemised figures of cost of production are available. The present practice is for Government to fix, at the beginning of each season, a rate at which Government would buy the salt from the Deshwals. This rate is varied from period to period and is made up of two items, one for the salt harvested and the other for its haulage to the storage yards. Before the last war the price paid for the harvested salt varied from Rs. 0-15-10½ to Rs. 1-4-5 per ton (7 to 9 pies per maund) depending on the grade produced. For the season, 1948-49 it was fixed at Rs. 4-4-0 per ton (Rs. 0-2-6 per maund) for the first grade, Rs. 3-15-5 per ton (Rs. 0-2-4 per maund) for the second grade and Rs. 3-10-11 per ton (Rs. 0-2-2 per maund) for the third grade. The haulage cost has also similarly varied. Before the War, it used to be from Rs. 0-12-6 to Rs. 1-1-0 per ton (5½ to 7½ pies per maund) depending upon the distance of the pans from the storage yards. It has now gone up from Rs. 2-15-8 to Rs. 3-11-0 per ton (from 21 pies to 26 pies per maund.)

9.2 In addition to the above payments there are other charges to be added to the cost such as maintenance of buildings, depreciation, supervision, royalties etc. We have reconstructed the cost in Table XXVI for the last year for which complete figures were available (1946-47).

TABLE XXVI—COST OF PRODUCTION OF DIDWANA SALT (1946-47)

	1st & 2nd grade Rs.	3rd grade Rs.
	(Per ton)	
(a) Cost of salt harvested . . . . .	3.60	2.98
(b) Haulage to stores . . . . .	2.51/2.98*	2.51/2.98*
(c) Maintenance . . . . .	0.04	0.04
(d) Supervision . . . . .	0.42	0.42
(e) Overheads . . . . .	0.09	0.09
(f) Rents and royalty . . . . .	0.68	0.68
(g) Interest . . . . .	0.04	0.04
(h) Depreciation . . . . .	0.01	0.01
(i) Miscellaneous . . . . .	0.04	0.04
	7.43/7.90	6.81/7.28
or Per maund . . . . .	0.4.4 0.4.8	0.4.0 0.4.3

\*The lower figure is for haulage from North Dariba Bore Section and the higher for the South Dariba Mata section.

We have commented at considerable length in the Chapter on Sambhar on the method of costing and these comments hold good with regard to Didwana costing also. The depreciation rate of Rs. 0.01 per ton is almost negligible and works out to a depreciation of a little over 1 per cent. of the capital cost of the building. The life of the buildings in the corrosive atmosphere of a salt works cannot be taken at more than 40 years and on this basis alone the depreciation should be at least 2½ times the present rate.

## 10. Sales and Distribution

10.1 As against the cost of Rs. 6.81 to 7.90 per ton (Re. 0-4-0 to Re. 0-4-8 per maund) depending upon the rate and place of extraction, the selling price of all the three grades was fixed by Government for the year 1946-47 at a uniform rate of Rs. 7.65 per ton (Re. 0-4-6 per maund). Thus, as at Sambhar, the salt from Didwana was sold at little or no margin of profit. This price was ex-works Didwana and to it had to be added the cess of Rs. 5.95 per ton (Re. 0-3-6 per maund). As at Sambhar, the salt is sold through one registered company of brokers who are allowed to charge a commission of Rs. 2.55 per ton (Re. 0-1-6 per maund). In this commission is included the charge for filling, stitching and marking the bags which are supplied by the brokers. The cost of gunny bags and the transport charges from the Works to the Balia railway station are extra. The total selling price of Didwana salt for the year 1946-47, was, therefore, as under:

	Per ton.	Per Maund.
	Rs. A. P.	Rs. A. P.
Issue price . . . . .	7 10 6	0 4 6
Cess . . . . .	5 15 3	0 3 6
Commission . . . . .	2 8 10	0 1 6
Total . . . . .	16 2 7	0 9 6

10.2 Owing to the poor quality of Didwana salt its sale, except in a few small areas where it continues to be sold for human consumption, is now restricted to industrial uses. Its chief industrial use has hitherto been for the curing of raw hides and skins, but we understand that both the foreign and Indian tanners have complained that the curing is adversely affected by the use of this salt owing to its high sodium sulphate content.

## 11. Recovery of Sodium Sulphate.

11.1 In 1941 Mr. J. M. Saha, Chemical Examiner to the Collector Central Excise and Salt, Delhi, identified the *rohr* deposits in the crystallising pans of Didwana as consisting almost entirely of anhydrous sodium sulphate. He pointed out the value of these deposits as a source of sodium sulphate of which there was a shortage during the War. The Government of India decided to exploit these deposits, but on a strict legal interpretation of their treaty rights with the Jodhpur Durbar it was discovered that the Didwana Salt Works were leased to the Government of India for the manufacture of common salt only and they could not exploit any other salt. Consequently the exploitation of these deposits was taken over by the Jodhpur Government who have been extracting and marketing the sodium sulphate since 1942. There are 250 pans at Didwana which have these deposits of sodium sulphate varying in thickness from 6 to 24 inches. On an approximate estimate the quantity available in these pans is 1,83,700 tons (50 lakh maunds). These deposits are firmly set and are dug out by means of crowbars and hammers and shaped into blocks of convenient size. The production for the last six years is as under:

	Tons	Maunds
1943 . . . . .	6,240	1,69,800
1944 & 1945 . . . . .	9,920	2,70,000

	Tons	Maunds
1946 . . . . .	1,650	45,000
1947 . . . . .	8,080	2,20,000
1948 . . . . .	9,100	2,47,600

In Table XXV we have given the analysis of the Didwana sodium sulphate and, as stated there, except for the insoluble impurities like clay, the quality is comparable to the imported material.

11.1.1 If the modified system of manufacture of salt at Didwana is accepted much larger quantities of sodium sulphate would become available annually as a byproduct of the salt industry. Even then the recovery of sodium sulphate from the old crystallisers should be continued without interruption and at a faster rate by using compressed air drills in order to bring back these pans into use either as condensers or crystallisers. The use of the drills will also help to cheapen the cost of extraction.

11.2 COST OF PRODUCTION—The cost of sodium sulphate at Didwana as arrived at from the figures given to us is shown in the Table XXVII.

TABLE XXVII—COST OF DIDWANA SODIUM SULPHATE PER TON

	Rs.
(a) Excavation charge . . . . .	1.70
(b) Reconditioning of pans . . . . .	1.23
(c) Contribution to Deshwal Benefit Fund . . . . .	1.70
(d) Bagging charges including the cost of bags . . . . .	10.20
(e) Transport to storage yard and Balia Rly. Station . . . . .	3.00
	17.88

No provision is made in this break-up for the overheads or establishment charges of the Jodhpur State (now Rajasthan) but assuming that this may work out to about Re. 1 per ton, the total cost would be Rs. 18.88 or say Rs. 19 per ton. The cost of the bags is more than 50 per cent. of the total cost and as the anhydrous sodium sulphate is not as easily soluble as its hydrated variety (Glauber salt), we do not think it necessary to pack it in gunny bags particularly for bulk users. Packing in bags provides little additional protection during the rains and the loss by dissolution would be negligible. The buyers should, therefore, be given the option to accept it in bulk in which case the price would be reduced to the extent of the cost of the bags. Bagging may be necessary when there is a break in the railway gauge in order to prevent loss in transhipment.

11.3 SELLING PRICE—As against the cost of Rs. 19 per ton, the selling price charged by the Jodhpur Durbar at one time was Rs. 95 per ton but it has been subsequently reduced to Rs. 75 per ton, f.o.r. Balia. The imported price of sodium sulphate before the War was about £4-6-0 (Rs. 57.33) per ton C.I.F. Indian Port; during the War this price increased to £9-6-0 (Rs. 126) per ton whilst today it is £6 (Rs. 80) per ton at Works in U.K. In U.S.A. the present price for crude sodium sulphate (Salt Cake) is \$24.00 (Rs. 114) per ton for bulk quantities at the manufacturer's Works. As compared with these prices, the price of Didwana sodium sulphate may not be considered excessive, but looking to the low cost of extraction the profit charged is very high and could be reduced with a view to finding a larger market not only in India but also in foreign countries. We had drawn the attention of the Government of India to this question after our visit to Didwana. As no



large scale expenditure is incurred on the recovery of these deposits, the material could be offered for export at a competitive price to earn for the country the much needed foreign exchange.

**11.4 USES**—Sodium sulphate has varied uses, chiefly in the manufacture of paper, sodium sulphide, glass and sodium silicate. The paper mills and the sodium sulphide factories in India are the two largest consumers and as the consumption of both these items is increasing, larger quantities of sodium sulphate will be required by these two industries. The consumption of sodium sulphate before the War was 3,000 to 4,000 tons per annum. Of this, half the quantity was being manufactured in India as a byproduct in the manufacture of hydrochloric acid and the other half was imported. The **Heavy Chemical Panel** had recommended a 5-year target of production of 7,000 tons of sodium sulphide per annum. Since 2 tons of sodium sulphate will yield 1 ton of sodium sulphide, the demand for sodium sulphate for this one industry alone can well go up to 15,000 tons per annum instead of the present estimated consumption of 7,000 tons per annum. In view of the large deposits available at Didwana the question of importing sodium sulphate from abroad no longer arises. At the same time no monopolistic position should be allowed to be created for the indigenous stuff.

**11.4.1** There is one other likely use of sodium sulphate which, if developed, may bring about a substantial increase in its consumption. In the British Intelligence Objectives Sub-Committee Report No. 429 of 1947, a German technical process for the electrolysis of sodium sulphate with a vertical mercury cathode and a lead-silver anode using a diaphragm of micro-porous rubber is described. The products obtained as a result of this electrolysis are (a) a 50 per cent. solution of sodium hydroxide (Caustic soda) and (b) a solution containing 25 per cent. sulphuric acid and 23 per cent. sodium sulphate from which sulphuric acid can be separated. The application of this process might, with advantage, be investigated, as India at present produces sulphuric acid from imported sulphur. The deposits of sodium sulphate at Didwana and Sambhar can play a useful part in reducing the import of sulphur and supplying the two most vital chemicals, caustic soda and sulphuric acid, particularly in times of national emergency.

**11.5** We have referred in the Chapter on Sambhar Lake to the possibility of the present treaty agreements between the Government of India and the Governments of Jaipur and Jodhpur being modified in the context of the changed political situation and the abolition of the salt duty. The manufacture of salt and sodium sulphate at Didwana is a good example of the present anomaly that exists. Without going into the merits of these agreements we would point out that it would be both awkward and irrational to leave the exploitation of sodium sulphate in the hands of the Rajasthan Government and the manufacture of salt with the Government of India. We have recommended important modifications in the method of manufacture of salt at Didwana whereby sodium sulphate will become recoverable as a direct byproduct of the salt industry. It will clearly lack in equity if this modification is to be carried out by the Government of India and the fruits of it are to be enjoyed in a substantial measure by the Rajasthan Government. Apart from this, we anticipate operational difficulties to arise if the differentiation in rights is to continue. We, therefore, recommend that the question of exploitation under a unitary control of the salt resources of Rajasthan including the byproducts be examined by the Governments concerned at an early date.

## **12. Summary of Recommendations**

- (a) A detailed study of the strata of the lake upto the basic rock should be carried out. (1.2)

- (b) The pans should be realigned to a standard size with a width not less than 40 ft. and a length of 100 ft. or above. Regular pathways should be provided to facilitate collection and removal of salt. (3.1).
- (c) The quality of salt produced is unfit for human consumption and to prevent it being sold for this purpose it should be cast into blocks for use as salt licks for cattle. (3.3)
- (d) A 2 ft. gauge track within the Works for transporting the salt from the pans to the storage yard should be provided to cheapen the cost of haulage. (3.4)
- (e) The method of manufacture should be radically altered. Some of the crystallising pans near to each well should be converted into condensers and charged with brine from the end of October. As the evaporation progresses it should be replenished with fresh brine and when it is saturated with respect to Sodium chloride it should be transferred in the early hours of the day to the crystallisers. The brine in the crystallisers should not be allowed to rise above 28° to 29° Bé and the bitters should be regularly eliminated in the hottest part of the day. In the winter months this procedure will yield edible salt and in the hot weather the salt obtained will be suitable only for making salt licks. (5.2.1 and 5.3).
- (f) The bitters should be allowed to collect and dry up in a separate area until a method is evolved for the recovery of the byproducts. (5.3.1.)
- (g) The sodium sulphate which deposits in the condensers should be collected at the end of the manufacturing season. (5.4)
- (h) The claim of the Deshwals to any hereditary rights of manufacture should be examined in the context of present day conditions. (5.6)
- (j) No central stores at Balia as proposed by the Works is necessary as it will involve double handling and additional establishment charges. Instead a metre gauge siding should be provided from the Didwana Works to the Balia Railway Station. (6.1.1.)
- (k) All modifications and extensions in the layout of the Works should be carried out by Government at their own expense, the Deshwals being only allowed to conduct the manufacturing operations on a lease or licence. (6.2)
- (m) Pumps worked by diesel engines should be installed to lift brine from the wells. (6.3)
- (n) The existing staff is inadequate to carry out the modifications suggested by us and should be augmented including the appointment of a civil engineer. For close chemical control of the operations a full time Chemist with a laboratory for routine analysis and other control operations should be provided. In the interest of efficiency a separate Accounting staff should be provided. (7.2)
- (p) The extraction of sodium sulphate should be carried out at a faster rate by use of air drills which will also help to cheapen the cost. (11.1.1)

- (q) Sodium sulphate be sold in bulk and bagging should be dispensed with except where there is a break in the railway gauge. (11.2)
- (r) The selling price of Didwana sodium sulphate should be reduced to attract foreign buyers and to earn useful foreign exchange. (11.3)
- (s) The application of the German process of electrolysis of sodium sulphate should be investigated for the production of sulphuric acid, and caustic soda. (11.4.1)
- (t) The question of exploitation under a unitary control of the salt resources of Rajasthan including the byproducts should be examined by the Government of India and the Government of Rajasthan at an early date. (11.5)

## CHAPTER VIII

### PACHBADRA

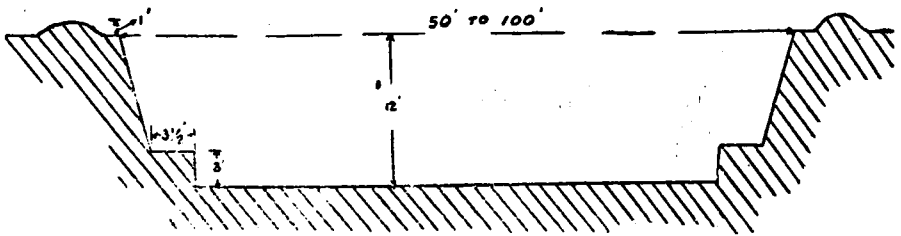
#### 1. Description

1.1 The Pachbadra Salt Works are situated within the territory of the former State of Jodhpur at a distance of 150 miles to the south-west of Sambhar Lake, in a depression of the Rajputana Desert. These works, like those of Didwana, were leased to the Government of India by the Jodhpur Durbar by the agreement of 1879 and are operated by the Government of India. The Pachbadra depression is 7 to 8 miles long and 4 to 5 miles wide and has a very porous soil which is partly sandy and partly clayey. The rain water leaches out the salts from a catchment area of 350 to 400 square miles and carries them to the sub-soil in this shallow basin. The rainfall is scanty; it falls during the months of July and August and averages 10.5 inches in the year. In years of good rainfall, when the brine supply is copious the production of salt is higher than in years of drought. The fluctuations in the rainfall from year to year, therefore, affect the production considerably.

#### 2. Manufacturing Process.

2.1 The manufacture of salt at Pachbadra is entrusted, as in the case of Didwana, to a clan known as *Kharwals* who claim similar hereditary rights and follow a traditional and ingenious method of manufacture. Rectangular pits 9 to 12 ft. deep, 150 to 400 ft. long and 50 to 100 ft. wide are dug in the basin to reach the brine. The excavated earth is thrown on the sides of the pits to form embankments to prevent rain water from flowing in. The pits are scattered over an area of about 5,000 acres which is divided into three main subdivisions, *viz.*, Hiragarh, Sambra and Pusali. The total number of pits dug is 1038, but only 370 are in use at present, the rest having been abandoned owing to either neglect or failure to produce saleable salt. A diagrammatic sketch of the usual pit is shown in Fig. 5.

FIG. 5.—DIAGRAMMATIC SKETCH SHOWING CROSS-SECTION OF A PIT AT PACHBADRA



2.2 The brine occurs at a depth of 8 to 10 ft. and varies in density from 14° to 21°Be'. From an analysis of this brine shown in Table IX Chapter III it will be seen that it is more akin to sea brine than the brines of Sambhar or Didwana. It is particularly remarkable that, in Pachbadra brine, the proportion of sodium chloride is even higher than in sea brine. The character and composition of the brine differs in different sections as will be seen from Table XXVIII.

TABLE XXVIII COMPOSITION OF PACHBADRA BRINES

Density	Hiragarh 17°Be	Pusali 18.5°Be
	(Per cent on dry basis).	
Sodium chloride . . . . .	85.66	88.24
Calcium sulphate . . . . .	2.97	3.53
Magnesium sulphate . . . . .	9.44	3.26
Magnesium chloride . . . . .	1.23	4.47
Undetermined . . . . .	0.70	0.50
	100.00	100.00

The accumulation of the various salts in this brine is attributed to the same factors which are responsible for the brines of Sambhar and Didwana, yet their compositions differ very considerably. No investigations seem to have been carried out to account for this difference and we reiterate that a thorough geological investigation of these three areas should be conducted.

2.3 It is noticed that pits in sandy soil yield a more copious supply of brine than pits in clayey soil and the density of the brine in the former is usually weaker. In pits which yield a low density brine the salt produced is usually contaminated with gypsum. Apparently at this low density the brine does not get a chance to deposit its calcium sulphate content in the subsoil before entering the pit. When the brine in a pit is above 20°Be' the salt obtained contains only small quantities of calcium sulphate and when the supply is also copious the salt is relatively purer. It may be that magnesium salts in the brine do not get the same opportunity to contaminate the separating common salt. In the case of pits which have not been renovated for a long time and have a low rate of percolation the salt deposited is largely contaminated with magnesium salts; this is because the magnesium content of the residual brine in the pit rises with the removal of each successive crop of sodium chloride and remains attached to the salt when extracted. There is no method by which the *Kharwals* can predict the quality of salt which they can obtain by digging a pit in any particular locality. Unnecessary expenditure is sometimes incurred in digging pits which do not yield saleable salt and have to be abandoned. A pit is abandoned either when

- (a) it gives large quantities of gypsum and the separation of common salt is slowed down resulting in the lowering of the quality of salt or
- (b) the initial density of the brine is high and rate of percolation is low leading to a rapid contamination with magnesium salts.

In either of these two cases the main contributory factor is in our opinion the low rate of percolation of the brine. In the case where calcium sulphate only separates out, the percolation does not permit the low density brine to rise in density, and common salt does not, therefore, crystallise out in adequate quantity. In the other case, with a high density brine, the low rate of percolation causes too rapid an evaporation leading to the separation of the magnesium salts along with sodium chloride. There is no regular record kept of the analysis of brine in different pits or of the salt obtained, nor proper investigation has been made to determine the causes which lead to the lowering of the quality of the salt and the abandonment of the pits. This question, in our opinion, requires to be examined and should be submitted for investigation to the proposed Research Station at Sambhar.

2.4 Brine of 14° to 21°Be' which percolates into the pits collects to a depth of 2 to 3 ft. and is allowed to evaporate in the pit itself. The loss by evaporation is more or less made up by constant percolation of fresh brine. When the

brine has attained a density of 25°, salt starts depositing and the crust is allowed to grow by accretion. The density of brine during the crystallisation of salt is not controlled in any manner and the quality of salt obtained is largely a matter of chance. Formerly, as soon as the density of brine reached about 25°Be', dry branches of a thorny shrub called *morali* (*Licium Europa*) were scattered at the bottom of the pit to assist the formation of salt. Large compact crystals of salt were formed both at the bottom and around the thorns and dry branches of *morali* by the gradual evaporation of brine and the crystals were allowed to grow for a period of 18 to 20 months by which time the crust of salt had become 2 to 3 ft. thick. The thick crust was then broken up by crowbars and raked to the sides of the pits. This was done usually some two months after the rains. This procedure is not followed now as several cart loads of the *morali* thorns are required to set a single pit and it increases the cost of production. The crust is, therefore, allowed to form naturally at the bottom of the pit and the period of accretion is reduced to 8 or 9 months during which time it does not grow beyond 8 inches. Due to scanty rainfall and the peculiar method of manufacture, the accretion of salt does not suffer interruption even during the rains. The raked salt is heaped on a drying ledge which is provided inside the pit above the brine level where it is allowed to drain for 48 hours. It is then carried up by head loads in baskets and stored in oblong heaps outside the pits. Immediately after the extraction of salt the pits are cleaned of their silt and encrustations and made ready for the next crop; this operation is known as *ghalni*. The works are provided with meter gauge sidings to the Pachbadra railway station. This is a distinct facility and enables the salt to be bagged and despatched directly from the works.

### 3. Annual Production and Quality.

3.1 The quantity of salt produced at Pachbadra during the last three years is as under:

	Tons	Maunds
1946	40,770	11,10,000
1947	56,970	15,51,000
1948	70,000	19,05,000

This quantity is estimated from the cubical contents of the individual heaps.

3.2 The quality of Pachbadra salt is much better than that of Didwana. The chief impurities which separate out along with common salt in the pits are locally known as

- Kajji* which consists mainly of crystals of gypsum coated with small cubes of sodium chloride. It separates in the form of lumps, discoloured with adherent clay;
- Haim* which is in the form of flakes or clear crystals usually tinted yellow and consists of gypsum, sodium chloride and magnesium sulphate;
- Phulia* which is another form of composite crystals of gypsum, sodium chloride and magnesium sulphate; it appears most noticeably during frosty weather as a white efflorescence on freshly extracted salt;
- Jalebi* which is the name given to the encrustations of gypsum on the *morali* twigs along with small cubes of sodium chloride; and
- Anetha* which is mainly gypsum occurring as small opaque crystals or in the form of flakes resembling mica.

At least one, and often several, of these impurities are associated with each pit and it is taken for granted that they cannot be avoided. They can, however, be easily distinguished by a visual examination. The analyses of random samples of salt drawn by the Committee from pits in different sections are given in Table XXIX.

TABLE XXXIX. COMPOSITION OF PACHBADRA SALT.

	Hiragarh		Sambra		Pusali	
	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
Sodium chloride . . .	95.79	(Per cent, on dry basis) 96.74	98.45	94.88	95.21	95.90
Sodium Sulphate . . .	1.00	1.85	0.43	1.88	1.94	0.70
Magnesium Sulphate . .	1.80	0.46	0.32	0.32	1.11	1.01
Magnesium chloride . .	1.28	0.03	..	1.05	1.22	0.65
Calcium Chloride . . .	..	0.46	0.67	..	0.18	1.39
Insolubles . . . . .	0.08	0.46	0.13	0.56	0.34	0.35
Undetermined . . . . .	0.05	..	..	1.31	..	..
	100.00	100.00	100.00	100.00	100.00	100.00

It will be seen that the sodium chloride content ranges between 94.88 and 98.45 per cent. There is a wide divergence between the percentages of calcium and magnesium salts. While the best of the samples contains only 0.43 per cent. of calcium sulphate, three of the other samples contain almost 2 per cent of this impurity. Similarly while the best sample contains magnesium salts to the extent of 0.32 per cent, one of the other samples contains as much as 2.33 per cent. These divergences are not surprising, because each pit is a unit and has its own good points and drawbacks.

#### 4. Renovations and Extensions.

4.1 We are of the opinion that the production at Pachbadra should be developed. Based upon the prevailing conditions and facilities we had estimated that the production could be increased during the manufacturing season 1948-49 by 16,000 tons (4 lakh mds.) if a systematic programme of renovation of the old pits were undertaken. In our Interim Report we, therefore, suggested that 100 pits should be renovated annually. This recommendation was accepted and we learn that some 107 pits were renovated which led to an increase in production by 20,000 tons (5,48,000 mds). We are satisfied that the production at Pachbadra can be raised to about 1,47,000 tons (40 lakh mds.) per year merely by renovating the existing pits. If the rate of renovation could be maintained at 100 pits per year it should be possible to increase the production on an average by 16,000 tons (4 lakh mds.) each year. It will not be worth while to renovate some of the pits either because of their intrinsic unsuitability or their distance from the railway sidings. The programme of renovation should, therefore, be determined with proper regard to the siding facility. New pits should be dug only if there are ample indications of copious supply of brine and there are no abandoned pits nearby that could be brought into operation by renovation. When the pits are renovated it should be seen that they are located at a distance of 300 ft. from the working pits. Furthermore, the priority for cleaning should be given to the pits near the railway sidings.

4.1.1 For the cleaning of these pits we had further recommended that adequate advances should be granted to the *Kharwals* and that these advances should be made in one instalment instead of several instalments as hitherto. The rate of advances should also be increased to roughly  $2\frac{1}{2}$  times the prevailing rate. To expedite this programme of work, we had suggested that a few dragline excavators might be made available to the *Kharwals* the cost of operating the excavators being recovered from them. The cost of renovation would thus be cheaper. We reiterate this recommendation for implementation.

4.2 While we are not disposed to scrap the present ingenious method of manufacture adopted at Pachbadra we feel that as a long range project a modification of it must be given some consideration in the report. The main factors that determine the quality of salt at Pachbadra appear to be

- (a) the initial density of the brine and
- (b) the non-removal from the pits of the residual liquor or bitterns containing magnesium salts.

As has been mentioned previously, calcium sulphate does not find its way into the salt produced from pits with brine of initially high density. But when the density is low (of the order of  $14^{\circ}\text{Be}$ ) it is inevitable that the calcium sulphate present in it must first separate out and remain as an impurity in the salt produced. In marine salt works, where brine is concentrated to various stages in a series of condensers, the separation of a substantial portion of calcium sulphate does not present a difficult problem. In the pit method of manufacture as adopted at Pachbadra, the contamination of the salt with gypsum can scarcely be avoided, unless the method of manufacture is radically altered:

4.2.1 The contamination with magnesium salts can, however, be remedied, though hitherto it has been largely neglected. In the present practice, when the concentration of the mother liquor is found to be continuously high and saleable salt can no longer be produced, it is baled out on to the sides of the pit to make room for fresh brine to percolate. This is at best a partial and temporary remedy because the sides of the pit slope inwards and even though the bitterns may get evaporated to dryness on these sides, the soluble salts consisting mainly of magnesium salts ultimately find their way back into the pit owing to leaching action by direct rainfall.

4.3 So long as the pit method of manufacture is continued at Pachbadra, we recommend that the discarded bitterns should be completely pumped out of the pit and, if possible led to a place at some distance from it. We would even recommend that these bitterns be allowed to evaporate further in the usual type of salt pans which may be provided by the side of each pit. If this is done and such a pan is divided into two compartments, it would be possible to recover in the first of these two compartments between  $28^{\circ}$  and  $32^{\circ}\text{Be}$  crude salt which may not be saleable, but which will have a higher ratio of sodium chloride to other salts than that found in the raw brine; this salt can be put back into the pit to enrich the brine. The second compartment could be used for the recovery of magnesium sulphate and, perhaps, magnesium chloride. This pre-supposes that it will be possible to prepare an impervious pan near each pit. It is reported that several centuries ago spontaneous salt was being gathered from the marshy ground at Pachbadra, but, because the top soil was too porous to permit the adoption of the usual method of manufacture by lifting the brine to the surface and evaporating it in condensers and crystallisers the novel method of producing the salt in pits apparently came into vogue. It was not possible for the Committee to determine the extent of land with an impervious top soil on which salt pans of the type which are in vogue at Sambhar, Didwana and other places could be laid. The present procedure of digging pits involves a heavy capital outlay; the salt produced has also to be carried by head loads from the pits to the



heaps. It would be both economical and convenient if, instead of carrying the salt, the brine itself could be lifted and evaporated in suitable condensers and crystallisers. This proposal requires a radical departure from the present practice and may demand a top dressing of plastic clay which might have to be brought into this area if such a clay cannot be discovered locally. We recommend that this alternative may be investigated as a long range plan and an experimental production unit set up. Should this be found feasible, the proposed method could replace the pit method and the quality of salt at Pachbadra improved by a proper fractionation of the various components of the brine.

4.4 A proposal made by the Works to construct a central stores near the Pachbadra railway station was placed before the Committee for its views. The Works have also proposed to dig 60 new pits in the Hiragarh section to increase production. The estimated cost of both these schemes was given as Rs. 18 lakhs, but no details as to how this estimate was arrived at were placed before us. We presume that in arriving at this estimate the cost of digging the pits would not have been included as this would be payable normally by the Kharwals. As in case of Didwana, we do not see any advantage in spending money over the central stores near the railway station. With the facilities of the sidings running right through the Works, the storage and loading of salt should continue within the Works area itself as hitherto and we cannot see our way to recommend this expenditure. With regard to the digging of the new pits in Hiragarh section, we consider that a heavy capital expenditure will be justified only after the renovation of the existing abandoned pits has been fully explored and carried out. The addition of any new pits may not be found necessary if the experimental production of salt in surface pans proves successful.

4.4.1 Another scheme submitted for our scrutiny was for the supply of drinking water to Pachbadra at an estimated cost of Rs. 1,47,000 and though no details were given of this estimate, we understand that pumps are proposed to be installed and a pipe line to be laid from Balotra, about 10 miles away, where plentiful supply of good water is reported to be available. We had recommended in our Interim Report that this scheme required immediate attention, because there was no good source of drinking water in Pachbadra and the lack of water was affecting considerably the operation of the Works as also the working facilities for labour. We also recommended investigating an alternate source of water supply at Tilwara, which is only about 6 miles from Pachbadra. We now understand that action has been initiated by Government and that Balotra has been confirmed by the Geological Survey of India as the more suitable source of supply. Lately it has been reported that at the instance of the Ministry of Agriculture, Government of India, tube wells have been sunk at Samdheri which is 35 miles from Pachbadra to tap the subsoil water of the Luni River and that a model farm is being set up. The supply of water from the tube wells has been reported to be copious. This newly found source may also be considered as a possible alternative.

## 5. Staff and Organisation.

5.1 The present staff at Pachbadra consists of

- (a) One Superintendent
- (b) Three Deputy Superintendents
- (c) Six Inspectors and
- (d) the necessary clerical staff.

The staff works under the general direction and control of the General Manager, Sambhar, whose office also looks after the Accounts section of the Works. The field operations are supervised by the Deputy Superintendents and Inspectors and their duty is

- (i) to ensure that a pit is properly cleaned before the manufacture starts;

(ii) to see that only saleable salt is extracted and heaped on the pit banks and

(iii) to classify the salt into different grades and estimate their quantities for the purpose of making payments to the Kharwals.

5.2 The main function of the Government staff at Pachbadra is to grade the salt and to buy such part of it as is declared saleable at the prices fixed for the two grades. They also sanction and make advances of money to the *Kharwals* for the renovations of their pits. So far as the manufacturing operations are concerned, their main function is to maintain a diary for each pit in which the following information is recorded.

(a) the date of cleaning the pit and commencement of manufacture;

(b) the date of setting the pit with *moralis* thorns and the quantity of *moralis* used (if and when used) and

(c) the density and mean depth of the brine in each pit before and after extraction.

We consider that a full-time Chemist should be appointed to carry out at Pachbadra the routine analysis of the brine and the salt for (a) a better control of the manufacturing operations, (b) differentiating edible from inedible salt and (c) classifying the edible salt into different grades. Data of the analyses of the brine in the pit at the commencement of the manufacturing season and of the salt extracted and the bitters left behind in the pits should also be maintained as it would be of great assistance in controlling the manufacturing operations, the grading of salt and determining the time for the renovation of the pits. Such data, collected for all the pits over a number of years, would provide a useful clue to the conditions which should determine the location of sites for new pits. To carry out the renovation of the pits economically and systematically, a Civil Engineer should also be appointed.

5.3 The labour is entirely of a temporary nature; it is drawn from the neighbouring villages within a radius of ten miles and is employed for renovating old pits or digging new pits and extracting salt. Their number is reported to be 1,500 and the average daily wage paid to them is about Rs. 1-8-0 per day.

## 6. Capital Block.

6.1 The capital invested by the Government of India at Pachbadra consists of railway sidings and office and residential buildings. Their cost was estimated in 1924 at about Rs. 1,56,000/-. As in the case of Sambhar and Didwana, the present value of these capital assets should be re-assessed.

## 7. Cost of Production.

7.1 As at Didwana, salt is purchased from the *Kharwals* at a price fixed by Government at the beginning of each season. The salt is classified into two grades according to its appearance. This classification is not based on any chemical analysis but is done arbitrarily by visual examination. The prices fixed for the two grades during the past three years are shown below:

Year	Prices			
	1st Grade		2nd Grade	
	Per ton	Per md.	Per ton	Per md.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1946-47 . . . . .	6 6 1	0 3 9	5 15 3	0 3 6
1947-48 . . . . .	8 8 1	0 5 0	8 1 3	0 4 9
1948-49 . . . . .	8 8 1	0 5 0	8 1 3	0 4 9

These rates include the initial cost of making the pit, the cost of maintenance and cleaning and the cost of manufacture and storage. Before the last War the rates were Rs. 3.40 and Rs. 2.55 per ton (Re. 0.2-0 and Re. 0.1-6 per maund) for the two grades of salt, but for the season 1947-48 it was fixed at Rs. 9.78 and Rs. 8.08 per ton (Re. 0.5-0 and Re. 0.4-9 per maund) respectively. The cost of maintenance of the sidings and buildings, depreciation, supervision, royalties, etc. which are borne by Government have to be added to the rates paid to the *Kharwals* to arrive at the overall cost of production.

7.2 We have reconstructed in Table XXX the cost for the year 1946-47 under different heads.

TABLE XXX. COST OF PRODUCTION AT PACHBADRA

	(Per ton).	
	1st Grade Rs.	2nd Grade Rs.
(a) Manufacture and storage*	6.38	5.95
(b) Maintenance (including repairs and betterment)	0.26	0.26
(c) Supervision	0.90	0.90
(d) Overheads	0.24	0.24
(e) Rents and royalties	0.55	0.55
(f) Interest	0.11	0.11
(g) Depreciation	0.04	0.04
(h) Any other miscellaneous charges	0.05	0.05
Totals	8.53	8.10
	or Rs. 0 5 0 per md.	Re. 0 4 9 per md.

\*Rate paid to *Kharwals*, 1st grade Re. 0.3-9 per maund. 2nd grade Re. 0.3-6 per maund.

Our comments made in the chapters on Sambhar and Didwana on the system of costing hold good for Pachbadra also. The rate of depreciation of Rs. 0.04 per ton is almost negligible as it works out at about 1.3 per cent. of the capital cost of the railway sidings and buildings. This is far too low a provision particularly when the railway sidings need constant renewals due to the corrosive atmosphere in which they are laid. The rate of depreciation should be calculated on standard income-tax rates provided for the salt industry.

## 8. Sales and Distribution.

8.1 As against the cost of manufacture of Rs. 8.53 and Rs. 8.10 per ton for the two grades of salt, a uniform selling price of Rs. 8.5 per ton was fixed by Government for both the grades. To this selling price a cess of Rs. 5.95 per ton (Re. 0.3-6 per md.) is to be added. In view of this low price, we understand that Government incurred a loss of Rs. 25,000/- on the season's operation. The salt is distributed through three companies of brokers who charge a commission of Re. 0.1-0 per maund and in addition charge a further Re. 0.1-0 per md. for filling, stitching and marking the bags. The final F. O. R. works cost of the salt to an indenter (exclusive of the cost of the bags) comes to as under:

	Per ton Rs. A. P.	Per maund Rs. A. P.
Issue price	8 8 1	0 5 0
Cess	5 15 3	0 3 6
Filling and despatch charges	2 2 0	0 1 3
Commission of registered brokers	1 11 3	0 1 0
	18 4 7	0 10 9

## 9. Summary of Recommendations.

(a) Proper records should be kept of the composition of the brines and of the salt produced in different pits. An investigation should be made at the proposed Research Station at Sambhar to determine the causes which lead to the lowering of the quality of Pachbadra salt and the abandonment of the pits. (2.3).

(b) 100 pits per year should be renovated to increase the production at Pachbadra by 16,000 tons (4 lakh mds.) annually. The programme of renovating the pits should be determined with proper regard to the siding facility. New pits should be dug only if there are ample indications of copious supply of brine and there are no abandoned pits nearby which could be brought into operation. When the pits are renovated it should be seen that they are located at a distance of 300 ft. from the existing working pits. (4.1)

(c) Advances to the Kharwals for the renovation of the pits should be adequate and paid in a single instalment at  $2\frac{1}{2}$  times the present amount. (4.1.1)

(d) The discarded bitters should be completely pumped out of the pit and led to a place at some distance or allowed to evaporate in a pan provided by the side of the pit. The salts that deposit between  $28^{\circ}$  to  $32^{\circ}$  B $\acute{e}$  should be collected separately and put back into the pits to raise the density of the brine, the residual bitters being used for the recovery of byproducts. (4.3)

(e) The possibility of manufacturing salt by lifting the brine and evaporating it in regular pans lined with impervious clay should be investigated. (4.3)

(f) We do not support the proposal of the Works for constructing a central stores near the Pachbadra railway station; nor do we approve of the suggestion to dig 60 new pits in the Hiragarh section for reasons stated in (b) and (e). (4.4)

(g) The supply of drinking water to Pachbadra needs immediate attention. The possibility of supplying water from Balotra, Tilwara and Samdheri which are all a few miles from Pachbadra may be investigated. (4.4.1)

(h) A full-time chemist with a laboratory for routine tests should be provided for Pachbadra for a better control of the manufacturing operations and sorting the salt into different grades. The analyses of the brine in the pit at the commencement of the manufacturing season, of the salt extracted and of the bitters left behind should be recorded. A Civil Engineer should also be appointed to supervise the work of renovation. (5.2)

## CHAPTER IX

### KHARAGHODA

#### 1. Description.

1.1 In the Little Rann of Kutch there are two salt works, one at Kharaghoda which is about 20 miles from Viramgam and the other at Kuda in the former State of Dhrangadhra. The Kharaghoda works are known as the Pritchard Salt Works and are owned by the Government of India. They are situated on the extreme south-east edge of the Rann. The works at Kuda belong to the Dhrangadhra Chemical Works Ltd. and are at a distance of about 20 miles to the west of Kharaghoda. The Rann is a flat low lying tract of barren waste land with no vegetation or human habitation and not much above the main sea level. It is about 60 miles long and 5 to 30 miles broad. According to geological investigations, it is of comparatively recent origin and forms part of a large salt marsh covering an area of about 9000 sq. miles which itself was at one time a part of the sea with its northern mouth at Khori Creek joining the Arabian Sea and the southern opening at Hansthal Creek in the Gulf of Kutch. During the time of Alexander the Great (325 B. C.) there was a navigable sea, where the Rann is at present situated, with a number of sea ports on its banks. The Rann which is divided by a two mile wide strip between Piprala and Ardesar into two parts, the Great and the Little Rann, was raised to the present level by later earth movements and cut off from the sea. The frequent earthquakes occurring in Kutch and the adjoining territory have affected the Rann and caused a noticeable rise or fall in the levels at several places. A further consequence of these earth movements has been a progressive retrogression of the sea towards the west.

1.2 During the rains, the strong winds from the south-west direction force the sea water into the Rann and this together with the flood waters of the rivers Luni, Banas, Saraswati, Rupan, Phulka, Bhamban, etc. from Sind, Rajputana, Kathiawad and Kutch, cover the entire area with a large sheet of water which varies in depth from one to seven feet. Much of this water ultimately percolates into the soil, but a part of it is left behind and evaporates during the summer, giving rise to salt encrustations over a wide area. Some of the powdered salt from the encrustations is carried by the winds further inland into the catchment area of the rivers from where it is again washed back into the Rann with the annual floods. The river waters thus carry with them an appreciable quantity of salt in solution and sandy silt. This process repeated from year to year, helps to enrich the concentration of salt in the various strata of the Rann through which the brine percolates, and ultimately reaches the surface where it accumulates in the form of concentrated brine.

1.3 GEOLOGY.—The geology of the Rann consists of alternating layers of silt, clay, sand, etc. contributed by the sea and the rivers. The surface layer is composed of a sandy silt, a few feet thick. Below it is a sticky bluish clay which appears to be varying in thickness up to 10 ft. and contains gypsum. It is evidently a deposit of sea mud at the time when the Rann was a part of the sea. Below this mud is a yellow or brown sandy clay, resting on strata of sand, consolidated gritty sand, etc. indicating its fresh water origin. Further below there are again layers of clay, sandy clay, sand, etc. denoting incursion and retrogression of the sea at different periods. From a study of the sections of a large number of brine wells located in Kharaghoda, Kuda and other surrounding localities, it is observed that these layers are not uniformly distributed throughout the Rann and are mostly lenticular and patchy. The total thickness of the

Rann formation is not known, but two tube wells sunk in the Kharaghoda Works for fresh water, one reaching a depth of 327 ft. and the other 229 ft. have not touched the basic rock. The brine bearing strata at Kharaghoda contain a belt of highly porous, coarse sand, interspersed with grit, and is met generally 20 to 30 ft. below the ground surface, though brine sometimes occurs at a depth of 11 ft. whilst at other times it goes as low as 40 ft. The lower periphery of the brine bearing sand is not exposed; its depth in brine wells is usually 2 to 6 ft., but a maximum of 9 ft. has been recorded. Dr. B. C. Roy of the Geological Survey of India, who visited Kharaghoda at the instance of the Government of India, in 1947-48 has drawn up a general geological profile of these wells as under:

Strata	Depth in feet
Fine fresh water slit	3 to 4
Bluish grey clay, locally known as <i>galli</i>	5 to 10
Brown on yellow sandy clay, locally known as <i>pilli mati</i>	2 to 6
Bluish grey clay with gypsum	2 to 10
Dry sand	2 to 6
Coarse, gritty, brine bearing sand	2 to 6

Although these strata are generally horizontal they are not uniform and vary in the order of succession. Moreover, they are interspersed with other layers, known by local names such as *khori* (ash coloured mud), *lilvo* (green mud), *damod* (jet black mud), *lappi* (wet mud mixed with sand), etc. A brown or yellow clay bed with kankar nodules, locally called *marund* is also met with. According to local belief, the presence of *galli* is considered as a good sign for obtaining high density brine and if *marund* is found before brine is met with, it is invariably taken to indicate that no brine will be found below it.

## 2. Manufacturing Rights

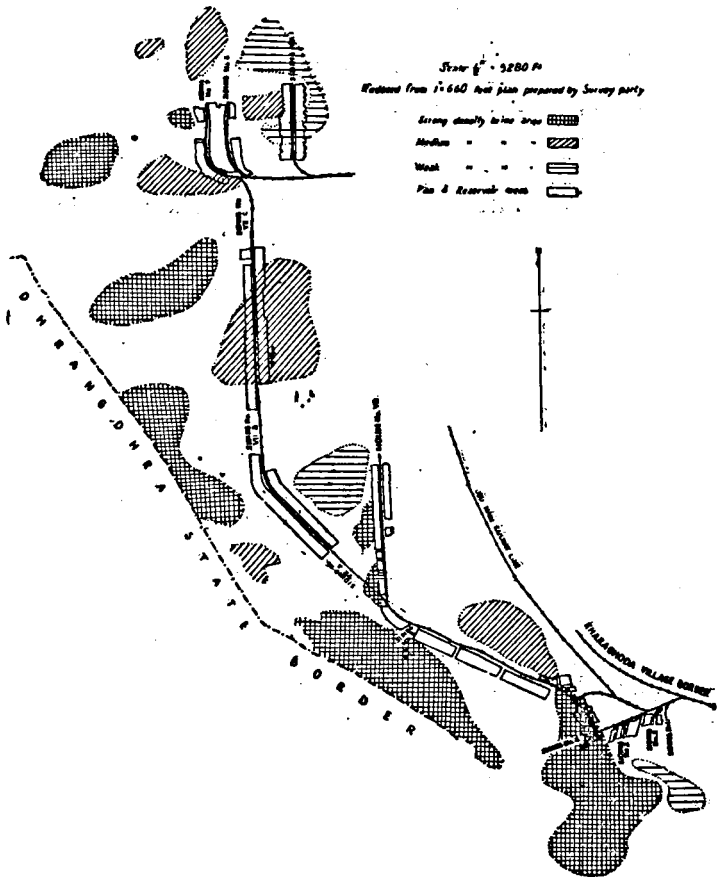
2.1 Salt has been produced in the Little Rann for a long time by a number of small States whose territories stretched over the Rann. More than a hundred years ago, as a part of the policy of the then Government of India to husband the salt resources of the country and derive revenue from salt duty, these small works were either closed down or taken over on lease and organised under direct Government auspices. Portions of the Kharaghoda salt works were originally within the territory of the former States of Patri, Jhinjhunwada, Radhanpur and the respective portions of the works which were within the territory of these States were leased to the Government of India under different agreements. The years in which these agreements were executed and the annual compensation paid to these States, by the Government of India are shown below:—

Year	Name of State	Annual Compensation
1824	Patri	A cash compensation of Rs. 10,521 and about 26 tons (715 maunds) of duty free salt.
1821	Jhinjhunwada	A cash compensation of Rs. 7,783 and about 12.5 tons (340.5 maunds) of duty free salt.
1840	Radhanpur	A cash compensation of Rs. 11,048 and about 13 tons (350 maunds) of duty free salt.

### 3. Manufacturing Process.

3.1 The Kharaghoda salt works are spread over an area of 84 sq. miles of which the reservoirs cum condensers occupy 116 acres, crystallisers 393 acres and storage yards 9 acres, making a total of 518 acres. The rest of the area is a vast expanse of waste land which is available for the expansion of the works. The salt works are divided into two parts, one comprising Kharaghoda proper and the other at Udoo at a distance of about 8 miles from the Kharaghoda railway station. There is, however, no natural line of demarcation between the two sections of the Works. A number of broad gauge railway sidings are provided for both these sections and the brine wells and the pans are located on either side of the sidings. A plan of the Works is shown in Fig. 6.

Fig. 6 Plan of the Kharaghoda Salt Works



3.2 The manufacturing season commences immediately after the rains, *i.e.* about the middle of September and the crystallisation is over by the end of March when the collection, heaping and storage of salt commence and continue up to the end of May. As the surface of the Works is under water during the monsoon, the wells, channels, reservoirs and the pans get silted up and are cleaned every year at the beginning of each season by Agarias (agar = salt works), a clan of hereditary workers, to whom the pans are leased annually at the rate of one pan for at least two families. The Agarias manufacture salt on a contract basis. They work the pans themselves, providing at their own cost all

the implements and materials necessary for the purpose. They also employ extra labourers, known as *sathis*. The Agarias come mostly from Kharaghoda itself, but a few of them come for work from the neighbouring villages.

3.3 Brine is obtained from wells, which are dug 20 to 30 ft. deep and 9 ft. in diameter. The wells are generally not located near the crystallising pans, and sometimes, when a copious supply of brine cannot be tapped nearer the pan, the Agarias sink the wells even at distances of 5,000 to 7,000 ft. from the pans. There is at least one and sometimes two or more wells to a pan. A cylindrical bamboo or junglewood structure known as *kantwa*, is inserted in the well (generally up to a height of 5 ft. from the top of the well) to prevent the sides of the well from caving in, but in spite of this lining, the well collapses after a period of 4 to 5 years. When this happens or when the mouth of the well, due to periodical cleaning and wear, widens and becomes inconveniently large for lifting the brine, the well is abandoned. Brine is lifted manually by means of an earthen pot or leather bucket which is supported at one end of a locally made wooden structure known as *dhenkwa*, the other end being counterpoised. This lifting is done in the early hours of the morning from 2 or 3 a.m. till 10 a.m. and again in the afternoon. The process is laborious and taxes the energy of the Agarias considerably. Brine is also lifted in a large leather vessel called *kos* which is operated by means of a rope and pulley and pulled up with the help of a pair of bullocks. No accurate data is available about the yield of the brine from the wells or the rate of its recuperation. The brine in some of the wells runs dry after a few hours of lifting operations when they have to be allowed to rest for recovery. It may take only half an hour or two to three hours or sometimes even more before the brine rises to the original level in the wells. The yield also varies within wide limits and the average is of the order of 300 to 400 gallons per hour, though a yield of 700 gallons per hour is reported for some of the wells.

3.4 The brine varies in density from 11° to 21° Be', the average being 17° Be'. The density varies not only in different areas, but also in adjacent wells and this is attributed to the variable thickness of the brine bearing strata as also to the possible dilution of brine by the subterranean seepage of fresh water. There is a belief that the Rann is connected underground with the sea which causes repeated replenishment of the brine; such a possibility is, however, discounted as Kharaghoda is too far inland from the sea. From the analysis of the Kharaghoda brine which is shown in Table XXXI it will be seen that although it is similar in composition to sea brine the proportion of magnesium chloride is very much higher and of magnesium sulphate relatively lower than in sea brine.

TABLE XXXI—COMPARATIVE COMPOSITION OF KHARAGHODA AND SEA BRINES

	(Per cent on dry basis)	
	Kharaghoda	Sea
Sodium chloride . . . . .	77.80	77.76
Magnesium chloride . . . . .	22.36	10.88
Magnesium sulphate . . . . .	2.31	4.74
Calcium sulphate . . . . .	2.12	3.60
Calcium carbonate . . . . .	0.06	0.34
Potassium chloride . . . . .	2.00	2.46
Magnesium bromide . . . . .	0.35	0.22
	100.00	100.00



As the Kharaghoda brine also owes its origin to the sea, the reduction in its magnesium sulphate content and the inordinately high increase in magnesium chloride require some explanation. It has been suggested that a part of the magnesium sulphate is converted by double decomposition into calcium sulphate which separates out when the concentration of the brine rises. This is supported by the fact that thin layers of gypsum are found in the strata. Furthermore, owing to the exposure of the brine to the cold in the winter months, a part of the sulphate radical separates out as sodium sulphate and the percentage of magnesium chloride, therefore, rises. This question, however, deserves a closer study for which the analyses of representative samples from a large number of wells over a number of years would be required.

3.5 From the wells, the brine is led by gravity through kutchra earth channels into reservoirs *cum* condensers locally known as *gamdu*. Since the channel is no more than a trench about a foot deep, there is considerable loss of brine by percolation and collapse of its sides. This is specially so in the case of a newly made channel where much brine is lost before the channel becomes leakproof. The length of the channel depends upon the distance of the well from the condensers some of the wells are situated as far as two miles from the reservoirs and when the channels are long, they serve to raise the concentration of the brine. Whilst this would normally be considered an advantage, the long lead becomes a handicap when concentrated brine is lost by percolation. A more permanent and a better constructed channel is necessary in order to prevent the loss of high density brine. The care and attention which are paid to condensers and crystallisers are unfortunately not bestowed on the construction of suitable channels, and this should be remedied. The other alternative is to locate the pans in closer proximity to areas containing the concentrated brine.

3.6 RESERVOIRS CUM CONDENSERS.—The reservoirs at Kharaghoda serve a double purpose; they act both as reservoirs and as condensers. Since the density of the initial brine is high separate areas for reservoirs and condensers are not necessary. There is one reservoir for every crystallising pan and it measures 80 ft. x 80 ft. x 16 in., with the floor sloping slightly towards the crystallising pans. After the rains, the reservoirs are cleared of the silt brought down by the rain water and the floor is puddled and tamped for about a week. This act of puddling and tamping is known locally as *kharavan* and is done twice and sometimes thrice to make the floor impervious to percolation of brine. The average quantity of brine that can be held in a reservoir is about 20,000 gallons if charged to a depth of 6 in. and it takes nearly a week to fill it up to this depth. Since the area of the reservoir is less than one third the area of the crystalliser it is inadequate and a part of the function of the condenser is thrown on the crystalliser. It is intended that the density of the brine in the condenser should be allowed to rise to 22°Be' and if this were done much of the calcium sulphate present in the brine would be eliminated. In actual practice, however, as the area of the condenser is not large enough, the brine is very often let into the crystallisers before it has reached this density and in consequence proper separation of calcium sulphate does not take place. For the density of brine available at Kharaghoda, which on an average may be taken as 18°Be'. the area of the reservoir should be nearly half the area of the crystallising pan.

3.7 CRYSTALLISERS—From the reservoirs the brine is fed by gravity to the crystallisers. There are 800 crystallising pans though all of them are not in use. Each pan measures 250 ft. x 80 ft. and the pans are laid parallel to the reservoir *cum* condenser with their length oriented in the direction of the prevailing wind. Before the brine is let in the floor of the crystallising pan is puddled and tamped in the same manner as the floor of the reservoir. It is then left to dry for a few days after which some brine is let in and allowed to evaporate to

dryness. The thin crust of salt which is formed is puddled into the floor of the crystalliser and more brine is let in; this process is repeated till the floor has finally become hard and dry and free from cracks. If no crack develops within two days, the condensed brine from the reservoir is let into the crystalliser for further evaporation and deposition of salt. The crystallisers are filled initially to a depth of 2 to 3 inches and this level of brine is maintained above the layer of the salt all the time. The method of crystallisation followed is the multiple irrigation system. Normally speaking, the brine should be let into the pans when it has reached the density of about 23° Be', but as mentioned in the previous paragraph, it is taken soon after it has reached 20° Be', or even earlier. In the pan the density is allowed to rise upto 26° Be', when fresh brine is charged to maintain the density between 25° and 26° Be'. Ten days after the salt has started to deposit, the crust is broken and raked by a special type of wooden rake to prevent the formation of hollow or flaky crystals and to obtain the characteristic large size uniformly developed conglomerate known as *baragan* or *radagara* meaning a big lump. The crystals are raked into ridges one day and spread out the next day and this process is continued till the salt is ready to be lifted from the pans. After one and a half months from the date of the initial feeding of brine, further supply of brine is stopped and the density is then allowed to rise upto 29° Be'. The bitterns are then drained into pits locally known as *farans* adjoining the crystallising pans, the pans are recharged with condensed brine and the whole process is repeated.

3.7.1 The collection of the salt starts towards the end of March by which time the crust reaches a thickness of 6 to 12 inches. The crystals which are agglomerates of smaller crystals are about  $\frac{1}{2}$  inch. to  $\frac{3}{4}$  inch. in size; they are dense and hard and can stand transport for long distances without breaking up. Formerly, it was the practice to destroy salt that was considered not hard enough, irrespective of its purity or appearance, but this has now been fortunately stopped. Salt is collected by shovels and piled into heaps in the crystallisers to allow the mother liquor or the bitterns to drain out into the *farans*. The yield of salt from a pan should be about 370 tons (10,000 maunds) per season, but due to various factors, the average production at present works out to only about 200 to 220 tons (5,500 to 6,000 maunds) per pan. The salt in the crystallisers is not subjected to any process of washing, but its raking and spreading every alternate day is looked upon as a process of washing. In our opinion, this can hardly be called washing and we shall discuss the question of washing in a subsequent paragraph.

3.7.2 From the preceding paragraphs it is possible to reconstruct a timetable of manufacturing operations at Kharaghoda. Soon after the monsoon, i.e., by the beginning of September, and until the end of November, the cleaning and renovation of the wells, channels, reservoirs and the crystallisers is done. The renovation of the majority of the wells is actually completed before the end of September. The work of *Kharavan* or puddling of the condensers and the crystallisers is continued till the end of October when the brine is first let into the crystallisers. The first raking of the salt takes place about the middle of November and the first discharge of the bitterns is not done till the beginning of February when fresh brine is again taken for the second time into the crystallisers. By the end of March the second and final discharge of bitterns takes place and the collection of salt starts from about the beginning of April. This means that after the end of March no brine is drawn from the wells and no further concentration of the brine is carried out. The collection of salt continues up to the end of April and the whole of May is utilised for transporting it from the crystallisers into the central store.

3.8 BITTERNS—The bitterns, discharged from the crystallisers twice in the season, are led through kutoha-channels into *farans* measuring 80 ft. × 80 ft. × 3 ft. In the *farans* the bitterns are allowed to rise in density to 36° Be' and then carried away by the Pioneer Magnesia Works to their factory near the Kharaghoda railway station for the recovery of the byproducts, most notably magnesium chloride and to a smaller extent magnesium sulphate and potassium chloride. We shall deal with the question of the disposal of bitterns at a greater length in later paragraphs.

3.9 When the mother liquor has been drained off, the salt is transported from the crystallisers to the central store in open broad gauge wagons for which purpose the B. B. & C. I. Railway place the requisite number of locomotives at the disposal of the Works for a period of one month. The store is situated near the railway station and the wagons are carried over two trestle bridges each of which is 251 ft. long and 24 ft. high. The store covers an area of 9 acres and has a capacity to hold 2 lakh tons (55 lakh mds.) of salt. The salt is shovelled from the wagons by manual labour to the ground below to form long heaps on either side and in between the bridges. From the store the salt is bagged and despatched to various parts of the country. A part of the store, to the length of 400 ft. on one of the bridges, is covered and is used for bagging the salt during the monsoon; the quantity that can be stored under cover is about 18,500 tons (5 lakh mds.).

#### 4. Annual Production and Quality.

4.1 The quantity to be produced during any year is fixed by the Salt Department before the opening of the season and the manufacturing programme is drawn up accordingly. The production of salt at Kharaghoda during the years 1945-46 to 1947-48 and the number of wells and pans employed is given in Table XXXII.

TABLE XXXII—PRODUCTION AT KHARAGHODA

Year	Tons	Maunds	No. of wells	No. of pans
1945-46 . . . . .	1,19,200	32,45,000	630	514
1946-47 . . . . .	1,32,750	36,11,000	766	584
1947-48 . . . . .	1,32,900	36,18,000	655	554

The analysis of Kharaghoda salt is shown in Table XXXIII.

TABLE XXXIII—ANALYSIS OF KHARAGHODA SALT.

(Per cent, on dry basis)

Sodium chloride . . . . .	96.68 to 98.60
Calcium sulphate . . . . .	0.71 to 1.55
Magnesium sulphate . . . . .	0.05
Magnesium chloride . . . . .	0.44 to 1.13
Insolubles . . . . .	0.09 to 1.42

The quality of the salt is fairly uniform and though the sodium chloride content is 96/97 per cent. the colour of the salt is not satisfactory and could be considerably improved. Also a fairly high percentage of magnesium salts are present in addition to gypsum; the latter could to a great extent be eliminated where the crystallisers fed only with brine of 23° Be:

## 5. Improvements and Extensions.

5.1 The Kharaghoda Works have felt for some time that the supply of brine in the wells was gradually depleting and in support of this belief they have pointed out that (a) the depth of the wells is increasing year after year, (b) the quantity and quality of the brine is becoming weaker, (c) the old wells take much longer time to recoup and (d) the new wells are being dug more and more in the westward direction. At the Kuda Salt Works which is west of Kharaghoda there was a contrary belief that the Kharaghoda wells yielded better brine. No definite conclusions could, therefore, be drawn from the data available at the Works. The Central Excise and Salt Department were naturally exercised over this question of supply of brine and in 1943 they requested the Geological Survey of India to depute a Geologist to Kharaghoda for the purpose of locating suitable areas for supply of brine and for determining the cause of variations in the output and density of brine in the existing wells. Dr. M. R. Sahni of the Geological Survey inspected Kharaghoda during the manufacturing Season 1943-44 and made a useful report; he arranged for a topographical survey of the Little Rann to be started for collection of data. He emphasised the need for collecting proper data for a number of years. As a result of the recommendations made by Dr. Sahni, records of geological sections for new wells have been maintained since October 1945 and they show the variation in the levels at which brine is found as also in the thickness of the brine bearing strata which sometimes peter out completely, when no brine is struck.

5.2 In 1947, Rai Bahadur Shiv Charan Das who was then the Salt Adviser to the Central Board of Revenue asked the Central Water, Power, Irrigation and Navigation Commission to examine the question of augmenting the brine supply at Kharaghoda in various ways. Mr. M. D. Mithal, Director of Irrigation of the Commission, who was later appointed a Member of this Committee, was deputed to study the problem. Mr. Mithal was asked to suggest ways and means of (a) storing the surface water after the rains in a reservoir or reservoirs for the manufacture of salt, (b) protecting the condensers and crystallising pans from flooding during the rains, (c) increasing the production of salt to about 1,47,000 tons (40 lakh maunds) or more per annum, (d) effecting economy in the manufacture of salt by mechanising the process of lifting the brine (e) collecting data of brine output and the soil strata met in the wells, and (f) completing at an early date the topographical survey started by Dr. Sahni.

5.2.1 In 1947 Dr. B. C. Roy of the Geological Survey of India was also asked to examine the possible effects of the proposed railway connection between Bombay and Sind which was then under contemplation, on the brine wells of Kuda and Kharaghoda and to investigate the possibility of reclaiming the Rann for agricultural purposes. He was requested by Rai Bahadur Shiv Charan Das, to visit Kharaghoda jointly with Mr. M. D. Mithal and submit a report on the alternative possibilities of (a) constructing percolation canals leading to a central reservoir, (b) laying subterranean perforated pipelines operated from a central pumping station, (c) sinking tube wells, and (d) introducing mobile pumps for drawing brine.

5.3. Dr. Roy and Mr. Mithal visited Kharaghoda to carry out these investigations towards the end of February 1948 and we have had the benefit of studying the reports which they have individually submitted. Their conclusions are nearly identical.

5.3.1 Dr. Roy has agreed tentatively with Dr. Sahni that there might be several horizons of concentrated brine strata in the Little Rann at different depths, which could be reached by deep borings going down to 150 ft. or more. He suggested the digging of 12 exploratory borings to a depth of 100 ft. with a

view to ascertaining the nature of the strata and the yield and density of the brine that might be available at different depths. We understand that this work has already been taken in hand by the Salt Department under the supervision of the Geological Survey of India and that the locations given by Dr. Roy have been accepted for the purpose of making the trial bores. We share with Dr. Roy his apprehension that a high-density brine may not be available at lower depths, but boring to these depths is necessary to obtain a correct picture of the underground resources as also the geology of the Rann.

5.3.2 Dr. Roy has classified the Kharaghoda wells into three groups, *viz.* high, medium and low, according to the density of brine obtained from them. The high density wells contain brine between 18° to 20° Be'; the medium density from 16° to 19° Be' and the low density between 10° to 16° Be'. The location of the three areas is shown in Figure 6. It will be seen that the source of good brine is in the west on the seaward side of the works though areas of high density brine are sometimes met with towards the landward side also. Dr. Roy considers this natural, as there is a greater chance for the brine in the eastern portion to get diluted with subsoil seepages of sweet water currents. The fact that the new wells yield a more copious supply of brine which later on deteriorates is probably due to incomplete replenishment and the closing of the pores of the brine bearing strata by the earth falling from the sides of the wells. This is further borne out by the fact that the supply of these wells improves if they are allowed to rest for a while and opened after a lapse of some years. The question of a slight deterioration in the density of the brine does not, therefore, materially affect the potentialities and production at Kharaghoda, because the density of the Kharaghoda brine is about five times higher than that of sea brine and a vast untapped area is available for further expansion. In order that time and money may not be wasted in digging wells in a haphazard fashion as at present, leading to some wells yielding dilute or no brine at all, Dr. Roy has suggested a topographical and hydrographical survey together with geophysical investigation of the entire Works area to locate sources of sub-terrestrial brine. We strongly support this recommendation. It is possible that as a result of this survey it may become necessary to shift the existing pans and sidings to a more favourable location or at least nearer to the areas of rich brine, as the future development of the Works depends largely on the question of brine supply.

5.4 CENTRAL RESERVOIR—Dr. Roy and Mr. Mithal are agreed that the surface water that collects in the Rann after the rains is poor in sodium chloride. Unlike Sambhar, the soil also is too porous for any brine to be stored in a reservoir except at an enormous cost for providing an impervious floor. As no reliable information was available on the topography of the Rann, Mr. Mithal has suggested the collection of data, at a series of stations across the Rann, on the depth, velocity and discharge of water and its salt content with a view to determining at a later date, whether it would be advantageous to build a central reservoir to collect the surface flood water having a higher concentration of salt. We agree with Mr. Mithal that without a very elaborate investigation of the kind suggested by him no proposal in support of a reservoir could possibly be entertained. The chances of getting a price of suitable concentration by such a survey are remote and the difficulties of storing it, even if it were found, are so insurmountable that we are of the opinion that this proposal may be left out of consideration altogether.

5.5 PROTECTIVE EMBANKMENTS.—On the question of providing a protective embankment to prevent the condensers and crystallisers from flooding, Mr. Mithal has expressed the view that there is no necessity of building embankments to protect the Works since they are not flooded in any serious manner except in years of heavy rainfall. The only flooding which he noticed was on the railway sidings which was due to strictly local causes, namely, the undulating ground below, and he has suggested the raising of the permanent way by one foot. We are in agreement with this view and would add that such reservoirs and crystallisers as lie in low lying areas and are liable to similar hazards be gradually raised so that the cost of renovating them may be reduced substantially.

5.6 PERCOLATION CANALS AND PERFORATED PIPELINES.—The suggestion of constructing percolation canals to tap concentrated brine in the strata of its occurrence was examined by Dr. Roy and was rightly held to be not feasible. The depth at which the brine horizon occurs varies from 15 to 40 ft. If the brine is to be tapped to the maximum quantity the canals would have to be dug at a uniform depth of 40 ft. and it is estimated that a net work of canals totalling 50 miles in length will have to be built if the subsoil brine resources over an area of 50 sq. miles of the Rann is to be tapped. Also as excessively porous strata would be encountered at this depth at some places, it would rule out the possibility of retaining the brine in the percolation canals. The possibility of striking sweet water currents also could not be ignored. If water is met with, it would dilute the brine considerably and any advantage that might accrue from percolation canals would be thus totally lost. The cost of construction of 50 miles of canals would be prohibitive and the maintenance of such canals by sheet piling or masonry retaining walls or stone pitching would be exacting and financially uneconomical. In view of these considerations any possibility of constructing the percolation canals of the type which have been found so successful at Sambhar have been ruled out and we concur with this view. For the same reasons, Dr. Roy has discounted the suggestion of laying perforated pipelines in the brine strata and connecting them to a central pumping station. Whilst theoretically it is possible to lay out subterranean perforated pipes there are too many practical difficulties involved and it will be found impossible to tap sufficient brine by this method efficiently and economically. In the first instance, the pipes will have to be run along the brine bearing horizon and as it occurs at various levels the pipes will have to be laid out in a zigzag fashion. Further, it will be necessary to excavate up to a depth of 40 ft. to lay the pipes if the brine at various depths is to be tapped. Such a scheme will also involve 50 miles of pipelines to be laid at an enormous capital expenditure. Besides, the perforations are likely to be choked by running sand in spite of strainers and other devices being provided. Corrosion of the pipelines will also be a serious factor and the cost of maintenance will be very high if not prohibitive. This proposal has, therefore, been ruled out and we are in agreement with Dr. Roy.

5.7 TUBE WELLS AND PUMPS.—The only course left open to tap the brine at different spots is either through wells of the present type or through tube wells. As there is no protective wall around the wells to prevent them from flooding during the rains, the cost of reconditioning an old well or of digging a new one is about Rs. 150, but with the rise in the cost of labour it is likely to increase from year to year. Moreover, by the present method much brine is lost in lifting and its transfer to the condenser. A considerable saving in this loss can be expected if the lifting is done mechanically by means of pumps. Mr. Mithal estimates that about 800 tube wells will be required for the present production of 1,84,000 tons (50 lakh mds.) of salt. Mr. Mithal has further suggested that the tube wells be sunk in the brine horizon at a distance of 150 ft. apart and in 50 groups of 16 wells each and preferably located in the existing wells wherever

possible. While Dr. Roy is of opinion that these wells, in the first instance, may be fitted with hand pumps, Mr. Mithal has expressed the view that they should be operated mechanically by mobile pumps, driven by electricity, generated by diesel engines. We accept Mr. Mithal's recommendation and are in agreement with him that one-fifth of the total number of 800 tube wells, i.e., 160 wells may be sunk each year so that the whole work may be completed in five years. This gradual process of sinking the wells has been suggested with a view to enabling the Agarias to adjust themselves to changed conditions. As the pumps will have a fairly high delivery, the pumping from the wells will have to be done intermittently, allowing sufficient time to the wells for recuperation in between the pumpings. Mr. Mithal has, therefore, proposed that one mobile pump should provide suction for a group of 16 wells at a time and one pump should serve three groups of wells in separate shifts. The pumping will be carried out in each group for a period of 2 hours followed by a rest period of 4 hours. In this manner, while brine is being pumped from one group of wells, 2 groups would be resting thus securing a rest period of 4 hours for all the wells in each group. The pumps, however, will be in actual operation all the 24 hours. 17 pumps will be sufficient for 50 groups of wells but allowing for breakdowns three additional standby pumps may be provided making a total number of 20 pumps for the entire Works.

5.7.1 Cost—Mr. Mithal has estimated the cost of the entire installation of tube wells, pumps, electric supply, etc., at about Rs. 11 lakhs for capital works and Rs. 2 lakhs for annual recurring expenditure. The details of the estimate are shown in Table XXXIV.

TABLE XXXIV—ESTIMATE FOR PUMPS AND TUBE WELLS AT KHARAGHODA

S. No.	Item	Cost per unit	No. of units	Total cost
		Rs.		Rs.
A.	Capital expenditure—			
1.	(a) Tube wells with 5 inch strainers (5 ft. long) @ Rs. 25 per foot	125		
	(b) Reducer 5" × 3"	15		
	(c) 3" pipe about 30 ft. long @ Rs. 1-13-0 per foot	55		
	(d) Well and pipe sinking including carriage and labour	100	800	2,36,000
		295		
2.	Connecting Pipes (3") 50 × 12 × 150 ft. = 90,000 ft. @ Rs. 1-13-0 per ft.		90,000	1,63,125
3.	Connecting pipes (5") 50 × 2 × 200. ft. = 20,000 ft @ Rs. 3 per ft.		20,000	60,000
4.	Lead pipes 2,000 × 50 ft. = 1,00,000 ft. @ Rs. 4 per ft.		1,00,000	4,00,000
5.	Sheds for housing pumps and motors	500	50	25,000
6.	One generating unit with 60 KWH Diesel engine	15,000	2 (1 spare)	30,000
7.	Pumps (3 H.P.) with electric motor, mounted on railers	1,500	20	30,000
8.	Electric wiring switches, poles, etc.		Lump sum	50,000
9.	Miscellaneous items roads, etc.	..	..	1,05,875
	Total	..	..	11,00,000

TABLE XXXIV—contd.

S. No.	Item	Cost per unit	No of units	Total cost
B.	Recurring Annual Expenditure—	Rs.		Rs.
1.	Interest @ 3% on capital cost . . . . .			33,000
2.	Depreciation @ 5% on capital cost . . . . .			55,000
3.	Maintenance @ 3% on capital cost . . . . .			33,000
	Fuel (Diesel oil) @ Re. 0·4 lbs/BHP/hr. (75 BHP for 24 hrs. a day for about 200 days in a year) 0·4 × 75 × 24 × 200 = 18,000 gls. @ Re. 1 per gallon			18,000
	8			
5.	Lubricating oil, kerosene oil, cotton waste etc. . . . .			2,000
6.	Tools and Implements . . . . .			5,000
7.	Staff:—			
		No.	Rate	Yearly amount Rs.
	(a) Engine drivers . . . . .	3 @	75 p.m.	2,700
	(b) Cleaners. . . . .	3 @	50 p.m.	1,800
	(c) Electricians . . . . .	3 @	75 p.m.	2,700
	(d) Helpers . . . . .	6 @	50 p.m.	3,600
				10,800
			Say	15,000
8.	Field labour for 8 months— 3 men per pump 3 × 16 = 48 say 50 @ 50/-p.m. . . . .			20,000
	Total running cost . . . . .			1,81,000
			Say	2,00,000

For an outturn of 50 lakh maunds of salt per year cost per maund of salt extracted = 8 pies against 3 annas at present.

In the estimate we find a provision of lead pipes to the extent of 1,00,000 ft. This has been suggested with a view to preventing corrosion of the pipes. We feel that cast iron pipes will serve just as well and their cost will be considerably less. Also cast iron pipes are made in the country whilst lead for lead pipes will have to be imported. The estimate will, therefore, have to be scrutinised. The cost of lifting and conveying the brine to the reservoirs has been worked out to Rs. 1-2-1 per ton (8 pies per maund) as against Rs. 5-1-8 per ton (Re. 0-3-0 per maund) of salt incurred at present. There is thus a distinct advantage in mechanising the lifting of brine. We, however, feel that in the estimate the depreciation of Rs. 55,000 per annum is low and we should like it to be increased to at least Rs. 1-5 lakhs. Similarly we consider the provision for wages and salaries for the operation of the pumps and engines at Rs. 15,000 insufficient and in our opinion it should be doubled, if not more. On this basis the annual recurring



expenditure is more likely to be about Rs. 3 lakhs instead of Rs. 2 lakhs estimated and the cost of lifting the brine will, therefore, come to Rs. 1-11-3 per ton (1 anna per maund) of salt. Even this higher figure is highly attractive as compared with the present cost of Rs. 5-1-8 per ton (Re. 0-3-0 per maund). There will be a saving of Rs. 3-6-5 per ton (Re. 0-2-0 per maund) which for a production of 1,84,000 tons (50 lakh maunds) will work out to over Rs. 6 lakhs per annum. Thus in the course of 2 years or so, the entire capital cost on the tube well installation can be recovered from the saving in the cost of manufacture. There is another way of looking at this question. In 8.1.1 we have shown the expenditure incurred by the Agarias on digging the wells, preparing the reservoirs and crystallisers and providing implements. The initial cost annually on this account for the year 1947-48 came to Rs. 1,150 per pan when 722 pans were in use. On this basis the amount spent by the Agarias exceeded Rs. 8,00,000. Thus the cost for two seasons would far exceed the amount required for providing the tube-wells and the necessary pumping equipment.

5.8 In 3-6 we have indicated that the area of the reservoir *cum* condensers is only 6,400 sq. ft. and that of the crystalliser 20,000 sq. ft. As no data of the rate of evaporation during different seasons is available it is not possible to arrive at a correct estimate of the quantity of brine which evaporates daily in the reservoir and which should be replenished. Assuming that the evaporation in the reservoir and crystalliser is at the rate of 0.33 in. per day as reported by the late Kapilram Vakil the quantity evaporated will be about 1,100 gallons in the reservoir and 3,475 gallons in the crystalliser. In addition some provision should be made for the loss of brine by percolation, leakage, etc., which may be assumed at one per cent. of the total quantity of 84,000 gallons of brine impounded in the reservoir and crystalliser or 840 gallons. Thus the total reduction in volume will be of the order 5,415 gallons or say 5,400 gallons per day. As a single well on an average does not give more than 3,000 gallons per day of 8 hours, two wells will be required for replenishing this quantity of brine daily.

5.8.1 Looking to the density of brine available at Kharaghoda which is on an average 18° Be', we are of the opinion that for a crystalliser of the present size, the area of the reservoir should be about 9,600 sq. ft. This is based upon the following calculations:

(a) Area of crystalliser . . . . .	20,000	sq. ft.
(b) Area of reservoir . . . . .	6,400	"
(c) Volume of 23° Be' brine in the crystalliser when filled to 3 in. depth . . . . .	31,250	gallons
(d) Volume of water evaporated per day in a crystalliser of the above area assuming the rate of evaporation @ 0.33 in. per day . . . . .	3,475	"
(e) Volume of biterms of 29.5° Be' resulting from 31250 gal. of brine at 14% . . . . .	4,375	"
(f) Number of days required to evaporate 31,250 gals. of 23° Be' brine to 4,375 gals. of biterms of 29.5° Be' . . . . .	8	"

The quantity of 23° Be' brine which will have to be fed into the crystalliser every day will, therefore, be as under:

(i) Average daily loss by evaporation . . . . .	3,475	gallons
(ii) Average daily loss of percolation at 1% . . . . .	312	"
(iii) Average daily equivalent of volume to be eliminated as biterms $4,375 \div 8$ . . . . .	547	"
Total . . . . .	<u>4,334</u>	"
(iv) Corresponding volume of 18° Be' brine . . . . .	about 6,000	"
(v) Area required to evaporate 6,000 gallons of 18° Be' brine to 23° Be' assuming the rate of evaporation to be 0.33 in. per day . . . . .	9,596	sq. ft.
or say approximately . . . . .	9,600	" "

The rate of evaporation during the manufacturing season will, however, vary from time to time and will depend upon a number of factors, but the extent to which the evaporation is affected by these factors will be the same both for the crystalliser and the reservoir. The ratio of evaporation under these two sets of conditions will, therefore, be constant, even if the actual daily rate varies. Provided the assumption regarding loss by percolation on which this ratio is based is correct, the relative sizes of the reservoirs and the crystallisers will not require alteration to suit the variations in the daily rate of evaporation. We, therefore, recommend that the size of the reservoir be enlarged to 9,600 sq. ft. for crystallisers of 20,000 sq. ft. Should for some reason the size of the crystallisers be made larger or smaller the ratio of area between the crystalliser and reservoir should be maintained, *viz.* that the reservoir should be very nearly equal to half the area of the crystalliser. This ratio, however, should be verified by a number of experiments at the Works during the different periods of the manufacturing season and alteration in the size of the reservoir should be effected only on the basis of the figures obtained by such experiments.

5.8.2 A proper reservoir crystalliser ratio has also an important bearing on the quality of salt produced. If the reservoir were to be extended it would be possible to concentrate the brine in it to a degree sufficient to induce the deposition in them of gypsum to a large extent. This will increase the sodium chloride content of the salt and bring about an improvement in its quality.

5.9 It should be added that apart from acting as a condenser the reservoir has to serve as a storage for raw brine. To increase the total capacity of the reservoir we would also recommend that the depth of charge in it may be increased to meet the varying exigencies of pumping and the need for charging the crystalliser. We foresee that when the crystalliser has to be charged with fresh brine, whether after the mid-season discharge of the bitterns when the density reaches 29.5° Be' as at present or for filling up the crystalliser *de novo* after the raising of the first crop, as proposed by us in later paragraphs, the reservoir will be required to supply a large quantity of brine. This can be done only if it is charged to a greater depth, well in time for the necessary condensation to take place, to supply a total volume of 31,250 gallons of 23° Be' brine, to fill the crystalliser to the usual depth of three inches. If the revised ratio of reservoir to crystalliser is adopted and an adequate quantity of brine is made available for replenishment, the existing crystallisers will yield a larger quantity of salt per unit area.

5.10 WASHERY.—The quality of salt can be improved if the percentage of magnesium salts is reduced by subjecting the salt to a process of mechanical washing in a washery similar to that suggested for Sambhar. No washing tests of Kharaghoda salt have been undertaken hitherto and we suggest that such tests should be carried out in some laboratory. Since the composition of Kharaghoda salt is not materially different from that of marine salt, we are confident that washing will considerably improve the colour and quality of the salt, but in view of the preference of the public for large size crystals which are a characteristic feature of Kharaghoda salt, washing trials should be first conducted to determine whether the size of the crystals is altered in any serious manner. In view of the experience of two bore wells sunk in Kharaghoda, there is no likelihood of shortage of fresh water supply. One of these wells is reported to yield 6,000 gallons of water per minute and ample water should be available for the washing of salt if a washery is decided to be established.

#### 5.11 INCREASE IN PRODUCTION.

5.11.1 During our visit to the Works in May 1948, we noticed that a number of pans had been kept idle; even in the pans that were in use the manufacturing operations had closed by the middle of May. There is a belief at Kharaghoda

that after the 15th of May it is not feasible to continue production, because of-

- (a) the trying working conditions due to excessive summer heat,
- (b) the likely shortage of brine supply in the wells,
- (c) the fear of heavy sand-storms which might affect the quality of salt by deposition of sand, and
- (d) the bottleneck in internal haulage.

We did not consider that the above reasons justified the stoppage of the manufacturing operations at a period which is otherwise the most favourable for salt manufacture. It is our considered opinion that production at Kharaghoda can be increased very considerably by utilising all the available pans each year, as also by extending the manufacturing season till the middle, if not, the end of June. It is a normal practice in all salt works to continue manufacturing operations till the break of the monsoon. As the monsoon does not break in Kharaghoda till the beginning of July we cannot stress too strongly the need to adopt at these Works the practice followed in all other salt works. This practice is followed even in Government salt works at Sambhar, Didwana and Pachbadra and it should be the aim of the Kharaghoda Works to overcome the inherent difficulties rather than to take the line of least resistance.

5.11.2 We recognise the inconvenience caused to the labourers during the periods of excessive summer heat, but the conditions are no worse than those in other works where the hours are so adjusted as to allow a recess during the hottest part of the day. It should be possible for Kharaghoda to adopt the same practice and avoid working between the hours of noon and 3 P.M.

5.11.3 In view of what has been stated in earlier paragraphs regarding geological and other observations, we do not share the fear of the Works that the brine in all the wells will run dry during the summer months and thus interfere with the manufacturing operations. During our visit many of the wells were still full of brine and we have no reason to believe that adequate supplies will not be available during the prolonged manufacturing season if the wells are suitably located.

5.11.4 We appreciate the difficulties of working when the dust-storms occur. On some days it may not be possible to work when a dust-storm is blowing continuously and makes working conditions intolerable, but we consider that on most days it should be possible to conduct normal operations. No records are available, as far as we are aware, of the number of days on which the duststorms blow or of their intensity or peak hours. It was mentioned to us that these storms usually blow between 12 noon and 4 P.M. and this is the very period which we ourselves have suggested for recess, when the work may be suspended. The belief that the quality of the salt would deteriorate considerably because of the dust that settles on it is considerably exaggerated. It is not an uncommon sight to find at all works in India a layer of dust on salt heaps lying in the open. The quantity that might be affected will be less than 1 per cent of the total production and the dust covered layer might well be rejected without causing any serious loss.

5.11.5 With regard to the haulage difficulty, the present system, as explained before, is to confine the haulage and storage of salt to a period of only one month (about the middle of April to the middle of May) when the B.B. & C.I. Railway supply locomotives for haulage. It is this limitation that creates the bottleneck and it can be remedied by arranging with the Transport Ministry for the loan of locomotives for a longer period, now that the general transport situation has eased considerably.

5.11.6 In our Interim Report we had recommended an immediate increase in production at Kharaghoda to about 1,47,000 tons (40 lakh maunds) by bringing a larger number of pans into use, extending the manufacturing season, and making a trial of collecting the salt from the crystallisers twice during the season instead of once, the first crop being collected early in March and the second by the end of May. We are glad to note that in the manufacturing season 1948-49 the production actually increased to about 1,84,000 tons (50 lakh mds.) by bringing 722 pans into use as against 554 in the previous year. Our recommendations for extending the manufacturing season and collecting two crops were, however, not acted upon by the Works for a number of reasons which are briefly summarised below:

(a) If two crops are raised, the salt crystals will not have had the time to mature and will not be appreciated in the market.

(b) The beds of the pans would require extensive repairs after the first crop, thus causing interruption in the manufacture.

(c) If the first crop is stored on the sidings it would suffer wastage and would get spoiled by duststorms. The extra labour required for heaping and storage would not be available, except during the limited period for which it is at present employed.

(d) The proposal to give a long recess during the summer heat would reduce the number of working hours and prolong the storage operations.

(e) The Agarias would protest against the raising of two crops as they might fear excessive wastage and rejection.

(f) The labourers would not agree to stay on as they would wish to get back to their homes before the rains set in.

(g) The wagons would depreciate much more if they were employed over a longer period.

(h) The railway sidings, high banks and the trestle bridges would not be ready to receive the salt earlier than the month of May.

(j) There would be extra expenditure on account of additional staff such as pointsmen, flagmen, mechanics, drivers in charge, Station Master, etc.

5.11.7 Some of these reasons advanced are patently unconvincing and border on the ridiculous. For instance, the argument that the rolling stock which at present lies idle, for a good part of the year, would suffer a greater depreciation, not commensurate with the service it would render, by merely extending its period of utility each year is frivolous. Likewise, the trifling expenditure on account of additional railway staff would be negligible compared with the very much larger output that we visualise; in fact the incidence of cost per maund of salt will be lower. We also fail to appreciate that the railway sidings, trestle bridges, etc. could not be got ready before the beginning of May. The monsoon ceases by the end of August and if all the other operations, viz. cleaning and renovation of the wells, reservoirs, crystallisers, etc. could be started at the beginning of September, it should be equally possible to start the cleaning and renovation of the sidings and bridges also about the same time and complete them by the middle of January or the beginning of February at the latest.

5.11.8 The argument that by raising two crops the bed of the crystallisers would suffer damage and require extensive repairs is utterly unjustified. The salt works of Kathiawad and Kutch harvest more than one crop in a season and we do not know of any extensive repairs being carried out at any of these works after the removal of each crop. It is true that the floor of the pans has to be levelled after harvesting a crop, but this does not involve the thorough puddling and tamping of the kind which is done only once a year at all the works at the

commencement of the season. We also do not appreciate the force of the argument that the salt crystals will not have time to "mature" if two crops are raised. Provided care is taken to let the brine into the crystallisers at 23° Be' and the present practice of raking the salt on alternate days is continued, the crystals will have the same opportunity to set and "mature" as they do at present and the resulting salt will not be inferior either in chemical composition or in the compactness of the crystals. We had not contemplated at any time the necessity to store the salt in heaps along the sidings. In fact our intention was to see that the salt was moved to the central store as early as possible and this would not expose it to any wastage on account of rainfall or by exposure to dust-storms. We recognise that the Agarias and the labour being steeped in tradition and conservative methods of working might show some hesitation in adjusting themselves to any new proposal even if it is to their own ultimate advantage. But the solution of this problem should not be beyond the supervisory staff at Kharaghoda. During the discussions that we have had with private parties at Kharaghoda (not Agarias) we found them anxious to take up the production of salt as licensees and to carry out the manufacturing operations on the lines we have suggested. This is well known to the Agarias and it is extremely unlikely that they would push their opposition to this proposal to the point of being displaced from their traditional occupation. The difficulties in regard to finding the necessary labour are not an uncommon feature of any proposition involving an extension of production. It is up to the supervisory staff to draw up a schedule for proper staggering of the labour so as to avoid excessive work during some periods and comparative idleness during others.

5.11.9 We are convinced that if an effort were made, it should be possible to carry out our recommendations at least as an experiment to begin with. We do not suggest that the whole of the Works should be brought into this schedule of production of two crops at once, but it should be possible to make a start in a small section of the Works as an experimental measure and, if necessary, on a departmental basis or with the help of private agencies to prove the feasibility of our proposal. We, therefore, reiterate the recommendations we had made in our Interim Report and would emphasise that the experiment be carried out during the next manufacturing season.

5.12 STORES.—In the event of an increase in production at Kharaghoda, the capacity of the stores will not be sufficient and we have received from the Works two proposals for increasing the storage capacity:

(a) to demolish the existing closed store and replace it by a larger one covering both the trestle bridges and long enough to accommodate a full rake of eighteen wagons. At present in the space adjoining the closed stores and below the second trestle bridge, no salt can be stored as the roof of the closed store slopes towards it and during the rains some of the salt stored in this open portion may be washed away. We, however, see no necessity to demolish the existing closed store and suggest instead that a similar closed store be erected over the second trestle bridge. The existing closed store can accommodate only 17 wagons at present while a rake normally contains 18 wagons. The last wagon has, therefore, to be uncoupled and hand shunted to the open store. The extension in length of the store's building may be carried out so as to permit all the 18 wagons being handled under cover. By this extension, about 3700 tons (1 lakh mds.) more salt can be stored under cover;

(b) to extend the width of the store to 223 ft. by shifting the railway sidings on either side. At present the railway sidings are not equidistant from each of the corresponding trestle bridges and by shifting the sidings by 12 ft. on one side and 21 ft. on the other a uniform increase in the width of the stores is

sought to be brought about. By doing this, the Works expect the capacity of the open stores to be increased by about 37,000 tons (10 lakh mds.). For any further increase in the capacity, either a third trestle bridge parallel to and of the same length as the existing two bridges or increasing the length of the existing bridges has been proposed. In our opinion, the modifications proposed are not as simple as they appear and will involve an expenditure which will not be proportionate to the advantage that is likely to accrue. The shifting of the sidings may mean shifting of all the tracks in the marshalling yard. The present method of storage involves carrying the salt up a ramp to the maximum height of the heap. The wagons and locomotives which form over 75 per cent of the total weight are a dead weight which has to be carried unnecessarily each time to the full height of the ramp. This method of storing may have to give place to a more economical method. The possibility of using belt conveyors running along the length of the rake for raising the salt to the required height should be investigated. This would anyhow be indispensable if a system of washing the salt is undertaken. The present method also involves an excessive expenditure of labour for spreading out the salt on a base which is considerably wider than the normal angle of repose of salt would allow. To increase the width of the base, as is proposed by the Works, would further add to this labour cost and prolong the spreading out operations. We are, therefore, not in favour of this proposal but we support instead the proposal to extend the present trestle bridges. The advantages gained thereby will be more commensurate with the expenditure involved. No estimate of the cost of these extensions was submitted and we recommend that estimates be called for on the basis of our proposals.

5.13 WORKSHOP.—If the recommendations for the installation of tube wells, pumps, washery, etc. are accepted by Government, it will become necessary to provide a well equipped workshop at Kharaghoda to maintain and repair the mechanical equipment. At present a small workshop is in existence at the Works for the repairs and maintenance of the wagons and the permanent way and this workshop will have to be extended and improved considerably. As we are unable to anticipate the extent and the stages in which these proposals will be implemented, we are not able to give a forecast of the likely expenditure on this account. We, therefore, recommend that estimates for equipping and extending the existing Workshop be obtained as a necessary part of implementing the various recommendations.

## 6. Staff and Organisation.

6.1 PRESENT STAFF.—The organisation at Kharaghoda for the management of the Works consists of

- 1 Assistant Salt Controller.
- 1 Accountant,
- 21 clerical staff.

for the field operations and for the distribution of salt there are

- 1 Superintendent,
- 1 Deputy Superintendent,
- 3 Inspectors,
- 1 Surveyor, and

the necessary subordinate staff.

6.1.1 The Assistant Salt Controller is in charge and exercises general supervision over the entire Works. At the beginning of each season his principal duty is to allocate the pans to the Agarias who are required to sign an agreement of lease under which they bind themselves to comply with certain terms and conditions and agreeing to sell the salt produced by them at a certain fixed rate. The field staff guide the Agarias and generally supervise the following operations—

- (a) preparation of the wells, reservoirs and pans,
- (b) charging of brine of proper density,
- (c) removal of bitterns,
- (d) rejection of such salt as is considered dirty or inferior in quality, and
- (e) loading of wagons and haulage to the central stores.

6.2 ADDITIONAL STAFF.—For Works of this dimension there is no technical staff. Neither a Chemist nor an Engineer is provided to control the operations or to look after the proper maintenance of the Works. We strongly recommend that a qualified chemist be appointed and provision be made for establishing a laboratory for carrying out routine chemical analyses of the brine and the salt produced at the Works. To enable the Chemist to carry out field experiments, one or two sets of reservoirs and crystallisers should be placed at his disposal. Appointments of one civil and one mechanical and electrical engineer should also be made. The civil engineer should be entrusted with the location of sites for tube wells, their construction and maintenance and the maintenance of the railway sidings. The mechanical and electrical engineer should be in charge of the workshop, power house, the mechanical equipment and the maintenance of the rolling stock. We also recommend that the Superintendent and the Deputy Superintendent be technically qualified, i.e., they should have basic technical qualifications either in Chemistry or Engineering. We suggest that when additional staff is appointed to meet the requirements of expansion or when filling up vacancies men with technical qualifications should be appointed. There should be two separate branches of accounts as proposed for Sambhar; one to look after the normal routine accounts and the other the costing section.

6.3 LABOUR.—As one set of reservoir and pan is allotted at present to two families of Agarias it is computed by the Works that about ten persons work on each set. In addition, the Agarias engage a *sathi* for each pan. In other words, about 11 persons work on a pan and a reservoir. As 500 to 600 pans are in use annually nearly 5,500 to 6,600 persons thus work on salt manufacture at Kharaghoda. When the number of pans is increased this number will go up correspondingly. Besides, at the time of storage of salt, additional labour is employed for loading and unloading the wagons. This labour is employed by Government and the payment made to it is deducted from the final payment made to the Agarias. Often Government share a part of this charge for giving relief to the Agarias. The bagging of salt for despatch to the markets is arranged by Government on a contract basis for which additional labour is engaged. For the production at Kharaghoda, the number of men engaged in salt manufacture is enormously high. A considerable saving in the labour cost can be brought about by mechanising the lifting of brine. In an earlier paragraph we have shown the saving in lifting cost by the installation of tube wells. Further saving in labour can be effected by installing mechanical bagging equipment and introducing belt conveyors for the storing of the salt. During the rainy season most of the Agarias engage themselves in agriculture and this migration is used as an argument for not keeping the Works in operation till the break of the monsoon. If some of the processes are mechanised, the number of Agarias can be reduced and some of them can be spared for agriculture without unduly interfering with the operation at the Works. In this

connection, a comparison of the labour employed at Sambhar, where also a reduction is possible by mechanisation, will not be out of place. For a production of about 3,67,000 tons (100 lakh mds.) at Sambhar the number of labourers is only about 3,000 whereas at Kharaghoda for half the production the labour is more than double. The need for reducing the labour strength at Kharaghoda cannot, therefore, be too strongly emphasised.

## 7. Capital Block.

7.1 The capital block of the Works as assessed on the 30th June 1947 is about Rs. 21.81 lakhs. The main items of the assets are as under:

	Rs.
(a) Land and buildings . . . . .	54,100
(b) Water pipes . . . . .	1,53,600
(c) Bridges and platforms . . . . .	12,14,700
(d) Weigh bridges . . . . .	14,900
(e) Railway sidings . . . . .	6,13,000
(f) Salt wagons . . . . .	1,30,700
	21,81,000

This figure, we understand, has been arrived at without providing any depreciation of the capital equipment since its inception. If the depreciated value were to be taken the net cost of the capital block today would be very much less. A careful itemised valuation of the total assets of the works should be carried out as suggested in the case of Sambhar.

## 8. Cost of Production.

8.1 Salt is purchased from the Agarias at a price which is fixed at the beginning of each manufacturing season and the system is very similar to that at Didwana and Pachbadra. This rate does not include a charge for the loading and unloading of salt at the central stores. Before the War the rate paid was Rs. 3-6-5 per ton (Re. 0-2-0 per maund) and was increased on 1st April 1946 to Rs. 6-12-10 per ton (Re. 0-4-0 per maund) and on 1st April 1948 to Rs. 10-3-3 per ton (Re. 0-6-0 per maund). As soon as the storage operations are over, the quantity of salt stored by each Agaria is credited to his account and payment is made to him after taking into consideration the following debits—

- (a) *taccavi* advances if any. Formerly the Agarias received these advances in two instalments during the manufacturing season; now advances are made by their own Co-operative society.
- (b) the share of the Agarias at the rate of Re. 0-9-6 per wagon on account of loading. The charge for loading a wagon has been fixed at Re. 0-14-0 of which Re. 0-9-6 is payable by Agarias and Re. 0-4-6 by Government; and
- (c) house rent and land assessment in respect of arable land, if any, leased for cultivation.

The entire amount, even after these deductions, is generally not paid and a certain portion is held back so that the Agarias come to work in the succeeding manufacturing season.

8.1.1 We show in Table XXXV a comparative statement of expenditure incurred by the Agarias in the manufacture of salt in the pre-war year 1938-39 and in 1947-48:



TABLE XXXV.—EXPENDITURE (PER PAN) INCURRED BY AGARIAS

For average production of 220 tons (6000 mds.) of salt per pan	Manufacturing season			
	1938-39		1947-48	
	Rs.	Rs.	Rs.	Rs.
(a) Lifting of brine . . . . .		158.5		938.0
(i) cost of digging well and providing <i>kantwa</i> (casing) . . . . .	27.0		106.0	
(ii) cost of <i>mandan</i> , counterpoised wooden beam and other accessories . . . . .	10.0		40.0	
(iii) cost of earthen pots, ropes and earthen pipes . . . . .	7.5		30.0	
(iv) cost of <i>kos</i> (leather vessel) and iron rings	12.0		32.0	
(v) cost of a pair of bullocks . . . . .	42.0		310.0	
(vi) cost of fodder, etc., for the bullocks . .	60.0		420.0	
(b) Preparation of channels, reservoirs, pans, <i>farans</i> . . . . .		42.0		166.0
(i) cost of cleaning the channels . . . . .	12.0		48.0	
(ii) cost of cleaning the pans . . . . .	10.0		48.0	
(iii) cost of <i>kharvan</i> . . . . .	10.0		48.0	
(iv) cost of making reservoir . . . . .	4.0		8.0	
(v) cost of making <i>farans</i> . . . . .	6.0		14.0	
(c) Cost of implements . . . . .		11.5		36.0
(i) spade, rake, shovel, baskets, etc. . . .	11.5		36.0	
(d) Labour charges at pans . . . . .		80.0		302.5
(i) feeding the pans with brine . . . . .	8.0		0.0	
(ii) ridging of salt . . . . .	6.0		34.0	
(iii) heaping of salt . . . . .	26.0		78.0	
(iv) wages of a <i>sathi</i> . . . . .	20.0		75.0	
(v) charges of a <i>sathi</i> . . . . .	20.0		115.5	
(e) Loading into wagons . . . . .		8.0		25.5
(f) Temporary huts . . . . .		8.0		24.0
(g) Interest paid to the co-operative so- cieties . . . . .		0.0		30.0
(h) Miscellaneous charges . . . . .		5.0		32.0
TOTAL . . . . .		313.0		1,554.0

For the year 1938-39 the price paid to the Agarias for salt was Rs. 3-6-5 per ton (Re. 0-2-0 per md.) and their realisation from an average production of 220 tons (6,000 mds.) per pan was Rs. 750. The nett return per pan which was shared between two families of Agarias was Rs. 437 giving each family Rs. 218-5. For the season 1947-48 the rate paid was Rs. 2,250 per pan (Re. 0-6-0 per md.) which yielded to the Agarias a sum of Rs. 2,250 per pan of 220 tons (6,000 mds.) of salt. The nett return per pan which was shared between two families of Agarias was Rs. 696 or Rs. 348 per family. Economically the Agaria is, therefore, much worse off today than before the War. Though he receives a rate which is 300 percent higher than before the War, his nett earning has increased only from Rs. 218-5 to Rs. 348 or about 60 percent. We consider that this question of payment to the Agarias needs to be closely examined so that they may receive adequate relief and their economic conditions may improve.

8.2 The B. B. & C. I. Railway who haul the salt to the central store are paid for the haulage and the hire of the locomotives. Till December 1943, the rate charged by the Railway was Re. 0-10-0 per ton (4-5 pies per md.), but, when the salt wagons were purchased by the Works, this charge was reduced to Re. 0-4-9 per ton (2-1 pies per md.). In addition to this charge a further payment at certain fixed rates is made to the Railway for the services they render in looking after the rolling stock.

8.2.1 Besides these payments there are other items of cost such as maintenance and depreciation of buildings, sidings, weigh-bridges and trestle bridges, supervision, overheads and rent.

8.3 We have reconstructed under different heads the cost per ton (27-22 mds.) of salt for the year 1947-48 in Table XXXVI.

TABLE XXXVI.—COST OF PRODUCTION AT KHARAGHODA

	Per ton		
	Rs.	A.	P.
(a) Labour and manufacturing cost including loading and unloading	10	3	3
(b) Haulage to the stores (paid to the Railway)	0	10	8
(c) Maintenance and repairs	0	11	8
(d) Supervision	0	9	5
(e) Depreciation	0	4	11
(f) Interest	0	11	4
(g) Rent	0	0	12
(h) Overheads	0	0	10
(j) Miscellaneous	0	0	4
<b>TOTAL</b>	<b>13</b>	<b>3</b>	<b>7</b>
or	Re.	0	7 10 per md.

It will be seen that the cost of manufacture at Kharaghoda is higher than at other Government works. This is understandable, considering the extensive preliminary operations that are carried out by the Agarias at the commencement of the season and the method adopted by them for lifting the brine. The depreciation on the capital investment of Rs. 21-81 lakhs at Rs. 0-31 per ton (2 pies per md.) is a little over one percent. This is very low for any salt works and this practice should give place to one of charging depreciation at the normal rate allowed under the Indian Income-tax Act. Had such a provision been made in the past, a considerable reserve fund would have been created which could have been spent usefully on the improvement of the works.

## 9. Sales and Distribution.

9.1 The selling price of Kharaghoda salt upto 15-4-1947 was Rs. 9-77 per ton (Re. 0-5-9 per md.), when it was increased to Rs. 10-20 per ton (Re. 0-6-0 per md.). This price has been further increased since May 1948 to Rs. 16-2-7 per

ton (Re. 0-9-6 per md.) owing to the increase in payments made to the Agarias. To this price a cess of Rs. 5-95 per ton (Re. 0-3-6 per md.) is to be added which brings the total price to Rs. 21-4-3 per ton (Re. 0-12-6 per md.) in bulk ex-Works. At this price no profit is made and our comments on this practice have already been made in the Chapter on Sambhar which are applicable to Kharaghoda and all Government salt works.

9.2 From Kharaghoda salt works the salt is distributed in three different ways: (a) 50 percent through registered dealers, (b) 33 percent under direct requisition by district nominees and (c) the remainder 17 percent to indents received from the Government salt agents, Messrs. Nawrojee Pestonjee & Co. who distribute the salt to about 30 Government Salt Depots situated at the principal railway stations of Gujerat. There is not much difference between the distribution through the registered dealers and by direct requisitioning by district nominees as in both cases salt is despatched by the registered dealers who charge a commission of Rs. 1-4-5 per ton (9 pies per md.) over and above the issue price fixed by Government. This method of selling is different from the method in vogue at Sambhar where the registered dealers are required to sell their entire quota to the district nominees, but the latter have nonetheless to place their indents through these registered dealers. As in Sambhar, the bags are supplied by the registered dealers, but the bagging is done departmentally by the Works through a contractor who charges Rs. 1-2-2 per ton (8 pies per md.) to the buyer for the cost of filling, sewing and loading the bags.

9.2.1 There are 52 registered salt dealers at Kharaghoda of whom 30 have formed themselves into a Limited Company under the name of "Kharaghoda Salt Dealers Ltd." who have about 90 percent of the salt sales in their hands. Previously, before the formation of the Limited Company these registered dealers worked in open competition, but since the movement of salt is zonalised they are being given a quota based on their past performances. Messrs. Nowrojee Pestonjee & Co. hold a controlling interest in this combine of registered dealers and have practically a monopoly for the distribution of a major production of Kharaghoda salt. Grant of monopoly to a single firm naturally leads to a certain amount of criticism from the public. An indenting system which would allow a large number of buyers to purchase the salt would have a more beneficial effect on the price of salt in the markets. The only caution to be exercised is to see that the salt does not go beyond the zone fixed for Kharaghoda and that the buyers are *bona fide* traders.

9.3 In the case of salt which is sold through Government Depots the salt agents get a commission of Rs. 2-8-10 per ton (Re. 0-1-6 per maund). This commission was increased in 1933 from Rs. 1-4-5 per ton (9 pies per maund) to Rs. 1-11-3 per ton (Re. 0-1-0 per md.) and again in 1947 to the present rate of Rs. 2-8-10 per ton (Re. 0-1-6 per maund). The selling price of salt at the Agencies is fixed by Government taking into account the issue price of salt, the cost of bags, railway freight and commission to the agents. The minimum quantity which is sold at the Depots is a bag load of 3 maunds. The higher commission given to the agents as compared with the registered dealers is to enable them to meet the cost of maintaining the godown and the establishment at different places. The quotas for the depots are fixed on the basis of the average sale of salt by them during the years 1939, 1940 and 1941. Any additional requirements of the districts in which these depots are situated are supplied by the registered salt dealers as well as by the district nominees.

## 10. Preferential Treatment for Agarias.

10.1 Our attention was drawn to the practice that had been adopted in recent years of leasing a large number of pans to parties other than Agarias for the manufacture of salt. Their terms of lease were different from those given to the Agarias inasmuch as they were not required to sell their salt at a fixed

price to Government but were free to dispose of it through their own agencies. It was represented to us on behalf of the Agarias that this infiltration of private parties in an undertaking which was otherwise virtually their monopoly might prove a menace to the Agaria community as a class and drive them from their present status of licensees to that of mere hired labourers. We understand that from the season 1948-49 this practice has been stopped and the pans are again given only to the Agarias. While we have no opinion to offer on the sociological aspect of the matter, we wish to record our opinion that the production of salt by scientific and upto-date method should be a condition precedent to the employment of Agaria licensees for the production of salt. We are in favour of giving preferential employment to Agarias in pursuit of their hereditary occupation, but it should be made clear to them that they have to move with the times and bring about improvements in the technique of production as recommended by us and not raise imaginary difficulties. Should such difficulties arise it may become necessary to resort to granting the licences to any outside parties who offer to adopt improved methods of manufacture on the lines of our recommendation. This, however, should be done only if methods of persuasion fail to impress on the Agarias the need of changing their hereditary methods.

## 11. Summary of Recommendations.

(a) Greater care and attention should be bestowed on the construction and maintenance of channels in order to reduce loss of brine by percolation and leakage: (3.5)

(b) The recommendation of Dr. B. C. Roy, Geological Survey of India, for a topographical and hydrographical survey together with geophysical investigation of the entire Kharaghoda area for locating sources of subterranean brine should be carried out. (5.3.2)

(c) The suggestion of building a reservoir on the Little Rann to collect surface brine after the rains is not feasible and its consideration need not be pursued. (5.4)

(d) The permanent railway track should be raised by one foot as recommended by Mr. M. D. Mithal. The reservoirs and crystallisers in low lying areas be similarly raised, by stages, to reduce the annual cost of renovating them. (5.5)

(e) The construction of percolation canals is not a practical proposition and the idea should be abandoned. Similarly it is not feasible to provide perforated pipelines for collecting and carrying the subsoil brine to a central pumping station. (5.6)

(f) The present type of wells should be replaced by tube-wells in stages over a period of 5 years and should be sunk in the brine horizon 150 ft. apart in 50 groups of 16 wells each. The brine should be lifted by mobile pumps driven by electricity. (5.7)

(g) The size of the reservoir should be to 9,600 sq. ft. for a crystalliser of 20,000 sq. ft. Should the size of the crystalliser be made larger or smaller, the reservoir should be maintained at very nearly half the area of the crystalliser. This ratio should be verified by actual experiments at the works during the different periods before it is adopted. (5.8.1)

(h) The quality of Kharaghoda salt can be considerably improved by mechanical washing. Washing tests should be carried out in some laboratory to determine the improvement in quality as also the effect, if any, on the size of the crystals. (5.10)

(j) The production at Kharaghoda should be increased by utilising all the available pans each year as also by extending the manufacturing season till the middle, if not the end of June. To avoid inconvenience caused to labourers working during the period of excessive summer heat, the working hours should be so adjusted as to allow recess during the hottest part of the day. Salt from the crystallisers should be collected twice during the season, the first crop early in March and the second at the end of May. To facilitate haulage, the B. B. & C. I. Railway should be asked to loan their locomotives for a longer period, *i.e.*, from 1st April to 30th June. (5.11)

(k) The extension in the length of the stores building be carried out to accommodate a rake of 18 wagons under cover. The present method of storing should eventually give place to a more economical method. The possibility of using belt conveyors running along the length of the rake for raising the salt to the required height of the heap should be investigated. If this is not found feasible the present trestle bridges should be extended in length. (5.12)

(m) A well equipped workshop to maintain and repair the mechanical equipment should be provided, once the recommendations for the installation of tube wells, pumps and washery are accepted by Government. (5.13)

(n) A qualified Chemist should be appointed and provision made for establishing a laboratory for carrying on routine chemical tests. To carry out field experiments one or two sets of reservoirs and crystallisers should be placed at the disposal of the Chemist. A Civil Engineer should be appointed and entrusted with the work of sinking tube wells and maintaining the railway sidings. A mechanical and electrical engineer should also be appointed to take charge of the workshop and power house and look after the maintenance of the mechanical equipment and rolling stock. A costing section should also be created. (6.2)

(p) Labour at Kharaghoda is excessive and should be reduced by employing labour saving devices. (6.3)

(q) A careful itemised valuation of the total assets of the works should be carried out. (7.1)

(r) The present system of entrusting the marketing of the salt to combines of registered dealers should be modified and an indenting system which would allow a larger number of buyers to purchase salt directly from the Works should be adopted. (9.2)

## CHAPTER X

### OTHER INLAND SOURCES

#### 1. General Description.

1.1 In the previous chapters we have discussed the major inland sources of salt which are under direct Government control. In addition to these sources, there is the important privately-worked Kuda salt works in Dhrangadhra, Saurashtra, which we visited. There are also other tracts in Rajasthan, Kutch and Punjab (India) where salt was produced at one time or another, but either because of lack of communications and the inability of these centres to sell salt in competition with the better organised salt works of Sambhar, Pachbadra, etc. or in order to safeguard the salt revenue of the Central Government, the production died out or was stopped. We did not visit these areas nor have we examined their potentialities in detail, because they are not of sufficient consequence to the immediate problem of making India self-sufficient, but we understand that the Rajasthan Government have recently appointed a Committee to make a preliminary survey of these sources. We may look upon these sources as reserves which may be either developed in the future, if the developed resources are unable to meet the increasing demand of the country, or brought into production to meet emergencies should they arise. It may be possible to revive some of these centres of production and attempts are being made in this direction. This exploratory work, especially for meeting the local demand, may be continued.

#### 2. Kuda (Saurashtra).

2.1 MANUFACTURING RIGHTS.—The Kuda salt works are situated on the southern boundary of the Little Rann of Kutch in the former State of Dhrangadhra (now Saurashtra), but 9 miles to the north of Dhrangadhra town and 2½ miles to the west of Kharaghoda. The salt works were formerly owned by the Dhrangadhra State, but in 1939 they were sold to the Dhrangadhra Chemical Works Ltd. Salt has been manufactured at Kuda from time immemorial, but in 1883, along with the other Kathiawad States, Dhrangadhra State agreed to restrict its manufacture for consumption in Kathiawad only. In 1900, the Dhrangadhra State which until then was permitted to manufacture the *baragara* type of salt, a concession which was not allowed to any of the other salt works in Gujerat and Kathiawad surrendered this concession in return for an annual compensation of Rs. 7,000. They were, however, permitted to manufacture only the light flaky variety locally known as *ghasia*. Production of *baragara* salt was, however, revived in 1922-23 to meet the requirements of the soda ash factory which had been started by the State and with it the payment of the annual compensation to the State was stopped. As the *baragara* salt produced at Kuda was in excess of the requirements of the soda ash factory, the Government of India agreed to purchase the surplus production and distribute it along with Kharaghoda salt to obviate the risk of its being smuggled. During the second World War Kuda salt was allowed to be despatched direct to Nepal and also by sea to Bengal. It was not able to reach the latter market as the port nearest to the Works is Navakhi (in the former State of Morvi, now merged into Saurashtra) which is at a distance of over 100 miles. On the abolition of the salt excise duty in 1947, the State was allowed to distribute its salt freely to any part of India, but in 1949, on the introduction of the zonal system, its markets were localised and fixed as Nepal and parts of Madhya Bharat, U.P. and Bombay.

2.2 When the soda ash factory was converted into a public limited company in 1939, they bought over the Kuda Salt Works and the factory was given the sole and exclusive right to manufacture salt on payment of a nominal rent of Rs. 450 per annum to the State and on its undertaking to sell salt at cost for domestic consumption within the State. It was also given the right to sell salt in excess of the requirements of the factory outside the State limits on payment to the State of a royalty of Re. 0-6-10 per ton (three pies per maund). This royalty was to be paid only on salt exported out of the State and not on salt sold for domestic consumption in the State or consumed by the factory. In 1946 the State withdrew the monopoly given to the factory and licences were granted to two or three other parties to manufacture salt at Kuda. None of these new works has yet come into operation.

2.3 MANUFACTURING PROCESS.—The Kuda Salt Works extend over an area of 5428 acres and there are about 320 pans in operation. The works are served by a metre gauge railway siding, as they are 9 miles from the Dhrangadhra station and the Chemical Works. The method of manufacture followed is very similar to that adopted at Kharaghoda. The brine is, however, drawn at much shallower depths from wells only 8 to 10 ft. deep and its density ranges from 17° to 19° Bé. The supply of brine is copious which is attributed to the fact that Kuda is nearer to the sea than Kharaghoda and that the sea penetrates up to Kuda while it remains about 20 miles further west of Kharaghoda. The pans are allotted in early September to the Agar'as as in Kharaghoda, but this depends upon the rainfall. If the rainfall is heavy the works are under 2 to 3 ft. of water and the manufacturing operations are delayed till the flood waters recede. The salt manufactured is of the *baragara* type, and is used both in the Chemical Works and for sale. The salt is very similar in quality to Kharaghoda salt, but in colour it does not compare well with Kharaghoda.

2.4 ANNUAL PRODUCTION AND QUALITY.—The production at Kuda during the three years 1946-47 to 1948-49 as also the number of pans worked during these years are given in Table XXXVII.

TABLE XXXVII. PRODUCTION AT KUDA (1946-47 to 1948-49)

Year	Production		
	Tons	Maunds	Pans
1946-47.	47,800	13,01,000	192
1947-48	67,200	18,29,000	302
1948-49	72,350	19,70,000	319

The Chemical Works utilise about 30,000 tons (8,17,000 mds.) of salt in the soda ash plant, whilst the surplus is sold for edible purposes. An analysis of a sample of salt drawn by the Committee during its visit is given in Table XXXVIII.

TABLE XXXVIII. COMPOSITION OF KUDA SALT  
(Percent; on dry basis)

Sodium chloride	96.50
Calcium sulphate	1.50
Magnesium sulphate	1.30
Magnesium chloride	0.13
Insolubles	0.30
Undetermined	0.27
<b>TOTAL</b>	<b>100.00</b>

## 2.5 IMPROVEMENT AND EXTENSIONS

2.5.1 As the brine used in the manufacture of salt at Kuda is very similar to that at Kharaghoda and the Dhrangadhra Chemical Works have not introduced any improvements in the quality of salt or the process of manufacture, our observations and recommendations with regard to Kharaghoda apply *mutatis mutandis* to Kuda. While the results of the geological investigations proposed for Kharaghoda will be of great use in regard to the development of the Kuda works, we strongly recommend that local geological investigations on the lines recommended for Kharaghoda should also be carried out independently by the Kuda salt works. The good offices of the Geological Survey of India should be secured for this investigation.

2.5.2 Whilst it is true that the *baragara* type of salt is appreciated in certain markets for edible purposes and has the advantage of resisting mechanical shock and rough handling, it has to be recollected that a good deal of manual labour has to be spent in the raking of the salt crystals in the crystallisers to secure the *baragara* type of crystals. For use in chemical manufacture where the grinding and or dissolution of hard crystals may actually involve further processing and additional expenditure, the production of *baragara* type is not necessary nor can it be recommended. Though we do not wish to discourage the production of this variety of salt for any markets which fancy it, we recommend that some experimental production of salt by the methods generally prevalent in Kathiawad marine salt works be carried out to determine the economy that can be effected by the change over to this process as also the improvement in the quality of salt that may be obtained thereby.

2.5.3 As stated by us in an earlier paragraph, two new salt works are proposed to be constructed at Kuda, one of which estimates to manufacture 50,000 tons (13,60,000 mds.) of salt per annum. We had mentioned in our Interim Report that both the Government of India and the Government of Saurashtra should consider whether adequate rail transport facilities and markets would be made available to these new works for disposal of their production. Unless this can be assured it would be advisable to delay the establishment of these two salt works. If as a result of this inquiry it is found that new works can be established and convenient markets found for their production, we would strongly recommend that the new works be designed to produce *kurkutch* salt as its cost of production would be lower than that of *baragara*. The layout of these works should be properly planned with due regard to the relative areas of condensers and crystallisers and the use of tube wells and groups for the lifting of brine.

2.6 COST OF PRODUCTION.—The break-up of the cost of production as furnished by the Kuda Works is given in Table XXXIX.

TABLE XXXIX. COST OF PRODUCTION AT KUDA.

	Per ton Rs. a. p-
(a) Cost of obtaining brine into reservoirs and labour . . . . .	10 5 11
(b) Power and fuel, maintenance (including betterment and repairs) .	0 0 6
(c) Supervision, rents, rates and taxes . . . . .	2 2 10
(d) Depreciation . . . . .	0 2 9
(e) Miscellaneous charges . . . . .	0 6 4
Total . . . . .	13 2 4
or Re. 0-7-9 per md.	



The manufacturers have stated that no account has been taken of interest and overheads as also loss of salt during rain. The cost as given is already higher than that of Kharghoda and when the other items are added, this cost will go still higher. The cost of labour as also of supervision is considerably higher than at Kharghoda and both these items of cost need to be looked into by the manufacturers at Kuda. We see no reason why it should not be possible to produce salt at Khoda at the same cost as that at Kharghoda.

#### 10. Sales and Distribution.

2.7.1 Before the advent of the Saurashtra Government, the Kuda salt was sold by the Dhrangadhra Chemical Works to a number of dealers on Dhrangadhra who, in turn, used to distribute it in the various markets. After the formation of the Saurashtra Government, this method of distribution was stopped and the Government of Saurashtra undertook instead to purchase from the Chemical Works their surplus production at the rate of Rs. 17-13-10 per ton (Re. 0-10-6 per maund) which the Saurashtra Government sold at Rs. 23-14-0 per ton (Re. 1-1-0 per maund). If the Government had purchased the salt for the purpose of cheapening its cost in the markets where it sells, we would have welcomed this move, but we cannot defend a policy of the Government making a large profit of about Rs. 11 per ton (Re. 0-6-6 per maund). The Saurashtra Government evidently appreciated that this policy could not be justified and from April 1949 they have arrived at a fresh arrangement with the Chemical Works under which the latter have undertaken to produce a minimum of 50,000 tons of salt, over and above the requirement of the factory, for sale within and outside Saurashtra and pay the Saurashtra Government a cess of Rs. 3-13-3 per ton (Re. 0-2-3 per maund) for the total quantity of salt manufactured by them. They are, however, exempted from the cess for such quantity of salt as is consumed by them for the manufacture of soda ash and other chemicals. The Chemical Works have also been given the freedom to sell the salt directly to such parties as are approved by the Saurashtra Government, the selling price being fixed at the same rate as may be determined by the Salt Controller for Kharaghoda salt.

2.7.2 During our visit to Rajkot, the Saurashtra Government and the salt dealers of Dhrangadhra represented to us that the zone allotted to Kuda by the Salt Controller was insufficient and would not absorb more than 10,000 tons (2,72,000 mds.) of salt annually, leaving a balance of about 15,000 to 18,000 tons (4,08,000 to 4,90,000 mds.) undistributed. In view of the fact that *baragara* salt of Kuda is very similar to the salt produced at Kharaghoda and also since the salt works at Khoda are being served by a meter gauge railway, we had recommended in our Interim Report that the Kuda salt should be given an adequate zone for distribution, particularly as the meter gauge line could transport the salt up to Kanpur and beyond. We understand that this recommendation has been accepted by the Salt Controller, as a result of which **Kuda salt can now be sold in Nepal and in parts of Rajasthan, Madhya Bharat, U.P. and Bombay.**

2.7.3 In our Interim Report we had suggested that the Saurashtra Government might re-examine the possibility of railing the salt from Kuda to Navlakhi for shipment to Calcutta where, we believe finely crushed salt of Kuda will find a ready sale. This undoubtedly will be a long route for the Kuda Works and they will be at some disadvantage in the matter of transport charges as compared with other Kathiawad salt works which are at or near a port. The Saurashtra Government have not reacted favourably to this suggestion and are of the opinion that this method of disposal would be uneconomical. The Saurashtra Government have perhaps overlooked the fact that the cost of manufacture of salt at Kuda is less than at the marine salt works due to the initial high density of the brine, more arid climate, and, therefore, more favourable conditions for

salt manufacture. The density of brine at Kuda is of the order of 17° to 19° Bé as against 3·5° Bé at the marine salt works. Moreover, the capital outlay is much less as a much smaller area is needed to lay out the reservoirs (condensers) as compared with the marine salt works. Whilst the Government of India have accepted our recommendation and allotted to Kuda a larger zone than was previously given, the Saurashtra Government should also appreciate that if they do not attempt to despatch this salt to Bengal where it is so much needed, the programme of expansion at Kuda will be hampered. The distance between Kuda and Navlakhi is about 125 miles. This is not such a long distance for salt to travel to the port, particularly when there is a deficit in the country and a gap has to be met from indigenous production as soon as possible. We, therefore, reiterate our recommendation that this question be examined more closely and, if necessary, tried out on a small experimental basis to determine its feasibility.

### 3. Rajasthan.

3.1 The whole of Rajasthan is rich in saliferous earths and subsoil brine which could be used for the production of salt. Some of these potential sources are in the Luni tract; Falodi; Lonkaran Sarr and Kanod; Bharatpur; Kumhar and Dig.

3.1.1 THE LUNI TRACT.—As the name Luni itself signifies, the Luni river carries along its course to the Rann of Kutch substantial quantities of salt in solution. During the dry season, this river dries up completely leaving behind extensive areas covered with a thin salt encrustation which was at one time gathered and sold for local consumption. As it was found uneconomical to continue the collection when other sources of salt came to be developed, it was abandoned. The development of the Luni tract appears to us as a feasible proposition if brine is drawn from subsoil sources and evaporated by solar energy in the usual manner as is done at Didwana and Sambhar.

3.1.2 FALODI.—This source is located in a depression of about 15 sq. miles, midway between Jaisalmer and Bikaner. Salt was manufactured at Falodi in the same manner as at Didwana and some 550 tons (15,000 mds.) were produced annually, but after the opening of the Jodhpur Bikaner Railway, connecting Sambhar and Pachbadra, the Falodi works were closed down in 1897 as they could not compete with salt produced at Sambhar and Pachbadra.

3.1.3 LONKARAN SARR AND KANOD.—Lonkaran Sarr, in the former State of Bikaner, is also a depression covering an area of 3 to 4 sq. miles where brine is found at shallow depths. Brine was obtained from pits to produce salt by solar evaporation to meet strictly local requirements. Salt was also manufactured at Kanod, in the former State of Jaisalmer, by a similar process. As no data are available regarding the composition or the concentration of the subsoil brines in these several places during different parts of the dry season, we recommend that the Rajasthan Committee or the Salt Department of the Government of India should arrange to conduct a survey of the quality of the brines with a view to ascertaining the quality of salt that could be manufactured from them should the need arise to utilise these sources in future. It would be advisable also to consult the Geological Survey of India regarding the subsoil conditions, and the quality of brine available in the different regions.

3.1.4 BHARATPUR, KUMHAR AND DIG.—The salt tracts in the former State of Bharatpur were once an important source of salt and, before the suppression of its manufacture in 1879, the average annual production in the State was 44,000 tons (12 lakh mds.). The method of manufacture adopted in olden days appears to have consisted in drawing brine from wells 30 to 40 feet deep with the help of draught animals and evaporating it in pans lined with lime plaster. Even today remnants of brine wells and salt pans for the manufacture of salt by

solar evaporation survive in Bharatpur, Kumhar and Dig where the old factories were located. As the Ruler of the State was unwilling to lease out the works to the Government of India, the latter, in order to safeguard their revenue from salt, offered to the Ruler an annual compensation of Rs. 1,50,000 and 37 tons (1,000 mds.) of salt from Sambhar Lake free of cost, in return for the stoppage of manufacture. This was accepted by the Ruler and the production was stopped. After the abolition of duty on salt in 1947, the annual compensation paid to the Ruler of Bharatpur was stopped and the State was allowed to restart the production. A small beginning was made during the 1948-49 season and about 37 tons (1,000 mds.) were manufactured at different places in this area. The following account describes the recent attempts made to restart this industry.

(a) The analyses of samples of brine drawn by one of the Officers of the Salt Department of the Government of India from the salt producing areas are given in Table XL.

TABLE XL.—COMPOSITION OF BRINES FROM BHARATPUR, KUMHAR AND DIG

Sample Number	Kumhar area		Bharatpur area		Dig area	
	I	II	III	IV	V	VI
Density of brine in degrees Be' . . . . .	3.5	4	4	3.5	1.5	3.25
	(Per cent ; on dry basis)					
Sodium chloride . . . . .	75.82	79.33	79.96	87.14	71.31	88.09
Calcium sulphate. . . . .	7.19	2.23	4.88	1.43	10.66	6.58
Calcium chloride . . . . .	..	..	..	2.50	1.64	..
Magnesium sulphate . . . . .	10.46	7.54	9.19	..	..	2.51
Magnesium chloride . . . . .	..	..	..	5.72	6.56	0.63
Sodium sulphate . . . . .	3.92	8.94	5.96	..	..	..
Calcium carbonate . . . . .	2.61	1.96	0.01	3.21	9.83	2.19
	100.00	100.00	100.00	100.00	100.00	100.00

We comment on these analyses with a certain amount of hesitation. It is not known when and how the samples of brine were collected and whether these samples are representative of the brine throughout the season. These wells having been in disuse, it is a matter of speculation whether the composition of the brine would not be different once they are brought into regular use and the brine is not allowed to stagnate in them for long periods. The figures of proximate analysis supplied to us were found defective in some respects and we have, therefore, given the figures in Table XL which have been obtained by recalculation on the basis of the radicals reported by the analyst. We feel that these recalculated values are more likely to be representative of the actual salts in solution than the figures supplied to us. Excepting sample No. V collected from the Dig area, the brine is more or less of the same density as sea water. The low density of sample No. V may probably be due to the occurrence of fresh water springs in the wells. As such springs may occur at any place, the area cannot be condemned on the basis of the density of brine obtained from a solitary well. The proportion of sodium chloride to other salt found in most of the samples is higher than that commonly found in sea water. The percentage of other

salts varies very greatly but one peculiar feature is that all the brines appear to be saturated with regard to calcium carbonate. Notwithstanding the diversity of the composition it should be possible to produce common salt of good quality from all these brines by solar evaporation. Special care will have to be taken however, to allow the brines to settle down and to deposit their calcium carbonate and calcium sulphate before the brines are led into the crystallisers. The removal of soluble magnesium salts could also be effected satisfactorily provided the bitterns are discharged regularly.

(b) Only a small quantity of salt was produced in 1948-49 and it was of inferior quality. The local authorities attributed this to the fact that people were shy of investing money and coming forward to start this industry at a time when changes in the political structure were impending. Leases were offered only for one year. Furthermore, there were very few people who possessed the necessary knowledge and experience of salt manufacture. The manufacturers had not used separate condensers and crystallisers and had made no attempts to separate the impurities from common salt. All these factors stood in the way of production being taken in hand in earnest with appropriate financial backing or under proper technical guidance.

(c) The Rajasthan Union Government, which has now taken over the administration of these areas has proposed an experimental unit for carrying out investigations—

- (i) to reduce the cost of lifting brine from wells by using either hand pumps or pumps worked by power or wind mills;
- (ii) to test plastic clay available in ponds and other low lying areas near the Fort of Bharatpur for preparing impervious beds in place of masonry pans; and
- (iii) to evaporate brine to different ranges of densities separate pans for obtaining a purer grade of common salts and for recovering byproducts.

The Rajasthan Union have requested the Government of India for the services of some experienced officers from the Salt Works at Sambhar to guide the experiments. The Geological Survey of India have also been requested to survey the area and to locate richer sources of brine.

3.1.5 We feel that if any production of salt is to be established in Bharatpur, it should be based upon a carefully planned and fairly complete investigation lasting over a full manufacturing season. Besides the directives issued by the authorities to which we have referred in the previous paragraph, the composition, density and quantity of the brine available in different localities should also be examined systematically. There is every likelihood that the prospective licensees will start the production on unscientific lines. Further they will be hampered by the fact that skilled workmen trained in traditional methods of manufacture are not available in the locality. We therefore feel that it would not be prudent to grant licences on an extensive scale except as an experimental measure, till a proper technique for dealing with Bharatpur brine has been worked out in the proposed experimental station. We would, therefore, recommend that licences should be granted only to a limited number of persons and in the granting of the licences a condition should be imposed that the licensee would be prepared to change over, when required, to a properly standardised method of production in the light of the results obtained in the experimental unit. Care should, also be taken that small units are not allotted to these licensees which might prove uneconomical to run in the face of competition from Sambhar and other areas. For this purpose we would tentatively suggest that a compact area of 100 acres should be treated as the

minimum prospective unit of manufacture. We also recommend that the entire area of a single unit should not be brought under production until the results from the experimental station are available. For the present the operation should be carried out more or less on an exploratory basis.

#### 4. Kutch.

4.1 In the chapter dealing with Kharaghoda, we have stated that geologically the Rann of Kutch formed originally a part of the sea which was subsequently raised owing to earth movements. The northern part of Kutch forms a part of the Great Rann. The geology of the Great Rann has not been investigated systematically, but it is traditionally reputed to be a rich store-house of salt. Reports have appeared periodically that deposits of salt, covered up by sand, lie buried under it. In our opinion, the Rann is not likely to contain massive deposits of rock salt, but it undoubtedly contains extensive layers of spontaneous salt. We recommend that a systematic investigation of the Great Rann be conducted to determine the extent of such deposits. A hydrographical survey will probably reveal the presence of rich subsoil brine sources which could be utilised for salt production as at Kharaghoda. Apart from the Rann there is justification to believe that saliferous earths, rich in sodium chloride, occur in the interior of Kutch in large quantities. It will be a matter for investigation as to whether, depending upon the availability of supplies of water, these earths could not be utilised for the production of common salt by a process of lixiviation and subsequent solar evaporation. The arid condition of Kutch and the prevailing temperatures are ideal for the manufacture of salt. We, therefore, recommend that geological investigation for the occurrence of saliferous earths may also be conducted in the interior and the availability of water or brine in the subsoil investigated.

#### 5. Sultanpur (Punjab I.)

5.1 Sultanpur salt sources are situated at a distance of about 30 miles west of Delhi in the Gurgaon District of Punjab (India). They consist of saline tracts spreading over 10 villages and covering an area of 20 sq. miles. Salt manufacture is reported to have been carried on for a long time in these villages by solar evaporation of brine obtained from wells, and the industry flourished till 1900 producing about 7,350 tons (2 lakh maunds) of salt annually. These works, however, could not compete with the Sambhar Salt Works and the manufacture slowly died out. A few of the works in the villages of Sultanpur, Mahmoodpur and Saidpur struggled for some time and were finally closed down in 1922. Attempts to start the industry were again made in 1931 when factories were opened at Sultanpur and Mubarkpur villages, but they did not survive. Most of the areas where salt was produced have now been utilised for agricultural purposes except in the villages of Sultanpur and Mubarkpur. Some remnants of salt manufacture, like abandoned wells and pans, still exist in these villages. These wells go down to a depth of about 30 ft. and contain brine of 2° to 4° Be'. No regular study of the geology of the areas has been made, but the profile of the abandoned wells, shows a 6 ft layer of clayey soil followed by 2 ft. of limestone, 4 to 6 ft. of sandy clay and finally coarse brine bearing sand which forms the rest of the strata in the well.

5.2 Salt manufacture can be conducted at Sultanpur for about 9 months in a year by solar evaporation if adequate supplies of brine are available. The variations in the composition of brine obtained from twenty wells are shown in column (1) of Table XII below. The Salt Department conducted experimental manufacture in a small unit consisting of 6 pans lined with lime mortar, four measuring 10 ft. x 15 ft. and two measuring 10 ft. x 7 ft. each. One of the smaller pans was used as a crystalliser and the rest as condensers. The brine was obtained from one of the abandoned wells and its density varied from 2°

to 3° Be'. The experiment was conducted from October 1948 to the end of June 1949. Analyses of the brine used and the salt obtained from it and of the bitterns left behind are given in Table XLI below. For purposes of comparison, analysis of sea brine is also given in the table.

TABLE XLI.—ANALYTICAL DATA OF EXPERIMENTAL PRODUCTION OF SALT AT SULTANPUR

	Range of 20 samples of brine	Brine used	Salt produced	Bitterns left behied	Sea Brine
	1	2	3	4	5
	<i>(Percent, on dry basis)</i>				
Sodium Chloride	65.70 to 53.59	60.83	97.50	15.77	80.22
Calcium Sulphate	12.36 to 9.15	11.02	1.08	..	3.60
Magnesium Sulphate	20.35 ..	4.92	0.96	28.07	4.74
Magnesium Chloride	0.57 to 21.57	20.71	0.11	64.16	10.88
Calcium carbonate	1.02 to 1.34	1.06	..	..	0.34
Calcium Chloride	.. 14.35	1.30	..	..	..
Insolubles	.. ..	..	0.09	..	..
Undetermined	.. ..	0.16	0.26	..	0.22
	100.00 100.00	100.00	100.00	100.00	100.00

5.2.1 On comparing the composition of the well brine with that of sea brine, it will be seen that the well brine is much richer in calcium sulphate as well as magnesium chloride and the sodium chloride content is considerably lower. It would not be correct to come to a final conclusion about the quality of brine available in this area merely from the results of analysis of samples drawn from wells which had not been in use for a long period. If, however, this analysis is fairly typical of the Sultanpur brine, salt of good quality can be produced and gypsum and magnesium chloride can also be recovered as byproducts in appreciable quantities.

5.3 We understand that the East Punjab (I) Government have a proposal to organise a Co-operative Society to run a salt factory in this area. We would suggest that before any attempt is made to produce salt on a large scale, the availability of brine, its composition and areas where it is present in abundance should be determined first trial bores to depths lower than 30 ft. to see if higher density brine is available in larger quantities. As the soil is sandy, masonry pans were used in the past for the evaporation of the brine, but investigations should be carried out with the locally available plastic clay to find out whether impervious clay beds could not be introduced instead of the more costly masonry beds. Also we do not recommend the starting of a large scale works until the economics of manufacture are worked out in an experimental unit of at least 10 acres of evaporating area.

## 6. SUMMARY OF RECOMMENDATIONS.

### 6.1 KUDA

(a) Local geological investigation of the strata at Kuda on the lines recommended for Kharaghoda should be carried out, the good offices of the Geological Survey of India being secured for them. (2.5.1)

(b) The manufacture and use of *baragara* salt for the soda ash plant is unnecessarily expensive and the salt works at Kuda should experiment with producing the ordinary type of *kurkutch* salt by adopting methods prevalent in the marine salt works of Kathiawad. (2.5.2)

(c) The development of new salt works at Kuda should not be undertaken unless adequate rail transport facilities and markets are made available. The new salt works, when started, should be laid out on scientific lines. (2.5.3)

(d) The Saurashtra Government should carefully re-examine the possibility of railing the Kuda salt to Navlakhi for shipment to Calcutta. This will create a wider market for the Kuda salt and offer opportunities for expansion of production at Kuda. (2.7.3)

6.2 RAJASTHAN.—Carefully planned and fairly complete investigations, lasting over a full manufacturing season, should be carried out with a view to determining the possibility and details of process of manufacture in Bharatpur. Licences should be granted for salt manufacture only to a few licensees till a proper technique for dealing with the available brine has been worked out in the experimental unit. Though a compact area of 100 acres should be considered as the minimum economic unit of manufacture and units smaller than this area should not be allotted, these licensees may conduct manufacture on an exploratory basis till the results of the experimental station are available. (3.1.5)

6.3 KUTCH.—A systematic investigation of the Great Rann and the interior of Kutch should be conducted to determine the extent and availability of crusts of salt, saline earths and brines. (4.1)

6.4 SULTANPUR.—Before any attempt is made to produce salt on a large scale, the availability of brine and its composition and the areas where it is present in abundance, should be determined by trial bores. Investigations should be carried out with the locally available clay to ascertain whether impervious clay beds could not be prepared. The economics of manufacture in this area should first be determined in an experimental unit which should be at least 10 acres in extent. (5.3.)

## CHAPTER XI

### MANDI MINES—ROCK SALT

#### 1. Description.

1.1 Before the partition of India, the salt mines of Khewra were a source of large supplies of common salt. They were economically important and had a great potential value inasmuch as the quality of salt obtained from them ranked fairly high in point of composition and uniformity of character. After the partition of the country, the Mandi mines are the only known rock salt deposits left in India and their importance has, therefore, greatly increased as also the need for their conservation and utilisation by efficient modern methods. The Mandi salt deposits are situated in the former State of Mandi along the western slopes of Ghoghar-ki-Dhar range which lies between  $76^{\circ}$  and  $77^{\circ}$  East longitude and  $31^{\circ}$  and  $32^{\circ}$  North latitude. The winning of rock salt from these deposits was carried on by the State for a few centuries at the two small villages of Guma and Drang. Since 1931, mining has been started in the village of Maigal also. The mines are situated on the main Jogindarnagar Mandi Road, Guma being at a distance of 7 miles, Drang 24 miles and Maigal 30 miles from Jogindarnagar.

1.2 The Mandi deposits have been visited from time to time by various Geologists and Mining Engineers who have submitted reports on the geology and the methods of mining. Dr. Warth of the then Inland Customs Department, who visited the mines in 1875, observed that in the Ghoghar-ki-dhar range there were spurs of flanking hills of different formations and salt was usually found where these spurs met the main range. Mr. M. M. Goswami, the Mining Engineer, Patiala State, who visited the mines in 1924, attributed the Mandi salt deposits to the evaporation of sea water from a sea bed which subsequently got elevated owing to land movements. In his view the Ghoghar-ki-Dhar range running from Sui in the north to Mastdhar in the south nearly divided the lower Himalayan zone on the east, which is chiefly composed of metamorphosed crystalline and aqueous rocks of secondary and Palaeozoic times, from the Sub-Himalayan zone on the west composed solely of tertiary deposits.

1.3 The rock salt as mined at present at Mandi contains earth, sand, pebbles, etc. to the extent of 25 per cent. and it is only on rare occasions that pieces of pure crystals of salt are found in the Mandi mines. The total absence of gypsum, which invariably occurs with rock salt, is remarkable in the Mandi deposits where the cover above the salt, locally called *lokhan* is a soft mass of earthy matter, generally pink but varying from ash white to shades of red and purple in colour. This coloured overburden is the remnant left after the lixiviation of layers of rock salt and is an index of the occurrence of salt below it. By the excavation at Guma and Drang only the uppermost beds of rock salt of not more than 40 ft. thickness have been laid bare and even these excavations have been confined to places where the salt strata had been exposed as a result of erosion by streams. The extent of the strata at lower depths is unknown and it is of great importance to determine the nature and extent of these lower beds of rock salt. At Khewra more than 100 ft. of low grade salt



overlies the good quality salt and as the underlying low grade salt at Khewra is similar in character to the Mandi salt, both Dr. Warth and Mr. Goswami expressed the view that similar deposits of white salt might be found lower down in the Mandi mines also. This, however, cannot be determined by superficial geological observations and regular borings will have to be carried out. Mr. Goswami believed that there were extensive salt resources hidden out of sight and that the working of the Mandi mines for several years had not yet laid bare sufficient geological strata to enable an estimate of the resources being made.

1.3.1 From the records placed before us varying estimates of the quantity of salt available at the Mandi mines have been given. They vary from 1.5 million tons to 20 million tons. Several geologists and mining engineers who have examined these mines from time to time have suggested schemes for their better working, but no systematic geological survey of these mines appears to have been carried out to determine the quantity of salt available there. Besides these mines, there may be other untapped areas which can be developed equally well. We recommended in our Interim Report that the Government of India should arrange for a detailed geological survey of the present mines and of the surrounding areas for location of rock salt deposits and estimating the quantity available. Such a survey was urgently called for as deposits of rock salt are a valuable asset to the country's economy and its industrial progress. We understand that the Government of India have accepted our recommendation and asked the Geological Survey of India to carry out this survey, and that a team of geologists have already started work and will be shortly submitting a preliminary report. As a result of this survey, it is possible that fresh areas yielding a quality of rock salt purer than is being obtained at present may be located.

1.4 Dr. Warth had also recorded that there were a number of brine springs at Maigal in the beds of the gorge. He estimated that thousands of tons of salt must be flowing each year from these brine springs into the principal water stream of the main gorge of Maigal Nala. As they appear to have been flowing for a century and more, the beds of rock salt through which they flow must be very extensive. Mr. M. M. Goswami also inspected these brine springs and, recognising their importance, drew up a procedure for the recovery of salt, both by solar and artificial evaporation. When we visited these springs we found the brine to vary from 8° to 11° Be', from spring to spring, and we roughly estimated the total flow to be 3600 gallons per hour. We were informed that this flow continues throughout the year with but small fluctuations in its rate or in its density.

## **2. Manufacturing Rights.**

2.1 When the area in which the Mandi State was situated was annexed by the British Government in 1846 and the Raja of Mandi was recognised as the ruler of the State, a provision was made in his Sanad for the regulation of the price of salt mined in the State. The price was fixed at Rs. 17-0-2 per ton (Rs. 0-10-0 a md.) and it continued in force till 1871. In 1869-70 it was noticed that a considerable quantity of untaxed Mandi salt was being consumed in the adjoining Indian territory, and to protect the salt revenue of the Government of India the price of the Mandi salt was raised with effect from 1871 to Rs. 34-0-5 per ton (Rs. 1-4-0 a maund, Re. 0-10-0 on account of price of salt as previously fixed in 1846 and Re. 0-10-0 as duty). It was further agreed that the duty of

Re. 0-10-0 a maund on all salt consigned to the British Indian territory would be paid to the Indian Government and the duty on salt consumed in the Mandi State would be retained by the State. An establishment of the Government of India was posted at the mines for collecting the duty on salt despatched to the Indian territory, whilst the Raja of Mandi was authorised to collect the duty at the mines on salt despatched within Mandi and the adjoining States. This arrangement resulted in some friction between the officials of the State and of the Government of India and it was revised in 1880 in consequence of which a uniform duty of Re. 0-10-0 per maund was charged on all salt mined. The duty was shared in the proportion of 2 : 1 between the Indian Government and the Raja of Mandi which corresponded to the approximate consumption of the salt in Indian territory on the one hand and in Mandi and its adjoining States on the other. In 1884, the duty on salt in the Indian territory was reduced to Rs. 54-7-0 per ton (Rs. 2/- per maund) and in consequence the duty on Mandi salt was proportionately reduced to Rs. 10-3-4 per ton (Re. 0-6-0 per maund). Provision was also made at the same time for an automatic adjustment of the duty on Mandi salt to the duty prevailing in the Indian territory, by fixing the duty on the former at 1/5th the duty on the latter.

### 3. Mining and Manufacturing Methods.

3.1 At the Mandi mines the dry mining method is employed and salt is quarried from open pits. The winning of salt commences from the middle of October and ends by the end of May. At the commencement of the season, i.e., after the rains considerable preliminary work is done each year before the mines are reopened for working. The rains are spread over two different seasons, the heavier fall being between June and September, whilst during January to March it is only spasmodic. The total rainfall varies from 50 to 80 inches per annum.

3.2 The mining method followed in the olden days and described by Mr. A. E. English, Superintendent, Northern India Salt Revenue Department, who inspected the mines in 1915, was as follows. The three months of the heavy monsoon were employed in clearing the quarry of its overburden and debris. The course of a rushing stream, coming down the gorges, was diverted to the quarry site and brought to play on the debris of stones, boulders and earth. The rush of water carried away the loose mud and earth whilst the larger stones and boulders which could not be thus cleared were removed by manual labour. In this manner 10 to 20 times more material was removed than could have been done by manual labour alone. To prevent the salt in the quarry becoming inaccessible, owing to the fall of debris during the rains, a deep cutting was made in the bed of the gorge up to the quarry pit and timbered; the mouth of the cutting was then bricked up. After the monsoon, the falling scree would bury the timber roof but when the mouth was opened a tunnel, locally known as dog, was made through the gorge to the quarry pit. The salt was blasted out and removed through the tunnel to the depots.

3.3 This method of mining has now been given up, largely owing to the scarcity of labour, but the new method is no improvement on the old and is very primitive. In the present method the site for a quarry is cleared only after the rains, but no use is made of the rushing water for the removal of the overburden. The practice of timbering has also been given up. Instead the debris is removed from the opening in the quarry by manual labour after the rains

and when the salt stratum is exposed it is quarried by blasting. As the mines are located on mountain slopes, which at places are precipitous, they get buried under the falling scree during the rains. The natural relative position of the different strata, which is a good index for locating the salt deposits, cannot be thus seen from the faces and sometimes the cost of clearing the debris is so high that it is cheaper to look for new openings than to reopen the old ones. This introduces a large element of chance. Many of the fresh tunnels or shafts, when driven, have had to be abandoned and the expenditure on them written off, because no salt deposits were struck even after tunnelling, for over 200 ft. Whenever tunnels were driven through the loose rubble on mountain slopes, water springs found their way into the mines and the wooden props which supported the roofs of the tunnels would give way completely, thus stopping all operations and adding to the difficulties and cost of mining. Salt appears to have been mined only with the object of supplying the immediate needs of the moment, no regard being paid to the ultimate damage that may be caused to the strata of salt in the succeeding rainy season. The equipment used for tunnelling is antiquated and the working conditions inside the mines are far from satisfactory. In some places it is difficult to work even in a sitting posture and it is hard to believe that human beings could or should be asked to work under such conditions.

### 3.4 LOCATION.

3.4.1 The Guma mines are situated on the southern side of the Luni Nala (gorge), at a height of about 5,000 feet above the mean sea level. The thickness of the salt seam is reported to be 100 ft. The tunnels here suffer from all the defects of improper mining, but the quality of the salt is slightly better than at Drang or Maigal.

3.4.2 At Drang, the mines are situated near the Drang village at a height of about 4,000 ft. and the thickness of the seam is said to be about 72 ft. Here two tunnels, at two different levels, have been dug. The tunnels are better than at Guma, having cemented walls and roof and are free from water percolation. Salt is also being quarried at Drang in a gorge in two places, one on the north and the other on the south. The northern quarry is a cubical pit of 30 ft. x 30 ft. x 30 ft. As it lies immediately at the foot of a steep hill rising over 1,000 ft., loose scree which rests in an unstable state on the steep slopes of the cliff roll down during the rains and bury the pit. As this gorge is a junction of several mountain streams, the quarry gets completely flooded with water during the rains and the reopening of the quarry at each season involves heavy expenditure. The southern quarry is similar but being a little removed from the steep hill slopes it is not liable to the same hazards.

3.4.3 At Maigal, the salt is being produced by the open quarry method as at Drang. The quarry is about 3,000 ft. above mean sea level and there is a proposal to start tunnelling in this area. There are also the valuable brine springs which are running to waste at present. An attempt is being made to manufacture salt by evaporating this brine in shallow cement pans, but the pans are very small and the quantity produced is negligible. The brine, being free from almost all impurities, can yield salt of 99 per cent. purity and above. We estimate that if all this brine could be utilised, nearly 10,000 to 12,000 tons (2,72,000 to 3,26,600 mds.) of salt of the highest purity could be produced annually from it. This quantity would be at least twice as much as that quarried or mined in the three mines together at present and would be preferred in areas which are accustomed to the good quality rock salt from Khewra.

3.5 SALT REFINERY—An attempt had been made to manufacture refined salt on a small scale at a refinery in Mandi city. Impure and rejected pieces of rock salt from the Maigal quarry were transported over a distance of six miles to Mandi where they were dissolved in water in small cement tanks and stirred manually with wooden paddles. When the brine reached saturation point it was pumped to a storage tank after filtering through cloth. The clear brine was then let into iron pans arranged in a cascade over a flue and was evaporated over wood fire. The salt that deposited was ladled out at frequent intervals, and dried in pans heated by the flue gases. It was sold as such or after grinding in a mill. The refinery worked for only one year and produced about 180 tons (5,000 mds.) of salt. It was closed down in 1947 when the salt duty was abolished as it was found that the refined salt, already very costly, could not stand the competition with Khewra salt. The cost of manufacture of the refined salt was prohibitive being as high as Rs. 136/- to Rs. 190/- per ton (Rs. 5/- to Rs. 7/- per maund). It is not understood why the refinery was at all located at Mandi, when constantly flowing brine of 10° Be' was available at Maigal. During our visit to Mandi we were consulted whether this refinery should be restarted, and we advised against this step, as salt could be manufactured by solar evaporation from the Maigal springs at a much lower cost.

#### 4. Annual Production and Quality.

4.1 The quantity of salt produced at Mandi during the three years from 1946 to 1948 is shown in Table XLII separately for each centre of mining.

TABLE XLII—PRODUCTION AT MANDI MINES 1946-48

Mines	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Guma . . . .	735	20,000	1,125	30,700	960	26,100
Drang . . . .	2,200	60,000	2,760	75,200	2,730	74,300
Maigal . . . .	250	6,900	635	17,300	490	13,300
<b>TOTAL . . .</b>	<b>3,185</b>	<b>86,900</b>	<b>4,520</b>	<b>1,23,200</b>	<b>4,180</b>	<b>1,13,700</b>

The production during the last ten years has not exceeded 5,000 tons (1,36,000 mds.) per annum and may be considered as negligible. This small quantity is being consumed locally and in the adjoining areas for domestic and cattle use.

4.2 The quality of the salt mined at Mandi is exceptionally poor, the sodium chloride content being as low as 60 to 62 per cent. and in no case going above 80 per cent. It is purplish in colour and can well pass for a dark stone, owing to its impurities which consist mostly of silica and calcium carbonate. In rock salts the colour generally varies from pure white to dark grey depending upon the impurities present. The rock salt at Khewra contains as much as 98-99 per cent sodium chloride and its colour is much whiter. Table XLIII gives analyses of samples of salt collected from two of the three localities in Mandi and is compared with the composition of rock salt in Cheshire on the one hand and Khewra on the other. An analysis of a filtered brine made from Mandi salt is also given to indicate the virtual absence of any other soluble salts in it.

TABLE XLIII—COMPOSITION OF MANDI SALT

	Mandi		Khewra	Cheshire	Mandi Brine
	Guma	Drang			
	<i>(per cent. on dry basis)</i>				
Sodium chloride . . . . .	77.09	62.61	98.86	95.60	99.01
Calcium chloride . . . . .	..	..	..	0.03	..
Calcium sulphate. . . . .	0.75	0.49	..	1.29	0.96
Sodium sulphate . . . . .	..	..	0.57	..	..
Sodium Bicarbonate . . . . .	..	..	Traces	..	..
Magnesium chloride . . . . .	..	Traces	..	0.08	..
Insolubles . . . . .	22.14	36.72	..	3.00	..
Undetermined . . . . .	0.02	0.18	0.57	..	0.03
TOTAL . . . . .	100.00	100.00	100.00	100.00	100.00

It will be noticed from this table that the Mandi rock salt is of an inferior quality and cannot be compared either with Khewra or Cheshire salt. The salt as it is mined is, in our opinion, unfit for human consumption and we doubt even of its fitness for use by cattle. In fact it is the worst salt we have seen so far in India. In the case of Khewra, the salt is pure enough to be utilised as such for human consumption whilst the Mandi salt can only be used after it is subjected to a process of purification. Its impurities consist mostly of insoluble matter which can be removed completely. This will be apparent from the analysis of the Mandi brine given above. The calcium sulphate component in this brine can be crystallised out during concentration and a relatively purer crop of sodium chloride crystals could be obtained from it with greater ease than from brine made from Cheshire rock salt.

4.2.1 We were informed that the people of Himachal Pradesh have a special preference for the impure Mandi salt. This is partly due to the mistaken notion that this salt has medicinal property and partly due to ignorance and prejudice, born of many years of habit. The Mandi people are not peculiar in this respect, because in other places in India also we have found this reluctance to give up the consumption of an impure material. The local inhabitants use the salt by dissolving it in water and leaving it overnight for the impurities to settle down and taking only the supernatant liquor for use. The separation of the insoluble silica by such extraction is not complete and it is inevitable that this injurious substance must be daily finding its way into their food. Education and propaganda can however bring about a change in this habit when purer salt is made available.

### 5. Improvements and Extensions.

5.1 In spite of the fact that mines have been examined from time to time by various geologists and mining engineers, no steps have been taken to improve either the methods of mining or the quality of Mandi salt and it continues to be quarried or mined in a primitive fashion. This neglect may have been due to the fact that the Khewra mines in the West Punjab produced a purer quality of salt and naturally received greater attention, as the principal source of supply of rock salt in undivided India. As far back as 1879 Dr. Warth condemned the methods of quarrying in Mandi and described them as primitive and dangerous to the lives of the labourers working in them. In 1942 one of the

mines at Drang collapsed and this led Mr. E. B. Lewis, Chief Mining Engineer, Salt Range Division, Khewra, to visit the Mandi mines in 1943, along with Mr. V. P. Sondhi of the Geological Survey of India to investigate the causes of this collapse and to advise the Mandi State on the future working of the mines. Messrs. Lewis and Sondhi reported that the inconsistent nature of the *lokhan*, the heavy rainfall, the absence of thick and good cover over the salt and the consequent tendency for fresh water to percolate into the mine all combined to shorten the working life of mines of this type. They recommended that greater care should be exercised and good mining practices followed in the future mining operations. They suggested new mines being opened at Nagrota and Guma where the existence of salt deposits was indicated by the *lokhan*. They gave direction about the action to be taken to reach the stratum of salt and to avoid water seepage and gave detailed technical direction as to the methods of mining to be adopted and the safeguards to be provided to prevent a recurrence of a collapse. They also recorded that no geological map of any of the areas where salt was mined was being maintained to show accurately the course of the mine's explorations and development. In their opinion, this was an essential aid to the choice of a site and recommended that one large scale map of not less than 1 inch = 100 ft. showing all surface features including contours, *nalas* and salt out crops, and another map on the scale of 1 in. = 50 ft. showing the working plan of the mine should be prepared. Mr. Lewis also expressed the view that the deposits did not lend themselves ideally to underground dry rining. Subsequent experience and mishaps all point to the need for scrapping the present methods of extracting the salt, whether by quarrying or dry mining.

5.2 We have come to the conclusion that the present method of mining or quarrying should not be continued for more than a year or two by which time positive steps will have to be taken by either the Government of India and/or the Government of Himachal Pradesh for introducing up-to-date methods for the production of salt of good quality. Unless easily accessible deposits of rock salt with a sodium chloride content of 98-99 per cent. are located (and there have been suggestions that they may be available below the present known strata), we feel that there is no future for the recovery of salt in Mandi by dry mining and that the only alternative is to mine the salt in the form of brine for subsequent evaporation. In our opinion, it is of paramount importance that the only available source of rock salt in India should not be dissipated by the present wasteful methods of extraction. We would have suggested the immediate closure of these mines, but such a step would affect a considerable number of men who obtain their livelihood from the mining operations. It would have also brought a sudden stoppage of supply of local salt in the Mandi area. In our Interim Report we had, therefore, recommended that for a brief period of two years the Mining Department of Himachal Pradesh should be provided with cheap mechanical appliances like drills, air compressors, etc. for driving tunnels, and that facilities be given to it to carry on such development work as is necessary. This would not involve a large capital outlay. In fact, we were averse to any large investment in view of our recommendation to close down the mines in two years' time. By adopting simple mechanical methods a saving would be effected in the cost of mining the salt and what is more important, these natural resources would be conserved and not frittered away as at present. In pursuance of these recommendations we are glad to note that the Himachal Pradesh Government have purchased these appliances and they expect to bring them into use during the next mining

5.2.1 *Brine Wells*.—Because of the low sodium chloride content of the rock salt at Mandi, the introduction of the brine well method and subsequent evaporation of the brine become a matter of increasing urgency and importance. It will be economical in cost, conserve the salt resources and remedy the defects to which the dry mining method is subject. Moreover, as the percentage of soluble impurities is small, brine of an exceptionally high purity can be obtained to yield a pure quality of salt. In U.S.A. where rock salt deposits are uneconomical to work by dry mining method on account of their depth or the impurities present in them, the brine well method is being increasingly introduced. Out of a total production in U.S.A. of 135.1 lakh tons (3677.4 lakh mds.) of salt in 1946, as much as 75.1 lakh tons (2044.2 lakh mds.) were recovered in the form of concentrated brine from the rock salt mines and sold as such for industrial uses. The production of rock salt as such amounted to only 30.4 lakh tons (827.5 lakh mds.). In Great Britain similarly as much as 18.0 lakh tons (490 lakh mds.) out of a total production of 26.3 lakh tons (715.9 lakh mds.) was produced as brine in 1938. In the course of the next few years it is more than likely that the production of rock salt by dry mining will still further be replaced by the brine well method. Unfortunately, there are no mining engineers in the country today who are experienced in this method of mining and we had recommended in our Interim Report that steps be taken to obtain the services from America of a set of engineers, versed in this method of operation.

5.3 THERMO-COMPRESSION EVAPORATORS—We do not, however, recommend the usual type of evaporation in pans or multiple-effect evaporators to be adopted at Mandi because the necessary fuel is not available near the mines and the price of fuel transported to this area from the plains will be very high. Mandi has no easy access to coal which would have to be transported all the way from Bengal or Bihar, but is blessed with hydro-electric power from Jogindarnagar. In Switzerland, where cheap hydro-electric power is available, salt is being manufactured by evaporators worked on thermo-compression. The heat economy in this type of evaporation is very much higher than even with multiple-effect evaporators. It works on the principle of compressing the vapours from the evaporator by electrically driven rotary turbo-compressors and using them over again for heating the evaporator, with the addition of a little make-up steam, which, if necessary could be obtained from an electrically heated boiler. This plant should produce 66,000 tons (about 18,00,000 mds.) of salt per annum which is considered to be the minimum for an economic unit. According to an agreement drawn up in 1925 between the Punjab Government and the Mandi Durbar relating to the Uhl River Hydro-electric scheme the former had undertaken to supply the Mandi State with 250 kw. of electric power free of cost and an additional 1000 kw. at cost price which is 0.9 of an anna per unit. The Mandi State and its successor the Himachal Pradesh Government have utilised hitherto only a part of the 250 kw. offered free of cost and some of it is still available for utilisation. We also understand that the Jogindarnagar Power House is anxious to develop a permanent load, once its supply of power to Pakistan ceases. Considerable surplus power would then be available for Himachal Pradesh and we recommend that the Punjab (I) Government seriously consider offering power to the Mandi evaporator plant at a lower rate than 0.9 anna per unit. Although this cost is not cheap, we believe that a thermo-compression brine evaporator plant offers a method of utilising the salt deposits of Mandi to the best advantage. We also recommend that the possibilities of using wood fuel for the boiler to give the required make-up steam be examined in view of the high cost of power. Even taking the cost at 0.9 anna per unit the cost of manufacturing salt from the evaporator plant will not exceed, in our opinion, Rs. 27;22 per ton (Re. 1)

per md.) and might be actually lower. As, however, none of us has any direct knowledge of the operation cost of a plant of the thermo-compressor type, our figure of cost is approximate and collected from such information as we have before us. The consumption of salt in Himachal Pradesh, Jammu and Kashmir, Punjab (1), Patiala and the East Punjab States Union and Delhi is in the neighbourhood of 1,00,000 tons (27,22,000 mds.) and the production of the Mandi factory could be easily absorbed by these markets.

5.3.1 In our Interim Report we had suggested that Messrs. Escher Wyss Engineering Works of Zurich, Switzerland, who specialise in the manufacture of thermo-compression evaporators should be invited to examine the problem at Mandi in all its details and asked to furnish complete technical data and operational details for supplying and erecting a thermo-compression plant. They also should provide the technical personnel in the initial stages of operation whilst the Indian personnel was being trained. We had estimated the erection cost of such a plant including working capital to be in the neighbourhood of Rs. 60 lakhs. As the conservation and economical utilisation of the Mandi mines is of great consequence to the country, we are of the view that the country's interest would be best served if the management and control of these mines as also of the salt factory are kept in the hands of the Government of India and the Government of Himachal Pradesh.

5.3.2 We understand that our suggestion in the foregoing paragraph has been acted upon and a technical representative of Messrs. Escher Wyss Ltd., who have been consulted, has visited the site for a preliminary investigation and submitted an interim report. He has stated that the general geological formation and the uniformity of deposits in the three different mining centres rule out the possibility that these deposits are purely local or that the quantity of salt is limited. He has also expressed an opinion that a huge salt layer, following the whole range of the hill chain, connects Maigal, Drang and Guma. He has suggested that the Geological Survey of India, who are at present investigating the area, be requested to locate by drilling the salt layer at Bejni (half way between Maigal and Mandi) which he considers as a possible site for the erection of an evaporator plant. They have offered to carry out a fuller investigation for a lump sum fee of Rs. 12,000/- plus the living and travelling expenses of the delegation of one or more of their experts at site and submit a detailed report on the following points:

- (a) the best methods of exploiting the existing salt deposits for the envisaged brine evaporator plant;
- (b) the general layout and plans for a suitable plant including purifying facilities, evaporators, salt extraction, drying, conveyance and storage;
- (c) a detailed study of the economics of the proposed plant and comparative production cost by other processes;
- (d) transport aspects;
- (e) power requirements;
- (f) labour; and
- (g) miscellaneous.

In case the order for a plant is ultimately placed with them they have offered to forego the fee of Rs. 12,000/-. We consider this offer as fair and strongly urge that it be accepted and the firm asked to conduct the survey and submit their detailed recommendation as early as possible. Messrs. Escher Wyss reckon that their plant could be put into commission within three years of the placing of the order and during this period the method of wet mining could be



introduced and stabilised. In an earlier paragraph we have mentioned the desirability of bringing out American experts versed in wet mining methods, but since Messrs. Escher Wyss are prepared to undertake this investigation, as a part of their scheme, we suggest that the consultation with American experts be deferred till this firm submit their report.

5.4 TRANSPORT—The location of the brine evaporator plant will depend upon the availability of transport for carrying away the salt. In our Interim Report we had suggested that the plant might have to be located either near the Guma mine or between Maigal and Mandi, Messrs. Escher Wyss in their preliminary report favour the latter site. Before World War II a narrow gauge railway used to operate between Pathankot and Jogindarnagar, but during the war, a part of this railway line, from Nagrota to Jogindarnagar, (35 miles) was dismantled. It was suggested by the Mining Engineer, Mandi, that the Government of India should be requested to restore this line in order to facilitate the development of salt industry in Mandi on a large scale. Although a good road exists from Mandi to Pathankot and beyond we do not believe that it would be possible to carry away by road 66,000 tons of salt each year at an economic cost. The only cheap and adequate mode of transport for this area is by rail not only for the salt traffic but for such other traffic as is available from Mandi and the adjacent Kulu valley. The restoration of the narrow gauge line from Nagrota to Jogindarnagar will not be as costly but we are not enamoured of this idea because a small railway of this nature is incapable of offering cheap transport. When this line was previously in operation it proved a losing proposition for a period of 13 years, because it could not stand up against road competition and it may meet the same fate on its restoration. If the Government of India are anxious to develop the resources of Himachal Pradesh we recommend that Mandi be connected by a broad gauge railway. This will afford cheap transport to Himachal Pradesh and help to open it up and bring it nearer to the rest of the country by making it more easily accessible. The East Punjab Railway is already operating a broad gauge railway service up to Nangal for the development of the Bhakra Dam project. Nangal is at a distance of only 50 miles from Mandi and it would be advantageous to extend this line. We have to remember that after the partition of India this area has assumed special importance and we anticipate a development of its economy due to its having become the northern frontier of India. Though this area is sparsely populated, at present it has an attractive climate and the need for new areas for expansion bring it into consideration for future development. Mandi can offer traffic in (a) salt, (b) wool and woollen goods, (c) timber, (d) wood products, (e) fresh fruit and vegetables and (f) tourist traffic for which there are considerable potentialities. The scheme for a brine evaporator plant which we have recommended will provide a load of 200 tons of salt a day from Mandi to the plains and the potentialities of this area, which we have envisaged, will make a demand for a substantial load from the plains towards Mandi. We would, therefore, urge that in the programme of railway expansion in this strategic and attractive area, preference should be given to the proposal to connect Nangal to Mandi by a broad gauge tract, and that this question should not be based entirely on past experience under conditions which have altered considerably.

5.4.1 The location of the brine evaporator plant will depend upon the rail transport facility that is made available. If it is decided to restore the narrow gauge railway from Jogindarnagar to Nagrota the factory will have to be located near the Guma mines; on the other hand if the broad gauge railway is to be extended from Nangal to Mandi, the factory will have to be installed near the Maigal mines.

## 5.5 MAIGAL SPRINGS

5.5.1 We have referred in an earlier paragraph to the observations made by Dr. Warth and Mr. Goswami on the occurrence of brine springs at Maigal. In 1929 Mr. Goswami examined the possibility of recovering salt from this brine and stated that pure white salt could be manufactured from it both by concentrating it in open iron pans heated by direct fire and for a part of the year by solar evaporation. Mr. Goswami had worked out the cost of manufacturing solar salt which, according to the conditions prevailing at that time, come to Rs. 17 per ton (10 annas per maund). Mr. Goswami's recommendation for the artificial evaporation of Maigal brine either in open pans or multiple effect evaporators was not adopted because the supply of fuel in the locality was found inadequate. An attempt was, however, made to lay out salt pans for solar evaporation, but the quantity produced was negligible and did not exceed 180 tons (5000 maunds) in any year.

5.5.2 In our Interim Report we had recommended a more effective utilisation of Maigal brine for the manufacture of salt by solar evaporation. Though no data was available of the rate of evaporation under the conditions prevailing at Mandi, Mr. Goswami had estimated its average rate at 0.4" per day; we had, therefore, suggested to the Mining Engineer at Mandi to collect data by carrying out actual evaporation experiments in the small cement pans which are available at Maigal. These experiments were carried out in 1949 and the average evaporation per day in the different months of the year has been reported as follows:

<i>Month</i>	<i>Inches</i>
January	0.10
February	0.15
March	0.20
April	0.25
May	0.29
June	0.33
September	0.20
October	0.17
November	0.12
December	0.10

We had also suggested that the manufacture be undertaken in the first instance during the two dry periods of the year, namely, October to December and March to May and had expressed a hope that it might be possible to continue the manufacture even in the months of January, February and March in spite of the occasional rains which occur during these months. The above results show that some evaporation does take place even during these months and it might, therefore, be possible to have a manufacturing season lasting from eight to nine months in the year.

5.5.3 The production of solar salt from the Maigal brine springs might be as much as 10,000 to 12,000 tons (2,72,000 to 3,27,000 maunds) per annum from brine which now runs to waste and which can be brought into use to create wealth for the State. We had calculated that if an area of about 20 acres were set aside for the construction of condensers and crystallisers, 5,000 tons (1,36,000 maunds) of salt could be produced in a year by working during the dry months alone. This scheme was independent of our recommendation for a thermo-compression plant and was to be continued even after wet mining and evaporation by thermo-compression came into operation. This output could, however, be increased by reducing the period of evaporation if the brine which has a density of 10° Be' could be made to flow over blocks of rock salt placed in the course

of its journey. The placing of these blocks could be so regulated that by the time the brine reaches the crystallising pans it might have a density as high as 20° to 22° Be'. The one serious difficulty which has to be solved first is in regard to making an impervious bed for the condensers and crystallisers. In all solar salt works, these beds are made of plastic clay, tamped and made impervious by treatment with brine. Such a clay, as far as we are aware, is not available in Mandi and it would, therefore, be necessary to carry out experiments with different kinds of locally available clay. We had recommended in our Interim Report that the Mining Engineer who is in-charge of the salt mines including solar pans should be deputed to visit the solar salt works in different parts of the country, particularly in Kathiawad, Kutch and South India to study the methods adopted there, so that they may be adapted to suit the local conditions of Mandi. We understand that the Himachal Pradesh Government have approved our proposal for the production of 5,500 tons (150,000 maunds) of solar salt by setting aside an area of 20 acres and have sanctioned an expenditure of about Rs. 43,500 for laying out the works. Before this work is taken in hand we reiterate our recommendation that the Mining Engineer should be deputed to visit the solar salt works in different parts of India.

5.5.4 The Government of Himachal Pradesh had asked our opinion whether it would be advisable to bottle the Maigal brine on a commercial scale to make it available for either as mineral water or for culinary purposes. As the density of the brine is high, it is unsuitable as a mineral water, nor does it contain any mineral other than sodium chloride to justify its being called a mineral water. Its use as a solution for culinary purposes is also not practicable; in fact it will be expensive and uneconomical. We, therefore, do not recommend any attempts being made in either of these directions.

5.6 *Iodized salt*—Reference was also made to us by the Himachal Pradesh Government whether we could suggest a means for iodizing the Mandi salt as a preventive against goitre which is prevalent in this area. The crude rock salt as available in Mandi, at present, cannot be iodized as such. Only salt of a high purity can be iodized and that too under controlled conditions. We, therefore, recommend that the consideration of this question should be deferred until the brine evaporator factory is erected and brought into operation. We understand that Messrs. Escher Wyss have agreed to include in their proposal the necessary equipment to manufacture iodized salt.

5.7 *Storage*—During our visit we were informed that no adequate provision existed at the mines for the storage of salt and that additional covered stores should be built. As we have recommended the closing down of the mines in the course of the next two years, we did not approve of any expenditure on the building of new stores. We suggested instead the method of covering salt heaps with grass and clay, a simple but effective technique employed at the salt factories in Bombay and Madras, where the rainfall is very much heavier and more widespread than at Mandi. We understand that the Mining Engineer tried out this suggestion but without success as he was not familiar with the technique. When he is deputed to visit the solar salt works, he should make a study of this method of storage also for adoption at the mines.

## 6. Staff and Organisation.

6.1 The staff at the mines consists of one Mining Engineer who supervises the working of the mines with the help of five Inspectors, one accountant, four clerks, three technicians and 12 peons. The functions of the Mining Engineer at present are manifold. He is not only in charge of the mining

operations but also in charge of planning, and designing, at all places where mining or quarrying is undertaken. Besides the salt mines, he has to supervise the other mineral mines in the State. He is being charged with a great deal of responsibility and it is advisable that he should be adequately assisted. Formerly he was not even provided with any means of transport for movement from mine to mine for inspection and supervision. We had recommended that he be given means of transport so that he could move quickly from one area to another. We are glad to note that he has now been provided with a staff car. We understand that the Salt Department will be taking over the administration of the Mines from 1st April 1950 and we recommend that steps be taken by the Salt Department to reorganise, completely the salt mining department in Mandi. As a first step we recommend that a Chief Mining Engineer, having considerable knowledge and experience in mining operations, should be appointed to take charge of the salt mines and quarries and the present Mining Engineer should be placed under him. When the wet mining method is adopted, the Mining Engineer would be associated with the foreign technical personnel, so that in due course he may be in a position to take over this operation from them. At a later date he might even be sent abroad to study the latest technique in different methods of wet mining.

6.2 The labour employed at the mines is local and comes from the surrounding villages. The total number of labourers employed at the mines and the brine works is about 300. Of these about 100 are skilled and 200 unskilled. The wages of the skilled miner varies from Rs. 1-4-0 to Rs. 1-8-0 per day whilst the unskilled labourer gets Rs. 1-1-0 per day.

## 7. Cost of Production.

7.1 The cost in 1948 of salt mined in Mandi was reported to be Rs. 22-2-0 per ton (Rs. 0-13-0 per maund). No details of cost were furnished to us but we were informed that this cost included wages, stores, repairs and renewals, administration expenses, distribution expenses and depreciation. The cost for 1949 is reported to have increased by 50 per cent. which would make the price of Mandi salt considerably higher than that of salt produced either in the Government or privately owned solar works elsewhere in India. No charge appears to have been included in the cost for the amortization of the mines which is necessary in view of the fact that the mines are a wasting asset. We recommend that proper costing methods should be adopted and adequate provisions made for depreciation and amortization of the mines.

7.2 For the small quantity of brine salt that is being produced, the cost during 1935-40 was reported as Rs. 40-13-0 per ton (Rs. 1-8-0 per maund), for 1940-45 at Rs. 54-7-0 per ton (Rs. 2-0-0 per maund). For 1949 it is estimated to cost Rs. 95-4-0 per ton (Rs. 3-8-0 per maund). With a larger production of 5,500 tons (150,000 maunds) of brine salt from the Maigal springs as proposed by us, the price of this salt should not exceed Rs. 27-3-6 per ton (Rs. 1 per maund).

7.3 The selling price of rock salt was Rs. 37-7-0 per ton (Rs. 1-6-0 per maund) up to July 1948, when it was raised to Rs. 54-7-0 per ton (Rs. 2-0-0 per maund). Similarly the price of brine salt was increased from Rs. 54-7-0 per ton (Rs. 2 per maund) to Rs. 108-14-0 per ton (Rs. 4-0-0 per maund). These prices include the cost of distribution. It will be seen from these prices that a margin of anything up to 75 per cent., over the cost of mining is being kept as provision for the heavy wear and tear and large losses and wastage that occur during the mining operations. In our opinion however this provision is not adequate to cover these losses particularly as the present method of mining is wasteful and a large quantity of salt is washed away each year by the rain. No sooner the

brine wells and the evaporators start functioning it would be possible to sell Mandi salt at a lower price than charged at present, inclusive of all costs and providing for a fair margin of profit.

## 8. Sales and Distribution.

8.1 Mandi salt is distributed by the mines themselves mostly to the Mandi District, Kulu and Kangra Valleys and certain parts of Punjab(I). It is transported to these markets. The small traders known as *batnis*, carry the salt on their backs to the nearby villages for local consumption. The markets farther away are served by the traders who transport it by head loads, pack animals, bullock-carts and motor lorries. The traders indent for salt on the mines which charge 3 pies per maund as loading charge and 6 pies per maund per mile for bringing the salt to the road side. Salt is also sold in wholesale and retail lots at Government Depots which are situated at convenient places on the motor road.

## 9. Summary of Recommendations.

(a) A detailed geological survey of the present mines and of the surrounding area to locate fresh deposits should be carried out to determine the extent of rock salt deposits in the country (1.3.1).

(b) The present method of mining or quarrying should not be continued for more than a year or two by which time positive steps should be taken for introducing the method of mining by means of brine wells and installing evaporators for the production of good quality salt. In the intervening period, the Mining Department of Himachal Pradesh should be provided with cheap mechanical appliances like drills, air compressors etc. to facilitate the dry method of mining. (5.2)

(c) For Mandi, we consider Thermo-Compressor evaporation of brine as the most suitable method of producing high quality salt in view of the fact that hydro-electric power is readily available. (5.3).

(d) The offer made by Messrs. Escher Wyss & Co. of Zurich, Switzerland for determining the best method of exploiting the salt deposits and drawing up general lay-out and plan for a suitable evaporator plant at a cost of Rs. 12,000 should be accepted and they may be asked to submit their recommendations as early as possible. (5.3.1 and 5.3.2)

(e) For the development of the salt industry in Mandi, it is necessary to provide a railway link. This can be done either by restoring the narrow gauge line from Nagrota to Jogindarnagar or by expanding the broadgauge line from Nangal to Mandi town. The latter should be preferred as it offers considerable advantages in opening out this part of Himachal Pradesh. (5.4)

(f) The manufacture of salt by solar evaporation of the brine obtained from the Maigal springs should be taken up by laying out an area of 20 acres. Experiments with different kinds of locally available clay to make the beds impervious should also be carried out. The Mining Engineer should be deputed to visit the solar salt works in different parts of the country like Kathiawad, Kutch and South India to study the methods in vogue there for adaptation to suit the conditions in Mandi. (5.5.3)

(g) No attempt should be made to bottle Maigal spring brine for use either as mineral water or for culinary purposes. (5.5.4)

(h) The manufacture of iodized salt should only be considered in conjunction with the installation of a brine evaporator plant. (5.6)

(j) The Mining Engineer when he visits the solar works should also be asked to study the method of covering salt heaps with grass and clay as employed in Bombay and Madras. (5.7)

(k) When the Salt Department of the Government of India takes over the administration of the Mandi mines from 1st April 1950 it should reorganise the Mining Department and appoint a Chief Mining Engineer having considerable knowledge and experience in mining operations to take charge of the mines. The present Mining Engineer should be placed under the Chief Engineer; he should also be associated with the foreign technical personnel when the wet mining method is adopted. (6.1)

## CHAPTER XII

### KATHIAWAD AND KUTCH

#### 1. Description.

1.1 The salt industry in Kathiawad and Kutch is of comparatively recent origin. The first salt works started in 1927 at Mithapur (Okhamandal) by the late Mr. Kapilram Vakil. The rapid development of the industry since then in these areas may be ascribed to the prevailing natural climatic conditions which are well suited for the manufacture of salt by solar evaporation. Low rainfall, long periods of dry weather, high winds and fairly high temperatures, together with the availability of sea brine and uniform salinity throughout the year make both Kathiawad and Kutch ideally suited for the manufacture of solar salt. There are at present nine large and four small salt works in Kathiawad and one in Kutch. In all of them manufacture is carried out by solar evaporation. The inland salt works at Kuda (Dharangadhra) which are also situated in Kathiawad have been dealt with in Chapter X on the Other Inland Sources, since the raw material, method of production and the type of salt produced at Kuda are different from the marine salt works of Kathiawad.

1.2 The location of the salt works in Kathiawad and Kutch is shown below.

	Large	Small	Total
<b>KATHIAWAD—</b>			
(a) Bharai (Junagadh)	..	1	1
(b) Bhavnagar	1	..	1
(c) Jaffrabad	1	..	1
(d) Jamnagar	3	..	3
(e) Lavanpur (near Navlakhi)	1	..	1
(f) Maliya (Khakhrechi)	..	1	1
(g) Mithapur (Okhamandal)	1	..	1
(h) Porbandar	1	1	2
(j) Velan (Kodinar)	..	1	1
(k) Versamadi (near Navlakhi)	1	..	1
	9	4	13
<b>KUTCH—</b>			
(a) Kandla	1	..	1
	10	4	14

The works at Versamadi and one of the works at Jamnagar were under construction at the time of our visit in November 1948 and were expected to come into production during 1949.

1.3 Of all the works in Kathiawad the Works at Mithapur are the oldest and were the first to come into existence due to the initiative and enterprise of the late Mr. Kapilram H. Vakil who may be termed the father of the salt industry in Kathiawad. He met with considerable difficulties in the initial stages in establishing his salt works against competition from imported salt. But it was largely due to his persistence and the enterprise of other manufacturers after protection was granted to the salt industry, that this industry, has established itself in Kathiawad. The Works at Mithapur, first known as the Okha Salt Works, were started in 1927 and were followed by the Nadir Salt

Works, now known as the Saurashtra Salt Works at Porbandar (1930), the Maharaja Salt Works at Lavanpur (1932), the Digvijaysinhji Salt Works at Jamnagar (1936), the Kandla (Kutch) Salt Works (1937), the Bhavnagar Works (1943) and the Jaffrabad Works (1945). The Mithapur Works are the largest in this group with a rated capacity to produce 1,25,000 tons (34,03,000 mds.) of salt per annum. The next in size are the Works at Kandla and one of the works at Porbandar with a rated capacity of 70,000 and 60,000 tons (19,00,000 and 16,33,000 mds.) per annum respectively. The rest of the larger works have a rated capacity varying from 20,000 to 40,000 tons (5,44,000 to 10,89,000 mds.) per annum. The smaller works at Porbandar, Khakhrechi, Bharai and Kodinar have a total production of about 6,000 tons (16,300 mds.) which is consumed in Kathiawad itself.

## 2. Manufacturing Rights.

2.1 These works were started under monopoly rights granted to the manufacturers by the various States of Kathiawad and Kutch in return for the payment of a small royalty. The monopoly system possessed certain advantages inasmuch as it encouraged the promotion of the industry by protecting the rights of the manufacturers against uneconomic competition at a time when the industry was in its infancy and facing a crisis due to the dumping of imported salt. It has to be recorded to the credit of some of the States that they waived the collection of royalty during the early periods of the existence of the works. In the context of the present day conditions, when the industry has made rapid strides and established itself, the monopoly rights appear to be out of date specially as the country is not self-sufficient in salt. These rights should, therefore be reviewed and modified if and when they impede further expansion of the industry. It is likely that there may be certain legal difficulties if the monopoly rights are revoked by a unilateral action, but we have no doubt that the manufacturers of Kathiawad and Kutch will agree to a readjustment of their rights in a manner which would protect their interests and at the same time allow the industry to be developed further to meet the requirements of the country. This has already been done by the former Navnagar State who had originally granted a monopoly to the Digvijaysinhji Salt Works and subsequently with the Concurrence of these Works withdrew this concession in order to establish three other works at Jamnagar.

## 3. Manufacturing Process.

3.1 Brine is conveyed from the sea at high tides into reservoirs through creeks or channels either by gravity or by pumping. In the reservoir the density of the brine is allowed to rise to about 5° or 6° Bé when it is transferred into a series of condensers where it reaches a density of 18° to 20° Bé before it is taken to the crystallising pans. The size of the crystallisers is much larger than in marine salt works in other parts of India and varies from 80 ft. x 150 ft. to 100 ft. x 300 ft. The multiple irrigation system is followed and the lifting of salt is not done until a crust of 2 or 3 inches has formed in the crystallising beds. The salt is crushed in roller mills before it is sold. The bitters are periodically discharged through channels which are separate from the brine intake channels. We are satisfied with the general layout of these works except at Lavanpur where we found the same channels being used for the feeding of brine and the discharge of bitters. As a result of our condemnation of this practice, on our visit to the Works, it has been given up. The technique of manufacture is well developed and the salt is of a uniformly better quality than that produced in marine salt works in Bombay, Madras, Travancore and Orissa. The area under salt cultivation of the larger works and the yield per acre on the basis of the total evaporating area are shown in Table XLIV. The areas are not properly regulated and they are on the side of what one may term as extravagance; particularly the area under reservoirs being far in excess of what is required.



TABLE XLIV.—AREA UNDER SALT CULTIVATION AND YIELD PER ACRE IN KATHIAWAD AND KUTCH

	Reservoir	Condenser	Crystal- liser	Total	Ratio Crystalliser to Reservoir + Conden- ser.	Yield per acre (average of 1946 to 1948)	
	Acres	Acres	Acres	Acres		Tons	Mds
<b>KATHIAWAD :</b>							
(a) Bhavnagar . .	1,425	240	70	1,735	1 : 24	12	326
(b) Jaffrabad . .	459	478	113	1,050	1 : 8	15	408
(c) Jamnagar (1) .	570	100	95	765	1 : 7	51	1,388
(2) .	300	300	100	700	1 : 6	Production only recently started	
(d) Lavanpur . .	1,384	3	48	1,435	1 : 28	24	653
(e) Mithapur . .	238	444	162	844	1 : 4	78	2,123
(f) Porbandar . .		Not available		702	..	..	..
<b>KUTCH :</b>							
(a) Kandla . .	91	684	72	899	1 : 12	49	1,333
				8,130	Average	37	1,010

3.2 MITHAPUR.—The layout of the Mithapur Works is such as to utilise the advantage of the natural conditions existing in the area, and the methods adopted for manufacture are designed to eliminate to a large extent the impurities associated with salt. A novel and unique feature of the Works is the salt washery which has been designed and fabricated locally and in which the salt is washed with concentrated brine. This enables them to obtain salt of over 98 percent purity and of low sulphate content as required by them for the manufacture of chemicals. The washery consists of a number of parallel troughs which are set at slight slope and in which the salt is moved up the incline by a screw conveyor against a counter current flow of saturated brine. The brine dissolves the soluble magnesium salts and also carries away small particles of insoluble matter like gypsum, clay, etc. When the salt has reached the end of the trough it is washed by a spray of sea water to remove the adhering brine and is then allowed to drain over a draining board and conveyed by belt conveyors for storage in heaps in the open. The brine leaving the trough flows by gravity into a large circular cement tank which serves like a classifier and where the suspended impurities are allowed to settle. The sludge is removed from the conical bottom of the tank by a diaphragm pump whilst the clear brine overflows the top of the classifier and is used over again.

3.3 LAVANPUR.—The Works at Lavanpur are comparatively badly laid out and poorly maintained with no suitable and separate provision for the entry of brine and the discharge of bitterns. The Works resort to the practice of mixing bitterns with the brine, fed to the crystallisers, in order to force up its density. Such a method might lead to a somewhat quicker production temporarily but it must necessarily bring about a considerable reduction in the purity of salt and in the long run also affect the rate of yield. This practice is occasionally followed at Porbandar and Jamnagar also. It cannot be condemned too strongly and should be stopped forthwith.

3.4 KANDLA.—The salt works at Kandla which are situated on the Gulf of Kutch are only works in Kutch. These works started in 1937, and were taken over in 1941 by the United Salt Works & Industries Ltd. who, in the light of their experience in the manufacture of solar salt at Aden, have remodelled and extended them considerably. The Works are well laid out and produce salt of good quality and are, in our opinion, the best solar salt works in India. In many respects they can be looked upon as a model and may well be copied by the salt works in the adjoining peninsula of Kathiawad as also by manufacturers in Bombay, Madras, Travancore and Orissa. An important advance has been made at Kandla in the method of harvesting the salt. Instead of following the normal practice of lifting the entire crust of salt from the beds, they have allowed a permanent bed of salt to be built up in the crystallisers by leaving a portion of the crop unharvested. They take special care to see that this bed is not impaired during the lifting operations and to secure this they follow a practice somewhat similar to that followed at Kharaghoda, *viz.* of raking the crystals as they deposit from time to time so that they do not attach themselves firmly to the permanent salt bed. This enables them to collect the salt without getting it admixed with the clay of the crystalliser beds. The result is that the salt is exceptionally white in colour and fetches a premium in price over all the other varieties produced in India. The milling of salt is also done carefully and uniformly fine grade is obtained which is superior to the crushed salts we have seen produced anywhere else in Kathiawad.

3.4.1 There are however the following defects and drawbacks in these works to which we would invite their attention.

(a) The chief drawback appears to be the low density of the brine, during or immediately after the monsoon owing to the dilution caused by the rivers draining into the Gulf of Kutch. Though no correct records of the density of brine during the different months of the year are maintained, it was reported to us that the density falls to 2° Bé during the rainy season and rises to 3° Bé only by October. This was given as one of the reasons why the manufacturing operations at these works could not be started immediately after the rains. In view of the comparatively low rainfall and the very extensive space that the Works have for storing and condensing brine we are of the opinion that they should not hesitate to start manufacture even with brine of 2° Bé instead of waiting for its density to rise. During years of scanty rainfall they should be able to continue operations almost throughout the year. Occasional showers should not cause any lengthy interruption. If and when a heavy shower occurs the Works might have to be stopped for a few days to be resumed immediately the fair weather sets in.

(b) Sea brine is pumped from a creek into the reservoirs, since the Works are well above the high tide level to permit natural flow by gravity. The lift employed is, however, unnecessarily high and could be reduced to some extent in the interest of economy in the cost of manufacture.

(c) Unlike other works in India where the ratio of crystallisers to reservoir cum condensers is high, the Works at Kandla err on the other side and maintain an unnecessarily low ratio. Against a total area of 900 acres under cultivation, only 72 acres are reserved for crystallising pans which gives the extraordinarily low ratio of 1 to 11. Whilst this ratio may be an advantage in the early months of the manufacturing season it impedes production during the later months when the rate of evaporation is high and the crystallisers become a bottleneck. The flow of brine through the

condensers has then to be short circuited and some of the condensers put out of commission in order to reduce the supply to the crystallisers. The production at Kandia can be substantially increased and more than doubled if the crystallising areas were increased from 72 to 150 acres by converting a part of the condensing system.

(d) Some reduction in cost also could be brought about by installing bulk handling devices like belt conveyors, mechanical harvesters, etc.

(e) In spite of the attention paid to the colour and physical appearance of the salt we were surprised that no chemical control over either the quality of the brine or the salt produced is maintained.

3.5 Some byproducts are recovered in a few of the works. At Jamnagar and Kandla gypsum is extracted whilst at Mithapur a systematic recovery of bromine, magnesium sulphate, potassium chloride and magnesium chloride is effected. In our Interim Report and during our visit we had suggested the extraction of gypsum also at Mithapur where we had noticed its formation and we understand that our recommendation has been acted upon and the recovery of gypsum has been made a regular feature of the Works' practice. These works have demonstrated the economic recovery of the byproducts from the bitterns which helps to lower their cost of production of salt and at the same time improves the quality of salt.

#### 4. Annual Production and Quality.

4.1 The production of salt during the three years 1946 to 1948 in the major salt works of Kathiawad and Kutch is given in Table XLV.

TABLE XLV.—PRODUCTION IN KATHIAWAD AND KUTCH 1946-48

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons.	Mds.
<b>KATHIAWAD :</b>						
(a) Bhavnagar . . .	16,000	4,36,000	9,000	2,45,000	35,000	9,53,000
(b) Jaffrabad . . .	8,000	2,18,000	8,000	2,18,000	31,000	8,44,000
(c) Jamnagar . . .	35,000	9,53,000	41,000	11,16,000	40,000	10,89,000
(d) Lavanpur . . .	25,000	6,81,000	38,000	10,34,000	40,000	10,89,000
(e) Mithapur . . .	37,000	10,07,000	74,000	20,14,000	87,000	23,68,000
(f) Porbandar . . .	51,000	13,88,000	62,000	16,88,000	60,000	16,33,000
<b>KUTCH :</b>						
(a) Kandla . . .	29,000	7,89,000	38,000	10,34,000	65,000	17,69,000
	2,01,000	54,72,000	2,70,000	73,49,000	3,58,000	97,45,000

There has been a substantial improvement in production in 1948 and it is to be hoped that this improvement will not only be maintained, but further efforts will be made to accelerate it. From the total area under cultivation, the average yield as shown in 3.1 is 37 tons (1,010 mds.) per acre. The yield, however, fluctuates from 78 tons (2,123 mds.) at Mithapur to 12 tons (340 mds.) at Bhavnagar. As the latter works are of recent origin, their low yield can be easily explained but there is no justification for the lower yields at the other Okha works. With the present area and without allowing for any extensions, the production in Kathiawad and Kutch should be at least 6,42,000 tons (1,74,75,000 mds.) per annum at the rate of 80 tons (2,180 mds.) per acre. This is an average yield and it is to be hoped that the yield in some of the better laid out works will exceed this figure considerably as is evident from the production figures for the year 1948, when the average yield came to 48 tons (1,316 mds.) and the highest yield was 103 tons (2,800 mds.) at Mithapur. What is, therefore, needed is a better layout and a proper ratio between the area of crystalliser to that of reservoir plus condenser. For the climatic conditions prevailing in Kathiawad and Kutch a ratio of 1:5 or 1:6 is ample and we recommend that the manufacturers do take steps to re-lay their works accordingly in order to increase their output and meet the deficit in the country.

4.2. The analyses of Kathiawad Kutch salt, drawn by the Committee during their visits to the various works is shown in Table XLVI.

TABLE XLVI.—COMPOSITION OF KATHIAWAD AND KUTCH SALT  
(Percent, on dry basis)

	Jamnagar	Kandla	Lavanpur	Mithapur	Porbandar
Sodium chloride . . . . .	98.13	98.74	96.68	97.98	98.40
Calcium sulphate. . . . .	0.66	0.53	0.59	1.03	0.62
Magnesium sulphate . . . . .	0.21	0.22	0.55	Traces	0.49
Magnesium chloride . . . . .	0.67	0.21	1.16	0.53	0.30
Insolubles . . . . .	0.05	0.05	0.07	0.06	0.09
Undetermined . . . . .	0.28	0.25	0.95	0.40	0.10
	100.00	100.00	100.00	100.00	100.00

It will be seen that the sodium chloride content varies from 96 to 98.5 per cent. The Works of Kathiawad and Kutch afford a practical demonstration of producing by solar evaporation salt of a purity which can meet most of the industrial and domestic requirements of the country. There is, however, scope for further improvement, particularly in these works where the purity falls below 98 percent. We believe that all the salt works in Kathiawad can bring up their quality to this standard. All that is required to improve the quality and colour of the salt is to establish a closer scientific control on the concentration of the brine fed into the crystallisers, the method of lifting and regular elimination of the bitters. It is regrettable to observe that except at Mithapur none of the salt works in Kathiawad or Kutch maintain a central laboratory and no records are kept of the quality of brine admitted into the works or of the salt produced. This omission should be rectified as early as possible. The advantages that will accrue by engaging a few scientific workers to guide the management in improving the layout of the works and the quality of salt produced cannot be too strongly emphasised.

## 5. Improvements and Extensions.

5.1 In our first Interim Report we had recommended that all the works in India should be asked to increase their production by 10 per cent. in the season 1948-49. These recommendations were accepted by the Government of India and we understand that the results have exceeded our anticipation. In our second Interim Report, after seeing the Kathiawad works, we had expressed the view that many of them could increase their production by 25 per cent. by merely increasing the period of manufacture. At present the works in Kathiawad and Kutch follow a conventional closure of their manufacturing operations from the middle of June till the end of October, as at Bombay. Conditions in Kathiawad and Kutch are, however, very different. Unlike Bombay, these regions do not have a prolonged season of heavy rainfall to justify such a long closure. With a short rainy season and in many years only scanty rainfall, the manufacturers in Kathiawad and Kutch should make the fullest use of their natural climatic advantages. We are of the opinion that the manufacturing operations could be continued until the monsoon actually breaks and even then the work should not stop altogether unless the rainfall is too heavy. In most years a few scattered showers occur in the beginning of the rainy season with periods of fair weather in between and the manufacturing operation can be continued with little or no serious interruption almost throughout the year. In 1948, the monsoon in Kathiawad had totally failed, but excepting the works at Mithapur, Jaffrabad and Kandla, advantage of the long dry period was not taken to keep the production going. We estimate that as a result of this traditional but unnecessary practice of closing the works during the rains; nearly 30,000 tons (817,000 mds.) of salt which could have been produced was thus lost. We reiterate that the salt works in Kathiawad and Kutch be asked to continue their manufacturing season as long as the climatic conditions will permit, and whenever possible keep the production going throughout the year. Some of the manufacturers had expressed a fear to us of a shortage of labour during the rainy months which compelled them to close down their operations earlier than it need be. It is possible that some shortage of labour will be felt, particularly during the years of favourable monsoon when some of the labour will switch over to sowing and harvesting. In years of low and scanty rainfall, however, no shortage of labour need be feared; in fact, the reverse will be the case and there will be a plentiful supply of labour, glad of the opportunity of employment. We are also of the opinion that if the labourers employed in the salt works are assured of permanent employment, many amongst them would not seek other employment during the rainy season but would continue to work at the salt works.

5.2. MITHAPUR.—We were shown by Tata Chemicals their plans to extend further their solar works at Mithapur in order to increase production to 1,25,000 tons (34,00,000 maunds) per annum by increasing the area of evaporation and adding a few more crystallising pans. These extensions are designed to meet the larger requirements of salt for the manufacture of soda ash and caustic soda when these plants are run at their rated capacities. The Bengal market, where their salt has a good reputation will continue to receive about 25,000 tons (6,80,000 maunds) annually.

5.2.1 In addition to the extension to the solar works, Tata Chemicals are also fabricating a quadruple effect brine evaporator plant to produce 75,000 gallons of distilled water per day and 45,000 tons (12,25,000 maunds) of vacuum salt per annum. The plant when installed will be the first of its kind in the country and the salt produced will no doubt be of a high purity suitable not only for domestic consumption but equally for industrial uses, wherever salt of an exceptional purity is required. The distilled water will be used in their high pressure boilers and will help to relieve the shortage of good

quality water which is keenly felt at Mithapur. This plant is expected to go into production some time in 1950. The market for such a substantial quantity of refined salt will have to be built up gradually, but since the Calcutta market used to import vacuum salt at one time from Cheshire, it should find no difficulty in absorbing this output. Whether this plant can produce salt at an economical cost remains to be seen and its progress should be watched with interest as it will yield important data which might be useful for similar installations elsewhere.

**5.3 NEW WORKS.**—Of the new works, the Halar Salt and Chemical Works of Jamnagar started manufacture in 1949 and produced about 10,000 tons (2,72,000 mds.) during that year. The owners of the Lavanpur works were constructing a new works at Versamadi, two miles from Lavanpur, where production is expected to start in 1950; the rated capacity of these works is said to be 50,000 tons (13,60,000 mds.) of salt per annum. We inspected the site of these works and in our opinion they should have been laid nearer the Navlakhi port rather than farther away from it. The construction of the works had made some progress at the time of our visit and the owners expressed their inability to change the location in view of the money already spent on them. If these works had been extended even in continuation of the Lavanpur Works they would have economised not only on the manufacturing cost, but also on the haulage of salt for shipment to the port. In our interim Report we had recommended that the location of these works might be re-examined, but the Saurashtra Government, to whom the matter had been referred, stated that these works could not have been extended towards Navlakhi, because adequate space was not available and the ground consisted of marshy, salty land which was subject to tidal floods. In our opinion, these are the very factors that are sought after in laying out salt works and they should have been an additional inducement for locating the new works there. Unfortunately as no technical or scientific staff was employed in laying out these works they did not have the benefit of expert advice in this matter and have thus lost an opportunity of utilising probably the most favourable site for a salt works.

**5.4 JAFFRABAD.**—There is also a proposal of the Jaffrabad Works to increase their production by 20,000 tons (5,40,000 mds.) which could be easily achieved by a few modifications and additions without any large expenditure. Unfortunately the Jaffrabad Works are not favourably situated from the point of view of transport and we do not, therefore, expect any material contribution to meeting the overall deficit in the country until the facilities available at the Port are improved.

**5.5 VELAN.**—At the instance of the former Government of Baroda we visited Velan, a small port situated on the southern coast of Kathiawad in Kodinar Taluka. Velan is about 100 miles by road from Junagadh. We were given to understand that spontaneous salt was being formed and collected there and that suitable sites were available for developing a salt industry on an extensive scale. We examined the low lying lands, near the seashore, which at high tides get flooded with sea water; when this water evaporates, salt gets deposited and a part of it is collected and sold locally for fish curing. At the time of our visit formation of spontaneous salt was not visible nor was it being collected, but we were shown some heaps of salt which had been collected during the previous two years. The quantity of salt gathered each year is estimated at about 550 tons (15,000 mds.) per annum, but we were told that a much larger quantity could be collected if there were a market for it. The salt heaps, we examined, were dark and unattractive in appearance, chiefly because of the insoluble impurities. The analysis of a sample of Velan Salt drawn by the Committee at the time of its visit is given in Table XLVII.

TABLE XLVII, COMPOSITION OF VELAN SALT

<i>(Percentage on dry basis)</i>	
Sodium chloride . . . . .	97.95
Calcium sulphate . . . . .	0.47
Magnesium sulphate . . . . .	0.17
Magnesium chloride . . . . .	0.43
Insolubles . . . . .	0.41
Undetermined . . . . .	0.57
	100.00

Looking at the present stage of development at Velan, we do not see any possibility of starting salt manufacture on a large scale. The present port is suitable for only small sailing ships and the nearest railway station of Kodinar is ten miles away. The road from Kodinar to Velan is also poor. The development of the Velan Port, where large ships can come, an extension of the railway line from Kodinar to Velan and a proper road are essential for the building up of a salt industry there. Also as most of the area is barren and arid, the question of fresh water supply would have to be carefully examined as also that of supply of labour which otherwise would have to be imported from other areas. Under the present conditions we cannot, therefore, recommend any development of a large salt works at Velan.

5.6 KANDLA—The works at Kandla have also an extension programme by which they expect to double their present production in the course of two or three years and bring it up to 1,20,000 tons (32,66,000 mds.) per annum. The rated capacity of the Works at the time of our visit in 1948 was stated to be 60,000 tons (16,33,000 mds.) and steps had been taken to increase it to 75,000 tons (20,42,000 mds.) per annum. Upto 1941, when the present management took over the works, the record of production for any one year was 31,000 tons (8,44,000 mds.) per annum. Unfortunately, under the orders of the Government of India, their expansion programme has been stopped owing to the possible requisition of the site on which the salt works are situated for the new port at Kandla, the construction of which has been recommended by the Major Ports Development Committee. Before this injunction was issued, the works had put into effect a part of their programme of extension from which they have already obtained an increase in production of 15,000 tons (4,08,000 mds.). We consider that if these excellent works have to be disbanded it will give a serious setback to the Indian salt industry. We had recommended in our Interim Report that Government should seriously consider ways and means of leaving these salt works undisturbed on the present site. Such a decision will enable the works to carry on with their extension programme of doubling their output and making a substantial contribution to the filling up of the present gap in the country. Apart from the natural advantages which make the manufacture of salt in Kandla so favourable there is an additional reason for not shutting down or shifting these works. In the first instance, in the event of the works being shifted, it would take nearly five years before the production at a new site could be brought up to the present stage. Secondly, Kutch is exceptionally backward industrially and these works are a bright feature in an otherwise barren landscape by making a contribution of some importance to the economy of the State in giving employment to nearly 1500 people. We, therefore, strongly urge that both the Government of India and the Kandla works should get together and arrive at a solution which will enable the Salt Works to continue and the port to develop.

5.7 We are satisfied, after visiting the Kathiawad and Kutch works, that with (a) the extension of the manufacturing season, (b) the expansion of some of the existing works, and (c) the advent of new works, the deficit in the country could be set right within a period of three years. The present deficit is of the order of about 3,00,000 tons (81,66,000 maunds) per annum. It is due to the fact that West Bengal and its adjacent markets insist upon, and rightly so, salt of good quality. We estimate that the total increase of production which can be achieved in Kathiawad and Kutch within the next year or two will be of the following order—

	Tons	Maunds
(a) by extending the season at all works . . . . .	30,000	8,17,000
(b) increased production at Kandla from the extension . . . . .	15,000	4,08,000
(c) increased production at Jaffraded . . . . .	20,000	5,44,000
(d) increased production at Mithapur . . . . .	20,000	5,44,000
(e) production from Halar salt work Jamnagar (new) . . . . .	25,000	6,81,000
(f) production from Versamadi (new) . . . . .	50,000	13,61,000
	<u>1,60,000</u>	<u>43,55,000</u>

To this has to be added the potential production of about 25,000 tons (6,81,000 maunds) of one more works which is contemplated at Jamnagar. On the other hand, it has to be borne in mind that if the Kandla Works are abolished there will be a reduction of 75,000 tons (20,41,000 maunds) and the net increase will, therefore, be 1,60,000 tons (43,55,000 maunds), plus 25,000 tons (6,81,000 maunds) of the new Jamnagar works minus 75,000 tons (21,41,000 maunds) of Kandla giving a net increase of 1,10,000 tons (29,95,000 maunds).

5.7.1 We are, however, not in favour of unlimited expansion of production of salt in one concentrated area unless it is found that other parts of India are either not able or not willing to produce salt of good quality at an economic price. A realistic outlook on national economy demands that we should not place all our eggs in one basket. Even if by concentration of production in any one locality, it is possible to produce salt at such a low price that, despite a long haulage, it could be sold competitively against the production of another locality, it has to be remembered that for a low priced commodity like salt, freight rates play an important part and a point is reached beyond which it would not be economical to send it. Disposal of salt production in different parts of the country should, therefore, be encouraged as far as possible. Even though certain areas may lack natural advantages, they should, if properly developed, be able ultimately to supply salt at a competitive price. While salt from Kathiawad and Kutch has to bear the brunt of wiping out the present deficit in the country as also of meeting the increase in demand resulting from the growth of population, and the development of industries, agriculture, fisheries, and unlimited expansion of the industry in this region should be avoided as far as possible. We consider it necessary to record this word of caution with a view to ensuring that the expansion of the industry is planned carefully.

5.7.2 We would also like to add another word of caution regarding the new salt works in Kathiawad. Whilst it is but natural and desirable that the new works should be started as near to ports as possible where the facilities of road, rail and shipping are available, we recommend that permission for construction of new works should be carefully regulated so as not to encourage concentration of several works in one centre. The Saurashtra Government have given permission for construction in Jamnagar of two new salt works in addition to the



two already in existence there. Whilst natural conditions in Jamnagar may be favourable for such development, the limitations of the Port of Bedi from where the salt is despatched should be considered, as we feel it may not be able to cater to all the four works. Furthermore, the concentration of a number of works in one centre might create a shortage of trained labour and a scramble between the works over available labour, leading to unhealthy competition and unnecessary increase in labour charges. In our opinion there are equally suitable places in Kathiawad such as Porbandar, Bhavnagar, Veraval for the expansion of the salt industry and it would be advisable to distribute the new works among all such suitable centres.

## 6. Staff and Organisation.

6.1 The staff at each works consists of a manager with the necessary clerical help. Except at Mithapur, there is no engineering or chemical personnel employed. As these works are of sufficiently large size, steps should be taken by them to engage a Civil Engineer as also an Electrical and Mechanical Engineer so that the works and their equipment may be better maintained than they are at present. We have already commented on the unnecessarily large size of the reservoir area in many of these works, as also on the wrong location of the Versamadi works which could have been avoided had there been a qualified Civil Engineer on the staff of these works. We have also recommended the establishment of a chemical and analytical laboratory at each of the works which would necessitate the appointment of suitable chemists. These defects should be rectified by the Kathiawad and Kutch works if they wish to maintain their reputation for producing good quality salt.

6.2 LABOUR.—The labour for the salt works is mostly local. In some of the works a small number of Agarias from Kharaghoda are also employed largely on the work of re-laying the beds and repairing them after each harvest. The labour is generally engaged for the duration of the manufacturing season but in one or two works, a part of the labour is now employed on a permanent basis and retained throughout the year. Both men and women labourers work in the salt fields, the men generally doing the heavy work of digging the salt from the pans and the women that of carrying it for loading into wagons. The total strength of labour at the Kathiawad and Kutch work is about 4,000 and the daily wage varies from Rs. 1-4-0 to Rs. 2-0-0 for the unskilled labour and from Rs. 2-0-0 to Rs. 5-0-0 for the skilled labour.

## 7. Capital Block.

7.1 The capital investment in the salt industry in Kathiawad and Kutch comes to about Rs. 100 lakhs. Most of this expenditure was incurred much before and during the early years of the War when the wages and the cost of materials were not very high. If these works were to be laid out today their cost would be several times higher.

## 8. Cost of Production.

8.1 The cost of manufacture in the larger works has been reported to vary from Rs. 1 to Rs. 18.5 per ton (Re. 0-7-7 to Re. 0-10-10 per maund). Some of the works have given us the break up of their cost for 1948 whilst others have given only the overall figures. The figures which have been supplied fall under the ranges given in Table XLVIII.

TABLE XLVIII.—COST OF PRODUCTION IN KATHIAWAD AND KUTCH  
1948

	Per ton		Rs. A. P.	
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
(a) Cost of brine . . . . .	0 8 9	to	1 0 0	
(b) Labour . . . . .	2 2 0	to	5 12 6	
(c) Power and fuel . . . . .	0 8 0	to	0 14 9	
(d) Maintenance, Interest and Miscellaneous charges . . . . .	3 2 3	to	7 2 6	
(e) Crushing charges . . . . .	1 13 0	to	2 5 0	
(f) Supervision and overheads . . . . .	0 12 9	to	4 6 9	
(g) Rent, rates and taxes . . . . .	0 8 0	to	0 11 0	
(h) Depreciation . . . . .	0 10 9	to	2 0 0	
(j) Washing charges . . . . .			1 9 0	
	15 8 0	to	18 0 0	
or Re.	0 9 1	to	0 10 10	
				per md.

This cost is considerably higher than the cost that was prevalent before the War. The Indian Tariff Board in their enquiry of 1931 estimated the cost for Kathiawad salt at Rs. 6.81 per ton (Re. 0.4-0 per md.) but owing to the increase in wages and the lower output per man hour, the cost has continued to rise. This cost is also higher than the cost at the Government salt works at Rajasthan or Kharaghoda, but it has to be remembered that at the latter works, brine of a much higher concentration is available and furthermore adequate provision is not made in their cost for depreciation and interest charges. If due allowances were made for these items of cost, the cost of Kathiawad and Kutch salt will be more or less equal to that at the Government works. The salt is not bagged but shipped in bulk. To arrive at a figure of f.o.b. cost, the cost of transport of the salt from the works to the steamers has to be added. This cost varies from works to works. At Kandla, the jetty is located by the side of the works and they incur expenditure only on loading the salt into boats for transhipment into steamers. At some of the other works like Mithapur and Lavanpur the salt has to be carried by rail from the works to the port over a distance of 7 to 12 miles respectively and thereafter loaded in the steamer. It is therefore, not possible to fix a uniform cost of haulage of salt from the different works to arrive at an overall average figure of f.o.b. cost.

## 9. Sales and Distribution.

9.1 Except for such quantities as are reserved by Tata Chemicals for their soda ash and caustic chlorine plants and about 19,000 tons (5,17,000 mds.) required for domestic consumption in Kathiawad and Kutch, the bulk of the salt produced in this region is shipped to Calcutta where it commands a good market owing to its good quality and white colour. The selling price is determined by the price of foreign salt at Calcutta. Before the last world war, when competition was acute and imports were not restricted, the price of Indian salt f.o.b. port of despatch was about Rs. 9/- per ton (Re. 0.5-0 per maund) but during the war it rose to as high as Rs. 50/- per ton (Rs. 1.13.4 per maund) but at present it has come down to about Rs. 29/- per ton (Re. 1-1-0 per maund). After taking into consideration all the items of cost, it is evident that the manufacturers of Kathiawad and Kutch make a handsome profit. World War II gave the salt industry an opportunity to consolidate its position and in spite of rising costs it has realised highly attractive prices in the Calcutta market. It has, however, to be remembered that the industry had to pass through several vicissitudes and its position was far from satisfactory before the war.

The war, however, gave it an impetus and offered an opportunity of consolidating its position. The industry is today in a position to stand foreign competition without tariff protection. Also since the imports of foreign salt are likely to be progressively reduced and stopped at the end of 1951, in pursuance of Government's policy to make India self-sufficient as early as possible, the salt industry in Kathiawad and Kutch will receive an added impetus and it behoves the manufacturers to offer salt to the Calcutta market at a still lower rate than at present.

9.2 The biggest individual factor adding to the cost of the Kathiawad and Kutch salt in the Bengal market is the shipping freight which used to be Rs. 5/- to Rs. 7/- per ton (Re. 0-3-0 to Re. 0-4-4 per maund) before the War, but which progressively increased during the War to Rs. 35/- per ton (Rs. 1-4-6 per maund). The freight since the War has declined, but it is still as high as Rs. 26/- per ton (Re. 0-15-3 per maund) which corresponds to about 85 per cent of the present f.o.b. price. The price in the Bengal market will always be tied up with the freight charges and any attempts to make salt available in Calcutta at substantially cheaper prices must include a review of the steamer freight charges. We recommend that Government should examine this question at an early date. We may also invite the attention of Government to the fact that some of the shipping companies participating in the Indian coastal traffic offer freight to Aden salt manufacturers at a rate lower than that to the Kathiawad and Kutch manufacturers. This is an indefensible situation as it means that Indian manufacturers have to pay a higher freight than the Aden shippers, particularly when the ships go empty from Indian ports to Aden. The coastal shipping freight should be so adjusted that the indigenous producers do not have to pay a higher rate than the foreign producers. With a careful re-examination both of the manufacturer's prices f.o.b. port of despatch and the shipping freight it should be possible to make a substantial reduction in the price of salt for Bengal.

9.3 In 1948 a diversion of salt from Kathiawad and Kutch took place and nearly 45,000 tons (12,25,000 mds.) were shipped to Bombay for onward transit by rail to several stations in the western half of U.P. as far as Kanpur and a little beyond. The mode of transport was found to be cheaper than carrying the salt to these stations from Calcutta because of (a) shorter haul to Bombay, involving a sea freight of Rs. 16/- per ton as against Rs. 28/- per ton which was the sea freight to Calcutta in 1948 and (b) shorter average distance for rail transport from Bombay. It was but natural that salt, routed via Bombay, could be offered at cheaper rates to the Western U. P. markets. In so far as salt was made available cheaply there could be no reason for complaint. To ease the transport situation in the country we had, however, recommended in our Interim Report that no salt from the marine works of Kathiawad should be carried by rail. Although no accurate information was available of the quantity that was being sent by rail from Kathiawad we had computed that about 15,000 tons (4,08,000 maunds) equivalent to two shiploads moved in this manner. Our object in recommending this restriction was to release a larger number of wagons to the inland salt works which depend entirely on the railways for the movement of their production. The other object was to make a larger quantity of Kathiawad salt available to Calcutta in order to reduce the dependence of West Bengal and its adjacent markets on foreign imports. This recommendation was accepted by Government and supplies of railway wagons to the coastal Kathiawad works were stopped. It is possible that the diversion of salt to Bombay took place as a result of this stoppage but if it had continued the purpose we had in view would have been defeated. With the introduction of the zonal system from the beginning of 1949, the imports of Kathiawad salt into Bombay have however, been restricted as the Bombay zone markets do not extend to U. P. where most of the Kathiawad salt used to be railed and to this extent the diversion from Calcutta has been checked.

## 10. Summary of Recommendations.

- (a) For the Kathiawad and Kutch works a ratio of 1:5 or 1:6 between crystallisers and reservoirs cum condensers is ample and manufacturers should take steps to re-lay their works accordingly. As a result of this production can be doubled without any extensions. (4.1)
- (b) A laboratory should be maintained at each of the works to maintain a scientific control over the methods of manufacture. (4.2)
- (c) The manufacturing operations in Kathiawad and Kutch should not be stopped as a matter of traditional practice, the production should be kept going till the monsoon breaks and then also if heavy showers occur. (5.1)
- (d) The works at Kandla should start manufacture even when the brine in the creeks is 2° Be' instead of waiting for it to rise above 3° Be' in view of the comparatively low rainfall and the extensive space that the works have for storing and condensing brine. (3.4.1)
- (e) The crystallising area at Kandla should be increased from 72 acres to 150 acres by converting part of the condensers to crystallisers. (3.4.1)
- (f) Further expansion of the works at Jaffrabad should not be undertaken until better transport facilities are available at the port. (5.4)
- (g) In view of the poor transport facilities available at Velan Port no possibility exists at present for developing a salt works there. (5.5)
- (h) The Government of India and the works at Kutch should get together and arrive at a solution which will enable the salt works at Kandla to continue in existence and the port of Kandla to be developed. (5.6)
- (j) The expansion of the salt industry in Kathiawad and Kutch should be harmonious with the development of the industry in India as a whole. There should be no unlimited expansion in the one concentrated area. (5.7.1)
- (k) Erection of new works in Kathiawad should be properly regulated and their concentration in any particular centre without due consideration of the facilities of port, transport and labour should be avoided. (5.7.2)
- (m) The works should employ civil and mechanical engineers as also chemists to guide and control the manufacturing operations at all stages. (6.1)
- (n) The f.o.b. price of Kathiawad and Kutch salt should be reduced. The coastal shipping freight should also be revised and adjusted so that the Indian manufacturers do not have to pay a high rate than the Aden shippers. (9.2)
- (p) The salt from Kathiawad and Kutch should be sold only in Calcutta and no diversion should be allowed to go through Bombay. (9.3)

## CHAPTER XIII

### BOMBAY

#### 1. Description.

1.1 Salt has been manufactured by solar evaporation in the State of Bombay since a long time. Besides the Kharaghoda salt works which have been dealt with already, the salt works in Bombay are situated along the coast from Dharasana in the north to Sanikatta in the south. The factories in Bombay are divided into 5 circles :

- (a) Kharaghoda
- (b) Dharasana
- (c) Bhayandar
- (d) Bhandup and
- (e) Uran.

Except for Kharaghoda and Dharasana Circles which comprise only Government-owned factories the other circles are subdivided into ranges, each range consisting of several factories. In this chapter we deal only with the four circles other than Kharaghoda. Table XLIX shows the distribution of the salt works in these four circles, the different ranges in each circle, the area under cultivation and the yield per acre in each range.

TABLE XLIX.—SALT WORKS IN BOMBAY

Name of circle	No. of salt works	Reservoir	AREA		Total	Ratio of crystallisers to condensers plus reservoir	Yield per acre (Average of 1946-48,	
			Con-denser	Cryst-alliser			Tons	(Mds.)
(in acres)								
<b>DHARASANA :</b> Dharasana (Gujrat) .	2	920	136	154	1,110	1 : 6·0	20	540
<b>BHAYANDAR :</b> Maroli (Thana Dt.) .	1	51	10	18	79	1 : 3·4	15	410
Bassein (Thana Dt.) .	29	1,664	280	725	2,669	1 : 2·7	22	600
Rai (Thana Dt.) .	46	1,659	156	728	2,543	1 : 2·5	24	650
Dadar (Bombay city)	17	499	136	350	985	1 : 1·8	21	570
<b>BHANDUP :</b> Bhandup (Thana Dt.)	5	677	278	422	1,377	1 : 2·3	13	350
Trombay (Thana Dt.)	22	558	91	408	1,057	1 : 1·6	26	710
Belapur (Thana Dt.) .	18	472	273	354	1,099	1 : 2·1	28	760
<b>URAN :</b> Shewa (Coloba Dt.) .	39	1,013	372	570	1,955	1 : 2·4	26	710
Uran (Coloba Dt.) .	38	621	188	357	1,166	1 : 2·3	29	790
Karanja (Coloba Dt.)	22	484	145	227	856	1 : 2·8	24	650
Pen (Coloba Dt.)	23	619	201	277	1,097	1 : 3·0	12	325
Shiroda (Ratnagiri Dt.)	16	1	18	56	75	1 : 3·0	28	760
Sanikatta (North Kanara.)	121	91	168	164	423	1 : 1·6	16	435
<b>TOTAL</b>	<b>399</b>	<b>9,229</b>	<b>2,452</b>	<b>4,810</b>	<b>16,491</b>	<b>Average</b>	<b>22</b>	<b>600</b>

1.2 Out of a total area of 16,491 acres under salt cultivation, 14,804 acres are situated within a radius of 30 miles of Bombay City. The total number of factories is 399, giving an average area under cultivation of 41 acres per factory. There is, however, considerable variation in the sizes of individual works; the largest of the works is at Chharvada (Dharasana Circle) and it covers an area of 690 acres whilst the smallest in Sanikatta measures only 0.43 acre. There are as many as 1888 licensees operating these 399 factories. Table L gives the details of the size of the largest and smallest works in each range, the total number of licensees, etc.

TABLE L.—NUMBER OF SALT WORKS AND LICENSEES AND RELATIVE SIZES OF SALT WORKS

Name of Circle and Range	Revenue District	Number of salt work	Total number of Licensees	Size of the largest works	Number of licensees in the largest works	Size of the smallest works	Number of the licensees in the smallest works
				(acres)		(acres)	
<b>DHARASANA :</b> Dharasana . . . . .	Surat	2	..	690.0	..	420.0	..
<b>BHAYANDAR :</b>							
Maroli . . . . .	Thana	113	..	..	..	..	..
Bassein . . . . .	Thana	29	188	388.2	(2)	25.5	(12)
Rai . . . . .	Thana	46	783	240.0	(3)	18.2	(2)
Dadar . . . . .	Bombay	17	68	221.2	(1)	8.2	(7)
<b>BHANDUP :</b>							
Bhandup . . . . .	Thana	5	11	392.2	(1)	180.0	(4)
Trombay . . . . .	Thana	22	28	127.5	(2)	15.0	(1)
Belapur . . . . .	Thana	18	28	191.2	(4)	14.5	(1)
<b>URAN :</b>							
Shewa . . . . .	Coloba	39	142	237.0	(18)	4.2	(10)
Uran . . . . .	Coloba	38	115	86.25	(1)	7.5	(1)
Karanja . . . . .	Coloba	22	171	237.0	..	4.2	(1)
Pen . . . . .	Coloba	23	97	221.0	(1)	6.2	(1)
Shiroda . . . . .	Ratanagiri	16	35	17.0	(8)	1.5	(5)
Shanikatta . . . . .	North Kanara	121	199	10.2	(1)	0.43	(1)
<b>TOTAL</b> . . . . .		399	1,888				

1.3 The natural conditions like the density of brine available during the different seasons, rainfall and its durations, humidity etc. are very similar for all the factories situated round Bombay city. The rainfall varies from 36 to 90 inches and the average rainfall for the ten years 1939 to 1948, is 74.35 inches as shown in Table LI.

TABLE LI—RAINFALL AS RECORDED BY COLABA OBSERVATORY

1939-48

in inches

Month	Average	Maximum	Minimum
January . . . . .	0.23	0.82	0.00
February . . . . .	0.04	0.38	0.00
March . . . . .	0.03	0.24	0.00
April . . . . .	0.25	2.52	0.00
May . . . . .	0.65	6.02	0.00
June . . . . .	16.82	30.19	3.61
July . . . . .	27.30	45.56	14.03
August . . . . .	15.18	28.27	3.30
September . . . . .	10.75	25.45	1.68
October . . . . .	1.78	4.89	0.00
November . . . . .	1.23	6.46	0.00
December . . . . .	0.09	0.61	0.00
TOTAL . . . . .	74.35		

The meteorological conditions in Bombay are not so favourable for salt manufacture by solar evaporation as in some of the more arid regions of Kathiawad, Kutch and Tuticorin. But owing to the proximity of the markets and the indirect protection from competition by the embargo on the sale of Kathiawar and Kutch salt in Bombay Presidency, the Bombay salt industry has been able to hold its own and has flourished.

## 2. Manufacturing Rights.

2.1 Even before the advent of the British an excise duty was levied on salt by the Maharatha rulers. Their system of taxation was, however, complicated, inconsistent and full of anomalies and it was simplified by the British. In 1838 the British brought the production of salt under a system of licensing under which illicit manufacture was penalised. They also abolished transit duties levied previously and introduced a regular excise duty at a fixed rate of Rs. 13-9-9 per ton (Re. 0-8-0 per maund) on the production. The amount realised from the duty in 1838 amounted to about Rs. 14 lakhs which shows that over a lakh of tons (28 lakh maunds) must have been sold during that year. The duty was enhanced to Rs. 20-6-7 per ton (Re. 0-12-0 per maund) in 1844, to Rs. 27-3-6 per ton (Re. 1 per maund) in 1859, to Rs. 34 per ton (Rs. 1-4-0 per maund) in 1861, and to Rs. 40-13-3 per ton (Rs. 1-8-0 per maund) in 1864. The excise duty was made uniform in all the British territories in 1884 and since then it varied from time to time till it was abolished in 1947.

2.2 The salt factories in Bombay are laid out either on *Inami* lands, owned by the manufacturers or on Government lands leased to private individuals for periods up to 99 years on payment of a small rental. There are also some factories which though owned by Government are leased to private parties for periods ranging from 1 to 5 years on a rental which is fixed by tenders. In addition to the rent they also pay a ground rent which is based on the quantity of salt produced. The private owners often lease out their factories to others for periods ranging from 1 to 3 years on a rental basis. The owners take little interest in the works except in collecting the lease money. The lessees also have no interest in the factories with the result that no major improvements are carried out and even the annual repairs and maintenance are neglected. On the expiry of the lease the lessee does not leave the works in good condition lest the owner gets a higher rental from another bidder. These abuses have affected the production as well as the quality of salt produced in Bombay.

2.3 The manufacture of salt is subject to a licence granted by the Salt Department. The licence is not given for any fixed period and is valid till it is revoked. No licence fee is levied, but the privilege granted under the licence cannot be alienated wholly or in part, by sale, mortgage or sub-letting. The terms of the licence are stringent and the Salt Department has the right at any time to vary the terms relating to the manufacture, storage, removal or sale of salt. Also no alterations can be made by the licensee in the layout of the works without prior permission of the Salt Department nor can the land be used for any purpose not connected with the manufacture and storage of salt. Furthermore, if the whole or any part of the land under salt cultivation is taken for public purposes, the licensee has no claim for compensation for his being deprived of his right to manufacture salt.

### 3. Manufacturing Process.

3.1 The Bombay factories start working from about the middle of October and continue operations till the end of May when they close down for the rains. Due to the heavy rains in Bombay and the surrounding areas most of the works are under water during the rainy season and this entails considerable preliminary operations at the commencement of each manufacturing season. The works are situated near creeks and backwaters from which brine is drawn but during October and November the brine is of low salinity and the actual production of salt does not start till the end of January or early in February. The works come into full production only in the month of March and continue at full capacity until May. During the two fortnightly high tides the brine is led through sluice gates into the reservoirs. The reservoirs are 2 to 2 1/2 ft. deep and can store enough brine at one filling to last till the next high tide. The brine is allowed to evaporate in the reservoirs till it attains a density of about 5° Be' when it is transferred to the condensers locally known as *tapavani* where it further rises to about 10° to 16° Be'. Then it is fed into the crystallisers which vary in size from 50 ft. × 24 ft. to 45 ft × 15 ft. Salt is produced by the single irrigation system and the density of the brine fed into crystallisers depends on the type of salt that is to be produced. As stated in Chapter V three varieties of salt are produced in Bombay Presidency, viz. (a) *mapi*, (b) *kuppa* and (c) *vajni*; the major production being of the lighter varieties of *mapi* and *kuppa*. The production of *kuppa* is about 10 per cent. of *mapi* and being of a very light flaky type it cannot withstand long transport and is therefore consumed solely in the city of Bombay and its suburbs. The light varieties of salt are produced solely because of the system of sale of salt by measure and special pains have been taken in developing the methods of their manufacture. These methods are looked upon by the manufacturers and specially by the skilled workmen, as trade secrets. For carrying out these operations specially skilled workmen of the *Kharva* and *Macchi* clans are imported from Surat who in addition to looking after the actual manufacture of salt also attend to the maintenance of the works and particularly to the em-kankments, pans, etc.

3.2 DHARASANA CIRCLE—The climatic conditions in this Circle are somewhat different from the rest of the Bombay salt works. No figures of rainfall are available but the area is drier and conditions are more akin to those in Kathiawad. There are two factories in this circle, near Bulsar on the Gujrat coast one at Dharasana and another at Chharvada. They are both owned by Government. In 1870, the Government of Bombay decided to close down all private salt works of Gujrat and to supply salt to Gujrat from the salt works at Kharaghoda. A salt depot was established at Surat for this purpose. It was, however, soon found that the people of Southern Gujrat would not use the *baragara* type of salt produced at Kharaghoda. Small sea salt works were, therefore, reopened at Dharasana and Chharvada. The Chharvada works were



again, closed down in 1885 after the Dharasana works were enlarged but were reopened in 1919 to meet the increasing demand for salt. The size of the factories in Dharasana circle is larger than the factories in other circles of Bombay State.

3.2.1 The area under cultivation at Dharsana is 420 acres and at Chharvada 690 acres. Each factory has a large reservoir in which sea water collects through sluices which are opened during high tides. The reservoirs feed a number of condensers to each of which are attached about 10 crystallising pans of 100 ft. x 20 ft. The number of pans at Dharasana is 1845 and at Chharvada 1020. The brine is led into the crystallisers at 17° to 20° Be' and the single irrigation system of manufacture is followed. Salt is harvested every 15 days when a 1/4 to 1/2 inch thick crust is formed. The bitters are not eliminated regularly, but only once in the season, usually during the month of May when production is at its peak. This is undesirable and regular elimination of the bitters after each lifting should be carried out. The area under reservoirs is 242 acres for Dharasana and 578 acres for Chharvada, the condenser area being 98 acres and 56 acres respectively. The ratio of the crystallisers to the reservoir and condensers is 1:3, at Dharasana and 1:10 at Chharvada. Such a disparity in two contiguous factories is unaccountable and it has an adverse effect on production at Chharvada. For instance, the average annual production at Dharasana during the ten year period of 1939-48 was 12,670 tons (3,45,000 mds.) while at Chharvada it was 7,160 tons (1,95,000 mds.). This gives the average yield at Chharvada of 10.38 tons (283 maunds) as compared with 30.16 tons (821 maunds) in the adjoining works at Dharasana. If the average yield per acre of crystallising area is compared it is 116.86 tons (3181 maunds) at Chharvada and 129.20 tons (3517 mds.) at Dharasana. This disparity in production can only be accounted for by the small area allotted in Chharvada for condensers as compared with the reservoir area. We are led to believe that this small condensing area is unable to cope with the brine available in the reservoir and we recommend an early redistribution of the areas under reservoir, condensers and crystallisers as shown below.

	<i>Acres</i>
(a) Reservoir . . . . .	240
(b) Condensers . . . . .	320
(c) Crystallisers . . . . .	90
(d) Bunds, Storage, Platforms etc. . . . .	40
<b>TOTAL</b>	<b>690</b>

It cannot be said that the production at Dharasana is optimum or ideal for works in this locality. The likelihood is that here also redistribution of areas under cultivation to 1:6 would lead to a greater production at less cost. The redistribution at Dharasana should be, therefore, as under.

	<i>Acres</i>
(a) Reservoir . . . . .	145
(b) Condensers . . . . .	195
(c) Crystallisers . . . . .	56
(d) Bunds, Storage, Platforms, etc. . . . .	25
<b>TOTAL</b>	<b>420</b>

3.2.2 We also recommend that the multiple irrigation system of manufacture be adopted in order to obtain a better quality of salt and a larger yield per acre. These works should find no difficulty in adopting the multiple irrigation system where the crust is allowed to grow into 2 to 3 inches thickness before it is lifted. A study of the method practised at Kathiawad would prove beneficial to both these factories and we suggest that the officer-in-charge of the Dharasana and Chharvada factories visit some of the neighbouring Kathiawad salt works, particularly at Kandla, Mithapur and Porbandar for this purpose.

3.2.3 The manufacturing operations at these works are not carried out departmentally, but as at Kharaghoda, the pans are distributed to the Agarias at the beginning of each year. The policy of distributing the pans to the Agarias, was adopted to enable the Salt Department to deal directly with the actual workers and to eliminate the lessee who is generally the middleman. The number of pans allotted to an Agaria family is restricted to five which is considered adequate for him and his family to work. The pans are allotted every year generally to the same Agarias or their descendants in order that they may maintain the pans in proper order and work diligently. The Agarias carry out all the operation *i.e.*, from the initial repairs at the commencement of the season to the storage of salt at the close of the season. No licence fee is charged to the Agarias, but they are required to sell the salt at a rate which is fixed by Government at the beginning of each season.

3.2.4 *Production and Quality.*—The production of salt at the two factories for the three years of 1946 to 1948 is shown in Table LII.

TABLE LII—PRODUCTION OF DHARASANA CIRCLE 1946—48

	1946		1947		1948	
	Tons	Maunds	Tons	Maunds	Tons	Maunds
Dharasana	15,720	4,28,000	12,640	3,44,000	13,320	3,63,000
Chharvada	7,200	1,96,000	5,950	1,62,000	10,510	2,86,000
<b>TOTAL</b>	<b>22,920</b>	<b>6,24,000</b>	<b>18,590</b>	<b>5,06,000</b>	<b>23,840</b>	<b>6,49,000</b>

The salt produced is mainly of the heavy *vajni* variety and its analysis as reported by the Works is shown in Table LIII.

TABLE LIII—COMPOSITION OF DHARASANA AND CHHARVADA SALT

	Percent on Dry Basis	
	Dharasana	Chharvada
Sodium chloride	92.90	92.68
Calcium sulphate	0.82	0.34
Magnesium sulphate	1.40	1.75
Magnesium chloride	2.66	3.23
Insoluble	0.26	0.24
Undetermined	1.96	1.76
	<b>100.00</b>	<b>100.00</b>

The quality of the salt is far from satisfactory. If the bitterns are eliminated regularly, the adhering mother liquor is allowed to drain off the lifted salt and greater care taken in harvesting, a better quality salt could be produced. Being Government owned works, better supervision over the method of manufacture should be exercised and if the multiple irrigation system is adopted there is no reason why these works should not be able to produce salt of a quality equal to that produced in some of the good factories in Kathiawad.

**3.2.5 Improvement and Extensions.**—It is reported that 1,169 acres belonging to the Government of Bombay are available adjacent to the existing factory, which could be brought into use for either making improvements in the layout of the existing two works or for extending them. The question of acquiring this land should be examined by the Government of India if and when they decide to extend these works. We consider it premature to bring this large additional area under salt cultivation until after the works are relaid in accordance with our recommendation. We believe that as a result of the relaying and change-over to multiple irrigation system there will be a substantial increase in the yield of salt from these works, particularly in Chharvada. It is only after the increased production finds a ready market and it is found that still larger quantity of salt is required from this Circle that the question of extension of these works should be undertaken.

**3.2.6** For works of the size of Dharasana and Chharvada it would be advisable to substitute mechanical appliances for the manual labour. The brine should be lifted by pumps to the reservoirs and/or condensers. For bringing the salt from the pans to the central stores 2 ft. gauge track and tipping wagons hauled by steam or diesel locomotives should be laid. The salt is at present transported by bullock carts from the works to the Dungri railway station. It would be desirable to lay down a siding from the railway station into the works in view of the likely increase in production. This would cheapen the cost of transport and reduce the selling price of salt.

**3.2.7 Staff and Organisation.**—The staff employed for the Dharasana Circle consist of 1 Deputy Superintendent and 1 Inspector assisted by 14 members of the ministerial staff and 58 in the Watch and Ward Department. As the entire labour is composed of Agaria families numbering 600, no other labour is employed. The Deputy Superintendent and the Inspector should be men with technical qualifications so that they might keep a better control over the manufacturing operations and give the necessary guidance and advice to the Agarias. Although we do not wish to deprive the Agarias of their means of livelihood it may be necessary for Government to engage additional staff, particularly if substantial improvement in quality is to be achieved and the method of manufacture is to be modified which the Agarias may be reluctant to adopt in the beginning.

**3.2.8 Cost of Production.**—When the Dharasana and Chharvada salt works were opened in 1870 Government fixed the selling price of salt at Rs. 3-6-6 per ton (Re. 0-2-0 per maund). Of this amount Rs. 2-2-0 per ton (Re. 0-1-3 per maund) was paid to the Agarias and the balance credited to Government under the head 'Proprietary Rights'. Since then the price paid to the Agaria has progressively increased as shown below;

	Per Ton			Per Maund		
	Rs.	A.	P.	Rs.	A.	P.
1870 . . . . .	2	2	0	0	1	3
1909 . . . . .	2	8	10	0	1	6
1917 . . . . .	2	15	8	0	1	9
1920 . . . . .	3	6	5	0	2	0
1921 . . . . .	4	10	10	0	2	9
1933 . . . . .	5	1	8	0	3	0
1944 . . . . .	6	12	10	0	4	0
1945 . . . . .	7	10	6	0	4	6
1946 . . . . .	10	3	4	0	6	0
1947 (from 1-9-47) . . . . .	13	9	9	0	8	0

In view of the fact that the salt is purchased from the Agarias by the Dharasana Co-operative Society no cost of manufacture is maintained at these works nor are the Agarias in a position to give it. We consider that some attempt should be made by the works to assess the cost of the different operations as is being done at Kharaghoda to form a rational basis for fixing the price to be paid to the Agarias. It will incidentally also help to determine their economic condition. The only information that we were able to obtain is that it costs Government Rs. 900 to level and repair the channels, crystallisers and condensers at the beginning of each season and this expenditure is treated as a part of the cost of administration. In fixing the price at which the salt is sold to the Society, the depreciation of either the salt works or of the buildings standing on them is not taken into account. This position should be rectified as Government salt works are public property and proper provision should be made to charge depreciation to the cost of manufacture. No information is also available of the capital cost of these works and it is advisable for the purpose of proper costing as also for that of determining the depreciation that the present day valuation of the capital cost of these works be made.

§.2.9 *Sales and Distribution.*—In 1933, the Dharasana Group Co-operative Salt Sales Society Ltd. was formed by the Agarias for the sale of salt produced in the Dharasana Circle. The Society pays to Government in addition to the price of salt, a ground rent of Rs. 1-4-5 per ton (9 pies per maund) and the salt cess of Rs. 5-15-3 per ton (Re. 0-3-6 per maund). To the Co-operative Society, the cost of salt works out, therefore to Rs. 20-13-5 per ton (Rs. 13-9-9+1-4-5+Rs. 5-15-3) or (Rs. 0-12-3 per maund) ex-works. To this price, the Society adds Re. 0-6-10 per ton (3 pies per maund) as its contribution for the Agarias Amelioration Fund and Rs. 6-1-6 per ton (Re. 0-3-7 per maund) for the cost of transport of salt to the railway station of Dungri, which is 2-1/2 miles from Dharasana and 4 miles from Chharvada. The total cost of salt to the Society, therefore, works out to Rs. 27-5-9 per ton (Rs. 1-0-1 per maund) f.o.r. Dungri. The Society sells the salt at Rs. 28-3-4 per ton (Rs. 1-0-7 per maund), thus making a profit of Re. 0-13-7 per ton (6 pies per maund) which is by no means excessive. This price includes the filling and sewing charges of the bags but does not include the cost of the bags which have to be supplied by the buyers. The contribution made by the Society to the Amelioration Fund is utilised by Government to provide medical aid, schools, etc. for the Agarias and for repairs of bunds, platforms, etc. of the works.

3.3 BHAYANDAR CIRCLE—The Bhayandar Circle is divided into four ranges (a) Maroli, (b) Bassein, (c) Rai and (d) Dadar. Except for the Maroli range, where there is only one factory, viz. the Bulkalay Salt Works, the other ranges have a number of factories all of which are situated within a radius of 30 miles of Bombay city. The number of the factories, the area under salt cultivation and the yield per acre have been given in Table XLIX.

3.3.1 *Maroli Range.*—The Bulkalay Salt Works are situated 40 miles south of Dharasana, near Umergaon Peta in the Thana District, and the area under cultivation is 79 acres. The bulk of the production is of the heavy *vajni* variety (77 per cent).

3.3.2 *Bassein Range.*—There are 29 works in this range, the largest of which measures 388 acres, and the smallest 25·5 acres. There are four government salt works in this range and they cover 416 acres. Both the light and the heavy varieties are produced. These works are reported to experience shortage of brine supply owing to the silting up of the creek and the reservoir. They also need remodelling in accordance with our recommendations in the chapter on Model Factories and Research Stations as the ratio of crystallisers to reservoir plus condensers is inadequate, varying from 1:3 to 1:1·6.

3.3.3 *Rai Range*.—There are 46 works in this range, the maximum size of any single one being 240 acres and the minimum 18 acres.

3.3.4 *Dadar Range*.—There are 17 works in this range, the largest measuring 221 acres and the smallest 8 acres. Three of these works belong to Government covering a total area of 212 acres, the largest among them being 121 acres in area. We had an opportunity of visiting one of the Government salt works in this range, where *kuppa* salt was being exclusively manufactured. These works are badly laid out and maintained and appeared to be in bad shape. The Government works are not operated departmentally but are leased out to private parties on tenders for a period of 1 to 5 years. The salt produced is of the light variety of *mapi* and *kuppa*. The ratio of crystalliser to condenser plus reservoirs varies from 1:1 to 1:1.2 which is inadequate and needs remodelling. We cannot apportion any part of the blame to the short-term lessees for this state of affairs. They naturally could not be expected to sink money in a property in which they acquire, by auction the farming rights for short duration. An acute shortage of brine is experienced in all the 3 factories owing to the silting up of the Mahul creek which is the main source of supply of brine. We were also informed that two culverts built over the creek by the Bombay Port Trust Railway restricts the flow of brine. The reservoirs are also silted up and have to be deepened to hold enough brine to last till the next high tide. Removal of silt from the creek and conversion of the culverts into broader bridges appear to be the only remedy to increase the supply of brine to these factories.

3.3.5 *Annual Production and Quality*.—The production of salt in the Bhayandar Circle in the different ranges for the three years 1946-48 is given in Table LIV.

TABLE LIV—PRODUCTION OF SALT IN BHAYANDAR CIRCLE  
1946-48

Range	1946		1947		1948	
	Tons	Maunds	Tons	Maunds	Tons	Maunds
Maroli . . .	1,030	28,000	960	26,000	1,620	44,000
Bassein . . .	65,060	17,71,000	40,370	10,99,000	73,180	19,92,000
Rai . . .	65,720	17,89,000	37,580	10,23,000	76,520	20,84,000
Dadar . . .	26,710	7,27,000	11,720	3,19,000	23,580	6,42,000
TOTAL . . .	1,58,520	43,15,000	90,630	24,67,000	1,74,900	47,62,000

The analysis of a sample of *kuppa* salt which we collected at the Dadar works is given in Table LV.

TABLE LV—COMPOSITION OF *KUPPA* SALT IN DADAR RANGE

(percent. on dry basis)

Sodium chloride . . . . .	96.06
Calcium sulphate . . . . .	0.53
Magnesium sulphate . . . . .	0.97
Magnesium chloride . . . . .	1.43
Insolubles . . . . .	0.19
Undetermined . . . . .	0.82
	100.00

The salt is better than *mapi*, but the effort spent on its production is not commensurate with the improvement in the quality or yield.

**3.3.6 Improvement and Extensions.**—In our Interim Report we had expressed the view that the practice leasing out Government salt works to private parties was undesirable. This practice is open to many objections. Firstly, Government expose themselves to the charge, by the lessees, that an exorbitant rent is being levied from them. We do not necessarily accept this charge, inasmuch as the lessees are in a position to assess the rent they could afford to pay in taking over the lease. But when Government accept a high rent they naturally set an example to the private owners who also are in the habit of farming out their works to the highest bidders. The second objection is that once the lease is given, Government exercise no control over the lessees in either the method of manufacture or the maintenance of the works. Thirdly the design of the works being no better than that of privately-owned works lay down no standard that could be expected from Government works which should be a model in all respects. If Government could operate the salt works in Rajasthan and Kharaghoda which are on a much larger scale than the works in the Bhayandar Circle, there is no reason why these marine salt works could not be similarly operated. We had, therefore, recommended that as and when the existing leases of these works expire, they should be taken over by Government and run departmentally. It is necessary and desirable to redesign these works so that they may serve as model factories for other works in the ranges in which they are situated. We appreciate that relaying these works might take a little time and affect the production. As an interim measure we suggest that Government operate them with such improvements as could be made without interfering with the production, the more radical alterations being made one after the other. The relaying of these works will have to be done in such a manner as to give a ratio of 1:7 between the crystallisers on the one hand and the reservoir plus condensers on the other; this condition must be enforced when these works are being relaid. We understand that Government have accepted our recommendation. One of the salt factories in the Dadar range has been taken over at the expiry of its lease and Government have decided to work it departmentally after relaying it as a model factory. The Salt Research Committee of the Council of Scientific and Industrial Research has also agreed to conduct at this factory experiments in improved methods of manufacture which could be demonstrated to the other manufacturers in this area. Since the Bombay manufacturers depend entirely on their artisans who are conservative in their outlook and will not change their methods easily, it will be easier to bring about a change throughout the range in order to produce salt of a better quality once the optimum conditions have been worked out at the model factory.

**3.3.7 Cost of Production.**—No cost of production of salt in Bhayandar Circle was made available to us either by the manufacturers or their association, the Bombay Salt Manufacturers and Shilotries Association. We were referred to the book "Salt Industry of Bombay Province" by Mr. K. K. Shende. This book deals with some of the general aspects that contribute to the cost of production, but does not give specific figures of cost for any particular area in the State of Bombay.

**3.4 BHANDUP CIRCLE.**—The Bhandup Circle is divided into three ranges (a) Bhandup, (b) Trombay and (c) Belapur. These ranges like three of the ranges in the Bhayandar Circle are within a radius of 30 miles of the City of Bombay. In the Bhandup range there are 5 salt works, the largest amongst them measuring 392 acres is next in size only to the works at Dharasana whilst even the smallest one covers 180 acres. At Trombay there are 22 salt works, the largest measuring 127·5 acres but the smallest only 15 acres. At Belapur there

are 18 works, the maximum being 191 and the minimum only 14·5 acres. In this Circle there are no Government owned works. All the works are situated on creeks which penetrate inland from the Arabian Sea and brine is drawn at high tides. The ratio of the crystallisers to the reservoir plus condensers does not go beyond 1:2 in any of the works. At Trombay the average comes to only 1:1·6. The salt produced in this Circle is chiefly of the *mapi* or *kuppa* type (71 per cent.) *vajni* being only 29 per cent.

3.4.1 We had an opportunity of seeing some of the works in the Trombay Range. We found them small, badly laid out, ill-designed and lying cheek by jowl to each other. The pattern of these salt works is uniform. It consists of small areas of reservoirs and condensers, the condensing area being even less than the reservoir whilst needlessly larger areas are under crystallising pans which vary in size from 15 ft. × 45 ft. to 20 ft. × 50 ft. The area for the storage of brine and its concentration is so small that the crystallisers cannot be fed with sufficiently saturated brine to give salt of good quality. Individual licensees holding even a small area have their own reservoir and condensers instead of joining hands with the neighbouring works and working on a co-operative system to provide for a better layout. The crystallisers which ought to receive brine at 23° Be' are actually utilised for concentrating the brine to the point of saturation, a function which properly belongs to the condensers.

3.4.2 *Annual Production and Quality.*—The production of salt in the Bhandup Circle for the three years 1946-48 is given in Table LVI.

TABLE LVI—PRODUCTION OF SALT IN BHANDUP CIRCLE 1946-48

Range	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Bhandup. . . .	20,570	5,60,000	10,510	2,86,000	22,300	6,07,000
Trombay. . . .	33,510	9,12,000	17,780	4,84,000	32,590	8,87,000
Belapur . . . .	33,320	9,07,000	23,620	6,43,000	36,300	9,88,000
TOTAL . . . .	87,400	23,79,000	51,910	14,13,000	91,190	24,82,000

The composition of the samples of *mapi* and *vajni* salt that we drew from the works we visited is shown in Table LVII

TABLE LVII—COMPOSITION OF SALT IN THE BHANDUP CIRCLE

The *mapi* salt has a low sodium chloride content and is largely associated with other salts present in sea water. It also contains a fair amount of insoluble residue which is mostly clay and sand. This can be easily explained, when one examines the method of manufacture adopted in producing this salt. Brine of low density being fed into the crystallisers deposits a major portion of its gypsum around which the sodium chloride crystals get formed. Since the bitterns are rarely eliminated, the magnesium sulphate and chloride also get deposited along with the sodium chloride. Since brine of higher density is fed into the crystallisers where *vajni* salt is produced, the salt has a lower calcium sulphate content, but, as the bitterns here also are not eliminated the magnesium salts get deposited in appreciable quantities.

3.5 URAN CIRCLE.—In the Uran Circle there are six ranges, viz., (a) Shewa, (b) Uran, (c) Karanja, (d) Pen, (e) Shiroda and (f) Sanikatta. Of these, the first four are in the Colaba District while Shiroda is in the Ratnagiri and Sanikatta in the North Kanara districts. The Colaba district salt works are all within 30 miles of the City of Bombay. The Shiroda works are situated a little north of Marmagoa whilst Sanikatta works are south of Marmagoa. The works in both these ranges are on the main sea coast unlike some of the works in the other ranges in this circle.

3.5.1 *Shewa and Uran ranges.*—In the Shewa range there are 39 salt works, the size of the largest works comes to 237 acres whilst that of the smallest is as low as 4 acres. In the Uran range the number of works is 38, of which the largest is 86 acres and the smallest  $7\frac{1}{2}$  acres. We saw some of the works in these two ranges and found them no different from the works at Trombay. Although the total number of works in these ranges is 77, the number of licensees is 257. It is, therefore, not surprising that the individual size of some of the works is as low as 4 acres. Even those which are apparently larger in size are no better because the number of licensees operating them is correspondingly larger, with the result that the area per licensee is reduced to an extremely uneconomical figure.

3.5.2 We visited the Moti Salt Works at Shewa where there is a small unit producing table salt. The area of the works is as follows:—

	Acres
Reservoirs . . . . .	117
Condensers . . . . .	50
Crystallising pans . . . . .	63
<b>TOTAL</b> . . . . .	<b>230</b>

This gives a ratio of 1:2.65 For the production of table salt, a part of the brine from the reservoir is drawn into one of the condensers and allowed to concentrate up to about 12° to 13° Be'. It is then pumped and sprayed through nozzels into a second set of condensers where it is allowed to concentrate to about 23° Be'. This highly concentrated brine is then filtered to remove insoluble impurities and charged into shallow cement crystallisers to a depth of 1-1/2 inches. In these pans, the brine is continually agitated by wooden rakes, or *pavis* to obtain fine crystals of salt. The salt is then collected in baskets, washed in a centrifuge by a spray of water and dried in the sun. The production of table salt has been carried on at these works for the last 10 years and its average production was reported to be about 735 tons (20,000 maunds) per annum. The cost of production was not furnished to us, but we were informed that this unit was not working economically, and the price of the imported table salt was lower than their cost of production. The composition of a sample of the table salt that we collected is shown in Table LVIII together with the analysis of *kuppa* salt drawn from one of the works in the Shewa Range.



TABLE LVIII—COMPOSITION OF TABLE SALT AND KUPPA SALT IN SHEWA RANGE

	Table salt	Kuppa
Sodium chloride . . . . .	99.36	96.59
Calcium sulphate . . . . .	0.43	0.25
Magnesium sulphate . . . . .	0.04	1.18
Magnesium chloride . . . . .	..	1.55
Insolubles . . . . .	0.08	0.07
Undetermined . . . . .	0.09	0.36
	100.00	100.00

The moisture content of the table salt sample was found to be only 0.35 per cent. and the chief impurity was calcium sulphate, to the extent of 0.43 per cent. This is higher than the calcium sulphate content in *kuppa* salt which was produced without the aid of any of these costly devices. We drew the attention of the works to the fact that brine concentrated up to 24° Be' was actually being diluted with brine of a much lower density drawn from the condensers in order to prevent salt crystallising out prematurely. Whilst a considerable portion of the calcium sulphate content would have been removed in concentrating the brine to 24° Be' the subsequent addition of brine of 12° Be' would again introduce this impurity and partially nullify the beneficial effect of the original concentration. We recommend that the mixing of dilute brine in order to reduce the calcium sulphate content be stopped.

3.5.3 We also wish to make the following suggestions for the more economical working of this unit. The use of sprays which is evidently intended to bring about rapid evaporation and to increase the density of the brine does not actually serve the object in view. During our visit we noticed that the brine immediately after it left the sprays was not more than  $\frac{1}{2}$ ° Be' higher in density which could have been easily achieved in the condensers. We recommend that spraying be discontinued. We were told that the constant agitation with wooden *pavris* was meant to keep down the size of crystals for which much labour is expended. This result could be achieved more easily by crushing the salt obtained in a small roller mill. The continuous agitation in the cement pans wears them out quickly requiring constant repairs which add to their cost of maintenance. The use of ordinary clay beds with a floor of salt, where only the upper layer of salt is collected, would serve the purpose better. A permanent crust can be allowed to form to a thickness of  $\frac{1}{4}$  to  $\frac{1}{2}$  inch over the clay beds which need not be disturbed during the harvesting. This salt when washed, dried and crushed in a roller mill would give a better product at a lower cost.

3.5.4 *Karanja and Pen Ranges.*—In *Karanja* there are 22 salt works of which the largest is 237 acres and the smallest 4 acres. In *Pen* there are 23 works the largest being 221 acres and the smallest 6 acres. We did not visit any of these works and we do not discuss them in detail, but from the information supplied to us they are in no way different from the other works in this circle.

3.5.5 *Shiroda and Sanikatta Ranges.*—In *Shiroda*, the number of salt works is 16, the largest works measures 17 acres and the smallest just  $1\frac{1}{2}$  acres. At *Sanikatta* where the total number of works is 121 the largest is 10 acres and the smallest less than half an acre. The ratio of the crystallisers to the reservoir plus condensers does not go beyond 1:3 at *Shiroda* and 1:1.6 at *Sanikatta*. The variety of salt produced at *Shiroda* is wholly *mapi* and at

Sanikatta wholly of the heavy *vajni* variety. We did not visit any works in these ranges as they are situated at a considerable distance from Bombay and are difficult to reach. The climatic conditions in both these ranges are different from the other ranges in Bombay Province and they experience heavy rainfall. The period of fair weather is comparatively small and, as in Orissa, light showers are common even in the months of April and May.

3.5.6 *Shiroda*.—At Shiroda the total area under salt cultivation is barely 75 acres, and it is divided into 16 small works which are operated by 35 lessees. Even the largest works of 17 acres is held by 8 lessees whilst the smallest works of 1.5 acres is shared between 5 lessees which gives an average of less than 1/3 of an acre per lessee. Of the 16 works, 7 are owned by Government and their total area is 22.75 acres which gives an average of only about 3.25 acres. The largest of the Government-owned works measures 5 acres and the smallest 2 acres. The size of these Government-owned works is totally uneconomical and in our opinion no purpose is being served by keeping them in 7 small independent units. We would have recommended their amalgamation into one unit, but as they are scattered it is not possible to coalesce them. There are only two solutions to this unsatisfactory state of affairs, viz. either to sell them to the owners of the surrounding privately-owned works or to form a co-operative society of the existing licensees who should then take over all the 16 works including the 7 Government works and operate them as a single unit of 75 acres. The existing licensees, should be asked to participate in the co-operative society by contributing to the share capital and by giving their individual labour for the manufacture of salt.

3.5.7 *Sanikatta*.—At the Sanikatta range, the total area under cultivation is 423 acres, but there are 121 small salt works which give an average of 3.5 acres per works. The number of licensees is 199 and the size of the largest works is 10.20 acres and the smallest as low as 0.43 acre. The small size of the works calls for a remedy similar to the one recommended for the works at Shiroda. Little purpose will be served by continuing the operations of such small units and a merger of the works either under Government control, or preferably, under a co-operative society appears to be the only remedy for saving these works, otherwise they are bound to be extinguished because of their uneconomic size, unfavourable climatic conditions, and the inaccessibility of their location.

3.5.8 *Production and Quality*.—The production of salt in the Uran Circle for the different ranges during the three years of 1946—48 is given in Table LIX.

TABLE LIX—PRODUCTION IN THE URAN CIRCLE 1946—48

Range	1946		1947		1948	
	Tons	Maunds	Tons	Maunds	Tons	Maunds
(a) Shewa . . .	61,130	17,12,000	27,150	7,83,000	64,140	17,68,000
(b) Uran . . .	43,090	12,10,000	15,980	4,36,000	43,170	11,72,000
(c) Karanja . . .	25,970	7,39,000	9,440	3,20,000	25,310	7,65,000
(d) Pen . . .	15,690	4,28,000	6,980	2,74,000	15,540	4,38,000
(e) Shiroda . . .	1,800	50,000	1,870	53,000	2,570	71,000
(f) Sanikatta . . .	..	2,000	7,240	1,98,000	6,210	1,74,000
TOTAL . . .	1,47,680	41,41,000	68,680	20,64,000	1,56,940	43,88,000

The drop in production during 1947 was largely due to the heavy unseasonal rains which fell in April 1947. It meant that all the concentrated brine was washed away and there was not enough time to produce fresh concentrated brine to resume the manufacturing operation to make up the loss suffered by the unseasonal rains. The low production was also due to the fact that the monsoon of 1946, extended right up to the month of November. This meant that all the preliminary work on the preparation of pans could only be started in the month of December, and the first crop could only be raised in the month of February of 1947.

3.5.9 A sample of *vajni* salt collected by the Salt Department from Sanikatta gave an analysis as shown in Table LX

TABLE LX—COMPOSITION OF SALT FROM SANIKATTA RANGE

(Percent, on dry basis)	
	Vajni
Sodium chloride . . . . .	93.88
Calcium sulphate . . . . .	0.75
Magnesium sulphate . . . . .	0.96
Magnesium chloride . . . . .	1.84
Insolubles . . . . .	1.20
Undetermined . . . . .	1.37
	100.00

Notwithstanding the high content of insolubles in this salt the percentage of sodium chloride is appreciably higher than that of *mapi* salt in the other factories in Bombay. The figure of insolubles clearly indicates bad handling which is an easily remediable defect. The high content of magnesium salts indicates that the bitters were not regularly eliminated and were allowed to contaminate the salt.

#### 4. Annual Production and Quality.

4.1 The total production of salt in Bombay Province for all the Circles for the three years 1946—48 is summarised in Table LXI.

TABLE LXI—ANNUAL PRODUCTION OF SALT IN BOMBAY 1946—48

Circle	1946		1947		1948	
	Tons	Maunds	Tons	Maunds	Tons	Maunds
(a) Dharasana . . . . .	22,920	6,24,000	18,590	5,06,000	23,840	6,49,000
(b) Bhayandar . . . . .	1,58,520	43,15,000	90,630	24,67,000	1,74,900	47,62,000
(c) Bhandup . . . . .	87,400	23,79,000	51,910	14,13,000	91,190	24,82,000
(d) Uran . . . . .	1,47,680	41,41,000	68,660	20,64,000	1,56,940	43,88,000
TOTAL . . . . .	4,16,520	1,14,59,000	2,29,790	64,50,000	4,46,870	

This production gives Bombay Province a very prominent position in the salt industry of the country, being only next to that of Madras. In quality, however, Bombay salt leaves considerable room for improvement. When compared with the salt manufactured in Kathiawad and Kutch, the Bombay salt is poorer in sodium chloride content which varies between 88 to 93 per cent. This applies both to the *vajni* and *mapi* varieties. The *kuppa* salt is distinctly better than either of the two varieties, but its method of production is so wasteful that its cost is inevitably high.

4.2 The light salt is graded into three different sizes answering specific trade definitions, *viz.* (a) *single*, (b) *double* and (c) *Calcutta*. The grading is done by repeated sieving and the largest crystals retained on the first sieve are known as *single*. Those retained on the second sieve are called *double* and those that pass through it consisting of broken and tiny crystals approximating to crushed salt, so popular in the Calcutta market, are known as *Calcutta*. The crystals of *mapi* and *kuppa* salt being fragile are stored in small heaps to save them from getting crushed and the sieving operation has to be conducted with special care. As the *Calcutta* grade leaves much less air space in packing, it is consumed in such areas where salt is sold in retail by weight.

## 5. Improvements and Extensions.

5.1 Chapter XIV on Travancore describes at length, the technique developed by the Travancore University for the manufacture of salt by the single irrigation method. The climatic conditions in Bombay are such that the multiple irrigation system cannot be adopted wholly, anywhere in the Province except at Dharasana. By adopting a proper ratio between the crystallisers and the reservoir *cum* condensers the production in Bombay could be appreciably increased without increasing the area under cultivation to any large extent, except at Maroli and Shiroda. Owing to occurrence of rains in Bombay Province during the manufacturing season the ratio of the crystallisers to the reservoir *cum* condensers should be about 1:7. In the case of Dharasana we have already recommended that the ratio should be of the order of 1:6. In adopting these ratios care should be taken to see that wherever adjustment between the respective areas is necessary, because of the lie of the land, such adjustments should be made. No compromise should, however, be made in the overall ratio of 1:7 in the case of other salt works and 1:6 in the case of Dharasana. As a result of this re-grouping of the areas under cultivation, it may be reasonable to expect an increase in the yield per acre of cultivation. At present the yield varies from 28 tons (760 mds.) per acre in the case of Shiroda to 12 tons (325 mds.) in the case of Pen Range. These wide variations could to a great extent be narrowed down by the re-arrangement of the areas under cultivation. At the present ratios, the yield per acre is only 22 tons (600 mds.). With proper layout and redistribution of the areas, the yield at Dharasana could be increased to at least 70 tons (1,900 mds.) per acre and at the other circles to 50 tons (1,360 mds.) per acre. On this basis, without any extensions, the production could be increased as under—

	Tons	Mds.
(a) In Dharasana Circle at 70 tons per acre for 1,110 acres .	77,700	21,15,000
(b) In the remaining circles at 50 tons per acre for 15,381 acres .	769,050	2,09,35,000
	<u>8,46,750</u>	<u>230,50,000</u>

The production in Bombay can then be increased by more than 100 per cent. over the average production of 1946—48 of 3,61,100 tons (99,19,000 mds.). Even on a conservative estimate it should be possible to increase the production by at least 50 per cent. without any difficulty.

5.2 In addition to the adoption of the proper ratio we recommend that the following changes based upon the experience gained in Travancore should be introduced in the salt works in Bombay Province.

(a) The brine should be allowed to deposit its suspended impurities in the reservoirs till it reaches a density of at least 6° Be'

(b) It should then be let into the first group of condensers in which the concentration of brine may be allowed to reach 17° Be'.

(c) In the second group of condensers the density of the brine should be allowed to rise to about 23° Be'. Then only it should be let into the crystallising pans to a depth of 2 inches and allowed to evaporate till it reaches a density of 28° to 29° Be'; the depth of the mother liquor at this concentration is expected to be about  $\frac{1}{2}$  in. The bed of the second group of condensers should be levelled and consolidated by tamping at the commencement of the season so that the gypsum deposited during evaporation may be collected at the end of the season. If a particular manufacturer does not wish to recover the gypsum he could dispense with tamping, without affecting in any way the quality of salt produced.

(d) The present practice of lifting salt from the crystallisers with the concentration of mother liquor at 30° Be' or above should be discontinued. After the mother liquor has been drained, the crystalliser should again be charged with fresh brine at 23° Be' in order to give the salt in the pans a wash to free it from contamination with mother liquor, rich in magnesium salts. The salt should be scraped only after this washing and care should be taken to prevent the clay from the beds being raked up in the process of lifting.

(e) Though we recommend the continuation of the single irrigation system, it is indisputable that the quality of salt improves if the frequency of its scrapings is reduced. The only reason for continuing the single irrigation system is the threat of unseasonal rains. While, towards the end of the manufacturing season, risks from rains may be fairly large and scrapings may have to be done once a week, during the middle of the season, when there is no threat from rains there is no need to lift the salt so frequently. All that is necessary is to let out the bitterns when the density rises to 28° to 29° Be' and to charge the crystallisers with fresh brine and allow the crust to grow.

(f) The mother liquor should be removed to the crude salt crystallisers for the production of crude salt. The crude salt crystallisers should also be tamped in the same manner as the salt crystallisers and the mother liquor should be allowed to rise in density to 32° Be'. The crude salt separating out in these crystallisers would not be fit for edible purposes, and it should be thrown back into the first series of condensers to enrich the brine there.

(g) The mother liquor at 32° from the crude salt crystallisers could be utilised for the manufacture of byproducts, if so required, as discussed in the chapter on the Recovery of Byproducts.

5.3 Another important feature to which we would like to draw attention is the total areas of the works in the different ranges, in the Bombay Province. A reference to the Chapter on Kathiawad and Kutch will show that the total area under cultivation in some of the ranges in Bombay is less than the area of a single works in Kathiawad or Kutch. In view of the natural advantages that Kathiawad and Kutch factories possess and the large size units they operate, the works in the Bombay ranges are at a considerable disadvantage from the point of view of manufacturing cost, over-heads, etc. In the three circles of Bhayandar, Bhandup and Uran there are 397 works covering an area of 15,381 acres; the number of licensees, is 1,888 which gives the average area per licensee to about 8 acres. This area by itself is very small, but on closer

examination of the figures it will be seen that one of the small works in Shiroda-range, covers an area of only 1.5 acres which is subdivided among 5 manufacturers giving an area of 0.3 acre per manufacturer. Again in the Shewara-range, a factory of 4.2 acres is divided among 10 licensees. In 1948, when the Government of India permitted residents on the sea coast to manufacture salt freely in plots of 10 acres it must have been on the assumption that it would not be worth anyone's while to carry on manufacturing operations in a smaller area. We find it difficult to reconcile ourselves to the position that any manufacturer can operate economically works not extending to more than a fraction of an acre. Since they continue to work from year to year we can only conclude that they must be barely making both ends meet or that the larger works are making excessive profits since the price charged for salt whether made in a small works covering only a fraction of an area or a large works covering several hundred acres or more is identical. This position is worsened by another consideration to which a reference has already been made by us. We have commented on the practice adopted by Government of leasing out their own salt works on a yearly basis to the highest bidder. We have further drawn attention to the fact that private licensees have also resorted to the same practice and some of these insignificantly small works must belong to such absentee proprietors. These petty lessees have obviously no interest in maintaining their works properly and they necessarily produce salt without any regard to its quality. This uneconomic fragmentation of salt land can be easily stopped by Government since the rights of the licensees in their holdings are subject to licences granted by Government. If the salt works in Bombay are to exist as an economic unit it becomes increasingly necessary that they should make serious attempts to form themselves into large size units. Otherwise once the factor of competition arises, they will not be able to hold their own against manufacturers who operate large size units and produce good quality salt at a lower cost. In this context it would be appropriate to quote from the Information Circular published in 1939 by the United States Department of Interior, Bureau of Mines, on the marketing of salt.

*“The United States Salt Industry is highly organised; it comprises fewer companies than when small crude works with primitive methods and equipment eked out salt for local needs, but concentration of output brought about by modern inventions and methods of production has improved the quality of the produce greatly and accelerated production.”*

What is true of the American salt industry applies with equal force to the Indian industry and particularly to the works in Bombay and Madras where they continue to be operated in small uneconomic units. If salt is to be made available to the people of Bombay and Madras at a lower rate the solution is to persuade the smaller units to combine to form bigger units, by forming themselves into co-operative organisations or joint-stock companies. The size of an economic unit should be a minimum of 100 acres and this is recommended for adoption in all the ranges. Where the total area under cultivation in any range falls below this figure as at Maroli and Shiroda which have only 79 and 75 acres respectively, Government should take steps to increase the area under cultivation to 100 acres.

5.3.1 Unlike some of the other parts of India, the licensees in Bombay enjoy the right to manufacture salt only till their licence is revoked. Such an uncertain situation may perhaps stand in the way of co-operative organisations or joint-stock companies being formed. In order to knit together the various units into works of an economic size, and as an inducement to the present licensees to do so voluntarily, we further recommend that in the event of such mergers taking place the duration of the licence be fixed for a reasonably long period of say 25 years, with a provision that on its expiry it will be subject to renewal for further periods.

5.4 In our Interim Report we had pointed out that the production of the two varieties of light salt, viz. *mapi* and *kuppa* in preference to the heavy variety, *vajni* had established itself, largely because retail dealers sell the salt by measure though they buy it wholesale by weight. After studying the method of manufacture of both the light and the heavy varieties we have come to the conclusion that the manufacture of light variety is a wasteful process involving more time and expenditure. The manufacturers whom we met during our visit to the works in Bombay have stated that their production could be increased by 20 per cent. if only the heavy grade was manufactured. They have made the same statement in their answers to our questionnaire. They have expressed their willingness to give up the manufacture of the light varieties provided the sale of salt by measure was banned.

5.4.1 Whilst a maund of heavy grade *vajni* salt gives by measure 11 to 12 pailies, a maund of light grade *mapi* salt gives 16 to 18 pailies. As a result of experiments carried out in Madras many years ago, it was found that the weight of salt for a given volume varied as much as 37 per cent; in the case of *kuppa* salt of Bombay the difference may be even more than 50 per cent. The retail dealer thus secures an unearned profit of about 50 per cent. by selling by measure the light salt. As the consumer who buys the salt by measure does not understand the difference between the light and heavy grades, it is obvious that a deception is practised on him and he is being defrauded in obtaining his requirement of salt by measure. Even if the buyer were aware of the difference either in the quality of the two varieties or of the weight delivered to him, for any given measure, he has no option but to buy the salt which is sold to him by the retail dealer. The manufacturers claim that they have to supply the varieties which the trade is willing to buy and they cannot bring about any change so long as there is a demand for the light variety. This is however, not entirely true. The wholesale price of salt is determined by the number of pailies that a maund of salt gives, rather than its quality or appearance. The manufacturers are, therefore, interested in making the light varieties because of the larger profit they make on them and this accounts for the reluctance and resistance of some of the manufacturers to give up the manufacture of the light varieties. In Table LVII we have given the analyses of both the light and heavy varieties. Although the quality of heavy variety is not as good as it should be it is better than the light variety. In the interest of the quality of the salt also, which should be improved as expeditiously as possible, we strongly recommend that the manufacture of the light variety be given up. The only way in which the consumer's and the manufacturer's interests can be protected is for the Provincial Government to pass legislation to ban the sale of salt by measure enforcing it by weight alone at all stages. If this were done, the manufacture of light variety of salt would automatically cease, the production of salt in Bombay would go up and the fraud on the consumer would be checked.

5.4.2 As legislation may take time, we had recommended in our Interim Report that Government should take steps, by departmental action, to reduce the production of the light variety of salt in Bombay by stages. We advised

a change over to the heavy grade over a period of three years lest an immediate stoppage of the production of light variety raise difficulties for those manufacturers who have been accustomed to produce it for the past several decades. Also it would give the Government of India and the Government of Bombay time to introduce suitable legislative measures to bring to an end the sale of salt by measure whether wholesale or retail. As a first step, we had, therefore, recommended that the Salt Department should insert a suitable clause in each licence by which Government would have the right to determine and regulate the varieties of salt to be manufactured in the works in Bombay Province. At the time of our visit in 1948, the production of the heavy variety of salt in Bombay was reported to be only 30 per cent. of the total production. We, therefore, suggested that from the 1948-49 season those manufacturers who produced the light variety should not be permitted to produce more than 50 per cent. of their production of the light variety. In the subsequent season, the proportion of light salt should be reduced to 25 per cent. and by 1950-51 no light variety should be permitted to be produced at all. In order to keep a watch over the progress achieved, we had further suggested that the Salt Department should collect quarterly figures of production of the different varieties from all the works in Bombay for periodical examination and review. We are glad to record that the Government of India accepted these recommendations and directed the Salt Department to enforce this regulation from the season 1948-49. Unfortunately, however, this enforcement has not been as effective as we should have wished it to be, though the overall result has led to an increase in the production of heavy variety in 1948-49 from 30 to 44 per cent, as will be seen from Table LXII.

TABLE LXII—PRODUCTION OF DIFFERENT VARIETIES OF SALT IN BOMBAY  
1948-49

Range	Heavy		Light		Total		Heavy (percent)	Light
	Tons	Mds.	Tons	Mds.	Tons	Mds.		
(a) Dharasana	26,150	7,12,000	..	..	26,150	7,12,000	100	
(b) Maroli	810	22,000	220	6,000	1,030	28,000	79	21
(c) Bassein	..	..	51,210	13,94,000	51,210	13,94,000	..	100
(d) Rai	24,500	6,67,000	31,410	8,55,000	55,910	15,22,000	44	56
(e) Dadar	2,390	65,000	13,700	3,73,000	16,090	4,38,000	15	85
(f) Bhandup	4,300	1,17,000	11,280	3,07,000	15,580	4,24,000	28	72
(g) Trombay	6,470	1,76,000	18,180	4,95,000	24,650	6,71,000	26	74
(h) Belapur	8,410	2,29,000	16,420	4,47,000	24,830	6,76,000	34	66
(j) Shewa	37,030	10,08,000	9,550	2,60,000	46,580	12,68,000	80	20
(k) Uran	12,120	3,30,000	18,400	5,01,000	30,520	8,31,000	40	60
(m) Karanja	9,840	2,68,000	5,770	1,57,000	15,610	4,25,000	63	37
(n) Pen	3,670	1,00,000	3,050	83,000	6,720	1,83,000	55	45
(p) Shiroda	..	..	1,690	46,000	1,690	46,000	..	100
(q) Sanikatta	7,460	2,03,000	..	..	7,460	2,03,000	100	..
TOTAL	1,43,150	38,97,000	1,30,880	49,24,000	3,24,030	88,21,000	44	56



It will be observed that the proportions we had suggested for the season 1948-49 have not been complied with in Bassein, Rai, Dadar, Bhandup, Trombay, Belapur, Uran and Shiroda. In the case of Shiroda and Bassein there has been no attempt to make any heavy salt at all. At Dadar, Bhandup and Trombay ranges the production of heavy salt has fallen below 30 per cent. The directive issued by the Salt Department has been ignored in these ranges and this is unfair to the other ranges where an attempt is being made to fall in with the programme chalked out by the Department. We understand that some of the licensees have put forward a number of excuses, the most important of them being that the cyclone in Bombay in November 1948 and the heavy rains that followed it damaged the works considerably with the result that the brine did not attain the required density to produce the heavy variety. To us, this is unconvincing. In our opinion the good opportunity for making alterations to the pans for producing the heavy variety was lost whilst the damage caused by the cyclone was being repaired. Had these manufacturers conformed to the Government's instructions to make *vajni* salt, they would have obtained a higher output and made up a part of the loss caused by the cyclone. Another reason advanced by the manufacturers was that the Madras manufacturers who also produce light salt would compete in some of their own markets and they (the Bombay manufacturers) would thus lose these markets for their salt. This reason is no longer valid, because with the inauguration of the zonal system, Madras salt is not likely to compete with Bombay salt. Moreover, we had made the same recommendation for reducing the percentage of light salt in the Madras factories also, and the chances of any Madras salt coming to the Bombay markets are remote. We see no reason to change our original recommendation and we reiterate that steps should be taken to increase the quota of production of heavy salt during the years 1949-50 and 1950-51. Any modification of this proposal would merely perpetuate the fraud on ignorant consumers in addition to acting unfairly on these manufacturers who have taken steps to conform to the programme in a spirit of co-operation. No exception on any ground should be made in favour of the recalcitrant producers and the Salt Department should see that its orders are enforced and any attempt to circumvent them is penalised.

5.5 No attempt whatever is made at any of the factories to control the manufacturing operations. It is necessary that at the larger works a laboratory for carrying out routine analysis and exercise effective supervision on the operations should be set up.

## 6. Staff and Organisation.

6.1 From what we saw of the salt works in Bombay, there is no qualified technical staff to look after the manufacturing operations. There is neither a chemist nor even an Engineer. It is not surprising that the works are so badly laid out and poorly maintained. This remedy should be rectified and the works should be directed to have on their staff qualified technical man to guide the management, to control the operations and to maintain the works in good order. A small expenditure of this nature would be amply repaid by the improvement that would be achieved in the quality as well as the yield of salt.

6.2 The total number of labourers employed in the salt factories is estimated to be 11,000 of whom those employed in factories within a radius of 30 miles of Bombay city are 8,500. About 70 per cent. of the labour is imported from places in Gujerat such as Surat, Navsari, Billimora and Bulsar and belong to the *Kharwa* and *Machhi* communities. The rest of the labour is local whose daily wage is considerably lower than that of imported labour. The labourers

usually work in gangs under leaders known as *patels* or *mukadams*. The rates of wages vary considerably depending on the type of salt produced. The *patels* are paid amounts varying from Rs. 600/- to Rs. 1,600/- for the entire season. The imported labour is paid a wage which varies from Rs. 60/- to Rs. 80/- per month with an occasional bonus of about Rs. 50/- for the season. The local labourer is paid only about Rs. 30/- per month plus a dearness allowance and a bonus which brings his total wage to Rs. 54/- per month.

## 7. Cost of Production.

7.1 The Bombay manufacturers, having not furnished their figures of cost of production, we have had to depend upon the figures of overall cost furnished to us by the Salt Department. These are given in Table LXIII for the different ranges.

TABLE LXIII—COST OF PRODUCTION IN BOMBAY

	Vajni		Mapi		Kuppa		Calcutta	
	Ton	Md.	Ton	Md.	Ton	Md.	Ton	Md.
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
(a) Maroli .	40 13 3	1 8 0			47 10 0	1 12 0		
(b) Bassein .			54 7 0	2 0 0	37 6 9	1 6 0	27 3 6	1 0 0
(c) Rai .	11 1 0	0 6 6	13 9 9	0 8 0	11 14 6	0 7 0		
(d) Dadar .	61 4 0	2 4 0	61 4 0	2 4 0	54 7 0	2 0 0		
(e) Bhandup .			59 8 9	2 3 0	57 13 5	2 2 0	32 5 0	1 3 0
(f) Trombay .			40 13 3	1 8 0				
(g) Belapur .			36 7 6	1 5 6	43 4 6	1 9 6		
(h) Uran and She- wa.	11 14 6	0 7 0						
(j) Karanja .	14 7 4	0 8 6						
(k) Pen .			47 10 0					
(m) Sanikatta .	57 13 5	2 2 0						

The cost of production varies from Rs. 11-1-0 per ton (Rs. 0-6-6 per md.) in the case of Rai range to Rs. 61-4-0 per ton (Rs. 2-4-0 per md.) in the Dadar range. There is no consistent variation in the cost of one variety to the other in any of the ranges. In Dadar the cost of production of *vajni* and *mapi* is higher than of *kuppa*, while at Rai the cost of *vajni* is the lowest and of *mapi* the highest. At Maroli the cost of *kuppa* is appreciably higher than of *mapi*. The cost of *Calcutta* variety is lower than any of the other varieties.

7.1.1 It is not possible to make use of the above figures for a break-up of the cost of production, but we have produced an approximate break-up from such information as we have been able to gather from the various statements made by the Bombay manufacturers and the reports of the Salt Department. This is shown in Table LXIV.

TABLE LXIV—ESTIMATED BREAK-UP OF COST OF PRODUCTION IN BOMBAY

	Ton	Md.
	Rs. a. p.	Rs. a. p.
(a) Cost of manufacture . . . . .	21 11 0	0 12 9
(b) Ground rent . . . . .	0 6 10	0 0 3
(c) Lease money . . . . .	5 15 3	0 3 6
(d) Overheads & supervision . . . . .	3 6 5	0 2 0
(e) Maintenance . . . . .	3 6 5	0 2 0
(f) Depreciation . . . . .	0 13 7	0 0 6
	35 11 6	1 5 0

The figure of lease money has been computed by us at Rs. 5-15-3 per ton (Re. 0-3-6 per maund) on an average. It has been reported that it varies between Rs. 2-6-0, to Rs. 23-13-0 per ton (Re. 0-1-6 to Re. 0-14-0 per maund). At one of the Government works in the Dadar range the lease money was stated to be Rs. 50,000/- per annum for an estimated production of 3,670 tons (1,00,000 mds.); the incidence of cost on this account for these works comes to Rs. 13-10-0 per ton (Re. 0-8-0 per md.). If the average figure taken by us for lease money is considered low and is replaced by a higher average figure of Rs. 8-8-0 per ton (Re. 0-5-0 per maund), the cost of production ex-works would not exceed Rs. 38-4-3 per ton (Re. 1-6-6 per maund).

7.2 In Table LXV is shown the incidence of labour cost on salt produced in the different ranges near Bombay. Side by side is also given the percentages of production of the light and heavy varieties in each of these ranges.

TABLE LXV—INCIDENCE OF LABOUR COST IN BOMBAY

	Per ton Rs. a. p.	Per md. Rs. a. p.	Varieties	
			Heavy (Percent)	Light
<b>Bhyandar :</b>				
Maroli . . . . .	10 3 4	0 7 0	79	21
Bassein . . . . .	16 5 6	0 9 7		100
Rai . . . . .	10 3 4	0 6 0	44	56
Dadar . . . . .	23 13 0	0 14 0	15	85
<b>Bhandup :</b>				
Bhandup . . . . .	12 13 6	0 11 8	28	72
Trombay . . . . .	13 9 9	0 8 0	26	74
Belapur . . . . .	27 1 10	0 13 0	34	66
<b>Uran :</b>				
Shewa . . . . .	6 12 10	0 4 0	80	20
Uran . . . . .	6 6 0	0 3 9	40	60
Karanja . . . . .	10 3 4	0 6 0	63	37
Pen . . . . .	14 15 6	0 8 9	55	45

The incidence of cost of labour varies widely from place to place and is uniformly higher in the ranges which produce either the light salt only or preponderantly this grade. Had we been able to secure the break-up of cost of production of at least the bigger units in Bombay we could have examined this aspect of the question in greater detail. While we realise that a number of variants may affect the incidence of labour cost, the strikingly higher rates found in the ranges where the major part of the production is of the light variety points to the conclusion that much more time and labour are required for the production of this variety. This extra and unnecessary cost could be reduced considerably by eliminating the production of the light variety. The system of piece-work employed in Kathiawad factories might be also profitably copied. According to Mr. Shende the output per man per month in the Bombay works comes to only 3.67 tons (100 mds.) which is considerably lower than the output given for labour in Kathiawad where the highest estimated figure is 16 tons (436 maunds) and the lowest 10 ton (272 maunds). The adoption of the piecework system in one form or another will help to secure more efficient output per man hour.

7.3 The cost could also be reduced if the manufacturers were to consider using simple labour saving devices. Provision of trucks and trolleys for moving the salt from the pans to the storage yards would bring about an immediate reduction. At present, there is not a single factory in Bombay where these devices are used. In the first instance, they should be tried out in the larger works, because it will be purposeless to adopt them in the small uneconomic units until they are coalesced into bigger working units.

## 8. Sales and Distribution.

8.1 We did not receive any information about the selling price of salt from the manufacturers. The only authentic information that has been supplied to us is that the selling price in the various markets in and around Bombay City is about Rs. 57-13-6 per ton (Rs. 2-2-0 per md.). In Table LXIV we have estimated the average cost of production at Rs. 35-11-6 per ton (Rs. 1-5-0 per md.). To this has to be added the cost of transport charges from the works which may be taken at Rs. 3-6-6 per ton (Re. 0-2-0 per md.) and a cess of Rs. 3-6-6 per ton (Re. 0-2-0 per md) and another Rs. 3-6-8 per ton (Re. 0-2-0 per md.) for brokerage. These figures are all on the liberal side and the overall cost of salt to the manufacturers would not, therefore, be more than Rs. 45-15-0 per ton (Rs. 1-11-0 per md) which leaves a margin of Rs. 14-11-6 per ton (Re. 0-7-0 per maund) as profit to the manufacturers. We consider that the selling price of salt in the Bombay area calls for a more detailed scrutiny and revision by the Salt Department, as the profit made by the manufacturers is on the high side.

## 9. SUMMARY OF RECOMMENDATIONS.

### (a) Dharasana Circle

(i) The areas of the reservoir, condenser and crystalliser at the Chharvada and Dharasana salt works should be redistributed as follows:

	Chharvada. Acres	Dharasana Acres	
Reservoir . . . . .	240	145	
Condensers . . . . .	320	195	
Crystallisers . . . . .	90	55	
Bunds, storage,—platforms, etc. . . . .	40	25	(3.2.1)
	<hr/> 690	<hr/> 420	

(ii) The Dharasana and Chharvada works should adopt the multiple irrigation system and for this purpose the officer in charge of the works should visit the neighbouring factories in Kathiawad to study the methods adopted there (3.2.2.)

(iii) The method of manufacture should be improved to yield a better quality of salt. (3.2.4)

(iv) No extension of the Dharasana factory should be undertaken until after the increased production which would result from the relaying of the two works finds a ready market. (3.2.5)

(v) Mechanical devices like pumps for lifting brine and tipping wagons drawn by locomotives on 2 ft. gauge tracks should replace the operations at present carried out by manual labour. A railway siding should also be provided from the works to the Railway station of Dungari. (3.2.6)

(vi) The cost of different items of manufacture should be maintained in order to fix the price payable to the Agarias. In fixing the sale price of the salt, depreciation of the salt works and the buildings should also be taken into account. (3.2.8)

### (b) Bhayandar Circle

(i) The works in the Bassein Range should be remodelled in accordance with our recommendations in the Chapter on Model Factories and Research Stations. The shortage of brine supply which is experienced by the works in this range should also be remedied. (3.3.2)

(ii) The works in the Dadar Range also need remodelling. The silt from the creek should be taken out and the impediments in the flow of brine be removed. (3.3.4)

(iii) The practice of leasing out Government salt works to private parties should be stopped and these works should be run departmentally and converted to serve as model factories for the other works in the ranges in which they are situated. (3.3.6)

### (c) Uran Circle

(i) The manufacture of edible salt at Moti Works in the Shewa range should be improved by taking the following steps:—

(a) the practice of mixing dilute brine with concentrated brine to prevent salt crystallising out prematurely should be stopped;

(b) the use of sprays meant for rapid evaporation of the brine should be given up;

(c) the continuous agitation of the brine in the cement pans to produce small crystals of salt should be discontinued. The use of cement pans is unnecessary and expensive and ordinary pans with clay beds should be adopted. (3.5.2 and 3.5.3)

(ii) The seven Government-owned works at Shiroda are too small to be operated as economic units. They should be either sold to the owners of the adjoining privately owned works or formed into a co-operative society with the remaining nine privately-owned works and operated as a single unit. (3.5.6)

(iii) As there are a large number of licensees at Sanikatta and the area of the individual works is extremely small, the licensees should form themselves into a co-operative society and all the works operated as a single unit, if they are to survive competition. (3.5.7)

## (d) General

(i) The areas under salt cultivation in all circles other than Dharasana should be redistributed in the ratio of 1 : 7 to obtain a much larger production. (5.1)

(ii) The method of manufacture should be modified in all the Bombay works and should be followed as indicated in paragraph (5.2)

(iii) The small manufacturers in Bombay should make serious attempts to coalesce into a large unit if they are to survive competition from the larger factories and continue in business. In order to induce the manufacturers to do so, to manufacture salt for such coalesced works licence should be granted for a minimum period of 25 years. (5.3 and 5.3.1)

(iv) The manufacture of light grade salt should be progressively reduced and no light variety should be manufactured from the season 1950-51. The restriction should be strictly enforced and any manufacturer who does not conform to the instructions of the Salt Department should be penalised. In the meantime steps should be taken to enact legislation prohibiting the sale of salt by measure. (5.4.2)

(v) At the larger works control laboratories should be set up to control and guide the manufacturing operations. (5.5)

(vi) Incidence of cost of labour is high. This is due to the fact that the output per man per month comes to only 3.67 tons (100 mds.) as compared with 10 tons (272 mds.) which is the lowest in Kathiawad factories. The system of piecework employed in Kathiawad factories should, therefore, be tried out to obtain a higher output at a lower cost. (7.2)

(vii) Simple labour saving devices particularly trucks and trolleys for moving the salt from the pans to the storage yards should be introduced in the first instance in the larger works. (7.3)

(viii) The selling price of salt in Bombay should be scrutinised by the Salt Department and lowered, if possible, as the profit made by the manufacturers at present appears to be on the high side. (8.1)

## CHAPTER XIV

### TRAVANCORE

#### 1. Description.

1.1 Although salt has been manufactured in Travancore for a long time, manufacture on large scale started only 14 years ago. Until 1936, Travancore made only about 5,500 tons (1,50,000 maunds) of salt which did not meet the entire demand of the State and the balance of its requirement of about 18,000 to 26,000 tons (about 5 to 7 lakh maunds) was imported from Goa, Bombay and Madras. Since 1936 however, owing to the encouragement which the Travancore Government gave by controlling imports into the State and the sustained efforts made by the manufacturers to build up the industry, there has been a rapid rise in production and Travancore is today not only self-sufficient but is in a position to export salt to other parts of the country. Salt is manufactured in the southern part of the State in the Nagercoil District on a coastline of 17 miles between Colachel to the north and Cape Comorin to the south. Climatically, Nagercoil District is well suited for salt manufacture. The rainfall varies from 16 to 36 in. in the year and the rains occur in two periods, owing to the two monsoons.

1.2 In the days of the British Government in order to protect the revenue from salt duty, it was a common practice to put restrictions on the movement of salt made in an Indian State. Travancore salt was thus prevented from being sent out of the State. This restriction acted as an impediment when the Travancore salt industry began to produce salt in excess of its domestic requirement. Various means had, therefore, to be devised by the Government of Travancore to restrict the production by either reducing the period of manufacture and/or by introducing a quota system for sales by which only a portion of the production in each factory was permitted to be sold.

#### 2. Manufacturing Rights.

2.1 The Travancore Government lease out sites for the manufacture of salt for a fixed period which is generally 50 years. A ground rent of Re. 0-6-0 per acre is levied from some factories and in addition the factories have to deliver to the Government a stipulated quantity of salt, varying between 20 and 40 per cent. of the estimated output, at a minimum price of Rs. 4-4-0 per ton (Re. 0-2-6 per maund). The price paid at present by Government is Rs. 4-11-0 per ton (Re. 0-2-9 per maund). The Travancore Government gave virtually a protection to the salt industry by (a) progressively shutting out imports of salt into the State from other sources and (b) fixing for the indigenous salt a comparatively high selling price of Rs. 34 per ton (Rs. 1-4-0 per maund). This price was suggested by the Government of India to protect their revenue from Travancore salt finding its way into the former British Indian territory and was based on what it would cost the Tuticorin salt to be delivered at the Travancore border. As no stipulation was made by the Travancore Government regarding the quality of salt produced, most of the manufacturers have made no attempt whatever to produce a good quality salt. The policy of fixing a high price has, therefore, created for the manufacturers a state of monopoly and led to a considerable degree of complacency in them. The lack of competition has stood in the way of improvement in the quality or output of salt at these works.

### 3. Manufacturing Process.

3.1 The manufacture is entirely by solar evaporation and sea brine or high density brine obtained from pits and tube wells is used. There are altogether 19 factories, covering an area of about 1,400 acres. The manufacturing season is divided into two periods, the first and longer, commencing about the middle of December and continuing till the end of May and the second and the shorter period beginning by the end of July and ending in the middle of October. Although there is a break in the manufacturing operations, Travancore has a period of about 8 months for salt production which compares favourably with the manufacturing season in Bombay and other areas. We visited a number of these works and held discussions with the manufacturers as well as the Government of Travancore. As most of the works have been established in recent years we consider that they could have been laid out better to produce good salt. A single factory is often worked by a number of licensees, each trying to make salt independently of the other in an area of a few cents instead of operating it as a single unit or on a co-operative basis. This has led to the manufacturing operations being frequently left in the hands of illiterate labourers who adopt primitive methods of manufacture and produce salt of poor quality. The area under salt cultivation is shown in Table LXVI together with the ratio of the area under crystallisers to the reservoir plus condensers.

TABLE LXVI—SALT WORKS IN TRAVANCORE.

	Reser- voir	Con- den- sers	Crys- tal- lisers	Total	Ratio of crystal- lisers to re- servoirs and con- densers	Yield per acre Average of 1946-48		Num- ber of licen- sees
	Acres	Acres	Acres	Acres		Tons	Mds.	
<b>A. West Coast :</b>								
(i) Colachal	17	19	19	55	1 : 1.9	22	600	3
(ii) Kovalam	13	17	17	47	1 : 1.7	67	1,830	5
(ii) Thamaracolam (Manakudi lake)	181	239	239	659	1 : 1.8	75	2,040	215
<b>B.—East Coast :</b>								
(Cape Comorin)								
(i) Palkulam	10	12	12	34	1 : 1.8	72	1,970	1
(ii) Thattarippuodai	..	11	3	14	1 : 3.9	76	2,070	1
(iii) Variyoor	5	2	2	9	1 : 3.5	28	780	3
Total	226	300	292	818	Average	71	1,920	228

The works at Colachal, Kovalam and Cape Comorin are all situated on the coast, whilst the Thamaracolam works are on the banks and reclaimed basin of the Manakudi Lake which was at one time a part of the sea. It is now cut off by a sand bar and formed into an inland lake into which the flood waters from the southern most tip of the Western Ghats flow.

3.2 Formerly the saline water of the lake was mainly used for the manufacture of salt. Its salinity is due to its past connection with the sea and the saline soil which occurs at shallow depths. The flood waters, however, have progressively reduced the salinity of the lake. Immediately after the floods the water in the lake is almost fresh and later in the season its density



rises to only about 2.5°Be'. The use of brine pits and of tube wells which have been sunk in some of the more progressive factories for tapping the subsoil brine of about 6° to 7°Be' have led to the abandonment of the use of the lake water for the manufacture of salt. Another reason for its abandonment is its constant fouling by the bitters either discharged by the factories directly into it or left behind in the crystallising pans and taken up by the flood waters during the monsoon. This has resulted in progressively increasing concentration of magnesium chloride salts in the brine and making it unfit for salt manufacture.

3.2.1 If the brine of the lake is to be continuously used for the economic manufacture of salt, the bar mouth would have to be kept open and a central channel would have to be dug in the lake basin to permit sea water to enter the lake. The opening of the bar mouth, however, will entail a high annual recurring expenditure. In the case of many of the works on the lake, the sea is not far off and for the supply of brine two proposals are under the consideration of the Government of Travancore and Cochin, viz. (a) to dig two channels from the sea on either side of the lake up to the salt works or (b) to pump the brine directly from the beach. If the Manakudi brine is not to be used in future, and the brine is to be obtained from the sea, the discharge of the bitters into the lake may be permitted. Normally, we would not have supported this practice and would have suggested that the bitters be discharged into the sea by means of separate channels, but as the Manakudi lake is of doubtful utility as a source of brine we do not wish to see an unnecessary expenditure being incurred on the digging of the bitters channels to the sea. We recommend that an early decision be taken by the Union Government on the two proposals before them.

3.3 TUBE WELLS—In the larger works on the Manakudi lake, brine of a higher density is obtained from pits and tube wells. The method of tapping the subterranean source of brine below a depth of 60 ft. is a new feature in salt manufacture and especially advantageous in areas where dilution of the brine during the rainy season is common. The brine from the pits or tube wells varies in density from 4° to 8°Be'. The pits are dug 6 to 8 ft. deep but, in the case of the tube wells, the depth reached varies from 60 to 180 ft. The density of brine in the tube wells at a lower depth was reported to be higher than at the top. This is quite understandable, because the higher density brine would sink to the bottom. The rest level of the brine in some of the wells was only about 15 to 20 ft. below the ground level, but brine was being drawn from lower depths to obtain higher density. Although the initial capital cost of sinking a tube well may be high there is a distinct saving in the cost of manufacture from high density brine as the yield of salt will be higher for the same volume of brine lifted and the cost of maintaining the condensing area will be less than in works which use weaker brine. For constructing a tube well, a small well 5 ft. in diameter and going to a depth of about 18 to 24 ft. is first dug. This well is lined with cement concrete rings and its bottom is provided with a cement concrete floor. A tube is then sunk to a depth of 60 to 160 ft., depending upon the supply and density of brine, and it is allowed to project 1 or 2 ft. above the cement floor of the well. The diameter of the tube varies from 4 to 5 in. and the brine is drawn by means of centrifugal pumps driven by diesel engines. The suction pipe of the pump which is 2½ to 3 inches in diameter goes into the tube well to a considerable depth. As galvanised iron tubes are used in the wells, they get corroded in about 2 to 3 years and when this happens the tube wells are abandoned and fresh wells are sunk. It is possible that the brine yielding capacity of these wells is still considerable, but by abandoning them every two years or three years unnecessary expenditure is being incurred which could be avoided by using monel or high silicon iron tubes, as used in America and other countries for sinking brine wells in rock salt mines. The Travancore manufacturers might be asked to examine this suggestion and try it out.

3.3.1 As stated in the previous paragraph, in some of the tube wells the rest-level of the brine was at a depth of 15 to 20 ft. from the ground surface. This would suggest that semi-artesian conditions are being created and the supply of brine is more than what could be utilised by the factories. In many of the factories we noticed that small lessees had their own individual engines and pumps which were only worked for short periods of a few hours each day; furthermore, the delivery pipes of the pumps were much higher than what was actually required. In one place we noticed that the brine was being lifted to a height of 20 ft. and dropped 8 ft. at the delivery end. A proper survey of the levels of the works should be carried out and the height of the delivery pipes adjusted to the minimum actually required by the contours of the factory lands. This will obviate unnecessary lifting of brine and reduce the pumping cost. When a copious supply of brine is being left unutilised, the individual small lessees should not be allowed to install their own pumps and engines. Instead a common arrangement for the supply of brine should be set up. A single pump unit working full time is likely to supply all the brine that is necessary to a number of these small lessees, instead of several pumps working only part time. This will help to lower the cost of production and at the same time release many of the pumping sets which otherwise lie idle for the greater part of the day, for use elsewhere. This reform is very necessary and should be enforced as early as possible.

3.3.2 It was reported to us that a number of tube wells had gradually deteriorated in volume and density of brine. No particular reasons were advanced for this deterioration nor has any investigation been made to find out its cause. A likely reason for this phenomenon is that the wells, having been located without proper hydrographical survey, may have been sunk in an area which is not suitable for a constant and copious supply of brine. In some respects, the experience with regard to Travancore tube wells is similar to that of the wells in Kharaghoda where after some years they have to be abandoned owing to reduction in the supply of brine. We recommend that a proper hydrographical survey be conducted to locate good sources of brine, to avoid in future the sinking of wells in a haphazard fashion as at present, and to their more widespread adoption by factories which do not use this method.

3.4 Salt is manufactured by the single irrigation system. Where the tube wells are in use, no reservoir is necessary and brine is taken directly into the condensers from where brine of 14°Be is charged into the crystallisers to a depth of 2½ to 3 inches and allowed to concentrate till the level of the brine has fallen to ½ inch. As in the Madras factories, the condenser is known as the male pan and the crystalliser the female pan. They are equal in area and in consequence the crystallising area is in excess of what is actually required and is responsible for the low density brine being fed into the crystallisers. When a crust of ¼ inch is formed, the pans are raked with wooden scrapers and the salt is heaped on the ridges of the pans to allow the mother liquor to drain off. From the ridges salt is transferred to a drying platform where, in accordance with the rules of the Travancore Salt Manual, it has to remain for a minimum period of three months. This is necessitated by the fact that it takes at least this much time for the magnesium salts present in common salt to sweat and drain out before storage. From the drying ground the salt is transferred to a storage platform where after weighment it is made up into heaps of about 44 tons (1,200 maunds) each and thatched with palm leaves for protection against rains. Before issue, salt is again weighed. The bitterns are not eliminated regularly. In some factories there are no separate channels for draining them out with the result that they get mixed up with the incoming brine and contaminate it. In other words the bitterns drain into the Manakudi lake where they again get mixed up with the brine. In some of the works, where the bitterns are not eliminated, they have soaked into the crystalliser

beds, and owing to the presence of a large percentage of magnesium salts, picked up by the brine from the beds, the deposition of salt sometimes does not take place, even when the brine has reached a density of 30° Be'. In such cases, the crystallisers, before the commencement of the season and when the pans are under water, have to be not only re-aligned but rejuvenated by a leaching process with dilute brine to purge them of their magnesium salts.

#### 4. Annual Production and Quality.

4.1 The quantity of salt produced in Travancore during the three years 1946-48 is shown in Table LXVII.

TABLE LXVII—PRODUCTION OF SALT IN TRAVANCORE 1946—48

	1946		1947		1948	
	Tons	Mds.	Tons.	Mds.	Tons.	Mds.
<b>A. West Coast</b>						
(i) Colachel	1,620	44,000	660	18,000	1,400	38,000
(ii) Kovalam	3,890	1,06,000	1,620	44,000	4,600	1,09,000
(iii) Thamaraculam	56,760	15,45,000	39,860	10,85,000	51,540	14,03,000
<b>B.—East Coast :</b>						
(i) Palkulam	3,010	82,000	1,620	44,000	2,790	76,000
(ii) Thattarippudai	1,430	39,000	700	19,000	1,100	30,000
(iii) Variyoor	260	47,000	180	5,000	290	8,000
<b>TOTAL</b>	<b>68,970</b>	<b>18,23,000</b>	<b>44,640</b>	<b>12,15,000</b>	<b>61,120</b>	<b>16,64,000</b>

4.2 The analyses of samples of salt drawn by the Committee from some of the Travancore works are given in Table LXVIII.

TABLE LXVIII—COMPOSITION OF TRAVANCORE SALT

(Percent ; on dry basis)	
Sodium chloride	84.71 to 95.91
Calcium sulphate	3.06 to 0.04
Magnesium sulphate	2.21 to 0.73
Magnesium chloride	2.24 to 1.59
Insolubles	6.02 to 0.33
Undetermined	1.76 to 1.40
	100.00    100.00

It will be noticed that there is a considerable variation in the quality. In the older factories the sodium chloride content goes as low as 84 per cent., whilst in some of the newer factories because of the care they take, and also because they have partially adopted the practice followed at the Model Factory in Travancore, to which reference is made in subsequent paragraphs it has been

possible to reach 96 per cent. sodium chloride content. According to the Travancore Salt Manual, which is largely based on the lines of the Madras Manual the concentration of the brine in the crystalliser should not exceed 30° Be' and salt containing less than 90 per cent. sodium chloride should be destroyed. These rules are, however, honoured more in the breach than in the observance and had they been rigidly enforced the quality of the salt produced at Travancore would have been considerably purer. The chief impurities in the salt consist of gypsum, magnesium chloride, magnesium sulphate and insoluble matter like clay which could be eliminated to a great extent if care is taken to charge the crystallisers with brine at 23° Be' and the density in the crystallisers is not allowed to go above 29° Be'. In 3.4, we have mentioned that in some of the older factories the crystallising beds are soaked with magnesium salts and if they could be leached out the quality of salt produced in them could be considerably improved. It was formerly believed that the low quality of salt produced in these factories was due to the poor quality of brine. but we were informed by the Department of Research of the Travancore University that by actual manufacturing operations they conducted in some factories, demonstrated that the defect lay only in the beds and not in the brine. This defect was remedied by a simple process of leaching the pans and reviving them to produce salt of good quality. We are satisfied that with reasonable precautions Travancore which has all the natural facilities to produce salt by solar evaporation, of as good a quality as is produced anywhere else in India can produce salt.

## 5. Model Factory.

5.1 The Travancore State established in 1946 a small experimental research station to serve as a demonstration centre to the salt manufacturers of Travancore. This Model Factory works under the direction of the Research Department of the University of Travancore and was founded by the enthusiasm and foresight of the then Director of Research of the University. The factory forms a part of Thattarippudai Allom (*allom* is the local name for salt factory) and covers an area of 8 acres. It has been well laid out and the areas under reservoirs, condensers and crystallisers are properly distributed, but being small it is uneconomical for operations and cannot be regarded as a model in all respects.

5.2 The brine is obtained directly from the sea by a cast iron pipe line connected to a well which fills with the tide. From the well the brine is pumped into a reservoir. As no provision is made for an automatic flushing of this well, it tends to get filled up with sand which is brought along with brine and it has, therefore, to be cleaned frequently at considerable expense. The density of the brine is carefully regulated, which permits of the separation of the gypsum in the condensers before the brine reaches the crystallising pans; at the end of each season the gypsum is collected from the crystallisers for sale. A novel feature of the factory is the provision of what are known as slush washing pans which are located adjacent to the crystallising pans and through which concentrated brine is led into the crystallisers. The purpose of these pans is to wash the slush which is periodically removed from the crystallisers. This slush is heavily charged with crystals of sodium chloride, and not being sufficiently plastic to be used over again in the crystalliser, it is put into the slush pans where it is washed by the condensed brine. The small crystals of salt get leached out by the incoming brine and the plasticity of the clay is revived, thereby making it fit for use again for re-lining the crystalliser beds on subsequent occasions. The crystallising pans are charged with brine at 23° Be' to a depth of 2½ inches and the brine is allowed to concentrate to a density of 28° Be'. When a crust of about ¼ inch is deposited, the bitterns are drained out completely. The pans are then charged afresh

with concentrated brine at 23° Be' and the crust of salt is washed in this brine before lifting. It is claimed that by adopting this technique, the crystals are washed free of the bitterns and the liquor which remains attached to them is not so heavily charged with magnesium salts as it would if the crop were harvested with the original mother liquor of 28° Be' in the pans. The salt harvested from the pans is allowed to drain on the ridges for a period of two to three days after which it is conveyed for storage.

5.2.1 The 28° Be' bitterns are led into a second set of crystallisers for separation of crude salt between 28° and 32° Be'. The crude salt is either thrown back into the condensers or washed in cement pans with 23° Be' brine to free it from magnesium salts. By this washing the sodium chloride content of the crude salt is raised from 91 to 94 per cent. and it could be raised even higher if a more thorough washing by mechanical means were adopted. After the deposition of crude salt, the bitterns of 32° Be' are taken to a separate crystalliser for the recovery of magnesium sulphate by solar evaporation. No attempt has been made to recover the other byproduct *viz.*, magnesium chloride, but, in view of the small size of the factory, we can well understand this as it would need the use of artificial heat, which would be uneconomical.

5.3 The production at the factory for the year 1946-47 was about 320 tons (8,680 maunds) and for 1947-48, 655 tons (17,800 maunds). The production in the first year was naturally low, but the increase that has occurred in 1947-48 shows what improvement is possible by a proper layout. The yield would have been much higher if this factory, like the other factories in Travancore, could obtain tube well brine instead of sea brine.

5.4 The quality of the salt produced in the Model Factory is excellent and is suitable for the Bengal market. This will be seen from Table LXIX giving the analysis of a sample of salt drawn by us from the Model Factory. The Table also shows the analysis of salt, after washing it with 23° Be' brine, in cement pans.

TABLE LXIX—COMPOSITION OF SALT FROM THE MODEL FACTORY.  
(Per cent : on dry basis)

	Unwashed salt	Washed salt
Sodium Chloride . . . . .	97.86	99.08
Calcium sulphate . . . . .	0.27	0.16
Magnesium sulphate . . . . .	0.58	0.23
Magnesium chloride . . . . .	0.90	0.29
Insolubles . . . . .	0.10	0.21
Undetermined . . . . .	0.29	0.03
	100.00	100.00

The Model Factory serves to demonstrate the correct method to be employed for producing good quality salt. Unfortunately much advantage of this centre has not so far been taken by the salt works in Travancore. One of the Madras manufacturers, *viz.* the Mettur Chemical Works Ltd. have however, relaid their works at Adirampatnam in the Tanjore District, on the lines of the Model factory, and have benefited both in increased output and improved quality as compared with the factories adjacent to them where traditional methods of manufacture are still pursued. The reluctance of the Travancore manufacturers to make a change in their practice is due to.

(a) the low standard of purity (90 per cent. sodium chloride content) which has been prescribed for salt in the Travancore Salt Manual;

(b) the uniformly high ex-factory price fixed for sale of salt without any regard to its quality, and

(c) the production of heavy variety of salt by the method adopted at Model factory. This is not favoured by the manufacturers who prefer to produce the light variety in order to make a large profit on sale of salt by measure.

5.5 During our discussion with the Government of Travancore it was suggested that the Model factory should be run jointly by the Government of India and the Government of Travancore on an expenditure sharing basis. The factory has hitherto been financed by the Government of Travancore and worked under the direction of the University of Travancore. In our Interim Report, we had recommended that the factory be converted after suitable expansion into a research centre for carrying out investigations on the best methods of manufacturing salt under different operating conditions and furthermore that, pending an agreement with the Government of India, the Travancore Government should continue to finance and maintain it. Since the Salt Administration in the Indian States and Unions is to be taken over by the Government of India from 1st April 1950, the question of joint responsibility does not seem to arise. If the Travancore Government is to divest itself of its jurisdiction over salt administration, it is a moot question whether it would be interested in continuing to maintain and finance the model factory. The future of the factory is, therefore, to some extent uncertain. As we recognise the useful work that has been done by the factory we have no hesitation in recommending to the Government of India that they should take over the responsibility of running it and relaying it on an extended scale, on a new site, as recommended by us. The advantages of having model station in Travancore in preference to establishing one at Tuticorin are that:

(a) the conditions of manufacture are more varied in Travancore than in Tuticorin; and

(b) Travancore has the advantage of getting the benefit of technical and scientific assistance from the Department of Research of the University of Travancore who have all the basic and fundamental data on the layout and method of working such a factory.

## 6. Improvements and Extensions

6.1 The production in Travancore can be increased considerably by proper care in the method of manufacture and redistribution of the area under salt cultivation as mentioned in 6.2. One or two factories in Tamaracolam which use tube well brine have reached a yield of 144 tons (3,920 mds.) per acre. In other factories it is as low as 33 tons (900 mds.) per acre, so that the average for this locality comes down to 75 tons (2040 mds.). In the factories using sea brine the yield at Variyoor of 28 tons (780 maunds) per acre is very low as compared with a factory like the Thattarippudai factory which uses sea brine and the yield of which is reported to be as high as 76 tons (2,070 maunds) per acre. This yield is better and is higher than the yield obtained in Kathiawad and Kutch factories. It has, however, to be remembered that in Travancore factories no areas are, provided for the reservoirs, even in factories like Thattarippudai which use sea brine, whereas in Kathiawad and Kutch large areas are set apart for reservoirs. If those areas are not taken into account the yield in Kathiawad will go up to 100 tons per acre. We consider that the yield in Travancore, on the whole, is low considering the availability of high density brine to many of the factories. It should be possible to increase the overall yield in all the works as under, depending upon the quality of brine used.

Density of brine	Yield per acre	
	Tons.	Mds.
(a) 3½° Be' (Sea brine) . . . . .	80	2,140
(b) 4° to 6° Be' (Pit brine) . . . . .	120	3,270
(c) 6½° to 8° Be' (Tube well brine) . . . . .	150	4,080

The figure in the case of sea brine is calculated on the assumption that no area is set apart for reservoirs. If however an adequate reservoir area is provided the yield per acre for factories using sea brine should be reduced to 60 tons (1,630 maunds), per acre. On the basis of the above figures the production in Travancore can be increased to over 1,00,000 tons (27,22,000 mds).

	Tons	Mds.
(i) From 104 acres in the four factories of Kovalam, Palkulam Thattarippu- odai and Varyoor using sea brine @ 80 tons per acre. . . . .	8,320	2,26,470
(ii) from 714 acres of the remaining factories using pit and tube well brine @ the mean figure of 135 tons per acre. . . . .	96,390	26,23,736
Total . . . . .	1,04,710	28,50,206
or say . . . . .	1,00,000	27,22,000

6.1.1 There are two factors which have deterred the Travancore manufacturers from increasing their production. The first is, that the production in Travancore is about 55,100 tons (15 lakh maunds) but as much as 73,500 tons (20 lakh maunds) has been produced in previous years. Owing to the difficulties of finding an export market and consequential accumulation of stocks the production in recent years has had to be curtailed to approximate the internal consumption. It was reported to us that in 1948 the Travancore Government had over 1,00,000 tons (27.22 lakh maunds) in stock. The second factor is the absence of healthy competition both internal and external which has stood in the way of the manufacturers making any serious attempt to improve their output. In our opinion, the present selling price of the salt fixed by the Union Government at Rs. 34 per ton (Rs. 1-4-0 per md.) irrespective of the quality should be reduced to the level of the price of Tuticorin salt. Unless this is done, and inefficient methods are eliminated, not only will it be difficult for the surplus Travancore salt to find an outlet which it so badly needs, but the cheaper salt produced elsewhere may begin to find its way into Travancore. With the union of Cochin State with Travancore, the Travancore manufacturers have now the advantage of supplying 13,000 tons (350,000 maunds) of salt to Cochin also. A further additional outlet can be found in south Malabar which at present receives salt from Bombay at a lower rate than Travancore can supply it, despite the fact that conditions for salt manufacture in Bombay are less favourable than those in Travancore. The deterrents in the way of the manufacturers would no longer apply if they were to produce salt to the extent of maximum yield per acre, and make a determined bid by reducing their profits to capture the South Malabar markets which are so easily accessible to them by water.

6.2 The practice of feeding the crystallisers with 14° Be' is undesirable because it leads to the separation of the gypsum in the crystallisers along with salt thus introducing an impurity which can be easily avoided. We recommend that steps be taken to modify this practice and to see that no brine is fed into the crystallisers until it reaches a density of 23° Be'. For this to be made possible a readjustment in the existing crystallising area will be necessary and at least 50 per cent. of the area should be converted into condensers. This will apply only where tube well brine of about 8° Be' is available. Where brine of 4° Be' or lower density is used the area under crystallisers should be reduced to 30 per cent. of the present area.

6.3 The bitterns should be discharged more frequently than is done at present and should not be allowed to mix up with the incoming brine. Under the rules and instructions of the Travancore Salt Act the manufacturers are required to empty the crystallising pans of the bitterns after every fifth scraping. These instructions have been modified and the discharge of the bitterns is now to be effected after every third scraping. As no advantage accrues by leaving over the bitterns of one scraping for succeeding evaporations, we recommend that these instructions should be further modified and it should be made obligatory on the manufacturers to discharge the bitterns after every scraping. When this is done, the crystalliser beds will be protected against unnecessary contamination with magnesium salts and the quality of salt will also greatly improve. If the contamination with the magnesium salts were reduced in the stage of the crystallisation and lifting, the long period of drying could be rendered unnecessary. Salt can then be heaped and stored straightaway from the ridges in the crystallisers after a preliminary draining for three or four days.

6.4 The double weighing of salt is unnecessary, wasteful of labour and leads to admixture with more sand and clay during handling. When salt is stored into heaps its weight can be estimated from its cubical content and only one weightment at the time of removal for sale is all that is necessary.

6.5 Another step is to adopt the multiple irrigation system during the longer period of the manufacturing season. At present the salt is manufactured in two seasons, the longer of which lasts from December to May. During this period it is quite possible, particularly when brine of 8° Be' is obtainable from tube wells, to manufacture salt on the multiple irrigation system. By adopting this method there will be substantial improvement in its quality. We believe that Travancore has all the possibilities of manufacturing salt, by solar evaporation, of a high purity and similar to that produced in Kathiawad and Kutch. When the Bengal market is in need of good quality white salt, it should be possible for the Travancore manufacturers to produce a quality acceptable to the Bengal market. The cost of its transport to a sea port might be more than what it costs the manufacturers in Kathiawad and Kutch, but the Travancore manufacturers stand to get a freight advantage over Kathiawad and Kutch because of the shorter distance of nearly 900 miles from Calcutta.

6.6 Although the brine is transported to the well at little or no cost at the model factory it has certain disadvantages. We suggest that this method be re-examined and a cheaper arrangement evolved for obtaining the brine. Instead of pumping out the brine from the well into the reservoir it would be cheaper to pump it directly from the sea or from a channel into which sea water could flow by gravity at high tides.



6.7 The possibilities of slush pans are worth examining by salt works which adopt the single irrigation system, where the need frequently arises for removing the slush during the manufacturing season and where the clay for making the crystalliser beds has to be brought from a distance, as in Travancore. In the Model Factory, these pans have proved definitely useful, but it has to be seen how far they could be provided in the layout of large and extensive works which produce thousands of tons of salt during the season. It is a matter for consideration whether, in the bigger works, the economy effected in the recovery of salt from the slush would compensate for the introduction of this novel feature. We commend this practice for adoption, on an experimental scale by other salt works and if found satisfactory and economical it should be incorporated as a normal manufacturing process.

6.8 The Model Factory, being a small experimental station, is not an economical unit. It works under many handicaps. The soil of the factory is reported to be porous and good impervious clay has to be brought from a long distance for lining the crystallisers. Though the object of the Model factory should not be to sell salt at profit but to produce the best quality under ideal conditions, we consider nonetheless that it can be made self-supporting if it is suitably expanded to give a higher output. In our opinion, a demonstration station should cover about 100 acres and should be able to obtain sea brine and tube well brine at a cheap cost. In the case of the Model factory this can be done only by shifting it to a new site. Since the entire area of Thattarippudai Allom is not sufficiently extensive and is not ideally situated for an experimental station, the Model factory should be shifted to a site by the side of the bar mouth of Manakudi lake, near the sea, where facilities exist for working with different types of brine.

6.9 The factories at Kovalam, Palkulam, Thattarippudai and Variyoor are in our opinion below the minimum areas required to work as economic units. Since they use sea brine exclusively the area of each of these works should be extended to at least 100 acres in order that they may produce good quality salt at a competitive rate. With regard to Colachel, which uses both sea and tube well brine, the minimum area should be 75 acres. As a general principle we suggest that the minimum economic size for the Travancore factories using different types of brine should be as follows:—

(a) Tube well brine . . . . .	60 acres
(b) Pit brine . . . . .	75 acres
(c) Sea brine . . . . .	100 acres

If any factories use a mixture of sea and pit or tube well brine their size should be correspondingly adjusted depending upon the average density of the brines used.

## 7. Staff and Organisation.

7.1 At none of the Travancore factories, we found qualified technical staff of either chemists or engineers to control the manufacturing operations. Since Travancore is now a large producer of salt, it behoves the manufacturers to engage suitable technical staff in order to guide the manufacturing operations and maintain the works in good condition. As recommended for other centres, we recommend that in Travancore also analytical laboratories should be established at the larger works where routine analyses of the brine and salt could be done to control the operations. As all the works need considerable re-laying, we also recommend that the major works engage civil engineers on their staff to help them in the re-laying of their works on scientific lines.

## 7.2 The staff at the model factory consists of

(a) Superintendent	.	.	.	.	.	.	.	.	.	1
(b) Clerk	.	.	.	.	.	.	.	.	.	1
(c) Field Assistant	.	.	.	.	.	.	.	.	.	1
(d) Foreman	.	.	.	.	.	.	.	.	.	1
(e) Peons	.	.	.	.	.	.	.	.	.	2

The Superintendent is a qualified Chemist and is assisted by a junior Chemist. The Superintendent's duty, in addition to supervising the factory, consists in visiting the other salt works with a view to helping them to improve their method of manufacture. The junior Chemist attached to the factory works at the University Laboratory at Trivandrum and carries out analyses of the various products obtained in the Model factory as also the analyses of samples of salt of other works.

7.3 The labour employed in the salt works in Travancore is drawn from the neighbourhood of the factories. Some 3,000 to 4,000 men are employed. During the off-season the labour is engaged in agricultural operations. The wage of a labourer varies from Rs. 1-12-0 to Rs. 2 per day which does not compare unfavourably with the wages paid in other parts of India. Though the labour usually works on the daily rated basis, work in some of the factories is also done on a piece rate basis through *kanganis* or gang leaders, who bring their own gang of labourers.

## 8. Capital Block.

8.1. Out of the 19 factories in Travancore, 11 gave their capital cost at Rs. 34 lakhs for laying out 670 acres. The area of the remaining factories is 157 acres and on the basis of the figures furnished by the 11 factories the computed cost for the whole area of 827 acres under salt in Travancore works out to about Rs. 42 lakhs.

## 9. Cost of Manufacture.

9.1. The cost of manufacture of salt at Travancore has been given as varying from Rs. 10-14-3 per ton (Re. 0-6-5 per maund) to Rs. 20-6-9 per ton (Re. 0-12-0 per maund). Some of the manufacturers have given the break-up of their cost and for others the Excise Inspectors in charge of the factories have furnished this data. On comparing these figures we found, that some of the returns given by the Excise Inspectors were on the low side. Considering all the figures placed before us, we are of the opinion that the cost of manufacture varies between Rs. 17 per ton (Re. 0-10-0 per maund) and Rs. 18-12-0 per ton (Re. 0-11-0 per maund). The lower figure may be taken to be the average cost of salt manufactured from high density brine obtained from tube wells, whereas the higher figure is the cost of salt made from sea brine. We give in Table LXX the break up of average cost of a few factories.

TABLE LXX—COST OF PRODUCTION IN TRAVANCORE.

	Tube well brine per ton			Sea brine per ton		
	Rs.	a.	p.	Rs.	a.	p.
(a) Cost of brine including power and fuel . . . . .	4	1	4	6	12	0
(b) Labour . . . . .	6	2	0	5	7	0
(c) Maintenance . . . . .	1	14	6	1	10	0
(d) Supervision, overheads, rates, rent & taxes . . . . .	3	8	6	1	10	0
(e) Depreciation . . . . .	1	5	8	0	5	0
(f) Miscellaneous . . . . .	Nil			3	0	0
	17	0	0	18	12	0
or	0	10	0	0	11	0
	per md.			Per md.		

These figures cannot be entirely depended upon, because no itemised data of cost is being maintained, but they give a fair picture of the cost of manufacture.

9.1.1 To this will have to be added the Travancore Government's cess of Rs. 3-6-5 per ton (Re. 0-2-0 per maund) and as mentioned in 2.1 most of the factories are required to give a stipulated quantity of their production varying between 20 to 40 per cent. to the Government at a price which varies between Rs. 4-4-0 per ton (Re. 0-2-6 per maund) and Rs. 4-11-0 per ton (Re. 0-2-9 per maund). This price being much below the cost of production, the loss that the manufacturers incur on the delivery of this salt has to be distributed over the rest of their production. This increases the cost on an average by 64 per cent. The total cost of salt from the tube well brine, therefore, works out to Rs. 27-15-0 per ton (Re. 1-0-5 per maund) and from sea brine to Rs. 30-10-0 per ton (Re. 1-2-0 per maund). With the selling price of salt fixed at Rs. 34 per ton (Re. 1-4-0 per maund) the manufacturers are left with a minimum margin of profit of 11 per cent. and this might be as high as 21 per cent. On an average the Travancore manufacturers make a profit of not less than 17 per cent.

9.1.2 Whilst we do not grudge a reasonable margin of profit, we consider that there is room for reduction in the manufacturing cost in order that the salt is made available at a lower rate. As many of the salt works are owned by a large number of lessees, we had recommended in our Interim Report that the Travancore Government should take steps to consolidate the small holdings on a co-operative basis so as to permit of a better efficiency in the manufacturing operations. We would however, like to add a word of caution. After seeing the working of the co-operative salt societies in Orissa where co-operation is limited only to sales and does not extend to production, we should like to stress that any co-operative organisation that may be formed in Travancore should be broad-based enough to include co-operative working in the manufacturing operation also. The small lessees who, at present manufacture salt using separate reservoirs, condensers and crystallisers should give way to large co-operative works where common pumps, reservoirs and condensers would be provided and only the crystallisers would be tended by individual members of the co-operative organisation. Only if such a procedure is followed will it be possible to gain the objective of true co-operation and manufacture good quality salt at an economic rate. Since Tuticorin salt is sold at Rs. 20-6-9 per ton (Re. 0-12-0 per md.), with profit to manufacturers, there is room for lowering the cost of production in Travancore. Whilst we recognise that Tuticorin has a manufacturing season of 10 months, Travancore enjoys a fair season of not less than 8 months and conditions are, therefore, favourable for salt manufacture at an economical rate. The monopoly which the Travancore manufacturers have hitherto enjoyed must come to an end, as we are averse to it being granted to any section of manufacturers.

9.2 The cost of manufacture at the Model Factory (for the manufacturing season 1947-48) is given in Table LXXI.

TABLE LXXI—COST OF PRODUCTION AT THE MODEL FACTORY

	Per ton. Rs. a. p.
(a) Cost of obtaining brine from reservoirs, power and fuel . . . . .	6 1 2
(b) Labour . . . . .	6 8 5
(c) Maintenance . . . . .	0 3 1
(d) Supervision . . . . .	10 14 4
	23 11 0
or	Re. 0 13 11 per md.

Under the terms of its lease, half of the output of the Model Factory has to be made over to the owners of the Thattarippudai factory as lease money. The actual cost is, therefore, double the above figure and comes to Rs. 47-6-0 per ton (Rs. 1-11-10 per md). The high cost is also due to the present system of purchasing the brine from the Thattarippudai factory and the expensive method of pumping employed. The expenditure on the supervisory and research staff is also debited to the comparatively small production which contributes to the high cost.

9.2.1 The other Travancore factories have criticised the cost of production of the Model factory as an argument for not adopting the technique developed and demonstrated there. They must not, however, forget that if the Model Factory had the area under cultivation which some of these works have, the cost of production would, if anything, be lower than their own costs. It has also to be borne in mind that the Model Factory maintains a staff which is already rendering indirect but useful services, free of charge, to the other factories. The overall small cost of maintaining this factory should not deter the Travancore Government from continuing and expanding it. In fact with an enlarged centre, the cost of salt produced will be much lower than the figure achieved at present.

## 10. Sales and Distribution.

10.1 Salt is sold in Travancore to the wholesale dealers direct from the factories. It is transported by bullock carts and lorries to Trivandrum and from there sent by *vallam*, shall barges, to other parts of the State. Salt is also transported by sea in countrycraft to coastal depots of the State. The cost of handling and transport to Trivandrum is about Rs. 17 per ton (Re. 0-10-0 per md.) as shown below:

	Per ton	Per maund
	Rs. a. p.	Rs. a. p.
Handling charges . . . . .	3 6 3	0 2 0
Freight . . . . .	13 9 9	0 8 0
	<hr/>	<hr/>
	17 0 0	0 10 0

10.1.1 The salt that is taken over by Government under the terms of the leases is sold by Government direct either at factories at a price of Rs. 34 per ton (Re. 1-4-0 per maund) or through Government depots where the cost of transport is added to the selling price. The profit that the Government make in this transaction is a kind of seigniorage in return for the licence and the lease of sites for the manufacture of salt. The Government sales serve to keep a healthy check on speculation in the prices, both at the factories and at the various centres of distribution in the State.

10.2 We were informed that the movement of salt from Travancore to Cochin and South Malabar is difficult owing to lack of adequate transport facilities. The majority of the salt factories being situated on either side of Manakudi lake, the nearest railway station of Trivandrum is 50 miles away. The lake is, however, used for conveying the salt to the Manakudi foreshore for onward transport by sea. The Government of Travancore suggested to us that the development of a port at Manakudi should be referred to the Government of India. In our Interim Report we had recommended that the site of this port might be examined with a view to determining its suitability for development as an all weather port for use by steamers and other sea going vessels. We understand that the Ministry of Transport to whom this question

was referred have reported that the Manakudi port could not be developed as a major port, but it could be made into an open roadstead for steamers and other sea going vessels. As, however, financing of such a development would have to be undertaken by the Union Government and as the cost of making even the preliminary investigations will be heavy, the Ministry of Transport have advised that this question be deferred for the time being. We have no comments to make on this decision, but we commend to the attention of the Union Government the importance of utilising the canals and backwaters for the transport of salt to Cochin in the north and Cape Comorin in the south.

10.3 It was reported to us that no area is given to Travancore salt in the zonal system drawn up by the Salt Controller. This is because the zonal system is only applied to the movement of salt by rail, and Travancore salt has no facilities for rail traffic. The despatch of Travancore salt can only be to the West Coast by the water route and advantage does not seem to have been taken by the manufacturers for the disposal of their surplus production there. When the salt duty was in existence Travancore salt was not allowed to move beyond the boundaries of the State, but since the duty is no longer levied, it is open to the Travancore manufacturers to send their salt by road to the contiguous portions of the Tinnevely District which now depends for its supplies of salt upon Tuticorin which is farther away than the Travancore factories.

10.4 As in Bombay and Madras, salt is sold in Travancore in retail by measure, a practice which we have already condemned. The sale by measure leads to the production of the light quality of salt which is the bane of the industry wherever it is produced. The light quality of salt accounts for its higher manufacturing cost. We, therefore, repeat that the sale of salt by measure should be prohibited in the interests of manufacturers as well as consumers. The manufacturers of Travancore are in favour of producing the heavier and better quality salt provided there is a law prohibiting sale by measure. To bring about such a measure should not be a complicated matter for the Union Government. We had recommended in our Interim Report that the attention of the Government of Travancore might be invited to the necessity for early legislation in this direction. We considered it opportune even though it might have brought about a slight dislocation in the trade for a few months. We had gone so far as to recommend that such a legislation should be passed by the Travancore Government before October 1949 and that a period of 12 months from the passing of the Act should be given to the manufacturers to dispose of their stock of light salt. This would have enabled the manufacturers to reorganise their programme of production of the heavier variety from the commencement of the season in December 1949. This recommendation has not yet been acted upon by the Government of Travancore, presumably owing to the integration of the Travancore and Cochin States. We reiterate our recommendation and commend to the attention of the Union Government the necessity and the urgency of bringing about this legislation in the interests of the consumers as also of the salt industry. It is too late to bring about a change in the manufacturing programme for the 1949-50 season, but if the Act is passed at an early date, it should be possible to devise a programme for the manufacture of heavy variety salt during the shorter season beginning from August 1950.

10.4.1 Should the Union Government, however, have any difficulty in getting the Act passed immediately, we recommend that the Salt Department of the Government of India, when they take over the salt administration in Travancore from 1st April 1950, should under the powers vested in the Central Excise and Salt Act prohibit the charging of crystallisers with brine of density lower than 23° Be'. This will automatically lead to the production of the heavy grade of salt and the public would not be defrauded even if the salt continues to be sold by measure.

## 11. Summary of Recommendations.

(a) Many of the works situated on the Manakudi Lake are not far off from the sea and the supply of sea brine to these works by digging channels or by installing a pumping station on the beach is under the consideration of the Government of Travancore and Cochin. An early decision in the matter should be taken to provide the salt works with adequate supply of sea brine. (3.2.1)

(b) Where tube wells are in use, the manufacturers should examine the possibility of using monel or high silicon iron tubes, as in America, instead of galvanised iron tubes as at present which get corroded in two or three years. (3.3)

(c) To obviate unnecessary lifting of brine, a proper contour survey of the works should be carried out and the brine lifted only to the minimum required height. In many of the factories, small lessees have installed separate engines and pumps which only work for a few hours in a day. To lower the cost of production of salt as also to release the pumping sets for other purposes a common arrangement should be arrived at by which a fewer pumps could work continuously and supply the brine to all the small factories. (3.3.1)

(d) A proper hydrographical survey should be conducted to locate good sources of brine and to avoid the sinking of tube wells in a haphazard fashion as at present. (3.3.2)

(e) Since the Government of India are taking over the administration of salt in Travancore from 1st April 1950 the model factory should be taken over and operated by them. (5.5)

(f) Production at Travancore can be considerably increased by a redistribution of the area under cultivation. The increased production can find a larger market in South Malabar if the price of Travancore salt is reduced. (6.1 and 6.1.1)

(g) The crystallising areas are unnecessarily large in all the works, costing them more in their maintenance. They should be readjusted, depending on the initial density of the brine available. (6.2).

(h) Bitterns should be discharged after every scraping to improve the quality of salt. (6.3)

(i) The present method of double weighment once while storing and again while making sales is unnecessary. When salt is stored in heaps, its weight could be estimated from its cubical contents and it need be weighed only once when it is sold. (6.4)

(k) Travancore manufacturers should attempt to produce salt by the multiple irrigation system during the longer season, to improve the quality of salt and to meet the requirement of the Bengal market. (6.5)

(m) The present method of obtaining brine at the model factory should be re-examined. It would be cheaper to pump brine directly from the sea to the works. (6.6)

(n) The slush washing pans devised at the Model Factory should be studied and adopted by other salt works which work on the single irrigation system. (6.7)

(p) The model factory should be shifted to a more suitable site near the mouth of the Manakudi Lake where utilisation of both sea and tube well brine is possible. (6.8)

(q) The size of several Travancore factories will have to be increased in order that they may form economic units of production. (6.9)

(r) Technical Staff should be engaged at the works. Also analytical laboratories should be set up at the bigger works. (7.1)

(s) The small units should be combined into big units working on co-operative basis, in order to bring about a reduction in cost, in addition to improvement in the quality of salt produced. (9.1.2)

(t) Sale of salt by measure should be prohibited in the interests of the manufacturers and consumers in the area. In case the Union Government find any difficulty in taking immediate legislative measure, steps should be taken by the Government of India to introduce a clause in the licence prohibiting the charging of crystallisers with brine of less than 23° Be'. This would automatically lead to the production of a heavy grade of salt. (10.4.1)

## CHAPTER XV

### MADRAS

#### 1. Description.

1.1 The Madras Presidency has a long stretch of 800 miles of sea on the Coromandal coast on the east, where salt has been manufactured, from a long time, by solar evaporation from sea and pit brines. On the Malabar coast on the west, where natural conditions are not very suitable for the manufacture of salt, production used to be also carried on until 1824 when cheaper salt from more favourably situated sources like Bombay replaced the local production. The present salt works stretch from Naupada in the north to Tuticorin in the south and form the largest single unit of marine salt works in India. The production in the Province is the highest in the country and forms nearly 35 per cent. of its entire output. The salt factories are divided by the Salt Department, for purposes of administration, into six circles viz., (a) Naupada, (b) Pennuguduru, (c) Madras, (d) Cuddalore, (e) Adirampatnam and (f) Tuticorin. In each Circle there are eight to ten factories worked by a number of licensees under varying manufacturing rights. We visited some of the factories in the circles of Naupada, Madras, Adirampatnam and Tuticorin. In spite of manufacture having been carried on for centuries, the works are small, badly laid out, and run inefficiently, in a primitive fashion. The quality of salt is also poor and on an average contains not more than 92 per cent. sodium chloride. The only good factory we saw, was of the Mettur Chemicals Ltd. at Adirampatnam, who appear to have taken pains to relay their works on modern lines in order to produce salt of good quality. The climatic conditions vary extensively from north to south and the factories in the northern circles have a manufacturing season of barely six months as compared with the factories in the southern circles which enjoy a dry season of nine to ten months.

#### 2. Manufacturing Rights.

2.1 MONOPOLY SYSTEM—Salt had always been a source of revenue to all the former rulers of India, but it was only after the advent of the British that the collection of this revenue was organized in a systematic manner. In 1802, the East India Company reserved to itself the exclusive privilege of manufacturing salt on the Coromandal coast, and production by private manufacturers was made subject to Government control. In 1805, Government also established a monopoly for the sale of salt by a regulation under which the manufacturers were required to sell their entire production to Government at a fixed price. The Government sold the salt purchased by them to the wholesale dealers, after levying on it an excise duty and other charges. The quantity to be produced, called *dittam* and the price to be paid known as *kudivaram*, were notified to the producers before the commencement of each manufacturing season. This system came to be known as the Monopoly System and there are still two factories in Madras working under this system. Their total area is 317 acres which represents only two per cent. of the lands under salt cultivation. In 1807 the system was extended to include the Malabar coast also. The sale of salt in the Madras Presidency for that year was 1,25,000 tons (34 lakh maunds) which would roughly indicate the annual production of salt in the Presidency during that period.



**2.2 EXCISE SYSTEM**—Until 1818, import of foreign salt into Madras was prohibited but thereafter, it was permitted on payment of an import duty of Rs. 81-10-7 per ton (Rs. 3-0-0 per maund) which was reduced in 1851 to Rs. 20-6-8 per ton (Re. 0-12-0 per maund). Foreign salt did not, however, find favour in the Madras market and an agitation was started by the salt manufacturers of England against the monopoly system. This agitation, which succeeded with devastating results in Orissa, was resisted in Madras for a considerable time and led in 1867 to the appointment of a Salt Commission, who were asked to go into the matter. The Commission recommended the adoption of an Excise System, in place of the Monopoly System, under which the licensees could manufacture salt without any restriction with regard to quantity and were free to sell it to the public direct, after paying Government the excise duty and other charges. This recommendation was accepted and the Excise system, gradually replaced the Monopoly System. Though apparently the Excise System was fair and gave scope for competition amongst the manufacturers, it shifted the responsibility of finding a market for their output from the shoulders of the Government on to those of the manufacturers. This change in system led to the withdrawal from the Indian producers, the patronage and protection they had enjoyed at the hands of Government. As Government were no longer required to fix a target of production, they were not concerned if the indigenous production remained unsold. It was presumed by Government that this change-over to the Excise System would encourage the import of foreign salt but the prejudice in the Madras market in favour of the indigenous salt helped to stem the progress of import of foreign salt. Though the Excise system gradually replaced the Monopoly system a need was felt for retaining a few factories at different centres of production on the Monopoly system in order that Government could have under their control a stock of salt which they could utilise to maintain the price of salt in the markets at a reasonable level in the interest of the consumers. When, however, a number of competing factories began to work under the Excise system and Government stocks in the Monopoly factories began to accumulate and deteriorate, the factories working under the Monopoly system were either closed down or changed over to the Excise system.

**2.3 MODIFIED EXCISE SYSTEM**—In 1926, by which time very few factories were working under the Monopoly system, a third system known as the modified Excise System was introduced in order to safeguard the price of salt against any undue rise. According to this system, the manufacturers were required to reserve a certain quantity of their production for sale to Government, when needed at any time during the year. If this reserve was not purchased by Government during the year, the manufacturers were free to dispose of it in the succeeding year, provided that they replaced the stock by their new production. With the introduction of this system, the need for continuing any factory under the Monopoly system has completely disappeared.

**2.4 LEASE AND LICENCE**—Most of the salt factories in the Madras Presidency are situated on lands belonging to the Government of India but some are also on private lands. The land belonging to Government is given on lease to the manufacturers for a period of 25 years generally. The lease is usually decided by calling for tenders and is granted to the highest bidder. On some of the lands, the lessees have to pay in addition to the lease money, a land assessment at the rate of Re. 1 to Re. 0-12-0 per acre. The lessees are not allowed to sublet or part with the land, except with the written consent of the Central Government. They can however, take into partnership other parties with the previous approval of Government. The lessees have to maintain and repair their works at their own cost to the satisfaction of the Salt Department, but if they fail to do so, the necessary maintenance and repairs can be carried out by Government at the cost of the lessees. The lease can be terminated at an

earlier date, by either party, at the close of any manufacturing season and the lessee is permitted to remove any machinery erected by him at the works. He is, however, not entitled to any compensation for the expenditure that he may have incurred in respect of the works nor for being deprived of the right to manufacture salt. Whether salt is manufactured on lands leased from Government or on private lands, the manufacturer is required to take out a licence to manufacture salt from the Salt Department. The terms of the licence depend on the particular system under which the factory is allowed to work. The licence is usually valid for the period of the lease, but its terms are subject to an annual review, before the commencement of the manufacturing season.

2.4.1 Till 1927, the Salt Department insisted on the observance of the following important conditions in the manufacture of salt:—

- (a) that a fixed ratio of area of crystallisers to that of condensers should be followed;
- (b) that salt should not be scraped when the density of brine in the pans exceeds 30°Be';
- (c) that salt should not be scraped when the brine in the pans is less than 1 inch;
- (d) that salt should be scraped only in the mornings and evenings to prevent deposition of magnesium salts;
- (e) that the bitters should be eliminated after 3 or 4 scrapings;

In 1927, however, all these conditions were abolished in the Excise and Modified Excise factories, while in the Monopoly factories only conditions (c), (d) and (e) were retained. Thus, in a majority of factories, all departmental supervision on the methods of manufacture was completely relaxed and the manufacturers were given full liberty to follow their own methods with the result that they have laid out the works in any manner they please and the crystallising area is considerably in excess of the area under condensers. This was done under the mistaken belief that a larger crystallising area will enable the maximum scraping to be done. It is difficult to appreciate the reasons for this step. Even though the rules were not strictly observed, their existence was a deterrent factor and their abolition was in effect an invitation to the manufacturers to disregard all heed to either the method of manufacture or the quality of salt produced. The admixture of impurities in the salt may have boosted up the weight of the salt and therefore, led to the collection of a larger amount of duty, but the relaxation was entirely against the interests of the consumers and has done much harm to the quality of the salt produced in Madras. We cannot condemn too strongly this imprudent step of withdrawing supervision and we recommend that immediate steps be taken to re-introduce it if the quality of salt is to make any improvement not only in Madras but throughout the country. The neglected condition of the works, their bad layout and the general disregard of all scientific laws of manufacture do not speak well of the supervision by the Salt Department.

### 3. Manufacturing Process.

3.1 Salt is manufactured in all the factories of Madras by the single irrigation method. The brine is drawn either from creeks or from pits by means of manual labour or pumps. Where manual labour is employed, the brine is lifted with the help of picotahs, a contraption which consists of a counterpoised long wooden beam, with a leather bucket attached to one end. Where sea brine is used, it is first let into a reservoir from which it flows by gravity into the condensers. In the case of pit brine however, the brine is charged directly into the condensers. In the condenser the brine is allowed to concentrate to 12° to 15°Be' before it is fed into the crystallisers. Most of the works are laid out

in such a manner that a condenser adjoins a crystalliser or a set of two or three crystallisers. The total area of the condenser is almost the same as that of the crystallisers although in some places its individual size varies depending on the number of crystallisers it feeds. The condenser is generally known in the Madras Works as the male pan, while the crystalliser is called the female pan. The size of crystallisers is small and varies from 30 ft. x 15 ft. to 15 ft. x 10 ft. The salt is scraped when it forms a  $\frac{1}{4}$  to  $\frac{1}{2}$  inch crust every third or fifth day depending on the season. The bitters are only occasionally eliminated and no separate channels are provided for them. They are usually thrown on the bunds of the crystallisers where they are allowed to dry up. Even where separate bittern channels are provided, the bitters partly soak into the soil and partly dry up there being no proper outlet for them. The dry residue of the bitters is often taken out and used for consolidating the ridges and bunds of the crystallisers, with the result that the bitters find their way back into the crystallisers and thus contaminate the salt produced. In Table LXXII is shown the number of factories in each of the circles of Madras, their location, the area under cultivation, the number of licensees and the average yield per acre for the three year production of 1946 to 1948.

(See Table LXXII next page.)

TABLE LXXII.—SALT FACTORIES IN MADRAS

Circle	Location of factory	District	Reservoir	Condenser	Crystal- liser	Total	No. of licensees	Ratio of crystal- liser to conden- ser cum reser- voir	Yield per acre (Aver- age of 1946-48 production)	
			Acres 1107	Acres 1348	Acres 1855	Acres 4310			Average	Tons. 27
(a) Naupada	(i) Pundi	Vizagapatam	344	100	280	724	2	1 : 1.6	10	276
	(ii) Bhavanapadu	"	293	122	230	645	1	1 : 1.8	13	362
	(iii) Naupada	"	223	372	309	904	153	1 : 1.9	25	676
	(iv) Mulapeta	"	156	236	439	831	161	1 : 0.9	38	1042
	(v) Calingapatam	"	..	110	221	331	234	1 : 0.5	28	758
	(vi) Konada	"	..	32	48	80	57	1 : 0.7	35	950
	(vii) Bimilipatam	"	17	34	40	91	38	1 : 1.3	43	1165
	(viii) Balacherevu	"	74	342	288	704	103	1 : 1.4	42	1131
(b) Pennugu- duru	-		657	1239	1126	3022	1000		32	858
	(i) Polavaram	Vizagapatam	..	118	59	177	110	1 : 2	9	237
	(ii) Jagannaick- pur	E. Godavari	40	35	80	155	1	1 : 0.9	36	974
	(iii) Gurzanapalli	"	273	135	135	543	193	1 : 3	29	790
	(iv) Pennuguduru	"	209	105	105	419	114	1 : 3	22	597
	(v) Pendraka	Krishna	135	35	140	310	1	1 : 1.2	13	355
	(vi) Manginapadi	"	..	200	100	300	89	1 : 2	22	607

Circle	Location of factory	District	Reservoir	Condenser	Crystal- liser	Total	No. of licensees	Ratio of crystal- liser to conden- ser cum reser- voir	Yield per acre (Aver- age of 1946-48 production)	
									Tons.	Mds.
(e) Madras	(vii) Chinnagan aj Jam North	Guntur	Acres ..	Acres 146	Acres 73	Acres 219	120	1 : 2	46	1247
	(viii) Do. South	..	..	193	96	289	69	1 : 2	42	1132
	(ix) Kanuparti	..	..	111	167	278	53	1 : 0.7	23	615
	(x) Pakala	Nellore	..	161	171	332	241	1 : 0.9	72	1970
	(i) Iskapalli	Nellore	1230	899	1530	3659	900	1 : 1.0	34 54	926 1461
	(ii) Krishnapatnam	..	167	84	251	502	280	1 : 1.0	50	1362
	(iii) Tada	..	8	11	95	114	72	1 : 0.2	60	1640
	(iv) Voyalur	Chingelpet	103	52	52	207	29	1 : 3	34	918
	(v) Attiput North	..	274	137	137	548	46	1 : 3	20	533
	(vi) Attiput South	..	310	155	155	620	54	1 : 3	22	603
(vii) Vallur	..	265	133	133	531	57	1 : 3	19	524	
(viii) Covelong	..	..	276	553	829	209	1 : 0.5	41	1120	
d) Cudda- lore.	(i) Cheyar	Chingelpet	460	927	671	2058	269	1 : 2	29 23	793 622
	(ii) Chunampet	..	70	266	89	425	12	1 : 3.8	28	762
	(iii) Markanam (Ex- cise).	South Arcot	73	203	102	378	67	1 : 2.7	27	725
	(iv) Markanam (Monopoly)	..	..	70	72	142		1 : 1		
	(v) Karambalam Extension.	..	52	43	43	138		1 : 2.2		

Adiram- patnam	(vi) Cuddalore . . . . .	..	37	37	74	28	1 : 1.0	70	1905	
	(vii) Manambady . . . . .	3	67	22	92	1	1 : 3.2	32	859	
	(viii) Neidavasal . . . . .	Tanjore	2	82	82	166	55	1 : 1	37	1006
	(ix) Tranquebar . . . . .	..	29	29	58	29	1 : 1	51	1379	
			151	335	557	1043	377	71	1935	
	(i) Negapatam* . . . . .	Tanjore	..	24	32	56	23	1 : 0.8	38	1035
	(ii) Vedaanyam . . . . .	..	25	207	232	83	1 : 0.1	191	5194	
	(iii) Tambikottai . . . . .	..	95	95	190	70	1 : 1	13	353	
(iv) Adirampatnam . . . . .	..	134	106	118	358	10	1 : 2	37	994	
(v) Kattumavadi . . . . .	..	14	15	28	57	1	1 : 1	66	1807	
(vi) Theethanda- thanam . . . . .	Ramnad	..	13	20	33	73	1 : 0.6	66	1788	
(vii) Vattanam . . . . .	..	20	20	40	78	1 : 1	82	2225		
(viii) Morekolam . . . . .	..	3	37	37	77	39	1 : 1.1	39	1052	
Tuticorin		355	749	551	1655	672	112	3045		
(i) Veppalodai . . . . .	Tinnevelly	42	16	31	89	1	1 : 1.9	113	3089	
(ii) Arasadi . . . . .	..	7	18	26	51	14	1 : 1.0	143	3902	
(iii) Sevendakulam . . . . .	..	27	101	89	217	130	1 : 1.4	180	4907	
(iv) Levingipuram . . . . .	..	60	67	77	274	101	1 : 1.6	152	4128	
(v) Karapad . . . . .	..	55	68	67	190	47	1 : 1.8	128	3473	
(vi) Urani . . . . .	..	65	173	85	323	7	1 : 2.8	102	2771	

\*Transferred to Cuddalore Circle since 1st June 1949.

Circle	Location of factory	District	Reservoir	Condenser	Crystal- liser	Total	No. of licensees	Ratio of crystal- liser to conden- ser cum reser- voir	Yield per acre (Ave- rage of 1946-48 production)	
									Tons	Mds
(f) Tuticorin —contd	(vii) Urani Extension	Tinnevely	Acres 99	Acres 174	Acres 62	Acres 335	1	1 : 4.4	26	714
	(viii) Kayalpatnam .	..	..	33	37	70	280	1 : 0.9	152	4143
	(ix) Armuganeri . (Keeranur)	..	..	87	71	158	90	1 : 1.2	122	3329
	(x) Kulasekara-pat- nam	..	..	12	6	18	1	1 : 2	102	2777
	<b>GRAND TOTAL .</b>			<u>3960</u>	<u>5497</u>	<u>6290</u>	<u>15747</u>	<u>3983</u>		<u>42</u>

3.2 NAUPADA CIRCLE.—There are 8 factories in this circle of which Pundi, Bhavanapadu, Mulapeta and Naupada are situated between the villages of Pundi and Naupada within a radius of 9 miles of the Naupada railway station and extend over a distance of 12 miles along the coast. We visited the factories at Bhavanapadu, Naupada and Mulapeta. The rainfall in this area varies from 26 to 43 inches most of it falling between June to November. It also experiences occasional cyclonic weather as a result of which heavy damage was caused once in 1923 and again in 1943. In Table LXXIII is shown the average rainfall at Bhavanapadu in the different months of the year during the ten years period of 1938 to 1947. The maximum and minimum fall in a month, in any particular year is also given in the table.

TABLE LXXIII.—RAINFALL AT BHAVANAPADU 1938-1947

(In Inches)

Month	Average	Maximum	Minimum
January . . . . .	0.59	3.13	0.00
February . . . . .	0.59	4.02	0.00
March . . . . .	0.78	3.37	0.00
April . . . . .	0.87	2.91	0.00
May . . . . .	2.03	9.86	0.04
June . . . . .	4.50	9.98	2.37
July . . . . .	4.55	9.40	1.70
August . . . . .	5.86	11.71	2.51
September . . . . .	6.80	11.48	3.76
October . . . . .	8.26	14.03	3.57
November . . . . .	2.16	7.50	0.06
December . . . . .	0.67	6.58	0.00
Total . . . . .	37.66		

The monsoon ends in November and the manufacturing season starts from the middle of December. As the repairs to the condensers and crystallisers take one to one and a half months, the actual manufacture of salt begins from the middle of February and continues till the break of the monsoon, which is usually in the middle of June. The soil consists of black plastic clay which is ideal for the preparation of impervious hard beds. The brine is largely obtained from the sea through tidal creeks and channels, but is also supplemented from pits. As occasional showers of rain are common even during the manufacturing season, the single irrigation method is followed.

3.2.1 Pundi.—The Pundi factory has a cultivated area of 724 acres and is worked by 2 licensees under the Modified Excise System. The larger works covering 604 acres are leased to the Maharaja of Parlakimedi for a period of 25 years on a ground rent of Rs. 2 per acre. The brine is obtained from the sea at high tides through a channel which is one mile long. The works are divided into 200 small independent units, consisting of condensers and crystalliser and locally known as *jamat* but the area under condensers is only 38



acres whilst that for the crystallisers is 250 acres which is disproportionately large giving a ration of crystalliser to condenser plus reservoir of 1 : 1.3. Although these works are owned by one licensee, they are broken up into un-economic *jamats* and farmed out to a number of labour gangs. The advantage of working the factory as a single large unit is thus lost and no control is exercised over the method of manufacture. The production at these works during the last three years is as under:

Year	Tons	Mds.	Yield per acre	
			Tons	Mds.
1946 . . . . .	1,837	50,000	3	83
1947 . . . . .	5,580	1,52,000	9	251
1948 . . . . .	6,130	1,67,000	10	276

No details of cost of production at these works were furnished but we were given the total annual expenditure at the factory under the following broad heads:

	Rs.
(a) Silt clearance and other repairs . . . . .	4,864
(b) Manufacturing expenditure . . . . .	67,065
(c) Establishment . . . . .	2,145
	<u>4,159</u>
(d) Conveyance and Transport . . . . .	78,233
<b>TOTAL</b>	<b><u>78,233</u></b>

On the average production of 5,5880 tons (1,60,000 mds.) for 1947 and 1948, the cost of salt on these figures comes to Rs. 13-5-3 per ton (Re. 0-7-10 per md.).

3.2.2. The other works at Pundi measure 120 acres and are divided into 58 *jamats*. The areas under reservoirs and condensers are 31 and 62 acres respectively and under crystallisers 30 acres, which gives a ratio of crystalliser to condenser cum reservoir of 1 : 3. Even though this ratio is not quite adequate, it gives these works a much higher production than the other works at Pundi as will be seen from the figures given below :

Year	Tons	Mds.	Yield per acre	
			Tons	Mds.
1946 . . . . .	1,726	47,000	14	332
1947 . . . . .	3,670	1,00,000	30	813
1948 . . . . .	3,050	83,000	25	675

Compared to the Maharaja's works, the yield of these works is at least three times better which is easily explained by their better lay out and better ratio between the crystalliser and the other evaporating areas. The small condenser area at the Maharaja's works and disproportionately large crystallising area account for the poor yields obtained by them. We suggest that the areas in the Maharaja's works be redistributed so as to conform to a ratio of 1 : 7 to obtain better results in yield and quality. With a better yield, the cost of manufacture also at the Maharaja's factory will go below Rs. 11-14-6 per ton (Re. 0-7-0 per md.). We also recommend to the other Pundi works to redistribute their areas in the similar ratio of 1 : 7; these works gave their manufacturing cost at Rs. 12-12-0 per ton (Re. 0-7-6 per md.) which in our opinion is high for the larger yield they obtain. As no details of the cost were furnished to us, we are unable to comment on them, but we suggest to these works to reexamine their cost figure as they should be able to produce salt at a cost lower than Rs. 11-14-6 per ton (Re. 0-7-0 per md.).

3.2.3. *Dhananapaḍu*.—This factory consists of two units, one the parent works covering 364 acres and the other the extension works of 281 acres. Both the units are worked under the Modified Excise System by a single licensee to whom a lease for the parent unit was given in 1918, and which was renewed in 1947 for a further period of 20 years; the lease for the extension unit was also granted in 1947 for the same period. The brine is obtained either from pits where its density is 6° to 8° Be' or from the Mosallagedda creek where it is 3° Be'. From the pits the brine is drawn by *picotahs* whilst from the creek it is pumped into the reservoirs covering 293 acres. The condensers cover only an area of 122 acres and crystallisers 230 acres which is unnecessarily large and gives the ratio of crystalliser to condenser plus reservoir of 1 : 1.8. The works are badly laid out and the quality of salt produced is inferior. Brine is led into the crystallisers at 14° Bé and the salt is scrapped every few days as soon as it forms into a thin layer. No attempt is made to make any improvement in the quality of salt produced. The bitterns are not regularly eliminated and age-old methods of manufacture are continued. Except for the pumps for the incoming brine and a few tipping wagons for transporting the salt to the platform, no mechanisation has been adopted. Labour is employed on a contract system and the labourers are paid Rs. 9-12-0 per ton (Rs. 43 per garce of 120 mds.). The yield of salt on the basis of production for 1947 and 1948 i.e. after the extension of the works had come into operation was 16 tons (422 mds.) per acre. The cost of manufacture was given to us as under:

	Per ton
	Rs. a. p.
(a) Cost of obtaining brine including power and fuel charges . . . . .	0 6 10
(b) Labour . . . . .	7 15 0
(c) Repairs and maintenance . . . . .	3 6 5
(d) Supervision and overheads . . . . .	1 4 5
(e) Rent, Rates and Taxes . . . . .	0 2 3
(f) Depreciation . . . . .	0 2 3
(g) Miscellaneous . . . . .	0 13 7
	14 2 9
or	0 8 4 per md.

3.2.4. The cost of Rs. 14-2-9 per ton (Re. 0-8-4 per maund) is higher than the cost of the Pundi factory. This is in spite of the fact that a part of the brine is drawn from the pits which is of a higher density. The cost would be much lower if the factory's layout was not so poor and the method of operations so primitive. As the factory operates with both pit and sea brines, we recommend that the area under cultivation be re-distributed so as to give a ratio of 1 : 6. This will give them a much higher production and reduce the cost considerably. Climatic conditions in Bhavanapadu are no different from those at Pundi and with a better layout the cost of Bhavanapadu salt should be less than Re. 0-7-0 per md.

3.2.5. *Naupada*.--Out of a total cultivated area of 904 acres, 620 acres are worked by two licensees while the remaining 284 acres by 151 licensees. The two major licensees are the Oriental Salt Co. (295 acres) under the Excise system and Chetty Bros. (325 acres) under the Modified Excise System. The ratio of crystalliser to condenser plus reservoir in the unit worked by the Oriental Salt Co. is 1 : 2 and that of Chetty Bros. is 1 : 4. The remaining units are extremely small, some of them covering only a few cents and their ratio of crystalliser to condenser plus reservoir is 1 : 1; actually they do not have any reservoir at all and the ratio is really between crystalliser and condenser. The Oriental Salt Co. use a mixture of pit and sea brine in the proportion of 1 : 2; Chetty Bros. use only sea brine and the minor licensees use a mixture of pit and sea brine in the ratio of 2:1. Pumps are used to lift the sea brine from the creek whilst *picotahs* are used for the pits. The major licensees complained of scarcity of sea brine as the creek had badly silted up. The density of pit brine is reported to vary from 6° to 12° Be'. The density of brine has an important bearing on the yield of salt as will be seen from the figures of yield given in 3.2.6. The brine is condensed in the condenser upto 11° Be' when it is let into the crystallisers. The salt is of the light variety and is scraped every fourth or fifth day. The bitterns are rarely discharged and in fact no bittern channels were seen to be in existence. A roller mill with a capacity to crush 59 tons (1,600 mds.) of salt per day of 8 hours is also installed in one of the larger works. The labour is employed on a contract basis and paid at the same rate as at Bhavanapadu.

3.2.6. The average annual yield of salt per acre of cultivated area is shown below:—

	Quality of brine used	Average yield per acre (1946-48 production)	
		Tons	Mds.
The Oriental Salt Co. . . . .	Pit plus sea (1 : 2)	27	745
Chetty Bros. . . . .	Sea	13	357
Minor Licensees . . . . .	Pit plus sea (2 : 1)	35	966

The lower yield of Chetty Bros. is due to their using only sea brine which is also not available in copious supply. The yield of the Oriental Salt Co. is more than double that of Chetty Bros. because 33 per cent. of the brine they use is pit brine. The yield of the minor licensees is the highest because they use pit brine to the extent of 66 per cent. The ratio of Crystalliser to condensers plus reservoir in the works of Chetty Bros. of 1 : 4 is obviously insufficient and it should be increased to 1 : 7. Similarly the Oriental Salt Co.'s ratio should be adjusted to suit the average density of the brine they utilise;

the present ratio of 1 : 2 is entirely insufficient. The minor licensees should be combined into a co-operative society to work their entire area as one unit, which should be relaid to provide a reservoir area for the sea brine and the ratio of the crystalliser to the condensers cum reservoir should be properly fixed to suit the average density of the brine used. We were furnished with the average cost of manufacture of salt during the five year period 1935-40 as also for the year 1948 and they are as under:

	1935-40 (Average) per ton	1948 per ton
	Rs. a. p.	Rs. a. p.
(a) Cost of obtaining brine including labour . . . . .	2 6 7	9 14 9
(b) Power and fuel . . . . .	0 4 6	0 11 4
(c) Maintenance including repairs . . . . .	0 11 4	0 11 4
(d) Supervision . . . . .	0 6 10	1 4 5
(e) Rents, rates and taxes . . . . .	0 2 3	0 4 6
(f) Depreciation . . . . .	0 6 10	0 6 10
(g) Miscellaneous . . . . .	0 13 7	0 13 7
Total or	5 3 11 0 3 1 per md.	14 2 9 0 8 4 per md.

3.2.7. *Mulapeta*.—Out of a total cultivated area of 831 acres 375 acres are worked by one company, G & A Rao Ltd., who were given a lease by Government for 25 years in 1943; the remaining 456 acres are worked by 160 licensees. In the large unit the brine is pumped from the creek during tides into a reservoir of 155 acres; it is the same creek which supplies brine to the adjoining Naupada Works. Pit brine is also used occasionally. The area under condensers and crystallisers is 92 and 128 acres respectively giving the ratio of crystallising area to that of the condenser plus reservoir 1 : 1.9. The crystallising area is thus excessive in relation to the condensing area. The crystallisers vary in size from 40 ft. x 18 ft. to 20 ft. x 24 ft. Brine is condensed to 11° Be' in the condenser and let into the crystalliser for further concentration. Two roller mills, one with a capacity to crush 44 tons (1,200 mds.) and another about 30 tons (800 maunds) of salt in a day of 8 hours have been installed in this unit. Considering that these works were laid out in 1943, it is disappointing to see such scant attention being paid either to the layout or the quality of salt produced. The remaining small holdings as in other factories are worked on very primitive lines.

3.2.8. *Calingapatam, Konada, Bimilipatam and Balacheruvu*.—These factories are situated further south of Naupada. We were not able to visit any of them nor have we received any replies to our questionnaire from the licensees of these factories. We were told that most of the holdings of the licensees are very small and run on primitive lines. The Calingapatam factory with a total cultivated area of 331 acres has 234 licensees, whilst Konada with an area of 80 acres has 73 licensees. The ratio of crystalliser to condenser plus reservoir is in some places not even 1 : 1. At Balacheruvu, out of a total cultivated area of 704 acres about 450 acres are being worked by one licensee under

the Modified Excise system and the remaining 254 acres by 103 licensees. The area of crystalliser to reservoir plus condenser is 1 : 1.4. The source of brine for all these factories is the sea and it is lifted by pumps from a creek. The areas of the factories at Konada and Bimilipatam should be increased to 100 acres and the areas in all these factories should be relaid to give a ratio of 1 : 7 and they should be formed into co-operative societies so as to operate as single units.

3.2.9. The production of salt in the Naupada Circle during the three years 1946-48 is given in Table LXXIV.

TABLE LXXIV.—PRODUCTION IN NAUPADA CIRCLE 1946-48

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
(a) Pundi . . . . .	3,560	97,000	9,260	2,52,000	9,180	2,50,000
(b) Bhavanapadu . . . . .	5,440	1,48,000	10,930	2,99,000	7,900	2,15,000
(c) Naupada . . . . .	15,210	4,14,000	28,250	7,69,000	23,910	6,51,000
(d) Mulapeta . . . . .	25,600	6,97,000	38,420	10,46,000	31,410	8,55,000
(e) Calingapatam . . . . .	7,350	2,00,000	11,830	3,22,000	8,490	2,31,000
(f) Konada . . . . .	2,390	65,000	3,340	91,000	2,680	73,000
(g) Bimilipatam . . . . .	3,780	1,03,000	5,000	1,36,000	2,990	79,000
(h) Balacheruvu . . . . .	25,930	7,06,000	35,630	9,70,000	26,190	7,13,000
Total . . . . .	89,260	24,30,000	1,42,710	38,85,000	1,12,660	30,67,000

We were able to draw samples of salt from the Naupada and the Mulapeta factories during our visit to them and the result of the analyses are given in Table LXXV:

TABLE LXXV.—COMPOSITION OF SALT IN NAUPADA CIRCLE  
(Per cent on dry basis)

	Naupada		Mulapeta	
	1948 crop	1949 crop	1948 crop	1949 crop
Sodium chloride . . . . .	95.21	94.61	95.92	94.58
Calcium sulphate . . . . .	0.44	0.65	0.65	0.38
Magnesium sulphate . . . . .	1.29	1.14	0.69	1.23
Magnesium chloride . . . . .	1.92	2.36	1.01	2.12
Insolubles . . . . .	0.62	0.84	0.80	0.30
Undetermined . . . . .	0.52	0.40	0.93	1.34
	100.00	100.00	100.00	100.00

The salt is somewhat better than that produced in some of the other circles of Madras. It, however, contains an appreciable quantity of magnesium salts because the bitterns are rarely eliminated. A considerable modification will be required in the areas under condensers and crystallisers and the method of manufacture will have to be changed if any improvement is to be effected in the quality of salt produced. The ratio of the crystallisers to condensers cum reservoirs is only 1 : 2 which is nowhere near the ratio, desirable for factories in this Circle. The average yield per acre for all the factories, comes to only 26 tons (706 maunds) which is unsatisfactory. The conditions in Naupada are in some respects similar to those prevailing in Bombay. The season is only of about 6 months duration though the total rainfall is not as heavy as in Bombay. We, therefore, consider that the production in this circle could be increased to 60 tons (1630 maunds). We have recommended for Bombay a redistribution of the areas under cultivation to give a ratio of crystallisers to the reservoirs plus condensers of 1 : 7. We would suggest the same ratio to the Naupada Circle factories using only sea brine. For those factories which use pit brine also, to some extent, we recommend that the ratio be adjusted to 1 : 6. Similarly the method of manufacture we have recommended for the Bombay works should be followed *mutatis mutandis* in the Naupada Circle. (Chapter XIII, paragraph 5.2). As, however, the Naupada Circle is subject to cyclonic weather, we advise that single irrigation method of manufacture be continued. If these recommendations are carried out, the production of salt in this Circle would be more than doubled, without any extension of the area under cultivation.

3.2.10. *Kakarapalli Swamp*.—Adjacent to the Bhavanapadu, Naupada and Mulapeta factories, extends a large swamp covering an area of 5 sq. miles (2 miles  $\times$  2½ miles). We were requested by the Salt Department to examine and report on the suitability of this swamp, as a site for laying a large size factory for supplying salt to the proposed soda ash factory at Sindri (Bihar). It was reported that in this swamp, rain water as well as tidal waters from the sea collects during the rainy season. The bulk of this water percolates into the soil and is available as sub-soil brine. From experimental pits dug in the area, the density of this brine was reported to vary from 6° to 10° Be'. Being a flat low lying area and having a soil of tenacious black clay similar to that in the adjoining factories, there should be no difficulty in laying out a salt works on this swamp. As Bengal Nagpur Railway runs close to the swamp, it should also be possible to construct a siding to connect the factories to the nearest railway station of Naupada. Three important questions will have to be considered before any salt works are constructed on this site. The first is the supply of brine. Although pit brine will be available during a part of the season, it may become scanty as the season advances and it will have to be supplemented by sea brine. It was suggested that by opening a bar near the creek and providing a channel from it, enough brine could be obtained during high tides from the sea. Another suggestion made was that with the help of a pump installed at the creek the brine could be lifted to an overhead storage tank and allowed to flow through pipes to the factory. We do not consider either of these suggestions as feasible. The bar, even if it is cleared, would form again soon enough as the flood water during the monsoon on their way to the sea will drain into the creek over the swamp and carry with it large quantity of silt

which will close up any channel that may be excavated to bring the sea brine into the factory. The other proposal of constructing an overhead storage tank to supply the brine appears impracticable. We suggest that the possibility of obtaining a copious supply of high density brine during the hot weather, by means of tube wells as in Travancore should be investigated. If this proves successful, the need for obtaining sea brine will disappear. The other question is that of protection to the salt works from inundation during the rainy season. For this purpose the factory will have to be protected by high embankments and a proper outlet for the drainage of the rain water will have to be provided. The cost involved on this protective work might be high and should be worked out in detail before any plans are drawn up for constructing a factory. The third question is with regard to the transport charges to be paid by the Sindri factory. The distance from Naupada to Dhanbad *via* Asansol is 532 miles and according to the present railway tariff, the freight will amount to Rs. 27-3-6 per ton (Re. 1 per maund). The present cost of production in the larger works in Naupada varies from Rs. 11-14-6 to Rs. 13-5-9 per ton (Re. 0-7-0 to Re. 0-8-0 per maund). Assuming that the cost of production in the proposed factory will be only Rs. 10-3-0 per ton (Re. 0-6-0 per md.) the cost of salt delivered at Sindri will come to Rs. 37-6-6 per ton (Re. 1-6-0 per maund). Even if a special concessional rate of freight could be arranged with the Railway Board, and it is brought down to half the present rate of freight the cost of salt delivered at Sindri will not be less than Rs. 23-12-9 per ton (Re. 0-14-0 per md.). We do not think that the supply of salt at this price to a soda ash plant would be considered economical and we would not recommend the laying out of a large salt works in this swamp, unless Sindri factory is prepared to pay this price. In the previous paragraph, we have indicated the possibility of doubling the present production of the existing factories in the Naupada Circle. If this were done, there would be no immediate necessity for constructing a new salt works in the Kakarapalli swamp, as the increased production would meet to a large extent the requirements of Sindri.

### 3.3 PENNUGUDURU CIRCLE.

3.3.1. There are ten factories in this circle which are distributed over five districts of the Province. The Polavaram factory is in the Vizagapatam District, Jaganaickpur, Guruzanapalli and Pennuguduru in the East Godavari District, Pendraka, and Maginapadi in the Kistna District, Chinnaganjam North, Chinnaganjam South and Kanuparti in the Guntur District and Pakala in the Nellore District. We were not able to visit any of these factories, but we were informed by the Salt Department that these factories were in no way different from the factories in the Naupada Circle. We, however, received replies to our questionnaire from some of the important manufacturers in this circle and also had an opportunity of discussing their problems with some of their representatives during our visit to Madras. The rainfall in the area varies from 26 to 56 inches, most of it falling between June to November. The average rainfall at Kanuparti in the different months for the ten years 1938 to 1947 as also the maximum and minimum in a month in any year are shown in Table LXXVI:

TABLE LXXVI.—RAINFALL AT KANUPARTI 1938—1947

(In inches)

Month	Average	Maximum	Minimum
January . . . . .	0.14	0.56	0.00
February . . . . .	0.15	1.13	0.00
March . . . . .	1.19	8.13	0.00
April . . . . .	0.31	1.23	0.00
May . . . . .	1.40	5.85	0.00
June . . . . .	2.24	4.27	0.65
July . . . . .	4.10	6.66	2.20
August . . . . .	4.44	6.61	2.34
September . . . . .	5.82	11.07	1.80
October . . . . .	10.54	31.60	3.17
November . . . . .	6.57	20.49	0.48
December . . . . .	1.06	4.35	0.07
Total . . . . .	37.96		

3.3.2. *Polavaram.*—The Polavaram Factory is one of the two still works under the monopoly system. It has 177 acres under cultivation and is worked by 110 licensees, the period of the licence being 25 years subject to renewal. A curious feature of the factory is that no area is set apart for a reservoir; the brine is baled directly from the creek into the condensers which cover 20 acres. There are no pumps or other mechanical devices used in the factory; the small lessees cannot afford them. According to the terms of the licence, the Salt Department can enforce a particular layout or method of manufacture but little direction seems to have been given to the licensees for improving layout or the method of manufacture. The factory is laid out on primitive lines with an unnecessarily large crystallising area of 59 acres into which brine of low density is led to a depth of 1 to 1½ inch and the salt is scraped when the crust is hardly 1/8 inch thick. We recommend that the licensees should be grouped together and work the factory as a single unit and for this to be done, the factory should be relaid. If the licensees are unable to find money for relaying it, Government should meet the expenditure and recover it in easy instalments from the licensees. In relaying the factory the ratio of 1 : 7 between the stalliser and the reservoir cum condenser should be maintained; common reservoir and common condenser should be provided, only the condensed brine be distributed among the licensees.

3.3.3 *Jagannaickpur, Guruzanapalli, Pennuguduru and Pendraka.*—The factories in these centres are similar to the Polavaram factory. The Jagannaickpur and Pendraka factories are run by single licensees, whilst the other two are sub-divided into small holdings among a number of licensees. The larger factories are, however, sub-divided into a number of *jamats* and farmed out to several persons who carry out the actual manufacturing operations. The brine is drawn from the sea through creeks and even simple mechanical devices like pumps, are not utilised for lifting the brine. These factories should be relaid to give a ratio of 1 : 7.



3.3.4. *Manginapadi, Chinnaganjam North, Chinnaganjam South and Pakala.*—The brine in these factories is generally obtained from pits and varies in density from 5° to 7° Be'. These factories have, therefore, no reservoirs. The brine is lifted by means of *picotahs*. The supply of brine gets depleted as the season advances and has to be supplemented in some of the factories with brine from the Buckingham Canal which is a navigation canal running parallel to the coast in this area. The density of the brine in the canal never exceeds 1 to 1½° Be', but since it runs between the factories and the sea, the factories are not able to draw brine from the sea and must of necessity take the dilute brine from the canal. As a pipe line cannot be laid across the Buckingham Canal, copious supply of brine can only be obtained by sinking tube wells to a sufficiently low depth in the factory areas as is done in Travancore. We recommend that a trial tube well be sunk in each of the factory areas to determine the availability, depth and density of brine.

3.3.5. *Kanuparti.*—One of the works at Kanuparti is run by the South India Salt Refineries Ltd., to whom a lease of 250 acres was given on the specific condition that they would produce and sell only refined salt. The common salt obtained by them by solar evaporation is dissolved in an iron tank in low density brine drawn from the Buckingham Canal and the resulting solution is evaporated in open iron pans by direct heating with oil burners. The salt that crystallises out is continuously ladled into baskets, allowed to drain and then centrifuged, dried and packed in 1 maund (82 lbs.) gunny bags or 1 lb. cartons. It was represented to us that the factory was working at a loss as they could not produce refined salt at an economic price because there was not sufficient demand for this salt. They urged that the conditions of their lease should be relaxed and they be allowed to produce and market solar salt. They have further asked for protection against foreign competition. There is no doubt in our mind that the process adopted at the factory is uneconomical and expensive. Evaporation in open pans is wasteful of both fuel and labour and we are of the opinion that these works could obtain by solar evaporation a fairly pure product by relaying the factory in the ratio of 1 : 5 and following proper methods. We recommend that the terms of their lease be relaxed and instead of continuing the present uneconomic process of refining, they should be allowed to market their solar salt provided it comes up to a purity of 97.98 per cent. sodium chloride content. An analysis of the unrefined salt produced at Kanuparti is given below:

(*Per cent on dry basis*)

Sodium chloride . . . . .	95.66
Calcium sulphate . . . . .	1.90
Magnesium sulphate . . . . .	0.19
Magnesium chloride . . . . .	0.13
Insolubles . . . . .	1.12
Undetermined . . . . .	1.00

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100.00

This quality of salt can be improved if the works were relaid on the lines suggested by us in the Chapter on Model Factories and Research Stations, and they should confine their refining operations, if necessary, to only a small portion of their production. One of the reasons for these works not being able to sell its salt in the Calcutta market is the high railway freight. When these works were established during the war, the freight on salt from Kanuparti to Calcutta was only Rs. 15-5-0 per ton (Re. 0-9-0 per md.). In October 1948, this freight was revised and increased to Rs. 33-12-0 per ton (Re. 1-3-10 per maund) for common salt and Rs. 89-10-0 per ton (Rs. 3-4-8 per maund) for refined salt. We do not see any justification for such a large disparity in the freight on two types of salt. As this salt is likely to find a ready market in Calcutta we recommend that the railway freight for this factory be reduced to a level not much above Rs. 20-6-8 per ton (Re. 0-12-0 per maund) so that it could compete with salt despatched by sea from Kathiawad. So far as protection to the Table salt industry is concerned, we are of the opinion that this question is premature as the factory has not yet started an economic method of production and has not made out any case for protection. There is no reason why this factory cannot produce both solar and refined salt at an economic rate by effecting an improvement in the layout of their solar works.

3.3.6. The production of salt in the Pennuguduru Circle for the years 1946 to 1948 is shown in Table LXXVII:

TABLE LXXVII.—PRODUCTION OF SALT IN PENNUGUDURU CIRCLE 1946—1948

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Polavarān . . .	1,650	45,000	2,940	80,000	..	..
Jagannaickpur . . .	5,580	1,52,000	5,660	1,54,000	5,400	1,47,000
Gurazanapalli . . .	10,000	2,72,000	19,400	5,28,000	17,850	4,86,000
Pennuguduru . . .	3,970	1,08,000	13,030	3,55,000	10,580	2,88,000
Pendrakā . . .	3,560	97,000	4,920	1,34,000	4,040	1,10,000
Manginapadi . . .	6,720	1,83,000	6,540	1,78,000	6,760	1,84,000
Chinnaganjam N. . .	9,770	2,66,000	8,600	2,34,000	11,760	3,20,000
Chinnaganjam S. . .	9,220	2,51,000	11,130	3,03,000	15,680	4,27,000
Kanuparti . . .	5,700	1,55,000	5,360	1,46,000	7,820	2,13,000
Pakala . . .	17,630	4,80,000	23,840	6,49,000	30,640	8,34,000
Total . . .	73,800	20,09,000	1,01,420	27,61,000	1,10,530	30,09,000

The analyses of salt from two of the factories in the Pennuguduru Circle are shown in Table LXXVIII. These samples of salt were not drawn by us, but the analyses were furnished to us by the Salt Department. The figures of sodium chloride show that the quality of salt as was to be expected is not upto the mark because of the primitive method of manufacture and unsatisfactory layout of the factories.

TABLE LXXVIII.—COMPOSITION OF SALT IN PENNUGUDURU CIRCLE

(Per cent: on dry basis)

	Guruzanapalli	Pakala
Sodium chloride . . . . .	90.82	93.14
Calcium sulphate . . . . .	1.43	2.09
Magnesium sulphate . . . . .	0.66	0.24
Magnesium chloride . . . . .	3.37	1.56
Insolubles . . . . .	0.64	0.97
Undetermined . . . . .	3.08	2.00
	100.00	100.00

## 3.4 MADRAS CIRCLE.

3.4.1. There are eight factories in this Circle covering a total area of 3659 acres and extending from Covelong, 16 miles south of Madras City to Iskapalli 135 miles to the north. Out of the eight factories, three, viz., Iskapalli, Krishnapatnam and Tada are in the Nellore District, while the remaining five, viz. Voyalur, Attiput North, Attiput South, Vallur and Covelong are situated in the Chinglepet District. Of these groups, we were able to visit the Vallur and the Covelong factories. The rainfall in this area varies from 32 to 86 inches most of it falling between July and December. In Table LXXIX, we show the average rainfall at Covelong in the different months for the ten years 1938 to 1947 as also the maximum and minimum in a month in any year:

TABLE LXXIX.—RAINFALL AT COVELONG (MADRAS) 1938—1947

( in inches )

Month	Average	Maximum	Minimum
January . . . . .	1.56	6.33	0.00
February . . . . .	0.24	1.56	0.00
March . . . . .	1.39	9.76	0.00
April . . . . .	0.96	4.37	0.00
May . . . . .	1.40	8.86	0.00
June . . . . .	2.12	3.70	1.01
July . . . . .	3.22	6.93	0.92
August . . . . .	4.78	6.50	2.29
September . . . . .	6.19	10.79	1.30
October . . . . .	9.94	27.11	3.07
November . . . . .	12.79	21.61	0.16
December . . . . .	7.77	33.95	0.10
Total . . . . .	52.36		

The dry season commences in January and the manufacturing operations start in February and last till the end of July. In the factories in the Nellore District, when the rains are sometimes delayed salt manufacture is continued even till September. The single irrigation system of manufacture is followed in this circle.

3.4.2. *Iskappalli, Krishnapatnam and Tada.*—In the first two of these factories, brine is obtained from the sea through creeks while at Tada it is obtained from pits and is supplemented by low density brine from the Pulicat Lake. All these factories are subdivided into small holdings among a large number of licensees and in their layout, the methods of manufacture and the quality of salt produced they closely resemble the factories in the Naupada and Pennugudurur Circles.

3.4.3. *Voyalur, Attiput North and Attiput South.*—The brine at these factories is drawn from the sea through tidal creeks and channels. It is either pumped or lifted with the help of *picotahs*. Most of the holdings in these factories are small and they follow primitive methods of manufacture.

3.4.4. *Covelong and Vallur.*—The brine at Vallur is drawn from the sea but at Covelong, which is at a distance of one mile from the sea, it is obtained from pits and supplemented from the Buckingham Canal. As the bar of the creek has not been opened for a long time the brine supply at Vallur is scanty. If enough supply of brine is to be made available to the factory the bar will have to be cleared periodically. The layout of both the factories is similar and unsatisfactory. They are old and date back to about 100 years and from their present condition it would appear that they have seen little improvement during their entire existence. At Vallur, the area available for salt manufacture is about 1330 acres of which only about 531 acres are cultivated by 57 licensees, who work independently. The area under reservoir measures 265 acres and under condensers and crystallisers 133 acres each giving a ratio of 1:3. At Covelong, the area under cultivation is 829 acres but it has in addition about 275 acres which can be brought under cultivation. The total number of licensees is 209. The area under crystallisers is 553 acres and that under condensers 276 acres giving the ratio of 1 : 0.5. As only pit brine ( $5^{\circ}$  to  $12^{\circ}$  Be) is used, no area for reservoirs has been provided. Since the area of the condensers is less than that of the crystallisers the brine in the condensers does not reach more than  $12^{\circ}$  to  $13^{\circ}$  Be, when it is transferred to the crystallisers to a shallow layer 1 to  $1\frac{1}{2}$  in. The thin crust of salt which is largely contaminated with gypsum is scrapped every 3rd day. The bitters which are occasionally eliminated partly soak into the soil and partly mix with the next charge of brine. With such a method of manufacture, it is impossible to produce salt of good quality and both the layout and the method of manufacture need complete overhaul. The salt produced at Vallur is dark-brown in colour, and that at Covelong is no better. We were furnished by the Salt Department the cost of production of salt at both these factories and they are as under:—

	Vallur per ton			Covelong per Ton		
	Rs.	as.	p.	Rs.	as.	p.
Labour . . . . .	9	10	2	12	5	4
Maintenance . . . . .	5	1	8	4	8	5
Haulage . . . . .	1	2	2	1	11	3
	15	14	0	18	9	0
Total . . . . .	or	0	9	4	0	10
			per md.			per md.

This cost does not include any supervision, overheads or depreciation. As these works are run by small licensees who put in their own labour to manufacture the salt perhaps these debits are not considered necessary. For the quality of salt produced, the prices are excessive and call for an early review by Government of the advisability of leaving the manufacture in the hands of small, ignorant and inefficient manufacturers. In the interest of both price and quality it is necessary that these works are relaid and operated co-operatively as single units.

3.4.5. At the request of the Salt Department, we visited a site proposed for starting a salt factory near the Semmanjeri village, about 10 miles from Madras and 6 miles from Covelong. The area available for salt manufacture is about 564 acres and we were told that a factory had been in existence at the site prior to 1906. We found that the local villagers had started a few small pans for the production of salt under the 10 acre concession given by the Government of India. In our opinion this site is well suited for laying a large Salt Works, as it has an impervious soil and facilities exist for obtaining sea brine and sub soil brine. The Buckingham Canal also runs close to the site and the salt produced can be transported to Madras Port by this canal for shipment to other markets. We understand that the land belongs to the Government of Madras. The site should be given on lease to either one single party or to a Co-operative Society to be formed by absorbing the existing small manufacturers and others who may be interested in salt manufacture. In either case the site should be laid out on model lines as indicated in the Chapter on Model Factories and Research Stations.

3.4.6. The production of salt in the Madras Circle for the three years 1946 to 1948 is given in Table LXXX.

TABLE LXXX.—PRODUCTION OF SALT IN MADRAS CIRCLE 1946—1948

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Iskapalli . . . . .	10,650	2,90,000	19,180	5,22,000	19,760	5,38,000
Krishnapatnam . . . . .	18,330	4,99,000	19,690	5,36,000	37,320	10,16,000
Tada . . . . .	5,990	1,68,000	2,310	63,000	12,270	3,34,000
Voyalur . . . . .	6,020	1,64,000	6,540	1,78,000	8,410	2,29,000
Attiput North . . . . .	7,750	2,11,000	11,640	3,17,000	12,750	3,47,000
Attiput South . . . . .	8,820	2,40,000	15,390	4,19,000	16,970	4,62,000
Vallur . . . . .	3,710	1,01,000	10,250	2,79,000	16,720	4,55,000
Covelong . . . . .	26,560	7,23,000	29,650	8,07,000	46,210	12,58,000
Total . . . . .	87,830	23,91,000	1,14,650	31,21,000	1,70,410	46,39,000

The analyses of salt from four of the producing centres is shown in Table LXXXI. The samples from Vallur and Covelong were drawn by us during our visit and the other samples were collected by the Salt Department.

TABLE LXXXI.—COMPOSITION OF SALT IN MADRAS CIRCLE  
(Per cent on dry basis)

	Iskapalli	Tada	Vallur	Covelong
Sodium chloride . . . . .	96.14	89.20	96.92	93.06
Calcium sulphate . . . . .	0.42	0.56	0.64	1.34
Magnesium sulphate . . . . .	1.16	3.81	0.15	0.56
Magnesium chloride . . . . .	1.88	5.40	0.41	1.51
Insolubles . . . . .	0.40	0.23	1.04	1.79
Undetermined . . . . .	..	0.75	0.84	1.74
	100.00	100.00	100.00	100.00

The quality of salt produced at Tada is very inferior despite the fact that the extent of insolubles contained in it is low. Such salt would appear white and might visually be considered suitable for edible purposes. Its high content of magnesium salts is obviously due to the fact that the bitterns are not being removed. Such salt should not be allowed to be marketed for human consumption and steps should be taken to improve the quality immediately as it falls below even the present low standard of 92 per cent. minimum sodium chloride content, laid down by the Salt Department. If the quality is not improved, the factory should be closed down. This improvement can be brought by relaying not only this factory but all the factories in this circle. Where pit brine is used the ratio of crystallisers to condensers should be 1:5; where however, sea brine is also used the ratio should be 1:6.

### 3.5 CUDDALORE CIRCLE.

3.5.1 There are seven factories in this circle out of which Cheyar and Chunampet are in the Chinglepet district, Markanam, Cuddalore and Manambady in the South Arcot District and Neidavasal and Tranquebar in the Tanjore District. The rainfall in this areas varies from 26 to 74 inches most of it falling between June and December. Table LXXXII shows the average monthly rainfall at Markanam during the ten years 1938 to 1947 and the highest and the lowest for each month during the whole period:

TABLE LXXXII.—RAINFALL AT MARKANAM 1938—1947  
(in inches)

Months	Average	Maximum	Minimum
January . . . . .	1.63	6.30	0.03
February . . . . .	0.69	3.03	0.00
March . . . . .	1.00	4.62	0.00
April . . . . .	1.64	8.14	0.00
May . . . . .	3.27	24.84	0.00
June . . . . .	1.93	3.92	0.15
July . . . . .	2.94	7.87	0.73

(in inches)

TABLE LXXXII.—RAINFALL AT MARKANAM 1938—1947—*contd.*

Months	Average	Maximum	Minimum
August . . . . .	3.48	6.83	0.2
September . . . . .	7.07	12.83	4.3
October . . . . .	7.53	13.63	3.6
November . . . . .	14.58	38.58	3.5
December . . . . .	6.02	19.38	0.1
Total . . . . .	57.78		

The manufacturing season is short and lasts for 5 to 6 months. The single irrigation method of manufacture is adopted in all the factories except in a part of the Markannam factory, where the multiple irrigation method is employed. We did not visit any of the factories in this circle but from the replies received to our questionnaire, the factories appear to be run more or less in the same manner as the factories in the Madras and other circles. Most of the factories are divided into small holdings and operated by several licensees. At Chunampet, Markannam, Cuddalore and Manambady a few large salt works are however, operated by single licensees.

3.5.2 *Chunampet*.—Out of a total cultivated area of 425 acres in this factory about 405 acres are worked by the Zamindar of Chunampet. Unlike other factories which are located on lands belonging to the Government of India, his works are laid out on his own lands and a licence for 215 acres under the Excise system for an indefinite period and a licence for 190 acres under the Modified Excise System for 25 years has been granted to him. The brine is pumped from the backwaters and led through a long channel into the works. The density of brine in the backwaters rises with the advance of the dry season and reaches 5° to 6° Be'. The area of reservoir of the factory is about 70 acres while in the neighbouring small holdings, no reservoirs have been provided. The area covered by condensers and crystallisers is almost equal. As the existing ratio of 1 : 3.8 is inadequate, the areas should be redistributed in the ratio 1:5 due to the higher density of the available brine. The small holdings should be grouped with the larger works for economy in working.

3.5.3 *Markannam including Karambalam extension*.—Out of a total cultivated area of 658 acres in this factory, about 138 acres (Karambalam extension) are worked by one licensee under the modified excise system on a lease of 25 years. These works had been closed for a long period and were restarted only in 1945 to meet the demand for salt during the war period. The source of brine is the sea and is drawn through a channel from which it is lifted into the works partly by pumps and partly by *picotahs*. In spite of the protective embankments, the works are flooded during the rains and a heavy expenditure is being incurred every year in repairing them. The reservoir is 52 acres and the condensers and crystallisers each cover about 43 acres giving a ratio of crystalliser to reservoir cum condenser of 1:2.2. Another area of 142 acres at Markannam is worked by 19 licensees under the Monopoly system. The brine is obtained from the sea through a creek and is lifted by manual labour into the condensers. The multiple irrigation method is followed in this factory and the crystallising pans are irrigated every second day with brine from the condensers for about 35 to 45 days. When a crust of salt about 1½ inches in thickness is formed, it is scraped. No proper control is however, maintained

over the density of brine at any stage. The crystals of salt are reported to be of large grain and white colour. All the salt produced in the Monopoly block is supplied by the Government of India to the French Government at Pondicherry which is only 20 miles from these works. The remaining area of 378 acres at Markannam is worked by a number of licensees under the Excise system. The areas of all these works should be redistributed in the ratio of 1:7.

3.5.4 *Manambady*.—The factory is situated at a distance of 2 miles from the sea on lands which belong to the Central Government and which are leased to a single licensee under the Modified Excise system for a period of 25 years. The area under production is 92 acres. The brine is obtained from a creek which is flooded by sea water during high tides. The brine is pumped and led to the factory through a channel, a mile long. The density of the brine is low as it is diluted by fresh water flowing into the creek and is less than 3° Be' in the early part of the season. The factory is flooded during the rains and needs considerable expenditure on repairs at the commencement of the season. In spite of the low density of brine the area under reservoir is only three acres while that under condenser is 67 acres and under crystallisers 22 acres giving a ratio of crystalliser to condenser cum reservoir of 1:3:2 which is quite inadequate. The licensee is of the view that by drawing the brine directly from the sea through a channel, a considerable increase in production can be brought about. We do not agree with this view as we feel that the natural advantage which is derived at high tides should not be lost. If the area of the factory was relaid to give a ratio 1:7 and extended to 100 acres, the yield will be improved. The alternative would be to locate the factory nearer the sea, provided a suitable site is available. It has also been reported to us that burrowing worms cause considerable loss of brine by percolation. We have already dealt in Chapter IV the measures that should be adopted to eradicate this pest.

3.5.5 *Tranquebar*.—This factory is very small and has only 58 acres under cultivation. This area is shared between 29 licensees the largest of whom has 14.5 acres and the smallest 0.3 acres. About 20 acres are owned by the Government of India and leased out for periods upto 25 years, while the remaining area is owned by the licensees themselves. The brine is obtained from pits with the help of *picotahs* and varies in density from 3° to 7° Be'. As the rains occur late in this area and there is a longer spell of dry weather than in the other factories in this Circle, the manufacturing season extends up to the end of September. As the area of this factory falls below the minimum of 100 acres, we suggest that the area of this factory should be extended, if possible, and in any case operated as a single unit on a co-operative basis.

3.5.6 *Cheyar, Cuddalore, Neidavasal*.—The Cheyar factory is the second biggest in the Cuddalore Circle with 585 acres under cultivation but as there are 77 licensees, most of the individual holdings are comparatively small. The ratio of crystallisers to reservoirs cum condensers is 1:2 which is unsatisfactory. The factory at Cuddalore measures 74 acres; it has only 37 acres under condenser and 37 acres under crystalliser. The area should be re-distributed to give a ratio of 1:5 to 1:7 depending upon the brine used. Its total area also should be increased to 100 acres. The factory at Neidavasal should also be relaid as its ratio is equally unsatisfactory being only 1:1.

3.5.7 The production of salt in the Cuddalore Circle during the three years of 1946—1948 is given in Table LXXXIII:



TABLE LXXXIII.—PRODUCTION OF SALT IN CUDDALORE CIRCLE 1946—1948  
1946—1948

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Cheyar . . . . .	8,930	2,43,000	15,140	4,12,000	16,090	4,38,000
Chunampet. . . . .	10,760	2,93,000	10,470	2,85,000	14,430	3,93,000
Markanam . . . . .	8,600	2,34,000	15,940	4,34,000	27,990	7,62,000
Cuddalore . . . . .	5,360	1,46,000	4,030	1,11,000	6,100	1,66,000
Manambady . . . . .	3,230	88,000	2,200	60,000	3,230	88,000
Neidavasal . . . . .	4,890	1,33,000	4,700	1,28,000	8,780	2,39,000
Tranquebar . . . . .	2,350	54,000	2,610	71,000	3,860	1,05,000
Total . . . . .	44,120	11,91,000	55,140	15,01,000	80,480	21,91,000

The analyses of salt from three of the factories as supplied to us by the Salt Department are given in Table LXXXIV:

TABLE LXXXIV.—COMPOSITION OF SALT IN THE CUDDALORE CIRCLE  
CIRCLE

(Per cent on dry basis)

	Markanam	Cuddalore	Manambady	Tranquebar
Sodium chloride . . . . .	94.75	96.69	92.25	90.63
Calcium sulphate . . . . .	0.62	0.58	0.49	0.42
Magnesium sulphate . . . . .	1.02	0.33	2.64	3.05
Magnesium chloride . . . . .	1.89	..	3.52	4.70
Insolubles . . . . .	0.42	1.80	0.79	0.42
Undetermined . . . . .	1.30	0.60	0.31	0.78
Total . . . . .	100.00	100.00	100.00	100.00

Except at Cuddalore the quality of the salt produced is poor. Even at Markanam where the multiple irrigation system is followed, the quality is below expectation and could be improved considerably. The high content of magnesium salt would suggest that the bitterns are not discharged and remain adhering to the crystals of salt. Even at Cuddalore, the high percentage of insolubles points to carelessness in the harvesting of salt. A considerable improvement in quality can be obtained by realigning the areas under cultivation

## 3.6 ADIRAMPATNAM CIRCLE.

3.6.1 There are eight factories in this circle of which the Negapatam Vedaranyam, Tambikottai, Adirampatnam and Kattumavadi are in the Tanjore District and the remaining three, *viz.* Theethandathanam, Vattanam and Morekolam are in the Ramnad District. The rainfall in this area varies from 37 to 57 inches, most of it falling from the middle of September to the end of December. Some showers also occur in April and May, but they do not generally interfere with the manufacturing operations. Table LXXXV shows the average rainfall at Vedaranyam for the ten years from 1940 to 1949 during the different months of the year as also the maximum and minimum in a month in any particular year.

TABLE LXXXV.—RAINFALL AT VEDARANYAM 1940—1949  
(In inches)

Months	Average	Maximum	Minimum
January . . . . .	1.37	3.49	0.00
February . . . . .	0.29	0.96	0.00
March . . . . .	0.94	2.84	0.00
April . . . . .	2.85	5.55	0.00
May . . . . .	2.47	11.52	0.00
June . . . . .	0.92	2.51	0.06
July . . . . .	4.08	9.63	0.35
August . . . . .	3.55	6.23	1.40
September . . . . .	5.72	12.32	0.86
October . . . . .	8.34	13.87	4.44
November . . . . .	11.42	23.32	2.14
December . . . . .	5.42	15.21	0.1
TOTAL-	47.37		

The single irrigation system is followed in all the factories and the two important factories we visited in this circle were Vedaranyam and Adirampatnam.

3.6.2 *Vedaranyam*.—This factory is situated on the fringe of the Vedaranyam swamp. The factory works on a 25 years' lease which is terminable on 31st December 1967. It has three blocks and is worked by 83 licensees. A sum of Rs. 261 is paid by this factory as land assessment and educational cess to the Government of Madras. No other rent, not even ground rent, is paid by the factory. The total area under cultivation is 232 acres of which the largest individual unit is 96 acres. The brine is obtained from shallow pits of 10 to 15 ft. depth and its density varies from 8° to 21° Be' as the season progresses. Owing to the high density of brine no reservoir is provided in the factory and even condensers did not exist until 1948. The total area under condensers and crystallisers was 25 and 207 acres respectively but from 1949 however, steps are being taken to increase the area of the condensers and reduce that of the crystallisers. When this work is completed it is expected that there will be 70 acres under condensers and 162 acres under crystallisers giving a ratio of 1:0.44. This ratio is utterly inadequate and the

area should be redistributed to give a ratio of 1:3 i.e. 58 acres under crystallisers and 173 acres under condensers. The size of the crystallisers varies in dimension from 20 ft. × 11 ft. to 23 ft. × 15 ft. The analysis of pit brine from Vedaranyam is compared in Table LXXXVI with that of sea brine:

TABLE LXXXVI.—COMPOSITION OF PIT BRINE FROM VEDARANYAM

(Percent on dry basis)

	Pit brine	Sea brine
Sodium chloride . . . . .	60.03	80.22
Calcium sulphate . . . . .	6.18	3.60
Magnesium sulphate . . . . .	11.01	4.74
Magnesium chloride . . . . .	22.70	10.88
Undetermined . . . . .	0.08	0.56
	100.00	100.00

It will be seen that the pit brine is richer in magnesium salts and calcium sulphate than sea brine and contains correspondingly smaller quantity of sodium chloride. This brine is partly subsoil in origin and partly obtained from the neighbouring swamp over which sea water collects during the months of May and June and is diverted by channels into the pits to supplement the subsoil brine supply. The brine is lifted from the pits with *picotahs* and charged directly into the crystallisers. Owing to the presence of large quantities of magnesium salts in the brine, common salt does not begin to crystallise even at a density of 27° Be'. This is due to the fact that this density is reached even before the brine gets saturated in respect of the sodium chloride. This feature becomes more pronounced in April and May when westerly winds carry the dust rich in magnesium salts from the swamp into the crystallisers. We collected samples of this dust at the time of our visit in April 1949 and its analysis is shown in Table LXXXVII:

TABLE LXXXVII.—COMPOSITION OF SWAMP DUST COLLECTED AT VEDARANAM

(Percent. on dry basis)

	Sample No. 1	Sample No. 2
Sodium chloride . . . . .	2.53	6.73
Calcium sulphate . . . . .	6.71	6.50
Magnesium sulphate . . . . .	3.30	0.64
Magnesium chloride . . . . .	8.40	7.53
Insolubles . . . . .	79.03	78.50
	100.00	100.00

The large quantities of magnesium salts contained in the dust force up the density of the brine in the crystallisers without increasing proportionately its sodium chloride content and the crystallisation of salt is delayed. Despite the high density of the brine, salt is not manufactured by the multiple irrigation system. The salt produced is of the light variety though the manufacturers were unanimously in favour of producing the heavier variety if the sale of salt

by measure were banned in Madras Province. The quality of the salt produced is unsatisfactory as will be seen from the following analysis:

	Sample No. 1	Sample No. 2
Sodium chloride . . . . .	93.53	92.3
Calcium sulphate . . . . .	0.59	0.4
Magnesium sulphate . . . . .	2.08	0.5
Magnesium chloride . . . . .	2.83	4.3
Insolubles . . . . .	0.87	0.3
Undetermined . . . . .	0.10	1.9
<b>TOTAL</b>	100.00	100.00

3.6.3. During our visit, it was represented to us, that the factory was suffering from lack of transport facilities which prevented it from increasing its output. The factory is served, by the railway station of Agastiyampalli, which is at a distance of 2 miles and to which salt has to be sent by small boats or bullock carts. This not only involves double handling but is also costly and increases the price of salt on an average by Rs. 5-15-3 per ton (Re. 0-3-6 a maund). The factory has been pressing the South Indian Railway for many years to provide a siding from the railway station to the storage platform so that salt may be loaded into the wagons at the factory site. Since the Railway is earning a substantial revenue from the salt loaded at the Agastiyampalli station [in the year 1948 the freight earned by the Railways was Rs. 5.84 lakhs on a total despatch of 41,330 tons (11.25 lakh maunds) of salt], we consider that the request of the factory for railway siding is reasonable and should be complied with. As the factory is owned by several licensees, it might be difficult for the Railways to recover the cost of the siding from each of the licensees, we recommend that the siding be constructed by the Railways at their own cost and a small charge of Rs. 1-11-3 per ton (Re. 0-1-0 per md.) be levied from the manufacturers so as to recover the cost of the siding over a period of years. This facility will reduce the price of salt of this factory by about Rs. 4-4-0 per ton (Re. 0-2-6 per md.) Another representation that was made to us was with regard to the carriage of salt from the factory to Topputurai port for shipment by sea. At present there is a canal leading from the factory to this port which is at a distance of about 5 miles and where it should be possible to load salt into sea going vessels. Unfortunately, the canal has been badly silted up and a bar has been formed at its mouth. It was urged that the canal should be cleaned and the bar opened to enable the boats to ply between the factory and the port. We endorse the request of the factory and recommend that steps be taken to clean the canal to make it navigable. We are not in a position to say whether it would be possible for steamers to load salt at Topputurai. As however, the canal extends up to Negapatam which is at a distance of 25 miles from Vedaranyam and where better facilities for shipment are no doubt available, we recommend that this question be examined sympathetically. As Vedaranyam factory has all the facilities for producing salt of good quality by changing the present method of production, we believe that by opening the canal it may be possible to ship this salt to Calcutta. It was represented to us that the salt as produced at present should be allowed to be sold in the Calcutta market under the zonal system. Since the zonal distribution is applicable only to movement by rail, there is no ban on the sale of Vedaranyam

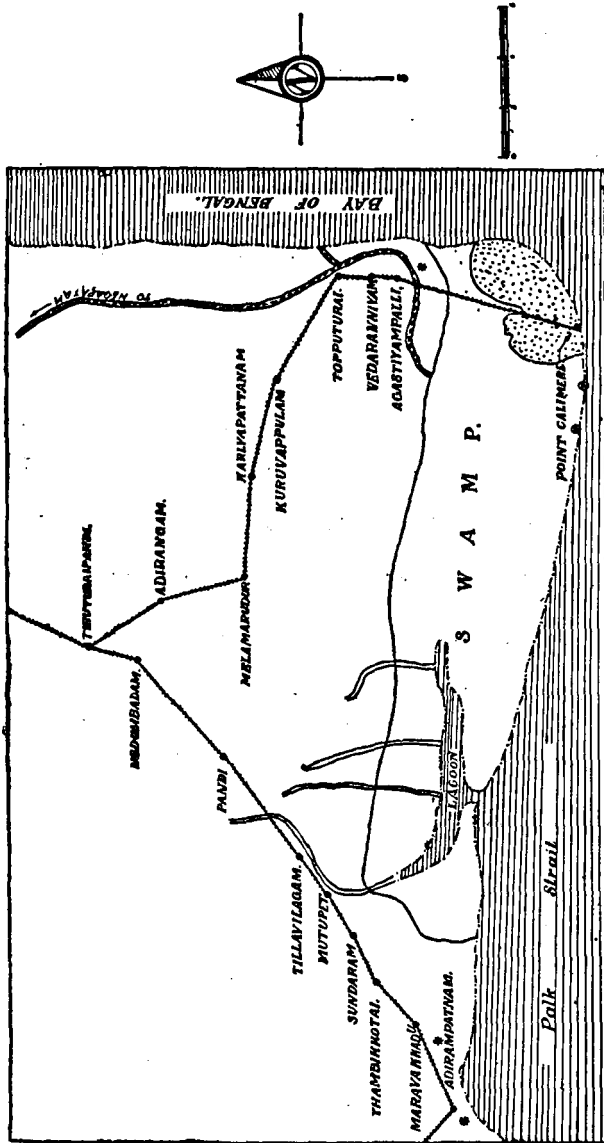
or any salt in the Calcutta market, if it is sent by sea. Knowing however the requirements of the market, we are convinced that Vedaranyam salt with a sodium chloride content of 92—93 per cent. will not find favour in that market, unless the quality of Vedaranyam salt is considerably improved. It is, therefore, upto the Vedaranyam manufacturers to improve the quality of their salt to suit the requirements of the Calcutta market.

3.6.4 For better quality of salt to be produced, the Vedaranyam factory should in the first instance switch over to the multiple irrigation system. The cost of manufacture will be reduced by this change over. Further economies can be effected by replacing the *picotahs* by electric pumps. We understand that the South Madras Electric Corporation of Tiruchirapoly (former Trichinopoly) are extending their former lines from Tiruturaipundi as a result of which, power would be available to Vedaranyam and advantage should be taken of it by the salt factory. When pumps are however, installed, care should be taken to see that money is not wasted on installation of a large number of small pumps for each individual licensee. If the factory were realigned and jointly operated by the licensees with common condensers, the cost of lifting the brine could be reduced. For this purpose, we recommend that the entire factory be converted into a single large co-operative unit.

3.6.5 *Vedaranyam Swamp*.—This swamp runs to a distance of about 28 miles along the coast, from Vedaranyam in the East to Muthupet in the West. It is 5 to 6 miles broad and covers an area of 144 sq. miles. It is more or less rectangular in shape and two of its sides lie along the sea coast, one along the Bay of Bengal to the east and the other along Palk Strait to the south, the tip of high land known as Point Calimere, forming a common corner of these two sides. Towards the western end of the swamp there is a fresh water lagoon into which four fresh water streams flow during the rains. The lagoon is seven miles long and half to one mile wide. During high tides in May and June, the sea flows into the swamp from the Palk Strait through two creeks and submerges it entirely cutting off Point Calimere from the mainland for several weeks. The tidal water finds an outlet into the Bay of Bengal through creek adjoining the Vedaranyam factory. When the high tides subside, the sea water recedes partly into the Palk Strait through the same creeks, through which it entered leaving behind a sheet of water in the swamp which gets rapidly evaporated and deposits salt over a wide area of the swamp. A sketch of the swamp is shown in Figure 7. In October, when the monsoon commences, rain water flows into the swamp through six small rivers and the spontaneous salt is washed back into the sea. If properly utilised, the Vendaranyam swamp is a promising source of supply of salt and could materially add to the production of the country. It has so far received very little attention. As far back as 1874, according to Ratton, about 27,500 tons (7½ lakh mds.) of spontaneous salt used to be collected from the swamp for consumption in the neighbouring areas. As it was difficult to control the collection of this salt for the purpose of excise duty, the collection was banned except for a small quantity which was allowed for fish curing purposes. Special preventive establishment was employed to prevent the collection of this valuable salt by smugglers. After the Gandhi-Irwin Pact of 1931, permission was granted to the villagers residing adjacent to the swamp to collect a limited quantity of this salt for their personal consumption. When the Government of India removed the restrictions on the collection, transport, storage and sale of spontaneous salt in 1948, the collection is estimated to have increased to about 7,300 tons (2 lakh mds.). Not only the villages adjacent to the swamp but also those from distant village have taken

advantage of this concession. In fact it has been reported that one or two merchants from Point Calimere have employed labour to collect the salt and sell it in competition with the salt produced at the Vedaranyam factory. As the quality of spontaneous salt is superior to that produced in the factories, being purer and whiter, containing 96 to 98 per cent. sodium chloride it is but natural that it finds a ready market. If energetic efforts are made and a systematic collection organised, it should be easy to collect several times this quantity.

FIG. 7. VEDARANYAM SWAMP



- References.
- Rivers.
  - Canals.
  - Rly. Line.
  - Salt factory.
  - Forest.
  - Creeks.

3.6.6 As we found during our visit in April 1949 that very little data had been collected about the formation of salt in the swamp, we recommended to the Salt Department to post a special officer from May 1949 to October 1949 to collect information on the following points:

- (a) the inlets through which the tidal waters from the Palk Strait enter the swamp;
- (b) the outlets through which this water flows into the Bay of Bengal;
- (c) the areas in the swamp that are inundated during these high tides;
- (d) a weekly record of the density of brine and its depth at different points;
- (e) the locations where the brine attains the maximum density;
- (f) the areas where the formation of salt first appears and the period taken for it;
- (g) the analyses of samples of spontaneous salt collected from different points;
- (h) the date of commencement of the rains, the amount of rainfall and its effect on the density of brine and the salt formations;
- (j) the streams that flow into the swamp during the rainy season;

3.6.7 The Salt Department acted on our recommendation and appointed a Deputy Superintendent with two Inspectors to carry out this investigation. They have submitted a report, which is summarised below:

(a) The high tides started on the 24th of May and continued for about a month. The tidal waters flowed into the swamp, continuously at two points, one about three miles and another about 5 miles to the West of Point Calimere through an opening about 60 ft. wide and  $2\frac{1}{2}$  to 3 ft. deep. In addition to this the sea water flowed into the swamp all along the coast, when the tides were particularly high and were accompanied by strong winds.

(b) The tidal waters overflowed into the Bay of Bengal through a creek situated to the south of the Vedaranyam salt factory. A part of this water was impounded by the Vadaranyam licensees and drawn through channels into their pits for supplementing their supply of brine.

(c) By about the 6th of June, the swamp was covered with brine to depths varying from  $\frac{1}{2}$  to 2 ft. except for seven high maunds which remained above the water level and formed into seven little islands.

(d) The density of the incoming brine was about  $4^{\circ}$  Be' and at places it was as high as  $11^{\circ}$  to  $16^{\circ}$  Be'. It was however, noticed that the density fluctuated from time to time owing to tidal fluctuations and sporadic showers of rain.

(e) The spontaneous salt formation was first noticed on the 8th of June, within 15 days at a distance of 4 furlongs from the Vedaranyam factory. This was followed, by extensive formations all along the swamp within a week particularly opposite the villages of Kandinavayal, Thennadar and Pannal. In the last week of June, the formations were noticed all over the swamp over an area of 12 sq. miles. The thickness of the crust varied from  $\frac{1}{2}$  to 1 in. Calculating on the basis, that one acre inch of salt weighs 110 tons (about 3,000 mds.) the quantity of salt formed to an average thickness of  $\frac{3}{4}$  inch in the swamp is computed to be about 6 lakhs tons (160 lakh mds).

(f) Analyses of three samples of spontaneous salt collected at three different points in the swamp is given in Table LXXXVIII:

TABLE LXXXVIII.—COMPOSITION OF SPONTANEOUS SALT IN VENDARANYAM SWAMP

(Percent. on dry basis).

	Sample No. 1	Sample No. 2	Sample No. 3
Sodium chloride . . . . .	96.80	96.10	98.30
Calcium sulphate . . . . .	0.22	0.73	0.17
Magnesium sulphate . . . . .	0.16	..	..
Magnesium chloride . . . . .	..	0.01	0.15
Insolubles . . . . .	0.58	2.57	0.16
Undetermined . . . . .	2.24	0.59	1.22
	100.00	100.00	100.00

The sodium chloride content of all the samples can stand comparison with the best solar salt produced in India.

(g) During this year, the rains commenced rather early in the season and 15.53 inches were recorded by the end of September 1949. The first fall was recorded on 18th June and as it rained only 10 cents, it did not bring about any change in the density of brine or interfere with the salt formation. On 2nd July, when there was a rain of 49 cents, it brought down the density of brine in certain portion of the swamp from 27° to 25° Be', while in other parts to as low as 9° Be'. The subsequent rains washed down a good portion of the spontaneous salt. The rainfall in the swamp as recorded near the Vedaranyam factory is given below:

	Inches.
June . . . . .	0.10
July . . . . .	5.89
August . . . . .	8.41
September . . . . .	1.13
Total . . . . .	15.53



(h) About seven streams flow into the swamp carrying most of the flood water from the surrounding area.

3.6.8 It was reported that within two weeks of the entry of sea water into the swamp, the brine over a large area reached a density of 24° Be to a depth of about 1 to 2 ft. This rapid rise in the density in such a short period was evidently due to the sea water dissolving the salt from the saline earth. If all the water which the receding tides leave behind in the swamp could be utilised for salt manufacture, the production would more than meet the entire requirements of the country. The main problem in its utilisation is its storage and prevention of dilution by the rain water that flows into the swamp. This is a civil engineering problem which should be examined in detail if it is found necessary to increase the production of salt in and near Vedaranyam. For the present we recommend that steps be taken to organise the collection of spontaneous salt on as extensive a scale as practicable. In addition salt could be produced for a period of about three months from the high density brine available in the swamp in pans laid along the northern fringe of the swamp, provided that arrangement is made for the transport of salt either into the interior or by canal to Topputurai or Negapatam for shipment to Calcutta. There is an area of about 400 acres to the South of the Vedaranyam factory on the south of the creek connecting the Bay of Bengal, which could be brought under salt cultivation by utilising the high density brine from the swamp. It is believed by the licensees in Vedaranyam that if this area were cultivated, the dust nuisance would be reduced. We do not attach any importance to this view but as the railway runs very close to this site, we recommend that it be brought under cultivation. The existing licensees might be given the first option to develop this site on a co-operative basis provided that they undertake to lay down salt works on model lines.

3.6.9 *Adirampatnam*.—This factory is situated to the south of the Vedaranyam swamp at a distance of about 40 miles from Vedaranyam. It covers a cultivated area of about 358 acres and is worked by 10 licensees. An area of 240 acres is worked by one licensee and another 84 acres by the Mettur Chemicals and Industrial Corporation Ltd. Both these licensees work under the Modified Excise system. The remaining 34 acres are worked by eight licensees mainly under the Excise system. In the works of the biggest licensees, the area under reservoir, condensers and crystallisers is each of 80 acres which gives a ratio of crystalliser to reservoir cum condenser of 1:2.

3.6.10 The Mettur Chemicals have distributed the 84 acres of cultivated area in their works as follows:—

Reservoirs . . . . .	54 acres
Condensers . . . . .	9 "
Crystallisers . . . . .	18 "
Crude salts and byproduct Crystallisers . . . . .	3 "
	<hr/>
TOTAL	84 "
	<hr/>

which gives a ratio of 1:3.5. These works originally formed a part on the works run by the biggest licensee and were taken over by Mettur Chemicals in 1942 in order to produce sulphate free salt for their alkali factory at Mettur Dam as the salt locally available was contaminated with a high percentage of sulphates and cost them a considerable sum in purifying it. As the salt that was being produced by the main licensees was also not upto the requirement of the chemical plant, Mettur Chemicals modified the salt works gradually in accordance with the layout suggested to them by the Travancore Model

station. These modifications have cost about Rs. 30,000 and they have been carried out without loss of production, even for a single season. The brine is drawn directly from the sea and pumped into the reservoir which is divided into 5 unequal parts. By the time it reaches the last part of the reservoir, the brine has attained a density of 15° Be'. It is then pumped into the first set of condensers which is divided into eight compartments, the size of each being 350 ft. × 80 ft. From there it flows into the second set of condensers which is also divided into eight divisions and by the time the brine has reached the last division of this set of condensers it attains a density of 23° Be'. The gypsum separates out in the last four divisions of the second set of condensers. The condensed brine is then fed into 108 crystallisers each of 125 ft. × 40 ft. The bitterns are drained out at 29.5° Be' and the salt is scraped only after fresh condensed brine is fed into the crystallisers. The single irrigation system is followed and salt is collected once in every 3 to 5 days when the crust is  $\frac{1}{2}$  to  $\frac{3}{4}$  inch thick. Some pans are also worked by the accretion system where the crust is allowed to grow for about 45 days before it is harvested. The bitterns are first discharged into the crude salt recovery pans and thereafter taken to the byproduct pans for the recovery of crude magnesium sulphate by solar evaporation. This work is still in an experimental stage and needs to be developed. A laboratory has been provided at the works and is staffed by two chemists who carry out apart from routine control tests and experiments on the accretion system of manufacture and the recovery of byproducts by solar evaporation. The salt produced is of the heavy type and the bulk of it is consumed by the alkali plant at Mettur dam. The small surplus is sold but does not find a ready market owing to the system of sale of salt by measure. The manufacturers claimed that their salt had 96.97 per cent. sodium chloride. Though the salt appeared white in colour the analyses of samples collected by us showed the sodium chloride content to be less than 95 per cent as seen from Table LXXXIX:

TABLE LXXXIX.—COMPOSITION OF SALT FROM THE WORKS OF METTUR CHEMICALS, ADIRAMPATAM

	Single Irrigation Method		Accretion Method	Crude salt
	Guindy Laboratory	Works Laboratory		
Sodium chloride . . . . .	94.51	96.51	94.82	92.02
Calcium sulphate . . . . .	1.53	0.55	0.88	0.40
Magnesium sulphate . . . . .	0.15	1.09	0.38	1.38
Magnesium chloride . . . . .	0.89	1.11	0.86	2.19
Insolubles . . . . .	1.28	0.74	0.36	0.95
Undetermined . . . . .	1.64	..	2.70	3.06
	100.00	100.00	100.00	100.00

The analyses of the samples drawn by us were carried out by King's Institute at Guindy, Madras. As the figure of undetermined components reported by the Guindy laboratory is very high, we have, therefore, deemed it advisable to show in the above Table an analysis as communicated to us by the manufacturers.

3.6.11 Even from the analysis furnished by the Works themselves, it would appear that proper control is not exercised in the discharge of the bitterns as otherwise the presence of nearly 1 per cent. of magnesium sulphate in the salt could not be accounted for. This is in spite of the fact that separate crystallisers have been set apart for the recovery of crude salt from the bitterns. The percentage of gypsum is also comparatively high. This can be explained by the fact that the condenser area is inadequate to permit all the gypsum to separate out. We recommend that the areas under cultivation be re-distributed as under so as to give an approximate ratio of 1 to 6 between the crystallisers and reservoir cum condensers:

	Acres
Reservoir . . . . .	39
Condensers . . . . .	30
Crystallisers . . . . .	12
Crude salt and byproduct crystallisers.	3

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84

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This will result in an improvement in the quality of salt produced and salt will then become better suited for the alkali industry. The area of the factory should also be increased from 84 to 100 acres and when this is done the areas under cultivation should be increased proportionately. The cost of manufacture was given to us at Rs. 16-8-0 per ton (Re. 0-9-8 per md.) which compares favourably with the cost of similar salt in Kathiawad. As the climatic conditions are favourable we recommend that the multiple irrigation system be adopted throughout the works in order to produce a better quality of salt, improve the yield and reduce the cost. In offering this criticism, we should not be misunderstood. We have no hesitation in saying that of all the works in the Madras Province we have visited, the works of Mettur Chemicals are the best and deserve to be congratulated on their initiative in adopting scientific methods of manufacture. We commend their example to other licensees not only in Adirampatnam but throughout the Madras Province.

3.6.12 *Negapatam, Tambikottai, Kattumavadi, Theethandathanam, Vattanam and Morekolam.*—Except for the Tambikottai factory, the other factories in Adirampatnam Circle are small and cover an area from 33 acres to 77 acres. As we did not visit any of these factories, we are unable to comment on the quality of their salt, but it will be seen from Table LXXII that the ratio of crystallisers to reservoir cum condensers in all the cases is extremely unsatisfactory. We recommend that the areas in these factories should in the first instance be increased to 100 acres each and the areas be redistributed to give a ratio of 1:4 to 1:6 depending upon the density of brine used.

3.6.13 The production of salt in the Adirampatnam Circle for the three years 1946 to 1948 is shown in Table XC:

TABLE XC.—PRODUCTION OF SALT IN ADIRAMPATNAM CIRCLE 1946—1948

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
1. Negapatam . . . . .	1,690	46,000	1,400	38,000	3,310	90,000
2. Vedaranyam . . . . .	29,030	7,90,000	39,570	10,77,000	64,140	17,46,000
3. Adirampatnam . . . . .	10,540	2,87,000	5,140	1,48,000	23,470	6,39,000

TABLE XC (contd.)

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
4. Tambikottai . . . . .	1,730	47,000	620	17,000	5,030	1,37,000
5. Kattumavadi . . . . .	3,780	1,03,000	3,080	84,000	4,520	1,23,000
6. Theethandathanam . . . . .	2,530	69,000	660	18,000	3,310	90,000
7. Vattanam . . . . .	3,230	88,000	2,020	55,000	4,560	1,24,000
8. Morekolam . . . . .	2,530	69,000	990	27,000	5,840	1,59,000
	55,060	14,99,000	53,780	14,64,000	1,14,140	31,08,000

## 3.7 Tuticorin Circle

3.7.1. Salt is manufactured along the coast of the Gulf of Manaar for a distance of 60 miles starting from Vepalodai in the North to Kulasekarapatnam in the South. There are 10 factories in this circle and all of them are situated in the Tinnevely District. Vepalodai and Arasadi are to the north of Tuticorin, Sevandakulam, Levingipuram, Karapad, Urani and Urani Extension are around Tuticorin Town whilst Armuganeri, Kayalapatnam and Kulasekarapatnam are to the south of Tuticorin. These factories cover an area of about 1,500 acres. We visited the factories at Levingipuram, Karapad, Urani and Urani Extension. In addition, small scale manufacture is practised extensively under the 10 acre concessions. The total area of such small works is equal to about  $\frac{1}{10}$ th the area of the factories. These small works usually adjoin the swamps in this area and their production is supplemented by the spontaneous salt formations in the swamps. The rainfall varies from 14.5 to 50 inches, most of it falling in November and December. Slight showers are, however, experienced during the south-west monsoon, i.e., in the months of March and April. The rainfall even in the months of November and December is not heavy and in years of low rainfall the factories work without a break. The manufacturing season therefore extends for 10 months in the year. The innumerable bays and swamps and the subsoil sources of high density brine add to the suitability of this circle for salt manufacture. In spite of these excellent facilities, salt is manufactured by the single irrigation system and the salt produced is inferior in quality. Table XCI shows the average rainfall for the ten years 1938-1947 at Karapad together with the maximum and minimum in a month in any particular year.

TABLE XCI.—RAINFALL AT KARAPAD 1938—1947  
(in inches)

	Average	Maximum	Minimum
January . . . . .	0.82	4.03	0.00
February . . . . .	0.97	3.04	0.00
March . . . . .	1.35	4.40	0.00
April . . . . .	2.32	5.67	0.27
May . . . . .	0.83	3.06	0.00
June . . . . .	0.40	3.76	0.00
July . . . . .	0.02	0.18	0.00

TABLE XCI (contd.)

	Average	Maximum	Minimum
August . . . . .	0.06	0.27	0.00
September . . . . .	0.42	1.73	0.00
October . . . . .	3.84	10.34	1.08
November. . . . .	7.88	27.30	0.00
December . . . . .	4.90	17.87	0.08
TOTAL . . . . .	23.81		

3.7.2. *Vepalodai and Arasadi*.—These two factories cover a cultivated area of 89 acres and 51 acres respectively. The Vepalodai factory is run by a single licensee under the Modified Excise system; its source of brine is the sea and the brine is pumped into a reservoir covering an area of 42 acres. The condensers and crystallisers are 16 and 31 acres respectively and give a ratio of crystallisers to reservoir cum condensers of 1:1.9. The factory at Arasadi is worked by 14 licensees. The brine is used both from the sea and pits. The pit brine varies in density from 7° to 10° Be'. As these factories are small uneconomical units, we recommend that they should be extended to a minimum of 100 acres each. The factory at Arasadi should also be worked as a single co-operative unit.

3.7.3 *Savandakulam*.—This factory covers an area of 217 acres and is run by 30 licensees. Pit brine is mainly used which is sometimes supplemented with sea brine. Some of the bigger lessees use pumps to draw brine from the sea, whilst at the pits the usual *picotahs* are used. The ratio of crystalliser to reservoir cum condensers is 1:1.4 which is totally inadequate and the areas should be redistributed to give a ratio of 1:4.

3.7.4 *Levingipuram*.—The cultivated area in the factory is 204 acres and is worked by 101 licensees. The brine is obtained in the small works from pits and is lifted with *picotahs*. The pit brine varies from 8° to 13° Be' in density. In the larger works the pit brine is supplemented by sea brine. About 74 acres of this factory *viz.*, Levingipuram, plot No. 111 was laid out by Government in 1918 as a model factory and worked departmentally for a short time, but it was leased out in 1921 and is still worked by a private party. It has 4 acres under reservoirs and 35 acres each under condensers and crystallisers. It has the advantage of supply of pit brine as well as sea brine and can become a model to the surrounding factories. When it was first laid out by Government, the areas of the crystallisers, condensers and reservoirs were properly proportioned, but since then the lessees have redistributed them on the same lines as the remaining factories in this area. We understand that the original lease of the factory has already expired and that only short extensions have been given to the lessee. We recommend that this factory should be remodelled on the lines suggested by us in the Chapter on Model Factories and Research Stations and run departmentally by Government as a Model Factory.

3.7.5 *Karapad*.—The total cultivated area of the factory is about 190 acres and is worked by 47 licensees. The largest works cover 124 acres and is known as the Machado factory. The area of reservoir is 51 acres and the ratio of the

areas of crystalliser to condenser cum reservoir is 1:2. The brine is drawn from the sea through a creek and is lifted manually. These works are in no way different in layout and quality of salt produced from the small holdings in the rest of the factory. These works should be relaid to give a ratio of 1:5 and the smaller licensees should be combined to form into a co-operative unit having a minimum of 100 acres under cultivation.

3.7.6 *Urani*.—The total cultivated area of this factory is 323 acres and is worked by 7 licensees. The largest unit consists of 124 acres and is worked under the Modified Excise system; the ratio of the areas of crystalliser to reservoir cum condenser is 1:1.5. The brine is drawn from the sea through a channel and is lifted with electric pumps. Another 39 acres which originally formed a part of these works are now worked as an independent unit with 7 acres under reservoirs and 16 acres each under crystalliser and condensers. This factory also draws brine from the sea by means of pumps and as the channel carrying the brine is fairly long, the brine attains a density of 5° to 6° Be' by the time it reaches the reservoirs. These works should be merged either with the parent works or with the remaining four small licensees to form a single co-operative unit of 131 acres. The areas should be redistributed so as to give a ratio of 1:5.

3.7.7 *Urani Extension*.—This factory covering 335 acres of cultivated area was laid out in 1944 and is run by a single licensee, the Tuticorin Salt Refineries Ltd. It is better laid out than the other factories with 99 acres of reservoirs, 174 acres of condensers and 62 acres of crystallisers giving a ratio of crystalliser to condenser cum reservoir of 1:4.4. The brine is drawn from the sea through a long channel and is lifted into the reservoir with electric pumps. The terms of licence of this factory provide that they should produce salt fit for the Bengal market but they have not yet achieved a quality suitable for this market. If they were to change over to the multiple irrigation system, the appearance and quality of their salt could be considerably improved. At present they follow the single irrigation system and scrape the salt every 3 or 4 days when it has formed only as a thin crust. This frequent scraping contaminates the salt with clay and discolours it. By adopting the multiple irrigation system and allowing the crust to grow from 3 to 4 inches and maintaining a proper control on the density of the brine, salt of much better appearance and quality could be harvested, which after crushing would be more acceptable to the Bengal market.

3.7.8 *Kayalpatnam and Armuganeri*.—These factories are situated close to each other towards the south of Tuticorin and cover a cultivated area of 70 and 158 acres respectively. The former factory is sub-divided into 280 small holdings and the latter into 90 holdings. The brine is mainly obtained from pits but it is supplemented by sea brine. These works are badly laid out and run on primitive lines. We recommend that the area of the Kayalpatnam factory be increased to 100 acres and both of them converted into co-operative concerns and worked as single units.

3.7.9 *Kulasekarapatnam*.—This is a small factory covering only 18 acres of cultivated area and is run by a single licensee. The source of brine is a river creek through which the sea water rises during tides. A pump is used to lift the brine into the reservoir. The ratio of crystalliser to reservoir cum condenser is 1:2. This factory is an uneconomic unit and should be extended to 100 acres and should be relaid to give a ratio of 1:5.

3.7.10 The production of salt in the Tuticorin Circle for the three years 1946 to 1948 is shown in Table XCII.

TABLE XCII.—PRODUCTION OF SALT IN TUTICORIN CIRCLE 1946—1948

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
1. Vepalodai . . . . .	9,220	2,51,000	8,160	2,22,000	12,970	3,53,000
2. Arasadi . . . . .	6,360	1,73,000	7,090	1,93,000	8,450	2,30,000
3. Sevendakulam . . . . .	36,840	10,03,000	33,650	9,16,000	46,870	12,76,000
4. Levingipuram . . . . .	24,500	6,67,000	31,960	8,70,000	36,370	9,90,000
5. Karapad . . . . .	23,510	6,40,000	20,130	5,48,000	29,130	7,93,000
6. Urani . . . . .	30,380	8,27,000	30,270	8,24,000	38,020	10,35,000
7. Urani Extension. . . . .	5,220	1,42,000	6,720	1,63,000	14,400	3,92,000
8. Kayal Ratnam . . . . .	9,840	2,68,000	10,140	2,76,000	11,940	3,25,000
9. Armugneri (Keeranur). . . . .	17,520	4,77,000	18,220	4,96,000	22,190	6,04,000
<b>TOTAL</b> . . . . .	<b>1,63,390</b>	<b>44,48,000</b>	<b>1,66,340</b>	<b>45,28,000</b>	<b>2,20,340</b>	<b>59,98,000</b>

The analyses of samples of salt drawn by us from some of the factories during our visit are shown in Table XCIII:

TABLE XCIII.—COMPOSITION OF SALT IN TUTICORIN CIRCLE

(Percent ; on dry basis)

	Levingipuram	Karapad	Urani	Unlicenced factories	
				No. 1	No. 2
Sodium chloride . . . . .	92.22	90.84	95.47	96.62	95.84
Calcium sulphate . . . . .	1.87	1.88	0.30	0.35	0.73
Magnesium sulphate . . . . .	0.55	2.16	1.19	0.63	0.59
Magnesium chloride . . . . .	2.74	1.73	1.75	0.86	0.88
Insolubles . . . . .	0.62	2.24	0.04	0.46	0.64
Undetermined . . . . .	2.00	1.15	1.25	1.08	1.32
<b>TOTAL</b> . . . . .	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

From these analyses, it will be seen that the purity of salt varies from 90.84 to 96.62 per cent. Notwithstanding the fact that the conditions of manufacture are far from satisfactory, the unlicenced factories appear to produce better salt than some of the licenced factories. We were told that some of the enlightened manufacturers who wished to modify their layout and adopt modern methods of manufacture to produce salt of better quality were deterred from doing so for fear the product would be of the heavy variety and would not find a market within the province and the neighbouring areas where salt is sold by measure.

#### 4. Annual Production and Quality.

4.1 The total production of salt in the Madras State for all the circles for the three years 1946 to 1948 is summarised in Table XCIV.

TABLE XCIV.—ANNUAL PRODUCTION OF SALT IN MADRAS 1946—48

Name of Circle	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
(a) Naupada . . . . .	89,280	24,30,000	1,42,710	38,85,000	1,12,660	30,67,000
(b) Pennuguduru . . . . .	73,800	20,09,000	1,01,420	27,61,000	1,10,500	30,09,000
(c) Madras . . . . .	87,830	23,91,000	1,14,650	31,21,000	1,70,410	46,39,000
(d) Cuddalore . . . . .	44,120	12,01,000	55,140	15,01,000	80,480	21,91,000
(e) Adirampatnam . . . . .	55,060	14,99,000	53,780	14,64,000	1,14,180	31,08,000
(f) Tuticorin . . . . .	1,63,390	44,48,000	1,66,340	45,28,000	2,20,340	59,98,000
	5,13,460	1,39,78,000	6,34,040	1,72,60,000	8,08,570	2,20,12,000

This production which represents about one-third of the total production of India places Madras in the foremost position among the various salt producing States in the country.

4.2 We have already given the analyses of salt produced in the different circles of Madras. The sodium chloride content of manufactured salt varies from 89.20 to 96.92 per cent. One of the samples of spontaneous salt which we collected from the Vedaranyam swamp showed as high a sodium chloride content as 98.30 per cent. The fact that the quality varies not so much from circle to circle as from factory to factory in the same circle, and the further fact that salt of fair quality is being actually produced in some of the factories show that there is no natural obstacle in the way of manufacture of salt of good quality if only proper attention were paid to the method adopted. We have made detailed recommendations for improving the quality in the previous paragraphs.

4.2.1 One factor which is responsible in a larger degree than any other, for the poor quality of salt is the prevailing practice of sale by measure which has led to the manufacture of lighter and lighter varieties as in Bombay and Travancore. Another factor which is also responsible for the impure quality of salt is the mistaken notion that a larger yield could be obtained by disproportionately increasing the area under crystallisers. In the Madras factories, the ratio of the areas of crystalliser to reservoir cum condensers varies from 1:5, at the Urani Extension factory in Tuticorin Circle to 1:0.01 at the Cuddalore factory in the Cuddalore Circle. These excessive areas under crystallisers give rise to production of salt containing impurities like gypsum, magnesium sulphate and magnesium chloride besides insolubles. The presence of insolubles is invariably due to the fact that the manufacturers resort to frequent scrapings in the harvesting of thin layers of salt following the single irrigation method and thereby collect along with salt, dirt and clay from the beds of the pans. In some cases, it has been reported that clay is even raked up with the salt to discolour it with a view to meeting the prejudices of those markets where, it is alleged, that only dark coloured salt would sell.

4.2.2 As the Madras Presidency has two distinct types of climatic zones, we recommend that in the factories south of Madras Circle, *i.e.*, in Cuddalore, Adirampatnam and Tuticorin the single irrigation system should be replaced by the multiple irrigation system. In the northern circles of Naupada, Pennuguduru and Madras, the single irrigation system may be allowed to continue.



4.2.3 Furthermore the production of the light variety of salt should gradually give place to the heavy variety. For Bombay and Travancore, we have made the same recommendation. While in the Bombay Province many of the factories already produce a part of their salt in the heavy variety, in Madras, except for the factory of Mettur Chemicals at Adirampatnam and the factory at Markanam, the manufacture of heavy variety is unknown. The problem of switching over to the production of heavy salt is beset with difficulties. For Bombay, we have recommended that the transition should take place within a period of 3 years because the manufacturers are already conversant with the process of manufacturing the heavy variety. In Madras, however, the change over might take longer than 3 years. We recommend that the production of heavy variety should be introduced simultaneously in all the circles. In the two southern most circles of Tuticorin and Adirampatnam, the change over should be completed within a period of three years, whilst in the remaining four circles, it may extend to five years. The Tuticorin and Adirampatnam licensees have the advantage of remodelling their works on the lines of the layout adopted by Mettur Chemicals and obtaining guidance and advice from the Model Factory in Travancore. For the other circles, the Salt Department should depute some of their officers in the Madras Province to visit the Travancore Model Factory, the works of the Mettur Chemicals as also the factories in Kathiawad and Kutch with a view to adopting the methods followed for producing the heavy variety of salt.

4.2.4 We reiterate the recommendation made in previous chapters that legislation be passed prohibiting the sale of salt by measure in Madras. If this is done, it would encourage the Madras manufacturers to change over more quickly to the production of heavy variety. The Tuticorin and Adirampatnam manufacturers have expressed to us their willingness to take to the heavy variety if Government impose this ban. In this connection, the Madras Government might well follow the example set by the Government of Bombay, who have recently declared their intention to stop the sale of salt by measure in stages. This order has already come into force in some of the districts of Bombay and is expected to be extended throughout the province in due course.

## 5. Improvement and Extensions.

5.1 In the previous paragraphs, we have already dealt with the improvements to be carried out in the factories in each circle. The common defect that we have seen in almost all the factories is that the areas provided under condensers and reservoirs are inadequate; the condensing area is ridiculously small particularly where pit brine is used. We have, therefore, recommended a redistribution of the areas under cultivation in order to obtain a ratio of 1:4 to 1:7 between the crystallisers and reservoir cum condensers. We have also recommended that wherever the factories are below 100 acres in extent, they should be brought upto 100 acres. Furthermore, those factories which are operated by a number of small licensees should be combined into co-operative groups and worked as single units of not less than 100 acres each. An important source of supply which has not yet been tapped is the spontaneous salt formed in the Vedaranyam swamp. If the collection of this salt is organised properly, several hundred thousands of tons could be collected annually. During our visit to the various circles, we heard complaints that owing to the zonal restrictions in the distribution of salt, a large quantity of salt was not being cleared and had accumulated in the factories. Both at Tuticorin and Vedaranyam we were told by the manufacturers that they saw no purpose in increasing production until more markets were made available to them. It was also urged that salt as now produced should be utilised to

meet the deficit of the Bengal market disregarding the quality demanded by the consumers. We have not seen our way to accept this recommendation, as we do not think it desirable in the interest of the country to reduce the standard of salt or to compel communities which are used to a purer salt to consume inferior grades. We are satisfied that with a little more care, it should be possible to improve the quality and yield of Madras salt substantially in order to meet the requirements of quality of the Calcutta market. Madras is already making a substantial contribution to the production of the country and we do not recommend that any new salt works be opened in this Province. If the existing factories were remodelled, we believe that the production could be considerably improved and a much larger yield obtained. The average yield of salt in the Madras circles based on the production for the three years 1946-48 is shown in Table XCV.

TABLE XCV.—YIELD OF SALT PER ACRE IN MADRAS CIRCLES

Circle	Area under cultivation	Yield per acre	
		Tons	Mds
Naupada . . . . .	Acres 4,310	26	726
Pennuguduru . . . . .	3,022	32	858
Madras . . . . .	3,659	34	920
Cuddalore . . . . .	2,058	29	793
Adirampatnam . . . . .	1,043	71	1,935
Tuticorin . . . . .	1,655	112	3,045
TOTAL . . . . .	15,747	Average 42	1,130

Considering the density of brine used, these yields are far from satisfactory. In the northern circles of Naupada and Pennuguduru the manufacturing season is similar to that of the Bombay Province, whereas in the Madras and Cuddalore circles the season is even longer than in Bombay. For Bombay factories we have estimated that the yield, by a proper redistribution of the areas under cultivation, could be increased to 50 tons (1,360 mds.) per acre. In Madras in view of the fact that many of the factories in these four circles use pit brine of densities varying from 6° to 10° Be', we estimate that on an average the production in these four circles could be increased to 60 tons per acre per annum. This estimate is not excessive in view of the fact that the factories of Pakala in the Pennuguduru Circle, Tada in the Madras Circle and Cuddalore in the Cuddalore Circle already yield appreciably more than 60 tons (1,630 mds.) per acre. In the Adirampatnam and Tuticorin circles, high density pit brine is generally used. The season at both these centres is longer than in northern circles of Madras, and we, therefore, estimate the average annual production in the Adirampatnam Circle at 150 tons per acre, as we have estimated for the Travancore works which use 6° to 8° Be' brine. In the Tuticorin circle, many of the factories are already obtaining yields appreciably in excess of 150 tons per acre, and as the manufacturing season is of at least 10 months' duration, we do not think that a yield of 200 tons per acre (5,440 mds.) would be an over-estimate. On the basis of these estimates, the annual production in Madras Province could be stepped up as given in Table XCVI:

TABLE XCVI.—ESTIMATED PRODUCTION IN MADRAS PROVINCE

Circle	Area under cultivation	Estimated Yield			
		Per acre		Total	
		Tons	Mds	Tons	Mds.
Naupada . . . . .	4,310	60	1,630	2,58,100	70,25,000
Pennuguduru . . . . .	3,022	60	1,630	1,81,000	49,26,000
Madras . . . . .	3,659	60	1,630	2,19,100	59,64,000
Cuddalore . . . . .	2,058	60	1,630	1,23,500	33,62,000
Adirampatnam . . . . .	1,043	150	4,080	1,56,400	42,58,000
Tuticorin . . . . .	1,655	200	5,440	3,30,700	90,03,000
<b>TOTAL</b> . . . . .	<b>15,747</b>	<b>Average 80</b>	<b>2,180</b>	<b>12,68,800</b>	<b>3,45,38,000</b>

In arriving at these estimates, we have not taken into consideration the extension of some of the smaller factories, which we have recommended. It will, therefore, be seen that Madras can easily step up its production to half of the total present requirement of India. We have previously referred to the need for dispersing the production of the country as widely as possible with a view to ensuring easy distribution without long haulages. In the case of Kathiawad and Kutch which are vast potential sources of production, we have recommended that further expansion should aim only at meeting the deficit in Bengal and developing export markets. Similarly, we are of the opinion that further expansion of the area under cultivation in Madras also should be contemplated only for the two purposes stated above. We have already drawn attention to the huge potentialities of the Vedaranyam swamp as a source of supply of salt. A decade hence, views regarding optimum consumption in India for domestic, industrial and agricultural purposes are likely to undergo a radical change. Coupled with the possibilities also of developing an export trade in salt, we visualise that the target of production in India will increase substantially. Like Kathiawad and Kutch, the Madras Province, as a whole in general and Vedaranyam in particular, will have a large contribution to make to the future expansion of the salt production in India. We recommend that investigations be initiated to determine the feasibility of large scale production of salt as a long range project at the Vedaranyam swamp.

## 6. Staff and Organisation.

6.1 We did not come across any technical personnel in the factories we visited except at the works of Mettur Chemicals at Adirampatnam. Even in case of the large works, no arrangements exist for control of the manufacturing operations or the quality of salt produced. The hydrometer is occasionally met with but it is doubtful if it is ever used as a routine works practice. This defect should be remedied and the larger works be induced to take on their staff technically qualified personnel and to establish analytical laboratories for chemical control of the manufacturing operations.

6.2 The labour employed in the salt factories total about 30 to 40 thousand. It is drawn usually from the neighbouring villages and is engaged for the duration of the manufacturing season which varies from 6 months in the factories

in the north to about 10 months in the factories in the south. The factories in Naupada and Pennuguduru circles employ labour on a contract basis. The workers are paid at rates varying from Rs. 30 to Rs. 50 per *garce* of 120 mds. (4.4 tons) of salt manufactured and delivered at the stores. The labourers work in the patches or gangs and during the rainy season find employment in agriculture. In the other circles labour is employed on daily wages which varies from Rs. 1-4-0 to Rs. 2-8-0 per day for skilled labour and from Re. 0-10-0 to Rs. 1-4-0 per day for unskilled labour.

### 7. Capital Block.

7.1 Many of the old factories were not able to give us an idea of the capital cost incurred on their construction. Out of 15,096 acres of cultivated area, the capital investment in factories covering about 7,500 acres was reported to be of the order of Rs. 75 lakhs. This comes to an average of Rs. 1,000 per acre and on this basis the total capital may be computed at Rs. 150 lakhs. Considering the primitive state of most of the factories, this cost appears to be high.

### 8. Cost of Production.

8.1 According to the figures furnished by the manufacturers, the cost of production of salt in the Madras factories varies from Rs. 5-7-0 per ton (Re. 0-3-2 per md.) to Rs. 35-10-6 per ton (Rs. 1-5-0 per md.). Some of the larger factories have given the break-up of their cost of production as shown in Table XCVII:

TABLE XCVII.—BREAK-UP OF COST OF PRODUCTION IN MADRAS FACTORIES.

	Per ton		Per ton
	Rs. as. ps.		Rs. as. ps.
(a) Cost of pumping and labour . . . . .	7 7 0	to	13 1 8
(b) Maintenance including repairs and betterment	0 3 0	to	3 3 8
(c) Supervision and overheads . . . . .	0 5 6	to	1 13 4
(d) Rents, rate and taxes . . . . .	0 1 0	to	0 14 2
(e) Depreciation . . . . .	0 3 0	to	0 5 3
(f) Misc. charges . . . . .	0 4 6	to	3 2 4
<b>TOTAL</b> . . . . .	<b>8 8 0</b>		<b>22 8 5</b>

or Re. 0 5 0 per md. to Re 0 13 3 per md.

8.2 There is a large variation in the statements furnished by different factories in the figures of cost of manufacture as well as in the break-up of this cost. Many of the works have either omitted items like depreciation, interest on capital, taxes etc. or not adequately provided for them. Since most of the factories do not maintain detailed accounts for which an accurate, itemised break-up of cost could be obtained, we consider, that the figures supplied to us are probably based on conjecture. As the factories in the Naupada and Pennuguduru circles pay for the salt produced on a contract basis and they cannot present a break-up of cost because the only direct expenditure that the management incurs is on repairs, maintenance and up-keep of plant and

machinery. We also noticed that there was little difference in the cost of production between the larger and smaller works in the factories north of Madras i.e. in the Naupada and Pennugudur circles. This is mainly due to the fact that the so-called larger works are in practice sub-divided into small units each worked more or less independently by a gang of labourers. Thus even the few licensees who own larger works, have fragmented their holdings into small uneconomic units. They could reduce their cost of production considerably if they conduct the manufacturing operations by employing labour for each item of work instead of leaving the entire operations to gangs of labourers on a contract basis.

8.3 The cost of production works out to Rs. 15-4-0 per ton (Re. 0-9-0 a maund) on an average. The cost of bags, weighing and filling charges, cost of transport from the works to the nearest railway sidings or booking stations, handling charges and the cess payable to Government have to be added in order to arrive at the f.o.r. cost. On an average, the cost per ton for these items will be as follows:

	Rs.	as.	ps.
Cost of gunny bags . . . . .	23	13	0
Cost of filling and weighing . . . . .	2	8	10
Transport to railway sidings or station.	5	9	8
Handling charges . . . . .	1	11	3
Cess . . . . .	3	6	6
<b>Total . . . . .</b>	<b>36</b>	<b>9</b>	<b>3</b>
or Re. 1-5-6 per md.			

The cost of salt delivered packed at the nearest railway station therefore, works out to Rs. 51-13-3 per ton (Rs. 1-14-6 per md.) and allowing for a margin of profit of Rs. 3-6-6 per ton (Re. 0-2-0 per md.) to the manufacturers, the selling price would be Rs. 55-3-9 per ton (Rs. 2-0-6 per md.) which is on the high side for the quality of salt manufactured in Madras.

## 9. Sales and Distribution.

9.1 The salt produced in the Madras factories meets the entire requirements of the Madras Presidency and Coorg and 40 per cent. of the requirements of Orissa, 18 per cent. of Central Provinces & Berar (Madhya Pradesh), 44 per cent. of Hyderabad and 56 per cent. of Mysore. Under the zonal distribution scheme drawn up by the Salt Department, Madras factories have been grouped into 4 zones and a separate area has been allotted to each zone for marketing its salt. Manufacturers in all the producing centres complained that the markets allotted to them were not able to consume their output. There is no doubt that the potential capacity of these producing centres is in excess of the requirements of the markets allotted to them. The only outlet that can be found for the surplus salt is the Bengal market provided the Madras manufacturers produce at an economic cost a quality of salt acceptable to that market. The Madras factories are situated at a shorter distance from Calcutta than the Kathiawar factories and many of them enjoy equally good natural facilities for the manufacture of salt. Convenient port facilities are available to many of these producing centres to ship salt to Calcutta, and we understand that shipping space has been specially provided by Government for the Tuticorin manufacturers to enable them to send salt to Calcutta. By improving their layouts and methods of manufacture, the Madras factories should be in a position to produce salt of a quality acceptable to the Calcutta market and deliver it at competitive rates.

## 10. Summary of Recommendations.

### (a) Naupada Circle.

(i) The Maharaja of Parlakimidi's works at Pundi should give a better yield than it does at present. Its area of crystalliser is disproportionately large as compared with the area under condensers. The areas should be re-distributed in order to give a ratio of 1:7 between the crystallisers and reservoir cum condensers. The area of the other factory at Pundi should also be re-distributed to the same ratio of 1:7 to give a still better yield. (3.2.1 and 3.2.2.)

(ii) The layout of the Bhavanapadu factory should be modified and the areas re-distributed to give a ratio of 1:6. (3.2.4.)

(iii) The layout of the Naupada factories should be modified and the areas re-distributed to suit the average density of brine used. (3.2.6)

(iv) The factories at Konda and Bimilipatam should be increased to 100 acres and relaid in the ratio of 1:7 and worked as single units on co-operative lines. The factories at Calingapatam and Balacheruvu should be similarly relaid. (3.2.8)

(v) Production in Naupada circle can be more than doubled by re-distributing the areas under cultivation. For those factories, using sea brine the ratio should be 1:7; those using pit brine in addition to the sea brine it should be 1:6. (3.2.9)

(vi) We do not recommend the construction of new salt works on the Kakrapalli swamp for supplying salt to the proposed soda ash factory at Sindri. If salt production in the Naupada Circle increases by a re-distribution of the areas under cultivation, the existing works would be able to meet a large part of the requirements of Sindri. (3.2.10)

### (b) Pennuguduru Circle.

(i) The Pollavaram factory should be relaid so as to give a ratio of 1:7. The licensees should also be combined to work the factory as a single unit. As this factory is a Government factory, the cost of relaying should be borne by Government and recovered from the licensees in easy instalments. (3.3.2)

(ii) The factories in Jagannaickpur, Guruzanapalli, Pennuguduru and Pendraka should also be re-distributed in the ratio of 1:7 to give better quality of salt and a higher yield. (3.3.3)

(iii) As there is a shortage of brine at Manginapadi, Chinnaganjam North, Chinnaganjam South and Pakala, a trial tube well should be sunk in each of these factories to determine the availability of brine supply and the economic depth to which wells should be sunk. (3.3.4)

(iv) The Kanuparti factory should be permitted to manufacture and sell solar salt, provided they undertake to produce salt of 97-98 per cent. sodium chloride content. The factory should also be relaid in the ratio of 1:5. The Railway freight on salt from Kanuparti to Calcutta should be reduced to Rs. 20-6-8 per ton Re. 0-12-0 per md. so that its production could be sold in competition with Kathiawad salt. (3.3.5)

### (c) Madras Circle.

(i) The areas of the factories in this Circle should be re-distributed. As most of the factories use pit brine the ratio should be 1:5. Small licensees should also be combined to form into co-operative societies so that the factories could be run as single units. (3.4.2, 3.4.3 and 3.4.4)

(ii) The area of about 564 acres near the Semmanjeri village on the road to Covelong can be leased out for a model factory either to a single party or to a co-operative society. (3.4.5)

(d) *Cuddalore Circle.*

(i) The Chunampet factory should be relaid to give a ratio of 1:5; the small holdings should be combined with the larger works for economy in working. (3.5.2)

(ii) The areas of the Markanam factory should be re-distributed in the ratio of 1:7 (3.5.3)

(iii) The Manambady factory should be re-sited nearer the sea, if feasible, in order to obtain adequate supply of brine directly from the sea. Its area should also be increased to 100 acres. (3.5.4)

(iv) The Tranquebar factory is very small and should be extended to at least 100 acres. It should in any case be operated as a single unit on a co-operative basis. (3.5.5)

(v) The areas of the factories of Cheyar, Cuddalore and Neidavasal should be re-distributed in accordance with the quality of brine available. The area of the Cuddalore factory should also be extended to 100 acres. (3.5.6)

(e) *Adirampatnam Circle.*

(i) The quality of salt at the Vedaranyam factory should be improved by switching over to the multiple irrigation system and by relaying the works in the ratio of 1:3. (3.6.2)

(ii) The Vedaranyam factory should be provided with a railway siding from Agastiyampalli railway station. As it might be difficult for the Railways to recover the cost of the siding from each of the licensees, the siding should be constructed at the cost of the Railway and the cost recovered from the manufacturers by levying a charge of Rs. 1-11-3 per ton (Re. 0-1-0 per md.) on the quantity of salt despatched. (3.6.3)

(iii) The canal leading from the Vedaranyam factory to Topputurai and further on to Negapatam should be cleaned to permit salt to be sent to these ports for onward shipment to Calcutta. (3.6.3)

(iv) With the availability of electric power the method of drawing brine by picotahs at Vedaranyam should be replaced by electric pumps. There should be common condensers to reduce the pumping cost and for this purpose the factory should be converted into a single co-operative unit. (3.6.4)

(v) The collection of spontaneous salt from the Vedaranyam swamp should be organised on an extensive scale. Additional salt can also be recovered from the brine in the swamp by laying out pans along its northern fringe, provided arrangement is made for transport of salt either into the interior or by canals to ports for shipment to Calcutta. (3.6.8)

(vi) The area of about 400 acres to the south of Vedaranyam factory could also be utilised for salt manufacture by using the high density brine from the swamp. The existing licensees at Vedaranyam might be given the first option to develop this site on a co-operative basis, provided they undertake to lay down the works on scientific lines. (3.6.8)

(vii) The salt produced at Adirampatnam by Mettur Chemicals Works can be improved by a better control on the elimination of bitters. The area of the works should be increased to 100 acres and the areas under cultivation re-distributed. They should also adopt the multiple-irrigation system in preference to the single irrigation system. (3.6.11)

(viii) The other factories in Adirampatnam Circle should be increased to 100 acres each and re-aligned to give a ratio from 1:4 to 1:6. (3.6.12)

(f) *Tuticorin Circle.*

(i) The factories at Vepalodai and Arasadi should be extended to a minimum of 100 acres each. The factory at Arasadi should also be worked as a single co-operative unit. (3.7.2)

(ii) The area of the factory at Sevandakulam should be re-distributed in order to give a ratio of 1:4. (3.7.3)

(iii) The factory at Livingipuram should be re-modelled and operated departmentally by Government as a model factory. (3.7.4)

(iv) The factory at Karapad should be relaid to give a ratio of 1:5 and the small licensees should be combined to form into a co-operative unit having a minimum of 100 acres. (3.7.5)

(v) The five small works at Urani should be combined to form one single co-operative unit of 125 acres. The areas of all the works should be re-distributed so as to give a ratio of 1:5. (3.7.6)

(vi) The factory at Urani Extension should be asked to adopt the multiple irrigation system in order to produce salt suitable for the Bengal market. (3.7.7).

(vii) The Kayalpatnam factory should be increased to 100 acres and along with the factory at Armuganeri should be converted into co-operative concerns and worked as a single unit.

(viii) The factory at Kulasekarapatnam is uneconomical and should be extended to 100 acres and relaid to give a ratio of 1:5. (3.7.9)

(g) *General Recommendations.*

(i) The single irrigation method should be replaced by the multiple irrigation system in the Cuddalore, Adirampatnam and Tuticorin circles. (4.2.2)

(ii) The production of light variety of salt should gradually give place to the heavy variety. In Tuticorin and Adirampatnam circles, the change-over should be completed within a period of three years whilst in the remaining four circles it may be extended to five years. The Salt Department should depute some of their officers in the Madras Province to visit the works of Mettur Chemicals, Travancore Model Factory and the factories at Kathiawad and Kutch to acquaint themselves with the method followed for producing the heavy salt. (4.2.3)

(iii) The Madras Government should be requested to pass legislation banning the sale of salt by measure. (4.2.4)

(iv) We do not recommend any new salt works in the Madras Province till the factories improve the quality of their product suitable to the Calcutta market or until a demand arises for the export of salt to other countries. (5.1)

(v) We estimate that the existing salt works could increase their production to more than 12 lakh tons (330 lakh mds.) by improving their methods of production and by a proper re-distribution of the area under crystallisers, condensers and reservoirs. (5.1)

(vi) The larger works should be induced to take on their staff technically qualified personnel and to establish analytical laboratories for the chemical control of manufacturing operations. (6.1)

(vii) The larger salt works, more particularly in the Naupada and Pennugudur circles, could reduce their cost of production considerably if they conduct the manufacturing operations by employing labour for each item of work instead of leaving the entire operations to gangs of labourers on a contract basis. (8.2)



## CHAPTER XV

### ORISSA

#### 1. Description.

1.1 Orissa once produced the finest salt in India and supplied it to the hinterland of Central India and by sea to Bengal. Salt is produced both by solar evaporation and the *punga* method. Solar salt is produced in the Puri and Ganjam districts from sea water, whilst *punga* salt is manufactured in the Balasore and Cuttack districts. By the *punga* method saliferous earth is lixiviated with water and the resulting solution is evaporated in open earthen pots over wood fire. Notwithstanding its extensive sea board, running to a length of over 250 miles and the availability of sites suitable for salt works, the manufacture of salt in Orissa has not been developed as extensively as conditions would warrant.

1.2 The history of the salt industry in Orissa has been chequered since the advent of the British into India. At the beginning of the 19th Century Orissa exported as much as 33,000 tons (9 lakh mds.) of salt per annum. Even up to 1860-61, the annual production in the three districts of Balasore, Cuttack and Puri amounted to about 97,000 tons (26 lakh mds.). But by 1865, when restrictions were imposed on the manufacture of salt, the industry had very nearly died out. From about 1880, attempts were made to revive the industry, but without much success. Even the present day production is less than 22,000 tons (6 lakh mds.). This includes the production of about 14,000 tons (3,80,000 mds.) of the Ganjam factories which before 1937 formed part of the Madras Province and were added to Orissa in 1937 when this Province was formed.

#### 2. Manufacturing Rights.

2.1 Till 1861 salt was manufactured in Orissa under the *monopoly* system by which the salt produced by the manufacturers was bought over by Government at a fixed price determined at the beginning of each manufacturing season. At the instance of the authorities in London, who were keen to promote the export of Cheshire salt (which was started as an experimental measure even as early as 1820 and which was being brought to India in steadily increasing quantities), proposals were made to replace the Monopoly System by the Excise System. Under this system the manufacturers were free to produce as much salt as they liked and sell it direct after payment of excise duty to Government. This brought about the decline of the salt industry in Orissa; this policy was enforced notwithstanding emphatic protests from the then Government of India. An extract from a minute of Lord Dalhousie, who was then the Governor of Bengal, is well worth quoting:

“Necessity may unfortunately compel this Government for the present, to continue to raise an objectionable impost upon an article of first necessity, but nothing can justify the Government in pursuing for this purpose, a system which unduly exposes a portion of its people to disadvantages that are rapidly depriving them of their means of livelihood. It is, therefore, I think the plain duty of the Government to endeavour to remedy this evil at once . . .

“Lastly if it should be objected that this revision of the selling price of native salt in India will create remonstrances and raise clamour-

among the owners and exporters of salt from England to India, the answer is easy: the act of the Government here can be shown to be founded on justice and necessity; any clamour against it in England, therefore, will have no foundation in justice or reason, and accordingly it ought to be, and safely may be disregarded."

The calamity dreaded by Lord Dalhousie and others was not averted. The abolition of the Monopoly System brought about almost famine conditions in 1866 and thousands of families lost their hereditary occupation. The famine took a toll of the salt producing class and depopulated Orissa by more than one-third of its total population. The people of Orissa were slow to adjust themselves to the change in the system of manufacture and the production between 1865 and 1883 did not go above 18,000 tons (5 lakh mds.) per annum. Further setbacks followed, and Orissa was not able to maintain even this production. As the salt, produced both by the *punga* and solar methods, could not face the competition with foreign salt, Government revived the Monopoly System in 1891. By that time the opening of the East Coast Railway further handicapped the manufacture of salt in Orissa. In addition to the competition from Liverpool, competition from Madras salt, produced under more favourable conditions was also felt and by 1898 the manufacture of salt in Orissa ceased altogether. Isolated attempts were made to set up salt works after 1901, but they were half-hearted and infructuous. The only production which continued was that of *punga* salt for local consumption.

2.2 As a result of scarcity of salt created by World War I, the question of reviving the salt industry in Orissa has been engaging the attention of Government since then. Heavy rainfall, cyclones and the poor salinity of sea water, caused by the large discharge of fresh water into the Bay of Bengal, are factors which operate against the revival of the salt industry in the northern districts of Balasore and Cuttack. The late Mr. Kapilram Vakil examined the possibility of manufacture of salt in Orissa in 1918 and came to the conclusion that manufacture would not be economical in the districts north of the Chilka Lake, but on the coast south of the Chilka Lake salt manufacture was possible owing to the climatic conditions being more favourable. Mr. F. W. Gooch of the Madras Salt Department also examined the question and reported that if an elaborate system of extensive and costly bunds were provided in about 10 sq. miles of the Chilka Lake to exclude fresh water and if an adequate inlet from the sea were provided and arrangements made for keeping it open, it might be possible to establish a large solar salt works on the shores of the lake. As the scheme involved a very heavy expenditure it was not pursued. In pursuance of the recommendations made by the Tariff Board in 1930, Mr. C. H. Pitt was deputed by the Government of India to investigate the possibility of manufacture of salt in Orissa. Mr. Pitt overruled the possibility of production by the *punga* method, but recommended the revival of solar manufacture on the Chilka Lake where he estimated that an output of 22 tons (600 mds.) per acre per annum could be obtained. His references to the unfavourable climatic conditions, his surprising statement that no record was available to show that salt was ever manufactured on the coasts of Bengal and Orissa, and other considerations such as competition from Madras and foreign salt, tended to make his report unfavourable to the revival of the salt industry in Orissa.

2.3 In 1938, after the formation of the Orissa Province, the Government of Orissa set up a Committee to explore the possibilities of the establishment of a salt industry in the coastal areas with special reference to Astarang in the Puri District, and to recommend the method of manufacture which could be adopted, after taking into consideration the natural conditions prevailing in the area. The Orissa Government, in setting up this Committee, were influenced by a recollection of the fact that the salt industry flourished in the Province till

eighty years ago and salt was actually being exported from Orissa to the adjoining provinces. In its findings, this Committee expressed the opinion that it was possible to manufacture salt in Astarang and other coastal areas of the Province. It preferred the solar evaporation method to the *punga* method and recommended that for the re-establishment of the industry, the Government of India should forego a portion, Rs. 6-12-10 per ton (Re. 0-4-0 a maund), of the salt duty in the early stages of its revival. In 1947 the Government of Orissa invited Rai Bahadur Shiv Charan Das, who was at that time the Salt Adviser to the Government of India, to pay a visit to Orissa and examine the possibilities of increasing the production of salt in the Province. Rai Bahadur Shiv Charan Das submitted his report in July 1948. Since he is a Member of this Committee, we have had the benefit of his experience, and his observations and recommendations have been incorporated in this report. In May 1948, the Government of Orissa appointed the Salt Manufacture Investigation Committee to conduct a proper investigation of salt industry in Orissa, to suggest suitable locations where salt could be conveniently manufactured, to ascertain the most suitable types of installations and to recommend the kind of organisation required for the manufacture of salt. The report of this Committee was published in 1948 and when we visited Orissa in 1949, we had the privilege of holding discussions with the Members of this Committee, as also with the Government of Orissa. The data furnished in the report of this Committee have been drawn upon in writing this Chapter.

2.4 Salt is manufactured in the four districts of Orissa, *viz.* (a) Balasore, (b) Cuttack, (c) Puri including Chilka Lake area and (d) Ganjam by either individual lessees or co-operative societies. Lands suitable for salt cultivation, are leased out for a period of 25 years by the Government of India or the Government of Orissa, according to the ownership of the lands. The terms of the licence for the first three districts are akin to the Excise System, but the factories in the Ganjam district are on the Excise and Modified Excise systems of Madras. The conditions of manufacture differ in the different districts and they are reviewed in the following paragraphs:

### 3. Manufacturing Process.

3.1 BALASORE DISTRICT.—In this district salt is manufactured entirely by the *punga* process, because of the uncertainties of climatic conditions and the availability near the sea coast of a large tract of saline earth and Bani scrub which, owing to its low cost, is utilised as fuel. The annual rainfall in Balasore town for the years 1937 to 1945 ranged between 49 to 87 inches with an average of 69 inches. Table XCVIII gives the particulars of the rainfall month by month together with the maximum and minimum during any month.

TABLE XCVIII.—RAINFALL IN BALASORE TOWN 1937—1945

(in inches).

Months	Average	Maximum	Minimum	Highest recorded in 24 hours
January . . .	1.21	4.76	0.00	2.17
February . . .	1.08	4.78	0.00	1.73
March . . .	1.60	5.14	0.00	2.51
April . . .	2.34	5.17	0.17	2.23
May . . .	2.30	4.84	0.55	2.26

TABLE XCVIII (contd.)

Months	Average	Maximum	Minimum	Highest recorded in 24 hours
June	9.28	18.16	5.24	3.35
July	15.66	30.96	10.08	13.67
August	14.44	23.84	7.66	6.11
September	10.56	18.17	2.80	4.01
October	9.39	22.26	1.54	12.73
November	1.04	3.71	0.00	2.67
December	Nil.	Nil.	Nil.	Nil.
	68.90			

The figures show that except the month of December heavy rainfall may occur in any month, though the monthly average from January to May is fairly low and there are years during which little or no rainfall occurs during these months. Whenever heavy showers fell they were due to the storms which occurred during the years to which the maximum figures relate. As rainfall fluctuates from place to place in the district these figures cannot be taken as truly representative for the whole of the district. They are, however, the nearest approximation and may serve as a guide to the general meteorological conditions prevailing in this area. The rainfall figures also reveal that if salt were to be manufactured by solar evaporation it should be started not earlier than November and must be completed before the end of May. In November, the density of the sea brine along this coast is likely to be low, because of the discharge of large quantities of rain water into the Bay of Bengal. Since the preparation of the condensers and crystalliser beds, at the commencement of each season, requires a period of about six weeks, the months of November and December could be utilised for raising the density of the brine in reservoirs and condensers to enable the crystallisation of salt to commence in January. Occasional showers in November would be no impediment for this preliminary operation. Owing to the short manufacturing season and occasional loss by cyclones the cost of production by solar methods is likely to be higher than at Naupada, but the cost of manufacture by the *punga* process is likely to be still higher.

3.1.1 *Talpada and Eram*.—Attempts were made from 1942 to 1946 by the Utkal Salt and Chemical Works Ltd., to manufacture solar salt at Talpada in the Balasore District. The total area of the factory is 236 acres, but the area under cultivation is only about 50 acres of which 10 are reserved for reservoirs, 30 for condensers and 10 for crystallising pans giving a ratio of 1:4. The manufacturing season was reported to have lasted for two months only, i.e. from mid April to mid June, but this presumably was the duration of the period when salt was actually harvested. The maximum production attained by these works was 180 tons (5,000 mds.) only in 1946, but as the factory had by then suffered heavy losses it was closed down. In Table XCIX is given the rainfall at Talpada during the fair weather for the three years 1946 to 1948.

TABLE XCIX.—RAINFALL AT TALPADA (JANUARY TO JUNE) 1946—48  
(in inches).

Months	Average	Maximum	Minimum	Highest in 24 hours	No. of rainy days (Average)
January	0.17	0.33	0.00	0.31	2
February	0.29	3.36	0.00	1.85	3
March	1.09	2.20	0.51	1.90	3

TABLE XCIX (contd.)

Months	Average	Maximum	Minimum	Highest in 24 hours	No. of rainy days (Average)
April	0.83	1.85	0.13	0.51	5
May	4.66	10.38	1.84	6.67	6
June	4.01	8.81	1.50	2.30	9
	11.05				

It will be seen that the season for manufacture of salt does not extend beyond May, but the conditions are uncertain and not dependable even in this month. The Registrar of Co-operative Societies, Balasore, also contemplated starting a co-operative society for the manufacture of solar salt in the district and some progress was made for establishing a salt factory at Eram. The Salt Manufacture Investigation Committee of Orissa doubted the success of this proposed factory and reported that the season being too short, economic manufacture of salt by solar evaporation in the Balasore district was not feasible.

3.1.2 While we have no sufficient data before us to say that salt manufacture by solar evaporation is not feasible in the Balasore district, we consider that it would be better in the interests of Orissa if, in the first instance, efforts to rehabilitate the salt industry are concentrated in more promising areas. We are guided in making this recommendation by the further fact that conditions in Balasore are in many respects similar to those on the Contai sea board of West Bengal. The operations at Contai have not proved more promising in the past than in the Balasore district and it would be desirable to defer the starting of any factories in Balasore till some experience of large scale manufacture at Contai is gathered.

3.1.3 We are doubtful whether the *punga* process of manufacture can be adopted on a larger scale. The saliferous earths no longer occur in great concentrations and have to be gathered from scattered places at considerable expenditure of time and effort. The cost of fuel has also been rising owing to the disappearance of the *Bani* scrub which have been progressively cleared in order to bring lands under paddy cultivation. The Orissa Committee had recommended that the reclamation of the scrub lands should be prohibited so that *Bani* may continue to grow and provide a constant supply of fuel for the manufacture of salt by the *punga* process. We consider that such a policy would not only militate against the "Grow More Food" attempts, but its economic success is extremely doubtful. No figures of production of salt by this process are available, but it is commonly believed that the output is steadily declining. A sample of salt collected by the Orissa Committee at Bulang, which is one of the centres of manufacture of *punga* salt, showed the sodium chloride content at 85.61 per cent. and magnesium chloride at 6.02, per cent. the other impurities consisting of magnesium sulphate, calcium sulphate, moisture and insoluble matter. The percentage of moisture in the sample was not reported and it is difficult to compare the results of the analysis with those of salt obtained in other places, but the percentage of magnesium chloride is so high that the salt would have poor keeping quality and would sweat and run to waste on storage. If supplies of the saline earth and fuel were plentiful and cheap, it would be possible to produce, by proper fractionation, salt of a good quality, but it could not be manufactured economically and Orissa should not build any hopes of getting large supplies of such salt. Where this method of production is

practised on a cottage industry scale it may be allowed to continue to meet the strictly local requirements.

3.1.4 We found a suggestion in the Report of the Orissa Committee that the possibilities of manufacturing salt directly from sea brine by applying artificial heat either by steam or electricity should be explored. In Chapter V, paragraph 10-2, we have expressed our views on this method of evaporation. Production of salt by artificial heat might be economical if saturated brine were available. In the Balasore district this would not be possible, as the dry season for bringing brine to saturation by solar heat will be only about 4 months. An evaporator plant to operate for such a short duration will excessively raise the cost of salt owing to heavy overheads and depreciation charges. The other alternative would be to concentrate the sea brine during the dry months of the year in quantities large enough to last an evaporator plant for about 6 to 7 months, but storage of such large quantities of saturated brine would not be feasible. So far as electricity as source of heat is concerned, it is agreed that even the cheapest hydro-electric power may not be able to compete with coal and other fuels. Even if it were found possible to provide electricity in Orissa at an extraordinarily cheap rate from the hydro-electric project in progress at Hirakud, it will be inadvisable to utilise it for the production of salt in the Balasore district when other more favourably situated districts are available for manufacture by solar evaporation.

3.2 CUTTACK DISTRICT.—In this district, manufacture of salt by the *punga* process is carried on in the coastal villages, but unlike Balasore the saliferous earth is reported to be more easily available and the *Bani* fuel is stated to be plentiful and cheap. Owing to difficulties of transport, the *punga* salt is sold only in the neighbourhood of the villages where it is produced and its price is as high as Rs. 90-10-0 per ton (Rs. 3-5-4 per md.). The quality of the salt is also as poor as at Balasore. Notwithstanding the more favourable conditions for following the *punga* process, the price at which this salt is sold is excessive and is a proof of the impracticability of adopting this process on a competitive basis. While production by this process may be continued on a strictly cottage industry scale to serve the local needs we see no future for this process and the conclusion is inevitable that when better transport facilities become available it must give place to solar salt. We give in Table C figures of rainfall at Chandbali which is between Cuttack and Balasore for the years 1937 to 1945. The annual rainfall varies between 83.97 inches and 48.56 inches, giving an average of 64.16 inches.

TABLE C.—RAINFALL AT CHANDBALI 1937—1945  
(in inches)

Months	Average	Maximum	Minimum	Highest recorded in 24 hours
January . . .	0.65	1.91	0.00	1.15
February . . .	0.89	3.37	0.00	1.43
March . . . .	1.38	5.08	0.00	1.62
April . . . . .	2.16	4.66	0.00	2.06
May . . . . .	2.58	7.38	0.11	4.18
June . . . . .	7.48	12.92	2.36	4.55
July . . . . .	16.91	25.58	9.32	12.67

TABLE C (contd.)

Months	Average	Maximum	Minimum	Highest recorded in 24 hours.
August . . .	13.12	18.49	4.87	8.27
September . . .	8.81	14.70	3.11	5.96
October . . .	8.12	14.35	2.47	6.12
November . . .	1.96	13.06	0.02	7.84
December . . .	0.10	1.07	0.00	0.74
	64.13			

From these figures of rainfall it is obvious that salt manufacture by solar evaporation in the Cuttack District is as unfavourable as in the Balasore District. The number of dry months is small and production will have to cease by May giving a relatively short season of manufacture and a higher cost of production. Two attempts were made during the past six years to manufacture salt by solar evaporation, one at Kensaripatia, near Trilochanpur in the Kujang Estate and the other at Sendkudi. Both these were reported to have proved a failure owing to the silting up of the creek from which the brine was drawn and unfavourable weather conditions.

3.2.1 The Orissa Committee have recorded that about 1,000 acres of waste land are available at Bhopal in the Cuttack district suitable for salt cultivation. There are said to be several creeks which could supply brine during high tides and the rainfall is also stated to be less intense than in other parts of the district. The area is almost level and labour is reported to be available. Transport facilities are also stated to be satisfactory, as boats can ply from the site to the Cuttack railway station. The Orissa Committee have recommended the development of this area and suggested that a factory covering 300 acres may be established on a co-operative basis. We advise that before any such step is taken the meteorological data of the locality should be obtained over a period of 7 to 10 years to make sure that unseasonal heavy showers of rain do not fall during the manufacturing season. Studies should also be made of the concentration and quantity of brine available in the creeks. The Orissa Committee also recommended the establishment of a salt factory on an area of about 300 acres near Harishpur, on the extreme south-east coast of the district. We cannot support this recommendation, because the proposed area has already been converted into paddy land and it would not be advisable to claim it back again for salt manufacture, especially when the country is short of rice. Moreover, the conditions of transport are unsatisfactory as there are no good roads. The Orissa Committee have further recommended the organisation of a co-operative society at Kharanasi and Bailkani. Here also we suggest that the necessary data of rainfall and brine supply should be collected in the first instance.

3.3 PURI DISTRICT.—Unlike the northern districts of Balasore and Cuttack; conditions for the manufacture of salt by solar evaporation in this district are more favourable. Salt is manufactured at present at Astarang and Timor and was formerly produced at Gurubai and Tua, two islands in the Chilka Lake. At the latter two centres, the works have not been in regular production as the manufacturers are reported to have suffered heavy financial losses. A fairly dry season of at least six months prevails in the Puri District between November and April and during these months manufacture of solar salt is feasible. The dilution of brine, due to the flood waters, will not be as large

as farther north in the Cuttack and Balasore districts. If the preliminary operations were started early in November and attempts made to concentrate the brine during the cold months of November and December, it should be possible to obtain concentrated brine for charging into the crystallisers from January onwards. The rainfall data for Puri for the years 1937 to 1945 is given in Table CI; the annual rainfall varies from 44 to 73 inches with an average of 56 inches.

TABLE CI.—RAINFALL AT PURI 1937—1945  
(in inches)

Months	Average	Maximum	Minimum	Highest fall recorded in 24 hours
January . . .	0.47	1.27	0.00	1.25
February . . .	0.92	4.15	0.00	3.08
March . . . .	1.01	4.55	0.00	1.94
April . . . .	0.66	3.09	0.00	1.55
May . . . . .	3.10	10.06	0.01	4.21
June . . . . .	7.82	18.32	0.89	6.82
July . . . . .	14.73	20.66	1.08	5.17
August . . . .	8.66	13.75	1.64	2.49
September . . .	9.33	17.06	1.07	6.07
October . . . .	8.46	12.90	1.63	3.02
November . . .	1.00	4.63	0.00	2.77
December . . .	0.21	1.18	0.00	1.07
	56.37			

3.3.1 *Astarang*.—We visited the salt factory at Astarang where salt is manufactured by the Astarang Salt Production and Sale Co-operative Society. The Co-operative Society was established in 1943 and has a share capital of Rs. 4,000, but it has been able to invest a further sum of Rs. 25,000 given as loans by the Provincial Government. The Society has 434 members of whom only 300 are actively engaged in the production of salt. The active members work in groups each consisting of 5 to 6 members. The Society has taken on lease an area of about 572 acres of land, which was acquired for them by the Provincial Government. Out of this area, 350 acres are fit for salt cultivation whilst the balance consisting of waste land covered with bushes and scrub could be brought under cultivation by proper levelling and clearing. The land is subject to floods, being situated near the Devi river and no adequate bunds have been provided to protect the salt works. The lack of embankment and the liability to flooding are a serious threat to the prosperity of this factory. Brine is drawn through a creek in which the density at the commencement of the season is stated to be only about 2° Be', but in the later part of the season it rises to 6° Be'. As the Society has not been able to provide funds for installing pumps, the brine is lifted by manual labour and charged into the reservoirs. The reservoirs and condensers extend over 225



acres whilst the crystallisers cover 75 acres, giving a ratio of 1:3 between the crystallisers and reservoir cum condensers. This ratio is totally inadequate for a marine salt works situated in a locality of high rainfall. The size of the crystallisers according to the Society, ranges from 8 ft. x 6 ft. to 10 ft. x 10 ft. The total number of crystallisers is 1200. Even assuming all the crystallisers to be of about 100 sq. ft. in area, the total area of 1200 crystallisers works out to only 2.75 acres while the area under crystallisers, as stated by the Society, is 75 acres. There is obviously some mistake, but be that as it may, there is no need to have crystallisers of such a small size, because a good deal of space is wasted in partitions and pathways. The single irrigation system of manufacture is followed and the depth of brine in the condensers is maintained at 4 inches and in the crystallisers at 1 inch which gives a very thin layer of salt. The use of hydrometers is practically unknown and there is little technical guidance given to the members who continue to employ the traditional primitive methods of manufacture. The factory is not worked as a single unit, but is a coalition of working groups, each group having 3 to 5 acres under its charge and each having its own independent reservoir, condensers and crystallisers. The salt produced by each group is stored separately in thatched sheds at some distance from the works, and is classified into three grades according to the colour. All the three grades appeared to be of poor quality and were badly discoloured with mud. The production of the salt by the Society during the years 1944 to 1948 is shown in Table CII.

TABLE CII.—PRODUCTION OF SALT BY ASTARANG CO-OPERATIVE SOCIETY 1943—1948

Year	Area under cultivation	Production		Yield per acre in Tons/Maunds	
		Tons	Mds.	Tons	Mds.
1944 . . .	150	1,200	33,000	8	220
1945 . . .	180	1,870	50,800	10	280
1946 . . .	150	250	6,700	2	45
1947 . . .	120	1,240	33,800	10	280
1948 . . .	300	1,140	31,000	4	103

The fall in production in 1946 was due to the inclement weather and unusual rainfall and flooding. These defects cannot be rectified unless the necessary protective embankments are raised to keep out the flood waters and a ring channel is provided to prevent the percolation of fresh water into the condensers and crystallisers. The yield is also poor, but this could be remedied if the area under cultivation is redistributed, allotting 35 acres for crystallisers and 265 acres for reservoirs and condensers, thus giving a ratio of 1:7.5. Further the size of the crystallisers should be enlarged to a minimum of 2,000 sq. ft. so as to do away with a large number of ridges and reduce the cost of maintenance. Salt is sold by the Society on account of the members. It charges a commission of Re. 0.13-7 per ton (Re. 0.0-6 per maund) which is utilised to meet its establishment charges. Sales are made in Cuttack, Jeypore and places in Puri District within a radius of 60 miles of Astarang. Salt is also manufactured in Astarang by a number of small manufacturers who are not members of the Co-operative Society. Their production is much larger than that of the Society and comes to about 1,837 tons (50,000 mds.) The area worked by them measures 851 acres.

3.3.2 Figures of cost of production were not available, because firstly no system of costing is in vogue and secondly the members of the Society are themselves the labourers. We were, however, informed that the cost of maintenance and repairs of pathways and ridges in the works comes to Rs. 2,500 per annum. The Society also maintains the staff quarters of the Salt Department for which no rent is paid to them and they consider it an unnecessary burden. They have urged that since the factory is under the supervision of the Registrar of Co-operative Societies, dual control by two Governmental agencies is not justified and that the control of the Salt Department be removed. We see no reason why the Co-operative Society should be treated differently from other licensees. The Registrar of Co-operative Societies can only guide the Society in matters of administration and organisation; he has no technical staff to guide the producers on the best technique of salt production. This is the function of the Salt Department and it should take upon itself the role of giving technical guidance, particularly to small and backward producers. The real handicap from which the Society is suffering is lack of capital and rationalisation of production. If adequate capital were forthcoming for providing pumping equipment, embankments, etc. the Society could compete with private producers on an equal footing. This is recognised by the Society itself and it has drawn up a scheme of improvements by which it expects to increase the yield to 7,350 tons (2 lakh mds.) by providing a pump, a ring bund above the height of the flood level, etc. at an estimated cost of Rs. 20,000. We commend these proposals to the Orissa Government for scrutiny and acceptance. The proposal for a ring bund is sound as it would obviate the annual repair charges on condensers and crystallisers which come to Rs. 8,000 per annum at present. This will also enable the production to be started earlier than hitherto and without the long delay of over 20 days now spent on repairs. The money for this capital expenditure can be advanced as a long term loan and recovered from the Society in easy annual instalments. Also if the Society were to provide common reservoirs and condensers it would enable them to operate the works more efficiently. We recommend that this be done and only the crystalliser area be allotted to the members on a group basis for the harvesting and collection of salt. Another serious handicap from which the Astarang manufacturers suffer is lack of suitable transport facilities. The nearest railway station is Khurda Road at a distance of 42 miles and no proper roads are available. Though transport by water is possible, the route by which the boats have to travel to reach the market is circuitous. Proposals have been made by the Registrar of Co-operative Societies for the improvement of the water route and we recommend that they should be given sympathetic consideration. The Orissa Committee have pointed out that an area of about 3,000 acres of land suitable for salt cultivation is available in Marichpur within a distance of 6 miles from Astarang. The success of the operations at Astarang is of very considerable consequence to the future increase in production of salt in the Puri District. It is, therefore, desirable that all facilities and help be given to the Co-operative Society to make a success of this venture so as to induce private licensees, who have hitherto kept aloof to join the Society and strengthen the co-operative movement.

3.4 CHILKA LAKE.—Special mention has to be made of the Chilka Lake and its possibilities for the production of salt. The lake is a pear shaped inland sea with a water spread of about 450 sq. miles during the monsoon and of about 350 sq. miles in the dry season. It is about 40 miles long with a width ranging from 20 miles in the north to 5 miles in the south. The average depth of water is reported to be about 5 to 6 ft., but there are parts which are about 14 to 20 ft. deep. The lake is separated from the sea by a long sandy ridge, varying from 100 to 200 yards in width and having one or more openings from the sea. The position and the size of the openings vary from time to time. The Devi and

the Bhargawi, branches of the Mahanadi River, and several other streams discharge their silt laden waters into the northern and north-western parts of the lake. The lake originally formed a part of the sea bed, but the silt from the rivers and the sand drift from the coast led to the formation of this large back-water. As long as the bar mouths were kept open by the outward thrust of the flood waters, sea water flowed into the lake after the monsoon and gave the lake water a certain degree of salinity to allow manufacture of salt during the dry season. At present there is a natural opening near Satpara in the north and an artificial opening at Rushikulya to the south, but it has been noticed that the lake water has been losing its salinity owing to the closing up of the bar mouths. There are several large islands in the lake of which Gurubai and Tua are of special importance, because salt factories are located on them. In the past they were the most flourishing of the solar salt works in this area. Proposals have been made from time to time to reclaim a portion of the lake for laying out salt works and for providing an inlet from the sea to increase the salinity of the lake water. For the latter purpose an attempt was made by the Bihar and Orissa Government in 1927 to make an opening through the sand bar, but this opening was soon filled up. The Orissa Committee has opined that the task of keeping an artificial mouth open would be difficult and expensive as it would require the services of one or two dredgers working continually for shifting the sand. Apart from these considerations, it is not possible to state at this stage the volume of water that would be discharged into the Chilka Lake on the completion of the Hirakud project. We have heard it said that the flood waters may be diverted into the Mahanadi thus helping indirectly to increase the salinity of the lake water, or that a portion of the impounded water at Hirakud may be discharged throughout the year into the Chilka Lake which would have the opposite effect. We recommend that the utilisation of the Chilka Lake brine for the purpose of manufacture of salt should be deferred till the effect of the Hirakud project is fully determined.

3.4.1 Mr. Uma Charan Patnaik, a Member of the Orissa Legislative Assembly, met the Committee during its tour of Orissa and presented us with a copy of his brochure entitled the "Chilka Scheme" for establishing a first class naval base in the lake. One of the incidental developments of his scheme relates to the salt industry. According to his proposal a permanent opening will have to be made in the sand bar for giving access to the naval base. This would make the water of the lake saline and provide an unfailing supply of brine to the low-lying lands situated on the shores of the lake where salt factories could be located. We are not competent to express any opinion on Mr. Patnaik's scheme, but we mention it only to show that the Chilka Lake has other potentialities.

3.5 GANJAM DISTRICT.—This district produces more salt than all the other districts of Orissa put together. Formerly this district formed part of the Madras Presidency and the development of the salt industry took place here long before its transfer to Orissa in 1937. The factories in this district are laid out on the same lines as the factories in the Madras Province and the production is entirely by solar evaporation. Figures of rainfall for Gopalpur for the years 1937 to 1945 are shown in Table CIII. The annual rainfall varies between 71 and 33 inches and the average is 46 inches.

TABLE CIII.—RAINFALL AT GOPALPUR  
(in inches)

Months	Average	Maximum	Minimum	Highest recorded in 24 hrs.
January . . . . .	0.21	0.92	0.00	0.55
February . . . . .	1.58	7.78	0.00	5.29
March . . . . .	1.44	7.51	0.00	1.77
April . . . . .	0.70	1.67	0.00	1.06
May . . . . .	2.61	13.04	0.06	4.98
June . . . . .	5.44	10.64	0.92	3.37
July . . . . .	6.54	11.44	3.15	4.60
August . . . . .	7.76	20.82	2.37	9.05
September . . . . .	7.82	13.03	3.14	5.24
October . . . . .	8.78	12.38	4.28	7.01
November . . . . .	2.92	19.39	0.00	8.91
December . . . . .	0.23	1.04	0.00	0.66
	46.03			

These figures show that conditions in the Ganjam district are considerably more favourable for the manufacture of salt than in any of the other districts of Orissa and are comparable to conditions in the Bombay Presidency.

3.5.1 Salt is at present produced in three localities, viz., Huma, Gokhurkuda and Sumadi; attempts are also being made to revive the manufacture at Surla. There are, moreover, good possibilities of manufacture being undertaken at Gopalpur. The lands under salt cultivation in the Ganjam district are all owned by the Government of India to whom the lessees pay a ground rent which at Huma is Re. 1-0-0 per acre and at Sumadi Re. 0-8-0 per acre. The areas under salt cultivation and the average annual yield per acre are shown in Table CIV. We have also indicated in this table the areas of contiguous lands that could be developed either as extensions of the existing factories or as new factories. At Gokhurkuda, the 300 acres available for expansion have been assigned to the Huma Salt Production and Sale Co-operative Society Ltd. Similarly, at Sumadi 810 acres are being added to the existing area under salt cultivation; of these 300 acres are being given to the two existing lessees and 510 acres to a new works called the National Chemical and Salt Works Ltd.

TABLE CIV.—AREA UNDER SALT CULTIVATION IN THE GANJAM DISTRICT

Factory	Reser-voirs	Conden-sers	Crystal-lisers.	Total	Ratio of crystal-liser to reservoir plus conden-sers	Average yield per acre (1945-48 production)		No. of lessees	Area available for expansion
	Acres	Acres	Acres			Acres	Tons		
Huma . . . . .	148	296	221	665	1 : 2	21	575	27	1,600 300
Gokhurkuda . . . . .	48	96	72	216	1 : 2	7	187	(Co-operative Society).	
Sumadi . . . . .	149	298	223	670	1 : 2	13	363	2	1,000
<b>TOTAL</b> . . . . .	<b>345</b>	<b>690</b>	<b>516</b>	<b>1,551</b>	<b>1 : 2</b>	<b>16</b>	<b>425</b>		<b>2,900</b>

Salt is manufactured by the single irrigation method. Brine is drawn from the Chilka canal for the Huma and Gokhurkuda works and from creeks for the Sumadi factory. All of them use pumps for lifting the brine and as initial evaporation takes place either in the canal or in the creeks, the density of brine by the time it reaches the reservoirs is about  $4^{\circ}$  Be'. The crystallising pans are small in size varying from 150 sq. ft. to 600 sq. ft., the bulk of them approximating the former size. The ratio of the crystallising area to the reservoir plus condensers average 1:2. This ratio is totally inadequate with the result that the brine is fed into the crystallisers from  $8^{\circ}$  to  $15^{\circ}$  Be' and the crystallisers are called upon to perform in part, the functions of the condensers. Brine is charged in the crystallisers up to a depth of 1 inch only which is far too shallow with the result that the rise of density cannot be controlled and the salt crystals do not get a chance to grow into compact form. Salt is scraped when it is less than  $\frac{1}{2}$  inch in thickness and as the scraping is done too frequently not only does the salt get admixed with a good deal of clay, but the beds are spoiled and have to be frequently tamped. Owing to the feeding of low density brine into the crystallisers, gypsum also gets deposited along with the salt and becomes an irremovable impurity. Moreover, there is no proper arrangement for the elimination of the bitterns; after every fourth scraping, the crystalliser bed is allowed to go dry and whatever salts remain behind are tamped into the floor of the bed. This means that the bitterns instead of being drained out get soaked into the crystalliser bed and are an ever present source of contamination.

3.5.2 *Huma*.—The Huma factory is one of the oldest factories in Orissa and is leased out to 27 licensees. The annual rainfall varies from 36 to 46 inches. As no bund is provided round the works they are reported to get flooded during the rains. Heavy rainfall begins from July and lasts up to November; though slight showers occur during the other months, they do not interfere with the manufacturing operations. The maximum area leased to a single lessee is 105 acres; there are four such lessees. The minimum area is, however, as low as  $2\frac{1}{2}$  acres. As in Astarang, each lessee has his own reservoir, condensers and crystallisers and the ratio of 1:2 is totally inadequate. Brine is obtained through the Chilka canal at a distance of  $\frac{3}{4}$  to 1 mile from the mouth of Rishikula river. In the case of the bigger lessees it is pumped from the canal into the reservoirs, but the smaller lessees bale it out by means of bamboo sling baskets. The lifting of salt starts at the end of March or the beginning of April and the heaviest production is during the months of May and June. The salt is scraped from the crystallisers every third day and heaped on the ridges for draining out the bitterns. From there it is carted to the drying platforms where it is allowed to dry for several weeks before being transported to the storage platforms. If a better quality of salt were harvested it could be dried on the ridges alone and transported direct to the stores. To improve the yield and quality of salt, the areas under cultivation should be redistributed in the ratio of 1:7 between the crystallisers and the reservoir and condensers. It is desirable that in the interests of economy and efficiency the 23 small lessees who work about 145 acres between themselves should be persuaded to form themselves into a co-operative society and work the area as a single unit. We were not furnished with any details of the cost of manufacture, but we were told that it varied between Rs. 20-6-8 and Rs. 23-13-0 per ton (Re. 0-12-0 and Re. 0-14-0 per md.). The details

of cost for the year 1947 were, however, collected by Mr. Shiv Charan Das and they are given below in Table CV.

TABLE CV.—COST OF PRODUCTION AT HUMA 1947

	Per ton Rs. a. p.
Labour charges for manufacture . . . . .	6 12 9
Drying and storing charges . . . . .	1 9 5
Ground rent . . . . .	0 14 6
Establishment charges . . . . .	1 5 9
Cost of packing excluding cost of bags . . . . .	1 11 2
Government of India salt cess . . . . .	3 6 5
TOTAL . . . . .	15 12 0 or Re. 0-9-3 per md.

No interest or depreciation charges have been provided in these figures. We were informed that the labour charges, during 1948 had increased by Rs. 3-6-5 per ton (Re. 0-2-0 per maund) which would give the cost of salt for that year at Rs. 19-2-5 per ton (Re. 0-11-3 per maund). At the nearest Madras factory of Naupada, the cost of production for 1947 was reported by Mr. Shiv Charan Das to average at Rs. 20 per ton (Re. 0-11-9 per md.). This shows that notwithstanding the handicaps from which the manufacturers in Orissa suffer they are able to produce salt at a competitive rate. The manufacturers stated that they charged a profit of only Rs. 1-11-3 per ton (Re. 0-1-0 per md.) which, if true, can be considered as reasonable.

3.5.3. *Gokhurkuda*.—Like the Astarang factory, the Gokhurkuda factory is run on a co-operative basis and is operated by the Huma Salt Production and Sale Co-operative Society. It lies adjacent to the Huma factory. The Co-operative Society was formed in 1942, but the manufacturing operations did not start till 1946. The Society has been given a lease of the lands by the Government of India for 25 years and the total area under cultivation is 283 acres; recently a further 305 acres have been assigned to the Society for extensions of the works. The subscribed capital is Rs. 22,500 on which the Society has obtained a loan from the Orissa Government of Rs. 58,000 all of which has been spent on the initial outlay of the works. At the time of our visit, the number of members of the Society was 426 and they had formed themselves into 69 groups, each group operating 3 to 5 acres. Each group of Society has its own reservoirs, condensers and crystallisers. Brine is supplied to the factory from the Chilka canal which also feeds the Huma factory and is pumped into the reservoirs. Since the works were started only in 1946 their yield is low and it is too early to judge the efficiency of the factory. We recommended to the Society that they should redistribute the area under cultivation so as to have common reservoirs and condensers and only the crystallisers should be worked by individual groups. In this manner they would save on the pumping charges as also economise on the expenditure incurred at present on maintaining individual sets of reservoirs and condensers. With such a modification it should be possible to increase the yield of the factory. We understand that for the additional 300 acres that have been leased to the Society a condition has been provided in the licence that the entire area should be laid out as a single unit and not distributed among the different groups. This is a step in the right direction. We further recommend that in re-distributing the areas under cultivation care should be taken to maintain a ratio of 1:7 between the crystallisers, and the reservoir cum condensers. The Society complained that for housing the staff of the Salt Department they had incurred a capital expenditure of Rs. 12,000 and to maintain the buildings they had to spend Rs. 1,500 each year. As the Salt

Department staff is housed free of rent, the Society is not earning any interest on this investment. Besides they have to provide free medical facilities and water supply to the staff of the Salt Department. They also complained that whilst the Salt Department maintains the roads in the small works, the roads within their factory area have to be maintained by them. These burdens have added to their cost of manufacture and put the co-operative unit at a disadvantage, compared with the small lessees who have remained outside the Society. These complaints appear reasonable and should be examined by the Salt Department with a view to offering the Society a measure of relief. No figures of cost were supplied to us, but as the factory adjoins the Huma factory the cost at Gokhurkuda should not be higher than at Huma. If anything, it should be lower since the factory is run on co-operative lines. Mr. Shiv Charan Das had, however, collected the figures of cost for the year 1947 and they are reproduced in Table CVI.

TABLE CVI.—COST OF PRODUCTION AT GOKHURKUDA 1947

	Per ton [Rs. a. p.]
Labour . . . . .	12 14 4
Drying and storage charges . . . . .	0 4 5
Establishment charges . . . . .	0 9 9
Cost of packing excluding the cost of bags . . . . .	1 11 2
TOTAL . . . . .	15 7 8 or Re. 0-9-1 per md.

To these figures have to be added interest and depreciation charges at the rate of Re. 0-9-9 per ton (4 pies per md.) for interest and Rs. 1-6-0 per ton (10 pies per md.) for depreciation which when added to the above cost would bring it up to Rs. 17-7-5 per ton (Re. 0-10-3 per md.). The *ex*-factory selling price has been given at Rs. 18-11-5 per ton (Re. 0-11-0 per md.) which gives the Society a profit of Rs. 1-4-0 per ton (Re. 0-0-9 per md.). This is low and does not give an adequate return on the capital invested by the members.

3.5.4. *Sumadi*.—The area in Sumadi for salt cultivation comprises 5,000 acres. Out of this, only 692 acres are at present being utilised. Messrs. B. K. Naidu and Others and Mr. M. M. Yusuf are leased 512 and 180 acres respectively; further 300 acres have been leased to each of these parties for extending their works. Messrs. B. K. Naidu and Others were granted in 1918 a lease for 25 years, which, on expiry in 1943, is being extended from year to year. They pay a ground rent of Rs. 301 per annum. To Mr. Yusuf, the lease was granted in November 1946 for a period of 25 years on an annual ground rent of Rs. 107. He informed us that he had invested about Rs. 3 lakhs on his works including Rs. 1,45,000 paid to the Government of India as assignment fee for obtaining the lease. An area of 510 acres has also been recently allotted to the National Chemical and Salt Works which are expected to go into production shortly. Thus, in all about 1500 acres out of 5300 acres have so far been leased out for salt manufacture. Brine is taken directly from the sea and it travels about 4 miles through channels over a swampy area before reaching these works. The method of production is primitive and the ratio of crystallisers to condensers plus reservoirs varies from 1:1 to 1:2. As the condenser area is inadequate, low density brine of 8° to 10° Be' is being charged into the crystallisers to a depth of 1½ to 2 inches. The size of the crystallising pans is 20 ft. x 50 ft. Salt is scraped every third day as soon as a thin layer of less than ¼ inch is formed.

By the time the brine has reached a density of 27° to 28° Bé very little of it is left in the pans and salt is scraped practically from a dry bed with the result that a lot of clay is collected along with the salt. The bitters are rarely eliminated. These practices should stop if the quality of the salt were to be improved. As in the case of the other factories the areas of the two Sumadi works should be redistributed in the ratio of 1:7. The break-up of the cost of manufacture at Sumadi was furnished to us by both the works, but their figures are conflicting as will be seen from Table CVII.

TABLE CVII.—COST OF PRODUCTION AT SUMADI

	Works I Per ton		Works II Per ton	
	Rs.	a. p.	Rs.	a. p.
(a) Cost of obtaining brine into reservoirs including the cost of power	2	8 10	1	9 0
(b) Labour	10	3 4	4	4 0
(c) Maintenance	1	11 3	1	4 5
(d) Supervision and overheads	2	8 10	1	2 2
(e) Rent, rates and taxes			0	2 3
(f) Interest	8	12 7		
(g) Depreciation			0	2 3
(h) Miscellaneous charges	6	12 10	0	4 6
<b>TOTAL</b>	<b>32</b>	<b>9 8</b>	<b>8</b>	<b>12 7</b>
	or Rs. 1	3 2	0	5 2

To these figures must be added the Provincial Government's cess of Rs. 1-11-3 per ton (Re. 0-1-0 per md.) for education. The labour charges furnished by Works II are abnormally low; for the year 1947-48 the prevailing rate for labour was about Rs. 6-13-0 per ton (Rs. 30 per garce of 120 mds.). On the other hand, the interest charges for Works I are calculated at 25 per cent. of the capital invested which is unjustifiable. Furthermore, Works I have made no provision for depreciation, but have shown under miscellaneous charges a sum of Rs. 6-12-10 per ton (Re. 0-4-0 per md.); no explanation has been given as to the items which go to make up these charges. The low depreciation shown on works II is apparently based on the cost of annual renewals and does not take into account the overall depreciation on the capital outlay. As the figures of cost are conflicting and unreliable we are unable to give a comparative appreciation of the cost of production and the selling price which in 1947-48 was about Rs. 17 per ton (Re. 0-10-0 per md.) ex-factory.

3.5.5 Table CVIII gives the output of salt in the Ganjam factories for the three years 1946 to 1948.

TABLE CVIII.—PRODUCTION IN GANJAM DISTRICT 1946—1948

	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Huma	11,100	3,02,000	17,050	4,64,000	13,850	3,77,000
Gokhurkuda	990	27,000	2,130	58,000	1,320	36,000
Sumadi	5,440	1,48,000	16,490	4,49,000	4,850	1,32,000
<b>TOTAL</b>	<b>17,530</b>	<b>4,77,000</b>	<b>35,670</b>	<b>9,71,000</b>	<b>20,020</b>	<b>5,45,000</b>



3.5.6 The quality of salt produced in the Ganjam factories is poor, the sodium chloride content being 95 per cent. and under. Analysis of samples of salt of the Huma and Sumadi factories are shown in Table CIX. These samples were drawn by us at the time of our visit in March 1949 from the production of 1948 and 1949.

TABLE CIX.—COMPOSITION OF SALT PRODUCED IN GANJAM FACTORIES  
(Per cent. on dry basis)

	Huma 1949	Sumadi			
		Naidu Works		Yusuf Works	
		1948	1949	1948	1949
1. Sodium chloride . . . . .	94.00	89.89	94.30	95.72	95.04
2. Calcium sulphate . . . . .	0.86	2.33	0.81	0.55	0.28
3. Magnesium sulphate . . . . .	1.08	0.71	1.17	0.80	1.19
4. Magnesium chloride . . . . .	1.60	1.54	1.85	1.55	2.42
5. Insolubles . . . . .	2.05	5.23	1.18	0.64	0.33
6. Undetermined . . . . .	0.41	0.30	0.69	0.74	0.74
TOTAL . . . . .	100.00	100.00	100.00	100.00	100.00

As salt has been manufactured in the Ganjam district for a number of years, it is regrettable that its quality is not uniform and is poor. It could be considerably improved with a little care in the manufacturing operations.

#### 4. Annual Production and Quality.

4.1 The annual production in Orissa for the three years 1946 to 1948, but excluding the *punga* salt and salt produced by solar evaporation by small unlicensed factories is shown in Table CX.

TABLE CX.—PRODUCTION OF SALT IN ORISSA 1946—1948

District	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Puri . . . . .	250	6,700	1,240	33,800	1,140	31,000
Ganjam . . . . .	17,530	4,77,000	35,670	9,71,000	20,020	5,45,000
TOTAL . . . . .	17,780	4,83,700	36,910	10,04,800	21,160	5,76,000

Even if the production by unlicensed manufacture which is estimated at 7,350 tons (2 lakh mds.) is added to these figures, the total production of Orissa is insufficient to meet the requirements of the Province. The annual consumption of the Province is about 92,000 tons (25 lakh mds.), but as the production falls short of demand, it imports about 59,000 tons (16 lakh mds.) or 63 per cent. of its requirements from Madras and Bengal; 37,000 tons (10 lakh mds.) or 40 per cent. from Naupada and 22,000 tons (6 lakh mds.) or 23 per cent. from Calcutta.

4.2 As stated in earlier paragraphs, the quality of salt produced in Orissa is unsatisfactory, its sodium chloride content varying from 89 to 95 per cent. While we appreciate that due to climatic factors it is not possible to adopt the multiple irrigation system in Orissa and the single irrigation system has necessarily to be followed, it should nevertheless be possible to manufacture salt of better quality by the single irrigation system as has been demonstrated at the Model Factory in Travancore and, on a bigger scale, by the Mettur Chemical's Factory at Adirampatnam, Madras Presidency. We recommend that the Orissa factories should introduce the method of manufacture developed by the model factory at Travancore.

## 5. Co-operative Societies.

5.1 It is only in Orissa that we came across co-operative societies for the manufacture of salt. Though this mode of co-operation is to be welcomed, the two societies now functioning in Orissa have not been in existence long enough to enable us to judge their activities purely on the basis of financial results. Co-operative Societies consist of working and non-working members. The former are individual producers, working in small groups each group operating small uneconomic units of 3 to 5 acres. The non-working members contribute to the share capital of the Society and are entitled only to the dividends that may be declared from the profits. The Astarang Society is working in an area which has been hitherto considered unsuitable for the production of solar salt. The society at Gokhurkuda is located further south where climatic conditions are more favourable for the production of solar salt, but as it started working only in the year 1946 it is too early to comment on the results. The Orissa Committee have in this report favoured the extension of salt manufacture by co-operative societies. While we generally support the extension of the co-operative movement as far as it is feasible we would invite the attention of the Orissa Government to the following factors in the working of these societies.

(a) While non-working members should not be excluded from the membership of the Society, care should be taken to see that the number of such members who are merely financiers is not increased merely to obtain additional capital. The inclusion of non-working members is desirable only if their service could be utilised for the purpose of guiding the affairs of the Society. The Co-operative societies are primarily organised for the benefit of those members who actually work on salt cultivation and they should not be converted into avenues of investments for the non-working members.

(b) The extent of application of the principle of co-operation has been somewhat restricted. The Societies have developed into a coalition of a large number of small producers who derive benefit mainly from the sale of salt. Though the Societies work both as producers and distributors of salt, only the selling side of the business appears to have received hitherto their attention. In the process of manufacture, the members work as separate units and do not in consequence get the benefit of improved efficiency and economy which they could obtain if they were to work as a single co-operative body. The costs of operation can be reduced if they are carried out jointly on a larger scale rather than in small individual units. Supply of brine by common pumps, its concentration up to 23° Be' in common reservoirs and condensers under scientific control, adoption of common protective measures against flooding, proper maintenance of works, and common stores are some of the benefits of which no advantage has been taken hitherto. Even in these operations, many of the working members can be gainfully employed if they were assigned definite duties. For example some members can attend to work on the pumping of brine, others on its condensing and still others on the

maintenance of the works. The only operation in which the members can individually engage themselves is in the lifting of salt and its transport to the storage yards. Such a joint effort in a common endeavour can alone be considered as working in the true spirit of co-operation.

5.2 The Co-operative Societies have been urging that they should be given preferential treatment by exempting them from building and maintaining quarters for the staff of the Salt Department, the payment of salt cess and, generally, from all supervision by the Salt Department. We do not find our way to recommending this preferential treatment as the Co-operative Societies, if they function on right lines, should be able to hold their own in competition with individual licensees. Their chief handicap, in their early stages, is lack of funds. We, therefore, recommend that the Orissa Government should offer the Societies easy loans and other financial help to meet the capital cost of laying out the works on a proper scientific basis so that they may be able to operate their works economically and at a fair margin of profit.

## 6. Improvements and Extensions.

6.1 Mr. Shiv Charan Das in his report on Orissa Salt Works had estimated on a conservative basis that the production could be increased to about 1,54,000 tons (42 lakh mds.) if the method of manufacture were improved and the areas available for salt cultivation were fully utilised. The areas worked by licensed and unlicensed factories and the areas available for further cultivation are shown in Table CXI.

TABLE CXI.—AREAS AVAILABLE FOR SALT CULTIVATION IN ORISSA

District	Factories	Area cultivated Acres	Area available for expansion Acres
(a) Puri . . . . .	Astarang . . . . .	1151	200
(b) Ganjam :—	(i) Huma, Gokhurkuda and Sumadi . . . . .	1551	2900
	(ii) Surla . . . . .	..	4900
	TOTAL . . . . .	2702	8000

Based on three years' production (1946 to 1948) the average yield per acre in the Orissa factories comes only to 12.5 tons (341 mds.). In spite of a comparatively short manufacturing season this yield is very poor. For works situated in Bombay and the Naupada and Pennuguduru circles of Madras we estimate that the yields could be raised to 50 tons (1,360 mds.) per acre by redistribution of the areas under cultivation. For the Orissa factories, by a similar redistribution of the areas under cultivation in the ratio of 1:7, it is within their reach to obtain a minimum yield of 40 tons (1,090 mds.) per acre. On this basis the production of salt from the existing factories could be increased to 1,08,000 tons (29,40,000 mds.) which would be sufficient to meet the present consumption in the Province. If the areas of 3,100 acres adjoining the existing factories in Puri and Ganjam districts are also brought under cultivation these areas could yield another 1,24,000 tons (33,79,000 mds.).

6.2 In addition to these areas there is a large area of 4,900 acres which is suitable for salt cultivation in Surla. A salt factory covering an area of 530 acres had been in operation there for more than a century, but was abandoned about 25 years ago. An attempt is being made to revive the

industry, and, out of an area of about 1,600 acres which is reported to be fit for salt manufacture, 696 acres have been allotted to Mr. M. M. Yusuf who is one of the two lessees operating a works at Sumadi. Mr. Yusuf expects to bring under cultivation about 228 acres and produce 1,840 tons (50,000 mds.) in the first year and to raise the production within three years to about 22,000 tons (6 lakh mds.). This is an underestimate and Mr. Yusuf can produce about 38,000 tons (10 lakh mds.) from the area allotted to him. Mr. Yusuf has also plans to start a heavy chemicals factory at this site, but this is a matter that does not concern us at the moment beyond our venturing the suggestion that the manufacture of salt should be fully established in Orissa before any proposals for starting a heavy chemical industry are taken up. The source of brine supply is a creek  $3\frac{1}{2}$  miles from the factory. The supply of brine is, however, reported to be scanty owing to the deposits of mud and sand in the channel of the creek. It is also reported that a sand bar 150 ft. long and 50 ft. deep is obstructing the flow of water and, if the bar mouth could be kept open and the silt regularly cleared, an even flow of brine to the factory site could be assured at high tides. Failing this, it would be possible to pump the brine at high tide by locating pumps at suitable sites.

6.2.1 There is a swamp on the eastern side of the Surla factory, covering an area of about 3,300 acres which is a potential site for locating new salt works and which could be brought into cultivation if supply of brine were assured. The development of this area should be considered only after it has been established that there would be no dearth of brine supply to the Surla factory that is being reopened by Mr. Yusuf. For the swamp area, it would also be necessary to construct a ring bund to prevent any salt works that might be established there from being flooded out during the monsoon. If this is not done, a large amount of expenditure would be incurred annually on repairs to condensers and crystallisers.

6.3 Apart from the areas mentioned above, Gopalpur in the Ganjam district is also a potential site for developing a salt factory. There will be no dearth of brine there, because it is on the sea. Transport will also be easier as it is connected by good roads and is within easy reach of the Berhampur railway station, 10 miles away.

6.4 It will be seen that the Ganjam district alone can meet the entire requirement of Orissa and has furthermore a potential capacity to export about 1,65,000 tons (45 lakh mds.). Though the cost of production in Ganjam is bound to be higher than in Kathiawad or Kutch, the Orissa factories have the freight advantage owing to their proximity to markets which usually depend upon imported salt. If salt of good quality could be produced in sufficient quantities the Orissa factories can contribute to reduce the shortage of good salt in the Calcutta market. Moreover, as the Ganjam factories are nearer to Sindri than the Naupada factories, they can meet the demand for salt of the proposed soda ash plant at Sindri more economically than either the Madras, Sambhar or Kathiawad factories.

6.5 The Chilka canal which supplies the brine to the Huma and Gokhurkuda factories was originally excavated for navigation purposes between the Ganjam and the Puri districts *via* the Chilka Lake. At high tides sea water enters into the canal through the mouth of Rishikula river. The canal was maintained formerly by the Madras Government, but, with the opening of the Bengal Nagpur Railway, its utility diminished, and in 1919 its maintenance was transferred to the Salt Department who constructed a bund near Mayurpada with a view to improving the supply of the brine to the two salt factories. One of the effects of this bund has been to prevent sea water from

flowing into the Chilka Lake as a result of which a portion of the canal beyond the bund has dried up. The Orissa Government have recently requested the Salt Controller to remove this bund on the ground that it has deprived the fishermen of the locality of their means of livelihood. The Salt Controller has asked for our views on this subject and after careful consideration we are of the opinion that a bund is not necessary and it could be removed. Since the brine for the salt works is mainly lifted by pumps the utility of the bund has largely diminished. If at all it is found necessary to store the water in the canal, we recommend that suitable sluice gates, operated manually, may be provided which could be kept closed at high tides to divert adequate quantities of brine into the subsidiary channels for storage. This suggestion is, however, subject to more detailed examination by the Orissa Government and the Salt Department of the extent of silting in the canal, the cost of re-opening it and the cost of its maintenance.

## 7. Staff and Organisation.

7.1 There is no technical staff at any of the two factories in Orissa to guide the manufacturing operations. As two co-operative societies are already operating the salt works in the Province and as we have recommended the extension of the co-operative method of working, we recommend that the large private factories and the Co-operative Department of the Orissa Government should employ suitable technical staff to help the works in producing salt of better quality and a higher yield. Control laboratories should be set up for routine analysis of the brine and the salt produced. The cost of these laboratories can be borne jointly by the lessees where necessary.

7.2 The Orissa Committee have recommended that an officer of the status of an Assistant Salt Controller, with headquarters in Orissa, should be appointed to look after the development of the salt industry in the Province. At present this work is being done by a Superintendent who is stationed at Huma and who works under the Assistant Salt Controller, posted in Calcutta, in charge of the salt works in Bengal and Orissa. The Orissa Committee have also complained that the salt works are not receiving any technical guidance from the staff of the Salt Department whose chief duty is to look after administration and revenue matters. This complaint is not entirely correct. When we visited Orissa, we met the Superintendent of Salt. He has had long experience in the manufacture of salt and we are confident that he could give technical guidance if the manufacturers so desired. The truth, however, is that as in most of the other salt works in the country, there is general conservatism in the methods of production and the manufacturers are chary of adopting modern methods to improve the quality or the yield of salt. The mere appointment of technical staff will not, therefore, solve the problem. The better way of offering technical guidance to the manufacturers is to establish a model factory in Orissa where the best methods of production, with due regard to climatic conditions, could be demonstrated. These questions have been dealt with in the subsequent chapters.

7.3 Labour is employed by the larger lessees on a contract basis. Payment is made at a fixed rate which in 1947-48 was about Rs. 6-13-0 per ton [Rs. 30 per garce (120 mds.)] and which in 1948-49 had risen to Rs. 9-1-0 to Rs. 10-3-0 per ton (Rs. 40 to 45 per garce). As suggested in the Chapter on Madras, the employment of middle men in engaging the labour should be discouraged and the factories should recruit their labour directly.

## 8. Summary of recommendations.

### (a) Balasore District

(i) Large scale manufacture of salt by solar evaporation should not be undertaken in the Balasore District. (3.1.2)

(ii) We do not support the suggestion of the Salt Manufacture Investigation Committee of Orissa that the *punga* process should be encouraged on any extensive scale. This process may be allowed to continue in the coastal villages as a cottage industry to meet strictly local requirements. (3.1.3)

(iii) The Balasore district is not suitable for setting up a brine evaporator plant worked either by steam or electricly. (3.1.4)

(b) Cuttack District

(i) Manufacture of solar salt in the Cuttack district does not appear to be feasible owing to heavy rainfall and a short manufacturing season. (3.2)

(ii) Establishment of salt factories at Bhopal, Kharanasi and Bailkani as proposed by the Orissa Committee should not be undertaken till meteorological data of these localities over a period of 7 to 10 years are fully studied. We also do not support the proposal of the Orissa Committee to set up a salt factory at Harishpur, as the proposed area has already been converted into paddy lands. (3.2.1)

(c) Puri District

(i) The area under salt cultivation of the Astarang Co-operative Society's factory should be redistributed so as to give a ratio of 1:7.5 between the crystalliser and reservoir cum condensers. The size of the crystalliser should also be enlarged to a minimum of 2,000 sq. ft. (3.3.1)

(ii) The proposal of the Society to do away with the control of the Salt Department cannot be accepted. (3.3.2)

(iii) A loan of Rs. 20,000 should be advanced to the Society by the Orissa Government for providing pump, ring bund, etc. for the factory. The Society should also provide common reservoir and condensers and allot only the crystallising area to the members on a group basis. Proper roads and waterway facilities should be provided to the Society to make a success of their venture. (3.3.2)

(iv) No new salt works should be established on the Chilka Lake until the effect of the Hirakud Project is fully determined. (3.4)

(d) Ganjam District

(i) The areas under cultivation in Huma should be redistributed in the ratio of 1:7. The 23 small lessees who work about 145 acres at Huma should be persuaded to form themselves into a Co-operative Society and work the area as a single unit. (3.5.2)

(ii) The Gokhurkuda Co-operative Society should have common reservoirs and condensers in order to save on the pumping charges and economise on the expenditure on maintenance of individual sets of reservoirs and condensers. The area under cultivation by the Society should also be redistributed in the ratio of 1:7 between the crystallisers and reservoirs and condensers. (3.5.3)

(iii) The Salt Department should examine the complaints of the Gokhurkuda Society about the liability placed on them for maintaining the roads within their factory and providing rent free quarters to the staff of the Salt Department. (3.5.3)

(iv) The area of the two salt works in Sumadi should be redistributed in the ratio of 1:7. (3.5.4)

(e) General Recommendations.

(i) To improve the quality of salt in Orissa the method of manufacture by single irrigation system as developed by the Model Factory at Travancore should be introduced. (4.2)

(ii) The number of non-working members in the Co-operative Societies should be restricted. (5.1)

(iii) The cost of operations in the Co-operative Societies can be reduced by installing common pumps and maintaining common reservoirs and condensers. (5.1)

(iv) The Orissa Government should offer the Co-operative Societies easy loans and other financial help to meet the cost of laying out the works on proper scientific lines. (5.2)

(v) The yield in the Orissa factories could be raised to 50 tons (1,000 mds.) per acre by proper redistribution of the areas under cultivation. By this method as also by bringing in new areas under cultivation the production in Orissa can be increased substantially which would not only make the Province self-sufficient but also enable it to export about 1,65,000 tons (45 lakh mds.) of salt to Calcutta and the adjoining Province of Bihar. (6.1 and 6.4)

(vi) The Orissa Government and the Salt Department should undertake a more detailed examination of the question of removal of the bund on Chilka canal. (6.5)

(vii) The large private factories and the Co-operative Department of the Orissa Government should employ suitable technical staff to help the salt works in producing salt of better quality. Control laboratories should also be set up for routine analysis of the brine and the salt produced. (7.1)

(viii) The employment of middlemen for engaging labour should be discouraged and the factories should recruit their labour directly. (7.3)

## CHAPTER XVII WEST BENGAL

### 1. Description.

1.1 Notwithstanding her long seaboard, Bengal has been a deficient Province with regard to salt for more than a century. Salt had been produced in this Province since early times, but at no time in the past was it manufactured by solar evaporation. The method that was followed and has survived to this day is the *punga* process. During the Mughal period both the manufacturer of and trade in salt was controlled by the Government of the day and looked upon as a special privilege to be granted to a few favoured persons. During the British regime, the East India Co., was more interested in its revenue than in maintaining the indigenous salt industry and impediments were placed in the way of its development in order that Liverpool and Cheshire salt could be imported in larger and larger quantities. The process of elimination of the indigenous industry was hastened by the fact that it was simpler and more efficient to collect duty on salt at its place of importation than from a multitude of small scale producers scattered all over the country.

1.2 The import of salt on an extensive scale began in the year 1870 at which time the quantity of salt manufactured and sold in Bengal was of the order of 55,000 tons (15 lakh mds). We have discussed in the chapter on Orissa, the disastrous consequence of the change over from the monopoly system to the excise system. In Bengal also the same change was introduced, but unlike Orissa the salt industry did not die out overnight, but kept on steadily declining. By 1880, the imports had steadily increased and the local manufacture fell to below 3,700 tons (1 lakh mds.) and ceased to be of any consequence. The imported salt was both cheap and of a higher quality than the indigenous salt. By 1898 salt could no longer be produced at a competitive rate and its manufacture was prohibited. The Province began to depend entirely upon imported salt which came from the U.K. and other foreign countries including Aden and the Middle East ports.

1.3 The first World war brought into the forefront the question of supplying salt to Bengal from Indian sources and the revival of the indigenous industry. The first enquiry on the possibilities of producing salt in Bengal and Orissa was made by the late Mr. Kapilram Vakil. In the past, the failure of salt manufacture in Bengal was attributed to the following three causes:

- (a) The cost of manufacture in Bengal was higher than the selling price of the imported article. Moreover on the indigenous salt produced by the *punga* process, heavy charges on account of preventive and warehouse establishments were levied from which the imported foreign salt was free.
- (b) The low salinity of sea water in the Bay of Bengal due to the discharge of large quantities of fresh water from the Ganges and the Brahmaputra.
- (c) The climate of Bengal was very humid and did not favour salt manufacture by solar process.

Mr. Vakil stated that the humidity at Calcutta was actually less than at Bombay where solar salt was being manufactured successfully on a large scale.



The only valid reasons which, according to him, would go against the production of salt on a large scale in Bengal were

- (i) the small area of the sea coast intercepted by estuaries which are not favourable to salt manufacture; and
- (ii) the Nor-westers and cyclonic storms from the Bay of Bengal.

From a close study of the climatological maps and memoirs published by the Meteorological Department of the Government of India, Mr. Vakil came to the conclusion that various factors gave Bengal and Orissa an unequable climate making the manufacture of salt necessarily a speculative proposition. Attempts made by Messrs. Andrew Yule and Co., to manufacture salt on an experimental basis on the Contai seaboard did not succeed, because of the high cost of production and transport.

1.4 In 1926, the Taxation Enquiry Committee recommended the advisability of making India self-sufficient in salt and favoured "the granting of a purely temporary advantage to the manufacturers, whether by way of a rebate of duty or of a differential duty on import or both." The Central Board of Revenue were however, averse to this since no attempt could reasonably be made to compel the consumer in Bengal to like the ordinary Madras and Bombay salt. They, therefore, came to the following conclusions:

- (a) the problem of making the mainland of India self-supporting in the matter of salt supply resolved itself into that of capturing for Indian salt the market for fine white crushed salt in Bengal;
- (b) the cost of transporting salt to Bengal from those places in India at which salt suitable for that market could be produced and the extent to which such transport could be made available, were factors of the greatest importance;
- (c) the probable limitations upon the output of sources in India which could produce the required quality of salt were such that in the evidence available, a reasonable probability that India could be made self supporting in this respect could not be regarded as established.

The Indian Legislative Assembly however, kept on pressing the need for stopping the imports of foreign salt and developing the industry in India and as a result of the recommendation of both the Tariff Board and the Salt Survey Committee, a further enquiry was conducted by Mr. C. H. Pitt on the question of production of salt in Bengal, Bihar and Orissa by solar evaporation. Mr. Pitt's findings were as under:

- (a) due to appreciable variations in the strength of the brine during different seasons of the year, manufacture of salt in Bengal might be possible for a limited period of the year only.
- (b) in view of the higher humidity, lower temperature and the winter rainfall, it seemed unlikely that a working season of more than four months could be obtained. These unfavourable conditions were further accentuated by the prevalence of cyclonic storms and barometric depressions at the head of the Bay of Bengal.
- (c) manufacture by vacuum evaporation required complicated and costly plant and skilled labour and an uninterrupted supply of concentrated brine which would at the best be obtainable in the Bengal coast for only four months of the year. Owing to the short working season, depreciation on the plant would be heavy, supervision would be costly and the probability of the plant's continuous working would be doubtful, so that it seemed unlikely that this system of manufacture would be successful.
- (d) one or more experimental factories might be established to test possibilities of manufacture by the Burma process which combined solar and artificial evaporation, but Government should take no part in the conduct of an experimental factory beyond arranging

for preventive work. One of the areas in which an experiment of this kind might be carried out was Lothian Island in the Sunderbans though there might be many areas more suitable in the Sunderbans. The areas east and west of Sola Khal on the Contai foreshore and round the mouth of the Bherikhan Khal near Contai might also be suitable.

Although Mr. Pitt did not say outright that the manufacture of solar salt in Bengal was not possible, his very grudging admission of its possibility subject to experimentation was interpreted as unfavourable to the proposal.

1.5 This view was not accepted by the Government of Bengal, who instituted an independent enquiry through their Industrial Chemist. He reported that a large scale manufacture by the *punga* process was not possible and that the method suitable for Bengal was the Burma process. As a result of this report, the Government of Bengal invited two experts, one from Sind and the other from Burma to report on the question. The Sind expert came to the conclusion that the manufacture of salt by solar evaporation was not possible in Bengal. The Burma expert held that it should be possible to manufacture salt by the Burma process on a commercial scale. The matter was again enquired into, in 1937, by Mr. D. N. Mukherjee, the present Salt Controller, Government of India and Mr. V. S. Rao of the Bengal Forest Service. Their enquiry was mainly confined to the Sunderbans. They made a survey of the sea brine along the steamer route from Saptamukhi to Terobanki Khal up to its junction with Harinbhanga and found that the brine was suitable for salt manufacture, and they recommended the adoption of the Burma process. For this purpose they made an exhaustive study of the firewood resources and came to the conclusion that the areas around Sunderbans could provide annually brushwood fuel to the extent of 47 lakh maunds. Calculating on the basis that 50 seers of fuel would be required to produce one maund of salt, they computed that the Sunderbans could yield annually about 1,36,000 tons (37 lakh maunds) of salt. They selected an area of about 5,800 acres in the Reserved Forest at the junction of Terobanki Khal and Harinbhanga river where a group of factories might be established in course of time.

1.6 The next stage in the series of enquiries into the salt industry of Bengal came when the Department of Industries, Bengal, made a reference to the Bengal Industrial Survey Committee who constituted in September 1941 a Sub-Committee for making a detailed enquiry into the position and prospects of manufacture of salt in Bengal. This Sub-Committee submitted their report in 1945 in which they came to the conclusion that the brine of initial density of 2.2° to 2.6° Be' as reported by M/s Mukherjee and Rao was quite suitable, and that it was possible to have a manufacturing season of 5 months from early December to early May. They recommended a threefold programme as follows:

- (a) all possible facilities should be made available to those who were producing salt under the Gandhi Irwin Agreement on a cottage basis;
- (b) adequate facilities, under favourable conditions, should be created to attract private initiative to start production of salt by any of the methods, *viz.* solar evaporation and the Burma method, or by both methods on a factory scale.
- (c) Government should take steps for starting one or more pioneer salt factories so that a good portion of Bengal's salt requirements may be met. In addition to these, they advocated the starting of several ancillary industries for the manufacture of byproducts and heavy chemicals for which the salt works might have to be

located at a distance of 25 to 50 miles inland from the sea. They also recommended that an independent and self contained Salt Development Department should be established by the Government of Bengal to develop the production of salt in Bengal and that a Salt Advisory Committee should be set up for this purpose.

1.7 Mr. G. K. Nag, Special Officer (Salt) of the Directorate of Industries, its requirements of salt, Bengal must install big factories and that the Bengal on a cottage basis and he submitted a report in 1947. While he was in favour of giving the necessary encouragement to the villagers in the coastal belt to produce more salt by the *punga* method he expressed the opinion that, to meet its requirements of salt, Bengal must install big factories and that the Bengal Government must install some factories of their own to serve as models to private enterprise.

## 2. Manufacturing Process.

2.1 The licence to manufacture salt in Bengal is issued by the Salt Department of the Government of India. The licences are renewable each year on payment of an annual fee of Rs. 5. The salt factories are situated in the two districts of Midnapur and 24 Parganas. The list of the factories is given in Table CXII.

TABLE CXII.—FACTORIES IN WEST BENGAL

District	Name of works	Location	Area under cultivation (in acres)			
			Reservoirs	Condensers	Crystallisers	Total
(a) Midnapur	(i) Bengal Salt Co.	Dadana-patra.	42	54	13	109
	(ii) Premier Salt Mfg. Co.	Purusha-tampur	Not known			25
(b) 24 Parganas	(i) Pioneer Salt Mfg. Co.	Sisirganj	5	25	5	30
	(ii) National Salt Mfg. Co.	Maipith.	Not known			25
	(iii) Lokomanya Salt Works.	Marsani	Not known			16
						205

Both the solar and the Burma processes are followed and the single irrigation system is adopted in the case of solar salt. Brine is drawn from the sea into the reservoirs during high tides. It is then either pumped or baled out to the condensers wherefrom it is fed into the Crystallisers. In some of the factories concentrated brine of 20° Bé obtained by solar evaporation, is heated in open pans over direct fire and the salt obtained is marketed as evaporated salt. Salt is also produced on a cottage scale by the *punga* method but the sodium chloride content of the product is only about 85 percent.

2.2 MIDNAPUR DISTRICT.—Of the two works in this area, the Bengal Salt Co., has been in existence for 7 years. We visited this factory in May 1948. It has probably the longest and the most sustained experience of manufacture of salt in Bengal, notwithstanding the vicissitudes through which it has had to pass. These works possess an area of 600 acres, but only 109 acres have been utilised so far as given below:

Reservoirs	Acres
Condensers	42
Crystallisers	54
	13
	109

This gives a ratio of 1:7.4 between the crystallisers and the reservoirs plus condensers which is not in any way excessive for an area of comparatively heavy rainfall. Table CXIII gives the particulars of the rainfall at Contai for the ten years 1938 to 1947 as also the density of sea brine month by month:

TABLE CXIII.—RAINFALL AT CONTAI 1938-1947

(In inches)

Month	Average	Minimum	Maximum	Average number of rainy days	Density of sea brine in Bé deg.
January	0.60	Nil	1.72	1.5	1.7
February	0.55	Nil	3.25	1.2	2.5
March	0.87	Nil	3.20	2.9	2.5
April	1.67	Nil	7.36	3.9	2.8
May	4.49	0.86	10.87	7.1	2.9
June	10.81	4.00	17.75	13.3	2.7
July	12.81	6.79	16.96	18.9	(Upto 15th).
August	17.66	9.99	40.21	19.6	Less than 1.0
September	11.27	7.66	23.09	15.4	
October	11.73	4.62	26.25	9.0	
November	0.73	Nil	3.30	1.6	1.0
December	0.37	Nil	3.63	0.4	1.0
TOTAL	73.56			94.8	

The density of the brine is very low upto February and the salt manufacturing season commences from February and closes by about the end of May when the rainfall is sometimes heavy. The density of the brine falls to about 1° Bé by the middle of June and no manufacture is attempted during the rest of the year because of the low density of brine. These works also carry out some production by evaporating concentrated brine with artificial heat. They store the concentrated brine at the end of the manufacturing season in a cement cistern in order to utilise it for artificial evaporation after the onset of the rains. They have also been experimenting with cement pans for use as crystallisers. The Midnapur coast is subject to periodical cyclones against which no adequate protection is possible. These works suffered a heavy damage during the cyclone of 1942 which washed away the entire factory and buildings and resulted even in the loss of life of some of the personnel. The works had to be started all over again.

2.2.1 The production of the Bengal Salt Company for the three years 1946-48 is shown in Table CXIV :

TABLE CXIV.—PRODUCTION OF SALT BY THE BENGAL SALT COMPANY 1946-48

	Tons	Mds.
1946	350	9,570
1947	960	26,060
1948	1,370	37,350

The average yield per acre comes to only about 7.35 tons (200 mds.) which is too low even for the short season during which these works operate. We feel that these works have not yet had time to establish themselves and the shortage of finance has been responsible for the poor progress made hitherto. The small quantity of salt that is being manufactured is sold in Calcutta to which place it is despatched in flat bottom boats.

2.2.2 The analyses of samples of salt collected by us during our visit to these works are shown in Table CXV:

TABLE CXV.—COMPOSITION OF SALT PRODUCED BY THE BENGAL SALT COMPANY.

(Percent; on dry basis)

	Solar salt		Evaporated salt
	Clay beds	Cement beds	
Sodium chloride	97.23	96.71	93.96
Calcium sulphate	0.68	1.21	1.02
Magnesium sulphate	0.54	0.10	1.93
Magnesium chloride	0.91	0.74	2.07
Insolubles	0.37	0.42	0.32
Undetermined	0.27	0.82	0.70
TOTAL	100.00	100.00	100.00

Notwithstanding the extra expenditure incurred on the artificial evaporation of brine, the result of analysis shows that the evaporated salt is inferior to solar salt. This is largely due to the fact that the crop of crystals is not being collected at the correct stages of fractionation and the adherent mother liquor is not effectively removed. If the artificial evaporation is to be continued, the works will be well advised to control the density of the brine at which it is fed into the evaporating pan and that of the mother liquor at the time of collection of the crystals. By using a small centrifuge, they should be able to drain away the adhering liquor and also give the salt a wash with water or dilute brine to remove the impurities. The salt obtained from the cement beds is also inferior to the clay beds. The calcium sulphate content is appreciably higher presumably because the brine has reacted with the cement. This was noticeable from the cracks and blisters that the cement pans had developed. We do not consider that there is sufficient justification for laying down *pacca* beds of cement. Considering the success that has been made of the ordinary clay beds in these works we recommend that here as elsewhere in India clay beds alone should be used.

2.2.3 The season of only four months is shorter than in any other part of India but despite the low density of the brine during November and December, an effort should be made by these works to take advantage of the dry months from November onwards for the concentration of brine. A period of about six weeks is necessary for the preparation of the condensers and crystallisers at the commencement of each season and this period should be utilised for the concentration of the low density brine in the reservoirs so that a large storage of brine of a fair concentration may be available as soon as the condensers are made ready. If this were done, it would be possible to feed the concentrated brine into the condensers in December so as to enable the deposition of salt in the crystallisers to commence in January. Considering the low density of the brine, the areas under cultivation will have to be redistributed to give a ratio of 1:11. On this basis the present 109 acres should be divided as under:

	Acres.
Reservoir . . . . .	60
Condensor . . . . .	40
Crystalliser . . . . .	9
<b>TOTAL</b>	<b>109</b>

By this redistribution, the yield of salt per acre should increase to a minimum of 25 tons (680 mds.) as compared with the present yield of only about 7.35 tons (200 mds). We are also of the opinion that the entire area of 600 acres in the possession of the works should be brought under cultivation and if this were done, the total should be distributed amongst the different components as follows:

	Acres
Reservoir . . . . .	330
Condensor . . . . .	220
Crystalliser . . . . .	50
<b>TOTAL</b>	<b>600</b>

By bringing this area under cultivation the production of the Bengal Salt Co may well be computed at 15,000 tons (4 lakh mds.) per annum.

2.3 The other factory in the Midnapur district *viz.*, the premier Salt Manufacturing Co. Ltd., has only 10 acres under production. Their average annual production is only 44 tons (1200 mds.) giving a yield of 4.4 tons (120 maunds) per acre which is even lower than that of the Bengal Salt Co.

2.4 24 PARGANAS.—Salt was being manufactured on a very small scale by seven factories in this area, but their history has been even more chequered than that of the factories in the Midnapur district. The Sunderbans being not easily accessible at the time of our visit to West Bengal, we were not able to visit any of the factories in this district. No manufacturing operations were in progress at that time.

2.4.1 One of the factories *viz.* the Pioneer Salt Manufacturing Co. Ltd., of Sisirganj have given us detailed information about their works and the conditions of manufacture prevailing with them could be applied *mutatis mutandis* to the other factories in the Sunderbans. The works of this Company are situated at Sisirganj in the Sunderbans at a distance of 58 miles from Calcutta.

Port Canning, 30 miles from Sisirganj, is the nearest railway station and the only means of transport from the works is by sailing boats. The Company acquired one plot of 430 acres in 1936 and commenced the construction of the works in 1938. Though originally it was planned that all the 430 acres would be utilised, the area under salt manufacture at present is only 30 acres. Out of these 30 acres, the reservoir covers an area of 5 acres, condensers 20 acres and the crystallisers 5 acres, giving a ratio of 1:5 which we consider inadequate for a place where the rainfall is heavy and the initial density of brine is only about 2° Be'. We have not been able to secure the figures of rainfall over any extended period for this locality, but it has been stated that the figures relating to the Saugor Island which is situated nearby would apply to this area. Table CXVI gives the average monthly rainfall for each month collected between 1871 and 1920. Since the average is based on observations over a fairly long period we consider that these figures may be treated as typical.

TABLE CXVI.—RAINFALL AT SAUGOR ISLAND 1871-1920.

(In inches)

Months	Average	Average number of rainy days
January	0.30	0.9
February	1.12	1.8
March	1.43	2.0
April	1.14	2.1
May	4.41	5.8
June	11.54	12.3
July	14.65	15.8
August	14.18	16.5
September	10.76	13.0
October	8.14	7.5
November	1.47	1.4
December	0.27	0.5
	69.41	79.6

It will be seen that the climatic conditions in the Saugor Island are, if anything, a little better than that at Contai; the average annual rainfall and the number of rainy days in the year are lower. The dry season starts from November and lasts till the middle of May. It is probable that the density of the sea brine in November will be as low as at Contai, but this handicap can be overcome to some extent by increasing the reservoir area so that advantage may be taken of the fair weather prevailing in November and December for concentrating the brine. If this is done, salt may start crystallising from January. From the statement of monthly production furnished by the works since their inception in 1938, we found that they were able to harvest some salt in the month of January though as a rule the collection had been confined to the months of March, April and May. There have also been years when some quantity of salt was collected even as late as June. From the data, we conclude that if full advantage were taken of the evaporating capacity in the months of November and December, the production of salt could start in January and continue till the middle of May. Both the solar evaporation method and the Burma process are followed. In spite of the proximity of the forest area from which fuel should be available, the works have reported that they have found difficulty in getting their supplies. At one time, they had installed 10 galvauised

steel pans, measuring 10 ft. x 10 ft. x 1½ ft. but these pans have corroded away and they have not been replaced as steel could not be made available to them during war time. We do not consider iron pans suitable for salt manufacture and if these works are to continue to produce evaporated salt they must use a material that would not be affected by the highly corrosive brine and the saline atmosphere of the works. Unless a dependable source of fuel supply can be established we would not recommend their restarting the boiling method for the manufacture of salt. They have also experimented with covered cement cisterns into which concentrated brine is led whenever there is a shower of rain. We feel that such a contraption cannot have a place in any large scale works where millions of gallons of concentrated brine have to be handled. We cannot help feeling that these works did not have the benefit of expert advice from persons experienced in the manufacture of salt which, if obtained, would have saved them the unnecessary expenditure on experiments.

2.4.2 In Table CXVII we reproduce the figures of production at these works for the 10 years from 1939 to 1948:

TABLE CXVII.—PRODUCTION OF SALT BY THE PIONEER SALT MANUFACTURING Co., LTD., 1939-1948.

	Tons	Mds.
1939	32	870
1940	18	490
1941	46	1240
1942	71	1940
1943	68	1840
1944	11	300
1945	18	500
1946	7	200
1947	36	990
1948	3	80

From these figures it will be seen that the highest production for any year was 71 tons (1940 maunds) which gives a yield of about 2.4 tons (65 maunds) which is very low. No salt works could be run economically at this rate of production and we recommend that these works be extended and that an area of 400 acres be brought under cultivation if salt is to be produced at an economic cost. The area should be distributed in the ratio of 1 : 11, between the crystalliser and reservoir cum condenser. With this ratio, the production of the works should go upto 10,000 tons (2,70,000 mds.) per annum.

2.4.3 These works have given us a statement of break up of cost computed on the basis of the probable production of a fully developed area. We show them below:

	Per ton
	Rs. a. p.
(a) Cost for obtaining brine into reservoirs	0 13 7
(b) Labour	4 4 0
(c) Maintenance including repairs etc.	3 6 5
(d) Supervision	0 13 7
(e) Overhead	0 13 7
(f) Rents, rates & taxes	0 6 10
(g) Depreciation	0 6 10
(h) Misc. charges	0 13 7
<b>TOTAL</b>	<b>11 14 5</b>
	or Re. 0-7-0 per md.



Apart from the fact that these figures do not take into account the interest charges on the capital outlay we feel that they are a gross under-estimate and the cost of manufacture in our opinion will exceed Rs. 27-4-0 per ton (Re. 1 per md.) This cost is undoubtedly high as compared with the cost of the more favourably situated areas, but against this the Bengal works have the advantage of much lower transport cost and should be able to compete with salt brought all the way from Kathiawad and Kutch. These works possess an undoubted advantage in having the Calcutta market almost next door which can be reached all the way by water during all weather by country crafts. The works are, however, not in favour of using the water route because they fear that the crafts in use are not built strongly enough to carry the salt all the way to Calcutta. They have, therefore, urged that the ban on the booking of salt by rail from the Port Canning Station should be withdrawn. When the production at these works reaches a reasonable proportion, the railways will no doubt look into their grievance and offer facilities for the movement by rail also.

2.4.4 No technical staff such as an engineer or a chemist is employed by these works. Besides the Manager and a clerk, there is one foreman, called Sardar and 5 skilled and 25 unskilled workers. Labour is permanently employed and resides in the vicinity of the works. As these works require technical guidance, they should also employ a Chemist or a Chemical Engineer who should be in charge of the works and who should be made responsible for manufacturing operations.

2.4.5 The other two factories in the 24 Parganas are not in operation. The total area of each is too small to be economic.

### 3. Production and Quality.

3.1 The total production of salt in West Bengal, by the licensed factories, has been negligible hitherto. The production for the three years of 1946-48 is shown in Table CXVIII:

TABLE CXVIII.—PRODUCTION OF SALT IN BENGAL 1946-1948.

District	1946		1947		1948	
	Tons	Mds.	Tons	Mds.	Tons	Mds.
Midnapur . . .	367	10,000	1,016	27,690	1,380	37,470
24 Prganas . . .	7	200	36	980	3	80
<b>TOTAL . . .</b>	<b>374</b>	<b>10,200</b>	<b>1,052</b>	<b>28,670</b>	<b>1,383</b>	<b>37,550</b>

The present yields are very low and the production could have been several times higher even from the present areas under cultivation if the works had been in continuous operation.

3.2 The quality of salt produced in Midnapur District is better than the quality produced in Madras and Bombay. This is largely because any inferior quality salt would not have found a sale in Bengal.

### 4. Improvements and Extensions.

4.1 The Government of West Bengal placed before us a programme for the future development of the salt industry on (a) Contai Sea Board and (b) the Sunderbans.

(a) On the Contai seaboard, the following three saline belts have been selected for development:-

	Area	Acres
(i) Purushattampur . . . . .		2,350
(ii) Deuli . . . . .		4,216
(iii) Ramnagar . . . . .		1,200
		7,766

In the opinion of the Government of West Bengal, the Bengal Salt Co. had achieved encouraging results in Purushattampur but the rate of development had been retarded owing to lack of capital. The Government offered to accelerate the development by affording financial assistance and technical guidance. With regard to the other two areas, the Government were contemplating the setting up of one or two industrial corporations for which the share capital would be provided by the West Bengal Government, the Government of India and private interests. The Government of West Bengal, held the view that even if participation by the Central Government was not forthcoming the State Government would go ahead with their proposals in collaboration with the public of West Bengal.

(b) Sunderbans (24 Parganas)—The Government of West Bengal proposed to develop 1500 acres available in this district by enabling the existing factories to acquire additional lands to become economic units. They were also contemplating granting financial assistance to the works already in existence. Basing their calculations on an average yield of 22 tons (600 maunds) per acre at the end of the first three years and an ultimate yield of 29 tons (800 maunds) per acre, the Government of West Bengal had made the following forecast of productions:

#### ANTICIPATED PRODUCTION

Locality	Total area to be developed	Expected yield after 3 years		Expected ultimate Yield	
		Tons	Mds.	Tons	Mds.
(a) Contai Sea Board (Midnapur):—	<i>Acres</i>				
(i) Purushattampur . . . . .	2,500	55,000	15,00,000	72,500	20,00,000
(ii) Deuli . . . . .	4,200	92,400	25,30,000	1,21,800	33,60,000
(iii) Ramnagar . . . . .	1,200	26,400	7,20,000	34,800	9,60,000
(b) Sunderbans (24 Parganas) . . . . .	1,500	33,000	9,01,000	43,500	12,00,000
	9,400	2,06,800	56,41,000	2,72,600	74,60,000

1.2 The estimates of yield of the West Bengal Government appear to us to be slightly higher and we would be satisfied if the lower figure of 25 tons (680 mds.) per acre indicated by us in previous paragraphs could be achieved. It is a practicable proposition but it could be reached only over a period of years. We have before us the example of the salt works in Kathiawad where nearly

20 years ago there was only one salt works but where today there are 13 large and small works producing 3,00,000 tons (81 lakh maunds) of salt per annum, and where the possibilities of further expansion are not exhausted. Before manufacture on such a large scale can be planned at Contai Sea Board, we had recommended in our Interim Report that a detailed and large size map showing the topography and the contours of this area should be prepared. As the meteorological and other technical data available at Contai were not adequate we had recommended that the Government of India should appoint an investigation officer at the salt works of the Bengal Salt Co. Ltd., to collect independently the following data:

- (a) distribution of rainfall, on daily, monthly and yearly basis,
- (b) daily maximum and minimum temperatures,
- (c) daily humidity,
- (d) daily wind velocity and direction,
- (e) tidal fluctuations (rise and fall in feet) daily, monthly and yearly,
- (f) density of sea water each week,
- (g) density of brine in the creek, reservoirs, condensers, crystallising beds and bittern channels of the salt works each week,
- (h) rate of evaporation of brine in different stages, month by month, and
- (j) analysis of sea water samples (to be done month fo month in a central laboratory).

This information gathered over a period of two or three years would serve as a useful guide to the existing works in Contai as also to the new works that might be established there. We had further recommended that this officer should be a meteorologist who is a graduate in Chemistry and that the Meteorological Department of the Government of India might be asked to recommend a suitable person for immediate appointment. We suggested the appointment of this officer by the Government of India in order that their Salt Department could keep itself in close touch with the development of the salt industry in West Bengal. This recommendation has not yet been acted upon and we reiterate it for adoption.

4.2.1 Another factor which should also be examined before any large scale manufacture is undertaken at Contai is the question of transport both by canal as well as by rail routes. Running parallel to the Contai sea-board is the Orissa coast canal which needs to be reconditioned to serve as an alternative means of transport to the interior of West Bengal. The railway station of Contai Road is about 40 miles from the sea-board and the provision of a railway line to it should be given a high priority so as to provide facilities of rail transport when large scale manufacture begins. Unless alternative means of transport are made available, the chances of development of salt industry in this area on an extensive scale will be remote.

4.3 Salt can be produced in West Bengal by solar evaporation. The conditions are decidedly less favourable than in other parts of India but a mere comparison of meteorological data is not sufficient. The success of manufacture depends upon a number of factors both favourable and unfavourable. The most serious handicap from which West Bengal suffers is the low density of the brine. Though there is little or no rainfall during November and December the brine at the commencement of the dry season is dilute and has a density of only 1 to 1.5° Bé. In the Manakudi Lake in Travancore brine of this density has been used successfully in the past for the manufacture of salt. In Bengal also, if the manufacturing operations were to commence from November when the fair weather sets in, brine of even this low density could be utilised if the ratio of the area of the crystallisers to the condensers cum

reservoir is kept at 1: 11. As the production of salt demands that brine should rise in concentration to 23° Be' as quickly as possible we would suggest that in the earlier months of the year brine should be charged in the reservoirs and condensers to shallow depths so that brine of 23° Be' may be made available by December. If this were done it should be possible to get 120 days for crystallisation which should give the yield of 25 tons (680 mds) per acre.

4.3.1 A serious threat to the manufacturing operations is the periodic occurrences of cloud bursts and cyclones which have caused serious damage in the past to the salt works in Midnapur district. While normal flooding may be avoided by providing embankments round the works and ring channels could also be constructed around the high density condensers and crystallisers to prevent excessive dilution of the brine, there is no way of securing protection against cyclones. The cyclones will, therefore, have to be looked upon as normal business hazards and the figures of their periodicity will have to be worked out. For instance, if it is found, that the cyclones occur once in four years, during the manufacturing season, the cost of production should allow for this factor and an amount equivalent to 25 per cent. of the cost of production should be added to the year's cost as an insurance against loss of total production in the years of the cyclone.

4.3.2 One favourable factor in the manufacture of salt, in West Bengal, is the nearness of the markets. As long as the demand for salt in the Bengal market has to be met by imports from such distant places as Kathiawad, Kutch, Tuticorin, Aden and the Middle East ports, the local manufacturers should be able to compete with imported salt even if their cost of production is twice as high as the cost in distant factories. At present the cost of transport from the West coast ports to Calcutta is about Rs. 27-2-2 per ton (Re. 1 per md.) and so long as this high rate of freight continues, the Bengal manufacturers should be able to compete with imported salt. If and when the sea freight falls appreciably, it might then be necessary to afford a measure of temporary protection to the Bengal manufacturers by giving them a financial subsidy.

4.3.3 It is fairly well agreed that the cottage manufacturers can do little towards wiping out the deficit of salt in West Bengal. The production of salt by the *punga* process has strictly limited scope and any large scale attempt to restore it would meet with failure. There is no future for this method of manufacture and we repeat that the solar evaporation method is the cheapest and the one likely to prove the most economical when conducted on a large scale.

4.3.4 The Burma process might be tried in addition to the solar method in places where firewood or coal can be supplied cheaply. It would not be correct to look upon it as an alternative method to solar evaporation but as an adjunct to it especially for the production of high quality salt for table use. The boiling process is however costly and its widespread use for producing domestic common salt would not prove economic. If salt is to be produced by artificial evaporation it should be only for specific purposes and for purchasers who are agreeable to pay more for it than the ordinary price of more edible salt.

4.3.5 In other parts of India where salt manufacture has established itself, we do not see any need for Government to set up large scale works of their own. The only recommendation that we have made, where Government factories already exist, is that they should be run by Government as model

factories to serve as demonstration centres for the private producers. In the case of West Bengal, however, as the manufacture is fraught with some hazard owing to climatic conditions, the Government of India and the Government of Bengal should set up a large Government factory at Contai and, besides, come to the help of the private producers by subsidising their venture on a partnership basis.

## 5. Summary of Recommendations.

### (a) Midnapur District.

- (i) The Bengal Salt Company should be advised to use only clay beds for the crystallisation of salt. (2.2.2)
- (ii) The manufacturing operations at these works should commence from November, when low density brine should be taken into the reservoir for concentration. The present area of 109 acres should be extended to 600 acres and distributed in the ratio of 1:11. (2.2.3)

### (b) 24 Parganas.

- (i) The Pioneer Salt Co. Ltd., of Sisirganj should start manufacturing operations from November in order that salt may start crystallising out from January. Unless dependable source of fuel supply can be established, they should not restart the boiling method of manufacture.
- (ii) The present area of 30 acres under cultivation at these works is uneconomical; it should be extended to 400 acres. The ratio of crystalliser to reservoir *cum* condensers should be 1:11. (2.4.2)
- (iii) These works should employ a Chemist or a Chemical Engineer who should be made responsible for manufacturing operations. (2.4.4)

### (c) General Recommendation.

- (i) For planning large scale production at Contai a detailed large size map showing the topography and the contours of the sea-board should be prepared. Also detailed meteorological and technical data should be collected by a Special Officer of the Salt Department. (4.2)
- (ii) The question of transport of salt from Contai by canal as well as by rail should be examined. (4.2.1.)
- (iii) Salt can be manufactured on a large scale in West Bengal only by the solar evaporation. (4.3)
- (iv) Manufacture of salt by the *punga* method on a large scale is not likely to meet with success. (4.3.3)
- (v) The Burma process might be tried out as an adjunct to the solar evaporation method for the manufacture of high grade salt only (4.3.4)
- (vi) The Government of India and the Government of West Bengal should set up a large Government factory at Contai and also assist the private producers financially in order to encourage the development of the salt industry. (4.3.5)

## CHAPTER XVIII

### RECOVERY OF BYPRODUCTS

#### 1. Introduction.

1.1 The recovery of byproducts from brines of various types has attracted little attention hitherto in the Indian salt works. Considering the large scale production of salt, the production of byproducts is comparatively negligible. There are only four or five centres where this recovery is attempted. They are (a) Kharaghoda, (b) Mithapur, (c) Kuda (Dhrangadhra) and (d) Model Factory in Travancore. Experimental production on a small scale has also been started by Mettur Chemicals at their salt works at Adirampatnam. The Digvijayasingji Salt Works of Jamnagar and the Kandla works recover only one of the byproducts, *viz.*, gypsum. Mithapur is the only place where the major components of sea brine are being recovered in a systematic way. At other centres, only some of the components are recovered. The processes adopted and the progress achieved at the different centres in the recovery of byproducts are dealt with below.

#### 2. Kharaghoda.

2.1 THE PIONEER MAGNESIA WORKS.--The Pioneer Magnesia Works were granted a licence in 1918 for a period of 35 years under which they were given the sole and exclusive right to utilise all the bitterns remaining after the extraction of salt at Kharaghoda for manufacturing magnesium chloride, magnesium sulphate and all other chemicals and derivatives except such chemicals or byproducts the manufacture of which may be departmentally undertaken by the Government of India.

2.2 CRUDE SALT.—At the Kharaghoda Salt Works the bitterns from the crystallising pans are transferred to a pit locally known as *faran* where they are allowed to collect and concentrate. The *farans* are adjacent to the crystallising pans and the bitterns are either baled out or drained into them through earthen channels twice during the manufacturing season. For each set of reservoir and crystallising pan, one *faran* is provided which is renovated every year. In accordance with their agreement, the Pioneer Magnesia Works are entitled to draw the bitterns as soon as they reach the *farans*, but in practice they collect and transport them to their factory, near the railway station, only when the bitterns have reached a density of 36° Be'. We consider this method of allowing the bitterns to collect and evaporate in the *farans* as highly wasteful. It is more than likely that a good deal is being lost by percolation in the pits. Besides when the bitterns concentrate from 29° to 32° Be', they deposit an appreciable quantity of crude salt containing 90 to 92 per cent. sodium chloride which can be easily collected if the preliminary evaporation of the bitterns is carried out in a separate set of crystallising pans, specially provided for the purpose. This crude salt can be marketed either as such, or after washing with concentrated brine, to eliminate the magnesium sulphate and magnesium chloride which form the major impurities in it. An alternative method of utilising the crude salt would be to throw it back in the reservoirs to increase the density of the brine; this will increase the total yield of salt from the brine lifted from the wells. For a proper recovery of crude salt, the bitterns will have to be discharged from the crystallising pans more frequently than at present.

2.3 CARNALLITE.—After the bitterns have reached 32° Be' in the crude salt pans, they can be transferred to another set of pans for further evaporation to 36° Bé. By doing so, the potassium chloride present in the bitterns will separate out in the form of crude carnallite (KCl, MgCl, 6HO). As the original well brine at Kharaghoda has a lower proportion of magnesium sulphate to magnesium chloride, when compared to sea brine, the interference of magnesium sulphate in the separation of carnallite is much less and a prior separation of magnesium sulphate is, therefore, not necessary. During our visit we collected several samples of crude carnallite that had formed naturally in the *farans*. The composition of the crude carnallite is given in Table CXIX and compared with that of pure carnallite.

TABLE CXIX,—COMPOSITION OF CARNALLITE

	Crude Carnallite (Kharaghoda)	Pure Carnallite
Potassium chloride (KCl) . . .	13.34	(Percent.) 26.83
Magnesium chloride (MgCl <sub>2</sub> ) . . .	35.44	34.29
Magnesium sulphate (MgSO <sub>4</sub> ) . . .	1.23	..
Sodium chloride (NaCl) . . .	6.43	..
Water (H <sub>2</sub> O) . . . . .	42.68	38.88
Insolubles . . . . .	0.88	..
	100.00	100.00

If the separation of carnallite could take place in separate pans, we are confident that a much better product would be obtained. At present the crude salt and the carnallite that get deposited in the *farans* are left behind and bitterns of 36° Be' only are removed by the Pioneer Magnesia Works. These valuable salts are washed away during the monsoon every year and thus lost. We compute that the quantity of crude salt that deposits annually would exceed 44,000 tons (about 12 lakh mds.) on the present production at Kharaghoda of 1,83,000 tons (50 lakh mds.) of common salt per annum. Similarly the potassium chloride (KCl) content of the crude carnallite that would be crystallising out would be more than 3,000 tons per annum. Potassium chloride is an important fertilizer for increasing the food production in the country. It is also the parent salt from which all other potassium compounds of commerce, *viz.*, caustic potash (KOH), potassium carbonate (K<sub>2</sub>CO<sub>3</sub>), potassium chlorate (KClO<sub>3</sub>), etc., are derived. Some of the naturally occurring deposits of potassium salt of the Punjab have gone over to Pakistan and it is, therefore, essential that we recover potassium chloride from the bitterns. We, therefore, recommend that a set of two crystallising pans, one for crude salt and another for crude carnallite, should be built along side the salt crystallising pans. For evaporating the bitterns from 29° to 32° Be', the size of the crude salt pan, corresponding to the present crystallising area of 20,000 sq. ft. should be 1,700 sq. ft. The size of the pan for crude carnallite should also be similar. However, in place of having one comparatively small pan of 1,700 sq. ft. for the recovery of crude carnallite, the bitterns at 32° Be' from two or more crude salt pans may be led for the convenience of collection to a proportionately larger pan. The bitterns from the crude salt pans will

have to be discharged regularly into the carnallite pan as soon as it reaches  $32^{\circ} \text{Be}$ ; otherwise some of the carnallite will separate out with the crude salt and will be thus lost. As the salt crystallising pans are at present along side the railway sidings, the location of the crude salt as well as the carnallite pans will have to be fixed as near the railway sidings as possible. We also recommend that the crude salt pan should be leased out to the Agarias along with the salt crystallising pans whilst the Pioneer Magnesia Works be given the first option to undertake the recovery of carnallite. Though, in accordance with the terms of the present agreement, Government can undertake the manufacture of carnallite departmentally, we would not recommend to Government to assume this responsibility at present. The Pioneer Magnesia Works even now recover in their factory this byproduct, on a small scale, from a part of the bitterns handled by them. Their average annual production between the years 1944 and 1947 was 278 tons. They should, therefore, be given the option and facility to build pans along side the proposed crude salt pans for the recovery of carnallite.

2.4 The present method of transporting the bitterns from the *farans* to the Pioneer Magnesia Works is primitive. The bitterns are filled manually into small containers either earthen or of galvanised iron and carried by head loads to a tank, mounted on a broad gauge under-carriage. The tank wagon is then pushed manually to the works over a distance of as much as 8 miles. In the process of transport the bitterns splash over the labourers and over the permanent way. Mr. Mithal in his report has expressed an opinion, which we endorse, that more damage is done to the permanent way by this splashing of the bitterns than from flooding during the rains. Carrying bitterns by headloads, sometimes over a distance of half a mile, must be injurious to the labour as high density bitterns have a corrosive effect on the skin and might lead to occupational disease. It is not understood why the Pioneer Magnesia Works do not utilise pumps for lifting the bitterns from the *farans* to the tank wagon. A hand pump could do this work more efficiently and economically than the present primitive method. We recommend this method for adoption and we also recommend that the practice of pushing the tank wagons by manual labour should be prohibited and the works be asked to provide a locomotive for this purpose.

2.5 MAGNESIUM CHLORIDE.—The bitterns are stored in open cement tanks at the works and are then heated in copper kettles by oil firing. When a temperature of  $162^{\circ} \text{C}$  is reached, the liquor, which is by then mostly fused magnesium chloride, is allowed to settle in the kettles when magnesium sulphate along with other impurities like mud, iron oxide, etc. sinks to the bottom as sludge. The supernatant magnesium chloride liquor is then decanted off into galvanised iron drums when it cools to a solid, fused, white mass. The quality of the magnesium chloride produced is considered satisfactory both by consumers in India and abroad.

2.5.1 When the Pioneer Magnesia Works started making magnesium chloride, they were helped by the conditions created by the First World War; after the War they had to face severe competition from powerful German interests and they had to apply for protection. The Tariff Board in their first enquiry of 1924 did not support the application for protection, but in 1925 the Government of India levied a revenue duty of 15 per cent. on imported magnesium chloride which helped the Pioneer Magnesia Works to continue their production. In 1927 the revenue duty was removed as a measure of relief to the textile industry and about the same time the competition from Germany again became more severe. In 1929 the Works applied again for protection and on this occasion they satisfied the Tariff Board that with a small measure of protection they



could establish the industry in the country within a few years. The protection was granted for a period of 7 years and a duty of Re. 0-7-0 per cwt. was levied on all imports. As a direct consequence of protection, two other factories came into production at Mithapur and Kuda. In 1931 the protective duty was increased to Re. 0-8-9 per cwt. and in 1934 further increased to Rs. 1-5-0 per cwt. or 25 per cent. *ad valorem* whichever was higher. In 1939 as a result of a fresh Tariff Board enquiry the protection was extended by a further period of 7 years, but the duty was reduced to Re. 0-12-0 per cwt. At the close of this period the protection was renewed year by year till 31st March 1949 when it was withdrawn, the manufacturers themselves declaring that they did not require any further protection.

2.5.2 The average annual production of magnesium chloride by the Pioneer Magnesia Works between the years 1936 and 1947 is as under:

Years	Tons Annual Average
1936—1940 . . . . .	6,089
1941—1945 . . . . .	3,851
1946—1947 (2 years) . . . . .	4,912

Before World War II its price was about Rs. 5 per cwt. delivered at Bombay and is now of the order of Rs. 7 per cwt. The foreign prices are somewhat higher and range between Rs. 9 and Rs. 10 per cwt. c.i.f. European ports. The fall in production during 1941 to 1945 was due to

(a) substantial reduction in consumption by the Indian textile industry as a result of the Cotton Textile Sizing and Filling Control Order of 1942 which was intended to reduce the demand for starch and

(b) fall in exports during the War.

Before the War the textile industry used to consume about 4,000 tons of magnesium chloride per annum; this was reduced to 2,000 tons because of the Sizing Control Order which is still in force. The Indian producers have, therefore, to depend mainly on foreign markets which is not a healthy situation for the industry as in course of time it might not be able to retain the European markets in competition with the magnesium chloride of Stassfurt, Germany. In European countries, magnesium chloride is consumed mainly for the manufacture of oxychloride cements used in the building trade. Recent advances in the preparation of these cements have eliminated many of the defects previously noticed in them and have increased their utility. These cements have certain advantages over Portland Cement in strength and resistance. As there are large deposits of magnesite in the country and the production of magnesium chloride is capable of large expansion, the development of the oxychloride cement industry has a good future in this country. Magnesium chloride, in its anhydrous form, is also the raw material for the manufacture of magnesium metal which is coming into increasing use in America for the manufacture of various lighter-than-aluminium alloys. Whilst the production of magnesium metal in India might not be feasible for some time to come it is advisable to bear this possibility in mind. The recovery of this important byproduct from the bitters is an essential part of the economies of the salt works and should be actively promoted by finding a wider use for it in the country.

2.6 MAGNESIUM SULPHATE.—As stated in paragraph 2.5, the magnesium sulphate present in the magnesium chloride liquor settles out with the sludge in the kettles. This sludge is then dissolved in fresh water and concentrated

by solar evaporation in cement pans for the separation of magnesium sulphate. The production of magnesium sulphate has, however, been negligible and bears no relationship or ratio to the production of magnesium chloride as will be seen from Table CXX.

TABLE CXX.—AVERAGE ANNUAL PRODUCTION OF MAGNESIUM SULPHATE AND MAGNESIUM CHLORIDE

	Magnesium Sulphate	Magnesium Chloride
	Tons	Tons
1937—40 (4 years) . . . . .	241	6,227
1941—45 . . . . .	231	3,851
1946—47 (2 years) . . . . .	37	4,912

When the average annual production of magnesium chloride in the four-year period 1937-40 was 6,227 tons, the average annual production of magnesium sulphate was only 241 tons. In the subsequent period of 1941-45, when the production of magnesium chloride was about 60 per cent. on the previous average, the production of magnesium sulphate was 231 tons. Similarly in 1946-47, against the average annual production of magnesium chloride of 4,912 tons, the recovery of magnesium sulphate had dropped down to 37 tons only. This would suggest that the Pioneer Magnesia Works are not making a sustained effort to recover all the magnesium sulphate from the bitters. There is a definite ratio of 1:11 between magnesium sulphate and magnesium chloride contents of the bitters at 36°Be and on this basis the average production of magnesium sulphate in 1937-40 should have been 566 tons per annum and in 1941-1945 it should have been 350 tons per annum.

2.6.1 The pharmaceutical or druggist quality or magnesium sulphate or Epsom Salt is used as a purgative and for dressing wounds. The commercial quality is used for sizing in the textile industry, for tanning leather and to some extent in the paper industry. Another important use to which it can be put is in the fireproofing of fibres and fabrics. The requirement of India for magnesium sulphate is in the neighbourhood of about 4,000 tons per annum. The Heavy Chemicals Panel had suggested that future demands could be met by increasing the production in the country "without any special difficulty". Besides its recovery at Kharaghoda, a small quantity is also recovered from the bitters at Mithapur, but the bulk of the country's requirement is manufactured by treating the naturally occurring magnesite with sulphuric acid. As India has to depend on foreign sources for its requirement of sulphur for sulphuric acid, the utilisation of this acid should be reserved for industries where it is indispensable. It is possible to recover from the bitters, magnesium sulphate of a quality comparable with the requirements of the pharmaceutical standards; what is needed is a sustained and better effort both at Kharaghoda and Mithapur to improve their present recovery. Also new recovery plants should be installed at some of the larger salt works in the country. If this is done it should be possible in the course of the next five years to obtain from these natural sources the entire requirement of the country and possibly some for export to the neighbouring countries.

2.7 IMPROVEMENTS.—Though the Pioneer Magnesia Works have done pioneering work in recovering magnesium chloride from the bitters of Kharaghoda, which had been going to waste for generations, they could have improved the technique of manufacture as also the plant and equipment which are antiquated and need modernisation. They themselves have realised the

need for reorganising their methods of operation, but as their lease expires on 31st of December 1953 they are, not unnaturally, reluctant to proceed with their programme of modernisation unless they are assured of the lease being renewed for a further period. The Tariff Board have also considered this question and in their report of 1948 have stressed the importance of an early decision by Government on the question of continuation of the lease. The Salt Controller has sought our advice also on this subject. The Tariff Board have recommended that the Pioneer Magnesia Works have a good claim for further renewal of their lease, provided they convert themselves into a public limited company. We agree with this recommendation and further recommend that:

- (a) the lease be extended for a further period of 25 years on the understanding that before the expiry of the present lease they would modernise their plant for the better and more efficient recovery of the byproducts;
- (b) the bitterns be made available to them only after the recovery of crude salt by the Kharaghoda Salt Works as recommended by us in paragraph 2.3;
- (c) the rate of royalty be fixed at Rs. 2 per ton or 2½ per cent. of the ex-Works selling price of the products recovered from the bitterns and/or their derivatives, whichever is higher. As the byproducts are cheap or essential chemicals, it would not be fair to fix a higher rate of royalty;
- (d) to keep check on the efficiency of operation, the quantity of bitterns of '36° Be' taken by the Works be measured when it is loaded into the tank wagons. On the basis that 1 gallon (13.30 lbs.) of bitterns at 36° Be' contains 6.4 lbs. of magnesium chloride ( $MgCl_2, 6H_2O$ ) and allowing for a recovery of only 75 per cent. 4.8 lbs. of magnesium chloride ( $MgCl_2, 6H_2O$ ) should be recovered per gallon of the bitterns. The royalty charged should, therefore, be subject to this prescribed minimum so that if they fail to recover it they should be required nonetheless, to pay the royalty on this minimum basis; and
- (e) if after a period of five years they are unable to bring about an improvement in their efficiency it should be open to Government to increase the rate of royalty.

2.7.1 In their proposal for modernising their plant, the Pioneer Magnesia Works intend to strip the bitterns of bromine and then to still them to recover magnesium sulphate, the residual liquor being then treated for the recovery of carnallite and magnesium chloride by artificial heat. To carry out these operations it must be presumed that they intend transporting the bitterns to the Works at a lower density than 36° Be'. Though they have not specified the exact density it appears to us that they propose to transport the bitterns at 32° Be', after removal of crude salt as envisaged by us. We however, consider that our recommendation for the recovery of carnallite by solar evaporation would be cheaper than the proposal of the Pioneer Magnesia Works and we suggest that these works carry on our proposal before they invest a large sum of money in an evaporator plant for the recovery of carnallite. We would also like to add a word of caution about their proposal to recover bromine. At present bromine has no ready market in the country and in the absence of the dye-stuff industry its consumption is limited to a very small quantity. A bromine plant is already in existence at Mithapur who have reported to us that they operate it at less than half its rated capacity as there is not enough demand for it or its derivatives. We, therefore, advise the Pioneer Magnesia Works to defer the expenditure on a bromine plant for the time being.

### 3. Mithapur.

3.1 The byproducts recovered at Mithapur are (a) bromine (b) magnesium sulphate (c) potassium chloride and (d) magnesium chloride. The processes employed are not novel and have been developed and modified from time to time in the light of experience gained under Indian conditions. Most of the equipment has been locally designed and fabricated.

3.2 CRUDE SALT.—The bitters as they emerge from the sale pans at 29° Be' are pumped to a second set of crystallisers, where they are allowed to rise in density to 34° Be' by solar evaporation to obtain a crop of crude salt. The crude salt is collected, washed and used in the manufacture of soda ash. In this manner a fair quantity of salt which would otherwise be lost and which is lost in other salt works the bitters is being recovered. We, however, recommend that the concentration of the bitters should not be allowed to rise above 32° Be' for the recovery of crude salt and for this purpose the existing area under bittern pans should be divided into two compartments, the first to be used for crude salt and the second for raising the density from 32° to B'. In this manner purer crude salt would deposit in the first compartment whilst the salt separating out in the second compartment would be heavily contaminated with the byproducts and could be processed separately for the recovery of magnesium sulphate.

3.3 BROMINE.—The byproduct first recovered is bromine. The bitters are pre-heated and sprayed from the top in a granite tower where they meet an upward current of steam and chlorine gas. The liberated bromine vapours are carried upwards and condensed in a special type of tantalum condenser. The resulting liquid bromine is separated off and stored in special stoneware jars. Except for the demand from chemical laboratories, which is very small, there is no large scale demand for liquid bromine in India at present. Most of the bromine recovered at Mithapur is converted into sodium and potassium bromides. Even the annual consumption of the two bromides is comparatively small and is estimated at about 5 tons for the former and 40 tons for the latter.

3.4 MAGNESIUM SULPHATE.—After the removal of bromine, the bitters are taken to the Epsom Plant where they are first cooled on chilling rolls, as a result of which crude magnesium sulphate crystallises out and is separated in a centrifuge. The crude magnesium sulphate (70 to 75 per cent.) is re-crystallised from fresh water or the mother liquor of a previous re-crystallisation to obtain a product of 98 to 99 per cent. purity. For the druggist or B. P. quality of Epsom salt, a further wash with fresh water is given.

3.5 POTASSIUM CHLORIDE.—The residual bitters, after the recovery of the magnesium sulphate, are then evaporated in triple effect evaporators when kieserite  $K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$  a double salt of potassium sulphate and magnesium sulphate, separates out and is removed through the salt box attached to the evaporators. The kieserite is dissolved in water and subjected to solar evaporation for the recovery of magnesium sulphate present in it, which is purified by re-crystallisation in the same manner as the product obtained from the chilling rolls. The liquor left over in the evaporators is transferred to continuous mechanical crystallisers where it is chilled for the separation of carnallite ( $KCl \cdot MgCl_2 \cdot 6H_2O$ ) a double salt of potassium chloride and magnesium chloride. The carnallite is centrifuged and dissolved in water to make a saturated solution and allowed to stand in cement tanks where crude potassium chloride of about 60 to 70 per cent. purity separates out. The potassium chloride is sold as such or is subjected to washing with chilled water or crystallisation to remove the sodium chloride present in it; by repeated re-crystallisation it is possible to obtain potassium chloride of as high as 99 per cent. purity.

**3.6 MAGNESIUM CHLORIDE.**—The Mother liquor left over after the recovery of carnallite is used for the recovery of magnesium chloride. The process is different from that followed at Kharaghoda. The liquor is heated in iron kettles by direct fire to 161°C and small quantities of potassium chlorate and lime are added to precipitate the iron salts. The hot liquor is then transferred to conical aluminium tanks where the suspended impurities are allowed to settle. The clear molten magnesium chloride  $MgCl_2 \cdot 6H_2O$  is then run off into G.I. drums in which it sets to a solid mass on cooling.

**3.7** The production of the byproducts at Mithapur for the last five years is given in Table CXXI, the figures of production of salt, for the same period, being also shown for the purpose of comparison.

TABLE CXXI.—PRODUCTION OF BYPRODUCTS AT MITHAPUR 1943—48.  
(In tons).

Year	Bromine	Epsom Salt	Potassium chloride	Magnesium chloride	Salt
1943-44	22	435	22	485	24,000
1944-45	2	538	46	477	36,000
1945-46	14	213	83	1981	41,000
1946-47	17	277	44	1400	56,000
1947-48	25	351	26	1613	68,000

These figures reveal that there is no relationship between the production of common salt and that of the various byproducts. It was explained to us that in the case of bromine, although the production has been progressively increasing from the year 1944-45, it is far below the rated capacity of the plant due to its limited demand. The same explanation was also given with regard to the production of magnesium chloride, particularly during the war years when due to the restrictions on the use of magnesium chloride in the textile industry and difficulties on finding an export market, the production was restricted to such quantities as could be consumed in the country. It is, however, to be regretted that the remaining two salts *vis*, Epsom salt and potassium chloride have not been recovered to the extent to which they should have been. Both these materials are in common use and in large demand in India. The attention of Mithapur works should be drawn to it so that they may attain more rational recovery ratio between common salt and the byproducts.

#### 4. Kuda.

**4.1** At the Kuda Salt Works magnesium chloride is recovered by the Mayurdhwaj Magnesia Works Ltd. The process of recovery is similar to that at Kharaghoda and the rated capacity of the Works is said to be 2,000 tons per annum. The Works produced between the years 1932 and 1936 on an average 1165 tons per annum. During the years 1937 to 1941, there was no production, but it was resumed on a small scale in 1942. The average production during the years 1942 to 1947 was about 635 tons per annum. As conditions in Kuda are similar to those of Kharaghoda, we recommend that these works should take into consideration the recommendation made for Kharaghoda in earlier paragraphs for the recovery of crude salt, carnallite and magnesium sulphate.

#### 5. Travancore.

**5.1** The Model Factory has conducted experiments to recover, by solar evaporation, magnesium sulphate and potassium salts from the bitterns after

the separation of crude salt. The production of these salts has not been established yet as a regular works' procedure. During the War they found a novel use for the bitterns of 36° Be' as an agent for water purification in place of alumina ferris or aluminium sulphate which was in short supply. The high content of magnesium chloride in the bitterns at this density helps to coagulate the suspended impurities in water when used along with lime. The composition of the bitterns at 36° Be' is given below:—

Magnesium chloride ( $MgCl_2, 6H_2O$ )	51.07
Sodium chloride (NaCl)	2.64
Magnesium Sulphate ( $MgSO_4, 7H_2O$ )	5.64
Magnesium Bromide ( $MgBr_2, 6H_2O$ )	1.17
Potassium Sulphate ( $K_2SO_4$ )	0.16
Water by difference	39.32
	100.00

## 6. Gypsum.

6.1 The Model Factory at Travancore has made it a regular practice to recover gypsum as a byproduct from the second set of condensers where brine is concentrated from 12° to 23° Be'. The beds of these condensers are tamped like the beds of the crystallisers at the beginning of the season and the gypsum, which crystallises out, is recovered at the close of each season by draining the condenser free of all the brine. The beds are allowed to dry for 2 or 3 days when the crust of crude gypsum detaches itself and is raked. The crude gypsum which contains 85 per cent. of  $CaSO_4, 2H_2O$  is then agitated in a cement cistern with water to remove the adherent clay. The process is repeated two or three times and clean crystals of gypsum are then dried on bamboo mats and stored in the open. The yield of crude gypsum is reported to be about seven tons per acre of the area covered by the high density condensers (12° to 23° Be) or a little over one ton per acre of the total cultivated area. From the seven tons crude gypsum about four tons of washed gypsum of the following composition are obtained:

	(On Dry Basis)	
Calcium sulphate ( $CaSO_4, 2H_2O$ )		97.74
Sodium chloride (NaCl)	—	1.28
Silica ( $SiO_2$ )		0.42
Undetermined		0.56
	TOTAL	100.00

6.2 Gypsum is used in the manufacture of Plaster of Paris, cement, potteries, fertilizers, etc. and its use in the manufacture of fertilizers has gained special importance in India. The fertilizer factory at Sindri in Bihar which is rated to produce 3,50,000 tons of Ammonium Sulphate per annum will require more than 5,00,000 tons of gypsum per annum. The fertilizer factory in Travancore, with a capacity of 50,000 tons of Ammonium Sulphate per annum also requires gypsum as a raw material. Gypsum is used to the extent of 2 to 3 per cent. in the cement industry and as the total production of cement in India is in the neighbourhood of about 2½ million tons, the cement industry requires annually between 50,000 to 75,000 tons of gypsum. Owing to lack of sulphur resources, gypsum is also being seriously considered as a raw material for the manufacture of sulphuric acid in India. After the partition of the country a major portion of the gypsum deposits have gone over to Pakistan and it is therefore, necessary that gypsum separating from brine should be

collected at all the major salt works in India. We appreciate the difficulty that would be encountered in raising gypsum from the condensers while they are in use, but if they were sub-divided, the compartments could be cut out of circuit and emptied of brine one by one for collecting the gypsum. Roughly about 0.055 ton of gypsum should separate out in the condensers for every one ton of salt produced. Even if this quantity were not recoverable in full, the salt works in India could provide annually a substantial quantity by making its collection a regular feature of their operations. Unfortunately the recovery of this important byproduct has been totally neglected, until recently even at Mithapur. Only two works in Kathiawad and Kutch, *viz.*, the Digvijaya Singhji Salt Works at Jamnagar and the Kandla salt works have hitherto made an attempt to recover gypsum. At Jamnagar, it is being collected as a part of the reconditioning operation of the condensers and at Kandla the crop is raised only once in two or three years. Even though gypsum is in constant demand at the cement works at Porbandar and is being imported from Jamnagar, the Porbandar salt works were not aware of the formation of the gypsum in their condensers until it was brought to their notice by the Committee during their inspection of the works. In Madras Province, only the Mettur Chemicals Works at Adirampathnam have introduced the recovery of gypsum as a regular practice. We strongly recommend that the importance of recovering gypsum should be brought to the notice of all the major salt works in India.

## 7. Summary of Recommendations.

### (a) Kharaghoda:

- (i) The present method of allowing the bitterns to collect and evaporate in *farans* is highly wasteful. Crude salt and carnallite could be recovered from the bitterns between 29° and 36° Be'. A set of two crystallising pans, one for crude salt and another for crude carnallite should be built along side the salt crystallising pans. The crude salt pans should be leased out to Agarias with the salt crystallising pans, while the Pioneer Magnesia Works should be given the first option to undertake the recovery of carnallite. (2.3)
- (ii) The method adopted by the Pioneer Magnesia Works to transport bitterns from the *farans* to their works is primitive. They should be asked to provide a pump for transferring the bitterns into tank wagons which should be hauled by locomotives and not by manual labour. (2.4)
- (iii) The use of magnesium chloride for the manufacture of oxychloride cements and magnesium metal should be promoted. (2.5.2)
- (iv) The recovery of magnesium sulphate by the Pioneer Magnesia Works is unsatisfactory and should be improved. (2.6)
- (v) The entire requirement of the country for magnesium sulphate could be obtained from the bitterns and recovery plants should be installed at some of the larger salt works in the country. (2.6.1)
- (vi) The lease of the Pioneer Magnesia Works which expires on 31st December 1953 should be renewed for a further period of 25 years if they undertake to modernise their plant for better and more efficient recovery of the byproducts, and agree to the other terms suggested by us. (2.7)
- (vii) The proposal of the Pioneer Magnesia Works to install an evaporator plant for the recovery of carnallite and a plant for the recovery of bromine should be deferred for the present. (2.7.1).

(b) Mithapur:

- (i) The existing areas under bittern pans should be divided into two compartments, the first to be used for raising the density up to 32° Be' for recovery of crude salt and the second for raising the density from 32' to 34° Be'. (3.2)
- (ii) The recovery of the byproducts should be improved to attain a more rational ratio between the common salt and the byproducts. (3.7)

(c) Kuda:

- (i) As conditions in Kuda are similar to those at Kharaghoda, the recommendations made by us for the recovery of crude salt, carnallite and magnesium sulphate at Kharaghoda are equally applicable to Kuda. (4.1)

(d) General:

- (i) In view of its importance in the fertilizer and cement industries, the recovery of gypsum should be made a regular works' practice in all the major salt works in the country. (6.2)



## CHAPTER XIX

### PRODUCTION, DISTRIBUTION AND CONSUMPTION OF SALT IN INDIA.

#### 1. Production.

1.1 PROGRESS OF INDUSTRY.—In the foregoing chapters, we have dealt in detail with the salt works in all the producing centres in India. The progress of the industry during the last 20 years has been noteworthy. In 1930-31 the production was only 12.12 lakh tons (329.70 lakh mds.) as shown in Table XII Chapter V; by 1948 it had very nearly doubled to 23.27 lakh tons (633.16 lakh mds.), *vide* Table XIII Chapter V. This development has taken place despite the vicissitudes of the industry in the early thirties, and is a testimony to the enterprise and initiative of the manufacturers. The tariff protection that was given to the industry in 1931 was also responsible for its growth, particularly in Kathiawad and Kutch. Table CXXII shows the progress made by the Indian industry, between the years 1930 and 1949 as also the progressive reduction in the imports of salt during the same period.

(See Table CXXII next page)

TABLE CXXII.—PRODUCTION AND IMPORT OF SALT 1931—1949

(in tons ; figures in brackets in maunds)

Year	Inland Works (Rajasthan) Kharaghoda (Kuda)	Kathiawad and Kutch	Bombay	Madras	Travancore	Orissa	West Bengal	Mandi	Total	Imports*
1931—35 .	4,18,920 (1,14,04,000)	1,30,000 (35,39,000)	3,50,040 (95,29,000)	4,83,020 (1,31,49,000)	5,500 (1,50,000)	included in Madras	..	4,080 (1,11,000)	13,93,560 (3,78,82,000)	4,26,890 (1,16,21,000)
1936—40 .	4,71,410 (1,28,32,000)	1,51,050 (41,12,000)	3,51,590 (95,71,000)	4,08,010 (1,11,07,000)	47,720 (12,99,000)	21,530 (5,86,000)	..	3,820 (1,04,000)	14,55,130 (3,96,11,000)	3,12,620 (85,10,000)
1941—45 .	5,51,100 (1,50,02,000)	1,61,300 (43,91,000)	4,42,730 (1,20,52,000)	5,37,300 (1,46,29,000)	57,670 (15,70,000)	29,350 (7,99,000)	..	3,600 (98,000)	17,83,140 (4,85,41,000)	2,10,140 (57,20,000)
1946—49 .	6,30,330 (1,71,59,000)	3,11,880 (84,90,000)	3,60,220 (98,08,000)	6,17,950 (1,68,22,000)	59,660 (16,24,000)	27,840 (7,58,000)	880 (24,000)	4,040 (1,10,000)	20,12,800 (5,47,93,000)	2,53,470 (69,00,000)

\*Imports from Aden are included in these figures even though Aden was considered a part of India upto 31-3-1937

It will be seen from this table that the most noticeable progress has been made in Kathiawad and Kutch where the production has increased by 140 per cent. The increase in the inland works is 50 per cent. and in Madras 28 per cent., notwithstanding the transfer of the factories in the Ganjam district to Orissa. There has been hardly any increase in either Bombay or Mandi. Mandi has hitherto played a very small part in the overall picture of the salt industry in India but the static condition of production in Bombay is an index of the state of the industry there and calls for attention. In Travancore, the increase has been phenomenal and the present production is more than 10 times the production twenty years ago. West Bengal has hardly made a serious start to produce salt but with altered conditions, we may anticipate that it will begin to make a significant contribution within five years.

**1.2 IMPORTS AND TARIFF PROTECTION.**—Prior to 1930 India imported more than 5,00,000 tons of salt from Aden and other Middle East Salt Works as also from Liverpool and Hamburg. These imports have declined steadily because the Indian salt industry received a timely assistance by way of tariff protection without which it would not have been able to withstand the determined onslaught of foreign salt. In 1927-28 when Kathiawad salt had not appeared in the Calcutta market, the price of foreign salt in Calcutta was about Rs. 27-22 per ton (Re. 1 per maund); by 1930-31 it was brought down to as low a figure as Rs. 11 per ton (Re. 0-6-5 per maund) to drive out Indian salt from Calcutta which had till then been a close preserve for foreign salt. The new Indian works had to struggle for their existence from the very inception and when they found it impossible to continue manufacture at a remunerative rate they had to seek protection. As a result of the recommendation of the Tariff Board, the fair selling price of Indian salt in the Calcutta market was fixed in 1931 by Government at about Rs. 18 per ton (Re. 0-10-7 per maund) ex-ship and a protective duty of Rs. 7-10-6 per ton (Re. 0-4-6 per maund) was levied on foreign salt. The protection to the salt industry was continued until 1939 but the rates of duty were progressively lowered. In 1933 the duty was reduced to Rs. 4-4-0 per ton (Re. 0-2-6 per maund) and the ex-ship price of Indian salt was correspondingly reduced to Rs. 14-14-6 per ton (Re. 0-8-9 per maund). In 1936 the duty was further reduced to Rs. 2-9-0 per ton. (Re. 0-1-6 per maund) and in 1939 protection was completely withdrawn. This position still continues and imports of foreign salt are allowed to come into the country free of any import duty. As Aden was part of India in 1930 and continued to be so till 31st March 1937, the imports from Aden were exempted from the payment of the protective duty and this continued even after Aden was separated from India. Under the shelter of the protective duty, the Aden salt manufacturers expanded their works and after the separation of Aden they made a bid, for a while, to hamper the development of the Indian industry by waging a rate war. The outbreak of World War II and the altered political and fiscal conditions in the country, however, put an end to this activity.

**1.2.1** In spite of this increase in production, the imports of foreign salt to the extent of about 2,53,000 tons (69,00,000 maunds) still continue each year, almost entirely into Calcutta. This is partly due to the insistent demand for fine white crushed salt in Bengal and the markets it serves. So far, the Bengal market has accepted Indian salt produced only in Kathiawad and Kutch; the salt produced in other parts of India, particularly in Bombay and Madras is not yet of the quality which is acceptable to it. Attempts have been made by Madras manufacturers, particularly those in Tuticorin, to introduce their salt into Bengal but unless they improve their methods of manufacture, there is little hope of their being able to secure a steady market for their surplus.

production. It is necessary to emphasise this fact because it is often argued that the imports could be easily stopped if only Bengal would accept the salt produced in Madras and Bombay. If the quality were good enough there would be no difficulty in marketing the salt, but it would be a retrograde step if people who are used to a better quality of salt are compelled to accept an inferior material, the quality of which could be improved if a little care were taken in its manufacture.

1.3 PRODUCTIVE CAPACITY.—Although production has increased substantially during the last 20 years, covering not only the increase in consumption due to the growth of population but also materially reducing imports, the increase could have been much larger had the works been properly designed and efficiently operated. We have dealt with the potentialities of each of the regions of production in the previous chapters but for a more convenient appreciation of the situation, we review briefly the possibilities that exist in India for not only achieving self sufficiency but making available a substantial quantity for export.

1.3.1 *Inland Salt Works*.—In the inland works, although production has increased by 50 per cent., a much larger increase is possible without opening any new works as shown in Table CXXIII.

TABLE CXXIII.—POTENTIAL CAPACITY OF INDIAN SALT WORKS.

	Tons	Mds.
Sambhar . . . . .	4,71,000	1,28,22,000
Didwana . . . . .	73,500	20,00,000
Pachbadra . . . . .	1,47,000	40,00,000
Kharaghoda . . . . .	2,20,500	60,00,000
Kuda . . . . .	80,000	21,98,000
<b>TOTAL</b> . . . . .	<b>9,92,000</b>	<b>2,70,00,000</b>

It will be seen that the average production of 1946 to 1949 could be further increased by 60 per cent. by bringing about the necessary improvements and alterations as we have indicated in related chapters. By establishing new works, a still larger increase can be secured but we must add a word of caution. The inland salt works are in a position of vantage for supply of salt to the interior of India and therefore, their production must be co-related with the internal demand and transport facilities.

1.3.2 *Salt Mines*.—The present production of about 4,000 tons (1,09,000 mds.) per annum in Mandi is insignificant. We have recommended that the present method of winning the salt be replaced by brine wells and an up-to-date brine evaporator plant be installed to produce 66,000 tons (18 lakh mds.) of salt. This salt is expected to be of the highest purity attained anywhere in India and comparable in quality with the best salt obtained anywhere in the world.

1.3.3 *Marine Salt Works*.—In Table CXXIV we show the area under salt cultivation in different producing centres, their present average yield and estimated output which could be achieved by re-distributing the areas under cultivation in proper ratios, and by following other suggestions, recommended by us in the earlier chapters.

TABLE CXXIV.—POTENTIAL CAPACITY OF MARINE SALT WORKS.  
(In tons; figures in brackets in mands)

Locality	Area <sup>1</sup> (Acres)	No. of factories	Average annual yield per acre 1946—48		Potential Production
			Present	Potential	
Kathiawad and Kutch . . . . .	8,130	14	37 (1,010)	80 (2,180)	6,50,000 (1,77,00,000)
Bombay . . . . .	16,491	399	22 (600)	51 (1,390)	8,47,000 (2,31,00,000)
Travancore . . . . .	818	19	71 (1,920)	122 (3,320)	1,00,000 (27,00,000)
Madras . . . . .	15,278	53	43 (1,180)	80 (2,180)	12,00,000 (3,26,00,000)
Orissa . . . . .	3,652	5	12.5 (340)	40 (1,090)	1,46,000 (40,00,000)
West Bengal . . . . .	1,000	5	6.5 (180)	25 (680)	25,000 (7,80,000)
	45,369	495			29,68,000 (8,08,00,000)

These estimates are calculated only for the works actually in production or for which areas have been allotted but which have not yet been fully developed. We have not taken into account the vast potentialities that exist and have been discussed for new works in Kathiawad and Kutch, the collection of spontaneous salt from the Vedaranyam swamp and the development of large areas both in Orissa and West Bengal. If they are also included, the production will exceed 40 lakh tons (10,89,00,000 mds.).

1.3.4 The combined potential capacities of all the salt works in India is given in Table CXXV. This estimate is what we consider as probable of achievement in the course of the next five years.

TABLE CXXV.—POTENTIAL CAPACITY OF SALT WORKS IN INDIA.

	Tons	Mds.
Inland works . . . . .	9,92,000	2,70,00,000
Salt Mine . . . . .	66,000	18,00,000
Marine works . . . . .	29,68,000	8,08,00,000
	40,26,000	10,96,00,000

1.4 QUALITY.—The quality of salt in India varies from place to place; even today ignorance, prejudice and self interests prevent an improvement in quality. Government have taken recently the first step to raise the standard of the Bombay and Madras marine salt by prescribing a minimum sodium chloride content of 92 per cent. (on dry basis) to be progressively increased in

the coming years. Protests have, however, been made by the manufacturers against this comparatively low standard being enforced. It has been urged that the salt as produced in Bombay and Madras had hitherto done no harm to the consuming public and there is no justification for improving its quality or raising its standard. It is even suggested that the quality of salt is not necessarily determined by the percentage of sodium chloride in it and that medical experts should carry out long and prolonged tests to determine whether the presence of impurities like calcium sulphate, magnesium chloride, etc. are injurious to the human system and the percentages up to which they could be tolerated. Some of the Madras salt manufacturers have even gone to the extent of stating that the removal of the calcium sulphate from salt would be like removing cream from milk. In some places the flavour of salt is attributed to the presence of black mud and we have heard of instances where the manufacturers have deliberately added the mud to the salt to satisfy this ignorant credulity. Unprogressive manufacturers must realise that the old days of supplying the public with a low quality salt are rapidly coming to an end, and if they do not voluntarily improve the quality of their output the State will have no option but to intervene. We are opposed in principle to any unnecessary interference by the State in the salt industry as we believe that private enterprise which has done so much has still a substantial contribution to make. We, however, have to recognise, that industrial development requires planning and to do this a certain amount of control and regulation by the State is inevitable. The 19th century economy of *laissez-faire* is no longer applicable to present conditions. Whilst the State should limit its interference to the unavoidable minimum, we cannot overlook the fact that a more vigorous control becomes necessary and has to be enforced, when for instance it is being argued that impurities like calcium sulphate, magnesium chloride, dust, etc., are necessary to give the salt its desired quality, flavour and taste.

1.4.1 In Table CXXVI is given comparative analyses of Indian salt from marine and inland works as also of rock salt.

TABLE CXXVI.—COMPOSITION OF INDIAN SALT  
(per cent on dry basis)

	Marine Salt Works					Inland Works				Rock Salt
	Kathiawad and Kutch	Bombay	Travancore	Madras	Orissa	Sambhar	Didwana	Pachbadra	Kharaghoda and Kuda	Mandi
Sodium chloride	96.68 to 98.74	90.04 to 96.78	84.71 to 97.86	90.84 to 96.62	89.89 to 95.72	96.67 to 97.75	83.37 to 90.69	95.21 to 98.45	96.13 to 98.47	62.61 to 77.09
Calcium sulphate	0.59 to 0.53	1.25 to 0.12	3.06 to 0.07	1.88 to 0.35	2.33 to 0.55	..	..	1.94 to 0.43	1.33 to 0.66	0.49 to 0.75
Magnesium sulphate	0.55 to 0.22	2.73 to 0.83	3.40 to 0.58	2.16 to 0.63	0.71 to 0.80	..	..	1.11 to 0.32	0.05 to 0.04	..
Magnesium chloride	1.16 to 0.21	3.82 to 1.22	2.93 to 0.90	1.73 to 0.86	1.54 to 1.55	..	..	1.22 to 0.00	1.13 to 0.39	..
Sodium sulphate	..	..	..	..	..	2.34 to 1.25	12.39 to 7.25	..	..	..
Sodium carbonate	..	..	..	..	..	0.53 to 0.34	..	..	..	..
Sodium bicarbonate	..	..	..	..	..	0.12 to 0.09	4.24 to 2.06	..	..	..
Insolubles	0.07 to 0.05	0.97 to 0.07	5.42 to 0.07	2.24 to 0.46	5.23 to 0.64	0.60 to 0.30	..	0.34 to 0.13	1.36 to 0.44	36.72 to 22.14
Undeter- mined	0.95 to 0.25	1.30 to 0.36	1.88 to 0.29	1.18 to 1.08	0.30 to 0.73	0.07	2.00 to 0.00	0.18 to 0.67	..	0.18 to 0.02

It will be noticed that in the marine and inland salt works the sodium chloride content varies from 88 per cent. to 98 per cent; in the rock-salt of Mandi it is below 77 per cent. The impurities are largely calcium sulphate, magnesium sulphate and magnesium chloride in the case of marine, Kharagodha and Kuda salt and sodium sulphate, sodium carbonate and bicarbonate in the case of the Rajasthan salt works. Most of these impurities can be easily avoided to a large extent if due care is taken in the manufacturing operations particularly in the extraction of salt from the crystallisers. In well designed marine works of Kathiawad and Kutch salt of 98 per cent. and above is normally manufactured by solar evaporation. This purity is attained largely because of the care taken in (a) maintaining a high ratio between the condensers and crystallisers, (b) removing the bitterns regularly and draining the crust before the salt is lifted (c) leaving behind (as is done in Kutch) a layer of salt on the crystallising beds to form a clean floor for preventing admixture with inorganic impurities like clay dirt, etc. What is possible in one region should be possible in the rest of India without any insurmountable difficulty.

1.4.2 One of the reasons for the poor quality of the salt produced in Bombay, Travancore and Madras is the practice so assiduously followed in producing what is known as light salt. The method of manufacture of this salt needs more effort and demands the employment of special skilled labour, involving greater supervision and expenditure. According to the report of a departmental Salt Committee set up in 1903 by the Government of India, the important special features in the manufacture of light salt were stated as follows:—

- (a) the crystallising pans have to be elaborately prepared. A pan which might usually take ten days would take 14 to 25 days to yield the light salt;
- (b) brine of a particular density has to be admitted into the pan to a shallow depth and salt has to be harvested after each irrigation. The depth of the charge varies with the soil of the pan, the state of weather, etc.
- (c) the crystals of salt are to be raked frequently in a skilful manner, as they form. This is to prevent the formation of compact crystals; and
- (d) the scraped salt has to be dried in thin layers to secure good exposure to the sun without damage to the crystals.

The manufacture of light flakes or hollow crystals was resorted to and came into vogue because, when packed, it included more voids than compact crystals. and for any given weight, gave a relatively larger bulk. The hollow crystals of light salt retain a large proportion of mother liquor in their cavities and apart from their intrinsic impurity they are liable to sweat in humid conditions and pick up and retain dust. Though the technique adopted in obtaining the light variety of salt is ingenious and developed after many years of experience, it is obvious that it has been done at the sacrifice of quality. It is claimed that for climatic and other conditions the method adopted aims at a maximum production in the minimum time.

1.4.3 Proposals have been made from time to time in the Madras province for the abolition of sale of salt by measure. It would be worth while therefore, to trace the history of the attempts made in the past in this direction. The earliest advocate of the sale of salt by weight was Dr. Ratton, the author of the classical *Hand book on Common Salt*. As early as 1864 he expressed a definite opinion that heavy salt was synonymous with good salt and light with bad, and that compulsory retail sale by weight would lead to the manufacture



of a superior article. His proposal was however, turned down by the Government of Madras under the mistaken notion that any attempt to control such sales by law would be misunderstood by the people and might lead to complications. This question came up again for reconsideration in 1882, owing to the difficulty experienced in disposing of the heavy variety of salt that was then being produced along with the light and which had accumulated in the Government depots. In spite of its poor quality, there was greater demand for light salt than for heavy salt, and the depots which had stocks of light salt were being exhausted while those with heavy salt were becoming overstocked. Light salt was being moved to even distant places and sold in preference to the heavy salt produced locally. The Madras Board of Revenue realised that a commodity which was being purchased from Government by weight and retailed to the public by measure, afforded to the middlemen engaged in this trade the means of unduly enriching themselves at the expense of the consumer. From a series of experiments, the Board found that the weight of salt, for a given volume, varied by as much as 37 per cent. They, therefore, recommended to the Government of Madras that the retail sale of salt by weight should be enforced as the only remedy against the fraud that was being perpetrated on the consumer. The Government again turned down this proposal and naively observed that the remedy lay in improving the quality of the article wherever it was light and inferior and making it uniform in all localities as far as possible. The view that heavy salt was necessarily better than light salt was also disputed by a departmental Committee of the Government of Madras in 1887. Reviewing the findings of the Committee, the Government remarked that the sale of salt by weight would be difficult of enforcement in retail transactions in the village markets throughout the presidency except with a great amount of inquisitorial interference and risk of oppression. In 1890 it came to the notice of the Board that Bombay salt had supplanted Madras salt in the Mysore and Bellary markets. Whereas Madras salt gave 19 to 21 measures to the maund, the specially prepared Bombay salt gave 22½ to 25 measures. The Government of Madras was again urged by the Board to pass legislation to ban the sale by measure, but the suggestion was again turned down and it was stated that the consumers would soon find out that the Bombay salt though seemingly cheaper was really dearer than the heavier but purer Madras salt, would regain in time the ground which it had lost. The Board, however, continued to condemn the practice of sale by measure. In 1893 they reiterated their proposal for legislation, observing that the evil had reached an acute stage and the Madras salt could not compete with the Bombay salt in the race for lightness. Moved by these arguments, and by representation from Madras manufacturers, the Government of Madras were ultimately convinced of the need for legislation and took up the matter with the Government of India, who, however, declined to undertake the legislation. In so doing the Government of India commended to the consideration of the Government of Madras, the desirability of ascertaining whether Madras salt, if manufactured light, could not hold its own in its markets. Experiments were, therefore, undertaken by Madras factories to produce light salt and an officer of the Salt Department was deputed to study the methods followed in the Bombay factories. In spite of the efforts in this direction, the Madras salt could not compete with the salt from Bombay as the natural conditions in Madras were not considered suitable for adopting the methods followed in Bombay. The Government of India were therefore, again approached in 1903 for enforcing the sale of salt by weight and the matter was referred to the Salt Committee of 1904. The Committee investigated the competition aspect of the problem and found that Bombay salt had completely displaced Madras salt in the Mysore and Coorg markets and that the preference for light salt was mostly from the

traders and not from the consumers as both the heavy and the light varieties were being sold at the same price for unit measure. On the question of legislation, the Committee expressed the opinion that a wholly artificial class of offences would be created and if any attempt were made to enforce the law with vigour, the evil resulting from inquisitorial interference, and the opportunities offered for the levy of blackmail and the institution of false cases would be out of all proportion to any benefit which might be expected. It was stated that the necessities of fiscal administration added largely to the number of criminal offences and it was highly undesirable to increase the unpopularity of the salt tax by subjecting the people to any further avoidable restraints in connection with its salt. They, however, suggested that the legislation might be tried in large towns and municipalities and the desirability of its extension to other places determined on the basis of the success achieved. Even then the Government of India did not undertake any legislation and the manufacturers were allowed to vie with each other in catering to the greed of the trader who continued to make large profits by selling the light salt by measure. The manufacture of light, flaky salt was thus given a fillip. It is worth while to consider the extent of fraud which is practised on the consumers from the example recorded in 1903 by the Madras Board of Revenue. It was found that Madras salt could be delivered at Erode at Rs. 3-2-8 per maund and Bombay salt at Rs. 3-7-0 per maund. The former gave 21 local measures per maund while the latter gave 24. The retail price per measure of both the varieties was Re. 0-2-8 per measure. A maund of Madras salt, therefore, sold at Rs. 3-8-0 as against a maund of Bombay salt which fetched Rs. 4. The retailer, therefore, found it more profitable to sell Bombay salt, although it cost him more per maund than the Madras salt.

1.4.4 It is obvious that the former provincial and Central Governments were averse to stop the sale of salt by measure for fiscal reasons which are no longer valid. In our first interim report we had recommended that this practice should be abolished by legislative enactments and we strongly reiterate this recommendations.

1.5 FRAGMENTATION.—Except in Kathiawad and Kutch where each licensee has several hundred acres under cultivation, most of the holdings in other producing centres are small and fragmented. In Table CXXVII is shown the area under cultivation in each producing centre and the number of licensees that work them.

TABLE CXXVII.—AVERAGE HOLDINGS OF LICENSEES.

Locality	Area under cultivation	Number of Licensees	Average area per licensee
	Acres		Acres
Kathiawad and Kutch . . . . .	9,130	14	580.71
Bombay . . . . .	16,491	1,888	8.73
Travancore . . . . .	818	228	3.59
Madras . . . . .	15,278	3,949	3.10
Orissa . . . . .	1,851	35	52.88
West Bengal . . . . .	205	5	41.00
<b>TOTAL</b> . . . . .	<b>42,773</b>	<b>Total . 6,119</b>	<b>Average 6.89</b>

In our previous chapters, we have drawn attention to the excessive fragmentation which has taken place in holdings in Bombay, Travancore and Madras. This is most widespread in Madras and Travancore. The full consequence of such sub-division of a salt works far below the economic optimum reacts not only on the cost of production and the profit which the individual licensee derives from his undertaking, but it also seriously affects the overall production in the country and the economic stability of the industry as a whole. It is for this reason that we have strongly advocated in the preceding chapters the consolidation of these holdings into economic units with a minimum area of 100 acres each by forming them into co-operative societies. It is not possible to give a quantitative idea of the consequences of this fragmentation because yield per acre depends upon a number of factors of which economic size of the works is only one, the others being the initial density of brine used, the length of the manufacturing season and other climatic conditions. In view of these factors, we have fixed different scales of estimated production per acre in different localities, Travancore being given the first place because of its favourable climatic conditions and the average high density of the brine used. Likewise many works in Madras are situated in areas of low rainfall and high evaporative capacity and have besides, the advantage of using pit brine.

1.6 We have not been able to obtain figures of the capital invested in the salt works in all centres but we have prepared an estimate of the capital costs of both Government and privately owned works from such information as was available. This is shown in Table CXXVIII. No figures for Mandi mines are given as they have not been maintained.

TABLE CXXVIII.—CAPITAL INVESTED IN THE SALT INDUSTRY

	Rs	Rs.
(a) Inland works :		88,60,000
(i) Sambhar	60,00,000	
(ii) Diwana	23,000	
(iii) Pachbadra	1,56,000	
(iv) Kharaghoda	21,81,000	
(v) Kuda	5,00,000	
(b) Marine Works		4,90,50,000
(i) Kathiawad and Kutch	1,00,00,000	
(ii) Bombay	1,60,50,000	
(iii) Travancore	42,00,000	
(iv) Madras	1,50,00,000	
(v) Orissa	36,00,000	
(vi) West Bengal	2,00,000	
TOTAL		5,79,10,000

The above figures show only the capital block of the works and does not include capital employed in operating them. The price of salt, sold ex-works, has varied from Rs. 10-3-4 per ton (Re. 0-6-0 per md.) at Sambhar Lake to Rs. 34 per ton (Rs. 1-4-0 per md.) in some of the marine works. Assuming that the average realisation ex-works is Rs. 20-6-8 per ton (Re. 0-12-0 per md.) the total value of the salt sold on the production (excluding Mandi) of 1948 of 23-27 lakh tons (633-16 lakh mds.) is Rs. 475 lakhs.

1.7 LABOUR.—The salt industry employs an estimated labour force of about 72,000 as shown in Table CXXIX.

TABLE CXXIX.—LABOUR EMPLOYED IN SALT INDUSTRY.

	Number		Average production 1946-48		Average annual output per man	
			Tons	Mds.	Tons	Mds.
(a) Inland Works		14,350				
(i) Sambhar	3,350		3,48,550	94,87,000	102.5	2,790
(ii) Didwana	1,000		35,470	9,62,000	35.5	962
(iii) Pachbadra	1,500		52,580	14,31,000	35.0	954
(iv) Kharghoda	6,000		1,28,280	34,91,000	21.4	582
(v) Kuda	2,500		62,450	17,00,000	25.0	680
(b) Mandi Mines		600	3,960	1,08,000	6.6	180
(c) Marine Works		56,900				
(i) Kathiawad and Kutch	4,000		2,76,330	75,22,000	69.8	1,880
(ii) Bombay	11,000		3,64,390	99,19,000	33.1	902
(iii) Travancore	4,000		57,580	15,67,000	14.4	392
(iv) Madras	35,000		6,51,800	1,77,44,000	18.6	507
(v) Orissa	2,400		25,280	6,88,000	10.5	287
(vi) West Bengal	500		940	26,000	1.9	52
TOTAL		71,850	20,07,610		27.88	758
or say		72,000		5,46,45,000		

1.7.1 These figures reveal the following features:

- (a) The average annual output per man is the highest in the works employing multiple irrigation system.
- (b) In places of excessive fragmentation, like Madras and Travancore the average annual output per man is low despite the fact that the yield per acre in these two places is high on account of the higher initial density of the brine used and more favourable weather conditions.
- (c) In Didwana and Pachbadra average annual output per man is greatly reduced because much manual effort has to be put in for the lifting of the brine from the well or of the salt from the pits.
- (d) In Kharaghoda and Kuda, despite the very high density of the initial brine and the favourable climatic conditions, the average annual output per man is low because each pan is allowed to two Agaria families consisting of 11 persons who may not all put in full time work on the manufacture of salt. Another reason is the closure of the manufacturing season in the most productive period in the year.
- (e) In Orissa the average output per man is greatly reduced by the fact that five co-operative societies have a large number of working members for the small area under cultivation. The average output in the large factories is much higher and is of the order of 15 tons (410 mds.) as compared with the output of only about 2 tons (55 mds.) in the Co-operative units.

As the incidence of labour cost is a very important portion of the cost of production, the price of salt in India can be reduced if factors leading to the employment of excessive labour were eliminated by mechanisation on the one hand and by a more rational consolidation of the holdings on the other.

1.7.2 At one time, the labour employed in the salt factories was completely unorganised and the manufacturers could do what they liked with it. Labour is now becoming organised and the manufacturers complain that production is being impeded by labour putting forth a large number of demands which could not be met. We would draw attention to some salient facts concerning labour in the salt industry. Manufacture of salt is a seasonal occupation. It makes exacting demands upon the labour employed as the work is uncongenial and hard. The labour in the salt works is drawn from a stratum of society which is ignorant and poor, but it develops by experience a skill which is an asset to the industry. During the off-season, labour takes to agricultural operations and if the monsoon is favourable and the crop good, it does not return to salt manufacture until after the harvest. If the salt industry wishes to be assured of the timely supply of labour in order to start the manufacturing operations immediately after the close of the rains, it would be necessary to find an alternative occupation for the labourers during the rainy season so that they may be helped to stay on in the neighbourhood and their cumulative skill is not dissipated. At present the manufacturers are not always sure of getting the labour in time with the result that invariably there is a race against time and the duration of the manufacturing season gets curtailed in consequence. The present system of contract labour which does not always look to the permanent weal of the labourer has to be altered. The solution will vary from locality to locality. The wages which the salt industry pay at present are on the low side whilst the number of labourers engaged is excessive and could be reduced if the operations were staggered and mechanised. If our recommendation for consolidating the small and uneconomic holdings into large co-operative units is carried out, there will be an immediate reduction in the number of hands employed. This will enable the manufacturers to reduce the cost on production and at the same time find work for the bulk of the labour for a longer period than at present.

## 2. DISTRIBUTION

2.1 Salt is despatched from the producing centres largely by railways. Only a small portion of the production is despatched by sea from the salt works in Kathiawad and Kutch and to a limited extent from the works in Bombay and Madras. Prior to the War, salt could be despatched from any producing centre to any place in the country irrespective of the distance, depending upon the demand for a particular quality from particular works. It was not unusual to find salt produced in Bombay being despatched right into the heart of the Madras Presidency or salt from Kuda going as far as Nepal; similarly salt from Tuticorin used to be sent into Hyderabad when salt from nearest sources like Naupada could have been delivered more quickly and at cheaper cost. During the War owing to the scarcity of shipping space, salt was transported by rail from Kathiawad into Bengal and Bihar and this practice was continued even after the War. Owing to the heavy burden put upon the Railways by the large traffic that was offered and their inability to cope with it because of scarcity of locomotives and wagons, distribution of salt was seriously hampered. When we visited the Sambhar works in June 1948, we were informed that the Railways were not able to meet even the limited quota of wagons allotted for the movement of salt; similarly in the Bombay works stocks were accumulating and were hampering production. As the works there are laid cheek by jowl and little room exists for adequate storage, the storage platforms are soon filled to capacity when transport is not available, thus leading to the slowing down of production. This dislocates the working programme and also creates discontent amongst labour. It further leads to artificial scarcity in the markets served by the works giving rise to an increase in prices and consequent outcry all round. It became, therefore, necessary to rationalise the movement of salt to relieve the overburdened rail-

way system. To avoid long haulages, cross movements and heavy cost of transport, the Salt Department introduced from 1st January 1949 a scheme of zonal distribution for despatch by rail.

2.2 ZONAL DISTRIBUTION.—Under the zonal system, the principal regions of production have been grouped together into eight foci of distribution as given below:

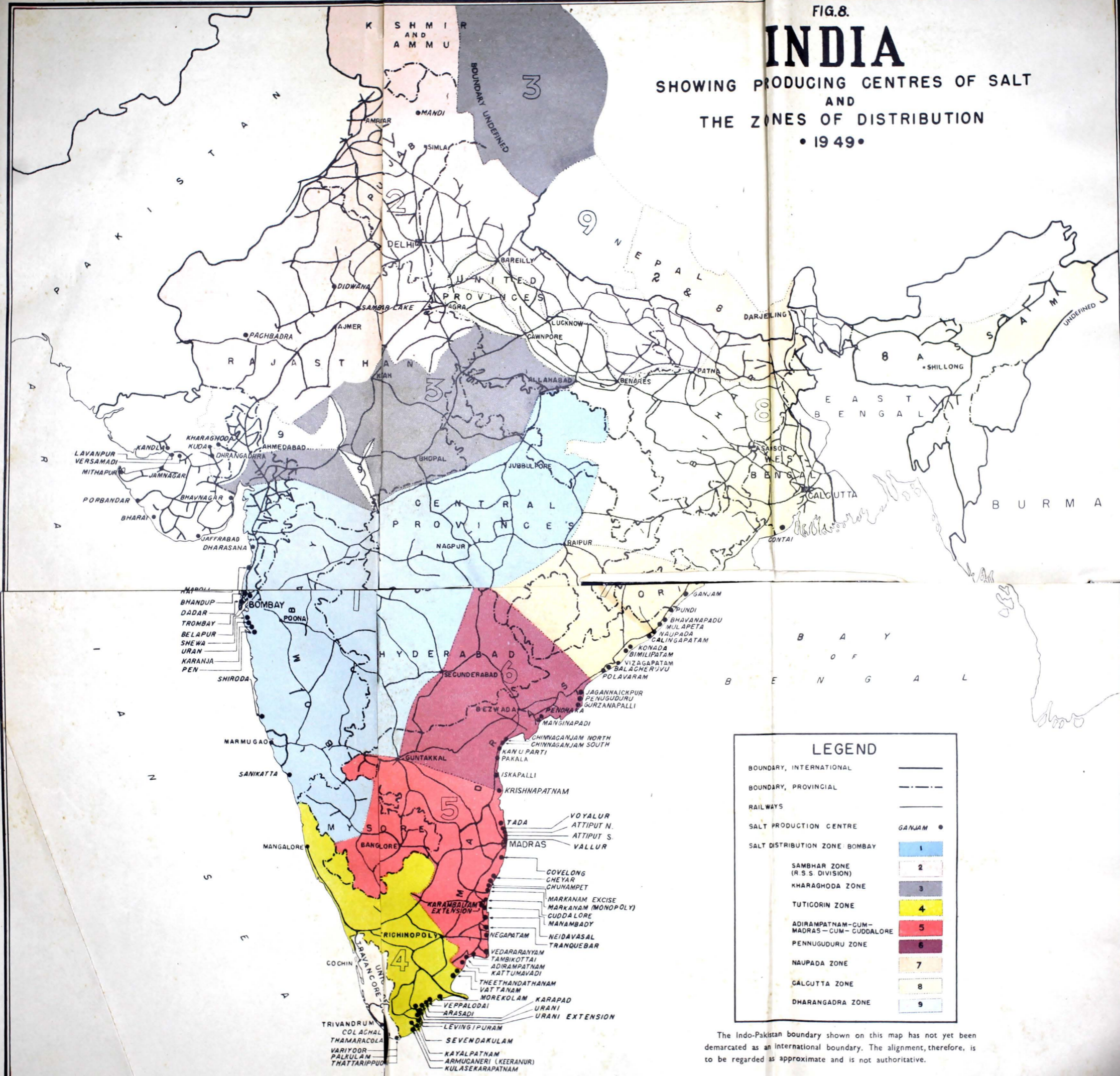
1. Sambhar, Didwana and Pachbadra
2. Kharaghoda
3. Kuda (Dhrangadhra)
4. Bombay
5. Tuticorin (Madras)
6. Adirampatnam and Madras
7. Pennuguduru (Madras)
8. Naupada (Madras) and Orissa

Though Calcutta is not a producing centre, it has been formed into the ninth focus for the distribution of salt which it imports by sea from the West Coast ports of India and from foreign countries. A zone of distribution has been allotted to each one of these focal points. We attach a map of India (Figure 8) showing the producing centres of salt and the corresponding nine zones of distribution. The zonal system is in our opinion the right solution for an equitable distribution of salt to all parts of the country without unnecessary and wasteful use of the overburdened transport system. By this arrangement salt does not travel by rail more than 500 miles on an average from the centre of production, although in some cases for special reasons salt is still allowed to travel long distances. We give in Table CXXX the farthest distance to which salt travels in each zone. By far the largest part of the consumption in each of these zones is however places near to the region of production. The table also shows the highest rail freight borne by salt in each zone. Excluding the movement of Dhrangadhra salt to Nepal, the freight varies from Re. 0-11-9 to Rs. 1-4-0 per maund.

TABLE CXXX.—MAXIMAL DISTANCE OF MOVEMENT OF SALT.

Region of Production	Route	Distance in miles	Freight per md. in wagon loads
1. Sambhar, Didwana and Pachbadra.	Sambhar to Darbhanga (via Kanpur, Anwarganj, Lucknow, Barabanki).	737	Rs. as. p. 1 1 7
2. Kharaghoda . . .	Kharaghoda to Allāhabad (via Virangam, Anand, Bhopal, Bina Katni).	851	1 3 0
3. Dhrangadhra . . .	Dhrangadhra to Raxaul for Nepal (via Virangam, Phulera, Savan, Sonapore, Muzaffarpur).	1291	1 3 6
4. Bombay . . .	Thana to Sambhalpur (via Jalgaon, Nagpur, Raipur, Bilaspur).	912	1 3 9
5. Tuticorin . . .	Tuticorin to Cannanore (via Dindigul, Pollachi, Olavakkot).	387	0 12 6
6. Adirampatnam and Madras.	Agastiyampalli to Secunderabad (via Villupuram, Katpadi, Guntakal).	712	1 1 3
7. Pennuguduru . . .	Chinnaganjam to Balharshah (via Bezwada, Kazipet).	350	0 11 9
8. Naupada and Orissa	Naupada to Sambhalpur (via Virangam, Raipur, Bilaspur).	588	0 15 9
9. Calcutta . . .	Calcutta to Diburagarh (via Parbatipur).	829	1 2 9

FIG. 8.  
**INDIA**  
 SHOWING PRODUCING CENTRES OF SALT  
 AND  
 THE ZONES OF DISTRIBUTION  
 • 1949 •



**LEGEND**

BOUNDARY, INTERNATIONAL	— — — — —
BOUNDARY, PROVINCIAL	- - - - -
RAILWAYS	— — — — —
SALT PRODUCTION CENTRE	● GANJAM ●
SALT DISTRIBUTION ZONE BOMBAY	1
SAMBHAR ZONE (R.S.S. DIVISION)	2
KHARAGHODA ZONE	3
TUTICORIN ZONE	4
ADIRAMPATNAM-CUM-MADRAS-CUM-CUDDALORE	5
PENNUGUDURU ZONE	6
NAUPADA ZONE	7
CALCUTTA ZONE	8
DHARAWADRA ZONE	9

The Indo-Pakistan boundary shown on this map has not yet been demarcated as an international boundary. The alignment, therefore, is to be regarded as approximate and is not authoritative.

2.2.1 Tables CXXXI and CXXXII give a complete picture of the basis of distribution under the zonal system. Table CXXXI shows the off-take in percentages of the different regions forming the 9 zones. For instance, Bihar consumes 17 per cent. of the production of Sambhar, Didwana and Pachbadra, 26 per cent. of the salt distributed from Calcutta and 25 per cent. of the imports from Khewra (West Pakistan). Table CXXXII shows how the demand of the different areas is met from the different producing centres. Taking once again the case of Bihar, it will be seen that it obtains 34 per cent. of its requirements from Sambhar, Didwana and Pachbadra, 58 per cent. from Calcutta and 8 per cent. from Khewra (West Pakistan). At the time when the zonal distribution system was introduced, no zones were demarcated for the production of Mandi and Travancore, as it was expected to meet only the local demand. Similarly Kathiawad and Kutch were not treated as distribution centres since, excluding the local demand, most of their production was shipped to Calcutta and a zone was allotted to Calcutta for all the salt imported into it. A certain amount of rock salt is imported from Khewra (West Pakistan) and consumed in Bihar, Himachal Pradesh, Punjab (I), Patiala and East Punjab States Union and U. P. Likewise a certain quantity of marine salt is exported by India from Calcutta to East Pakistan. Mandi, Travancore, Kathiawad and Kutch, Khewra (West Pakistan) and East Pakistan have been therefore included in these two tables to obtain a complete overall picture of the distribution of salt in India.

(See tables CXXXI and CXXXII next page.)



TABLE CXXXI.—, OFFTAKE OF SALT IN PERCENTAGE BY DIFFERENT REGIONS

S. No.	Area of distribution Zone No.	Sambhar, Didwana, Pichhadra	Kharaghoda	Kuda (Dhargandhra)	Bombay	Tuticorin	Adirampatnam and Madras	Pennuguduru	Naupada and Orissa	Calcutta including imported salt	Mandi	Travancore	Kathiawad and Kutch (including exports to Calcutta)	Khewra (West Pakistan)	Total requirements	
		I	II	III	IV	V	VI	VII	VIII	IX					Tons.	Mds.
1	Ajmer-Merwara . . . .	1	..	..	..	..	..	..	..	..	..	..	..	..	3,670	1,00,000
2	Assam . . . . .	..	..	..	..	..	..	..	..	14	..	..	..	..	72,590	19,76,000
3	Bengal . . . . .	..	..	..	..	..	..	..	..	26	..	..	..	..	1,37,760	37,50,000
4	Bhopal & Panth Piploda	..	3	..	..	..	..	..	..	..	..	..	..	..	4,960	1,35,000
5	Bihar . . . . .	17	..	..	..	..	..	..	..	26	..	..	..	25	2,29,260	62,41,000
6.	Bilaspure State . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	660	18,000
7	Bombay . . . . .	..	28	8	49	..	..	..	..	..	..	..	..	..	2,15,600	58,69,000
8	Coorg . . . . .	..	..	..	..	1	..	..	..	..	..	..	..	..	1,470	40,000
9	Delhi . . . . .	1	..	..	..	..	..	..	..	..	..	..	..	4	8,300	2,26,000
10	East Pakistan . . . . .	..	..	..	..	..	..	..	..	14	..	..	..	..	73,470	20,00,000
11	French Settlement . . . .	..	..	..	..	..	1	..	..	1	..	..	..	..	2,420	66,000
12	Himachal Pradesh . . . .	..	..	..	..	..	..	..	..	..	100	..	..	1	5,880	1,60,000
13	Hyderabad . . . . .	..	..	..	18	..	10	19	..	..	..	..	..	..	1,08,370	29,50,000
14	Jammu & Kashmir . . . .	1	12	..	..	..	..	..	..	..	..	..	..	..	25,240	6,87,000
15	Kutch . . . . .	..	..	..	..	..	..	..	..	..	..	..	16	..	3,120	85,000

16	Madhya Bharat . . .	3	10	16	1	..	..	..	..	..	..	..	..	..	44,820	12,20,000
17	Madhya Pradesh . . .	..	20	..	21	..	..	..	18	..	..	..	..	..	1,23,240	33,55,000
18	Madras . . . . .	..	..	..	2	96	77	81	25	..	..	..	..	..	4,76,040	
19	Mysore . . . . .	..	..	..	4	3	12	..	..	..	..	..	..	..	51,940	14,14,000
20	Nepal . . . . .	2	..	14	..	..	..	..	..	..	..	..	..	..	44,080	12,00,000
21	Orissa . . . . .	..	..	..	..	..	..	..	57	..	..	..	..	..	93,120	25,35,000
22	Patiala & East Punjab States Union . . . .	3	..	..	..	..	..	..	..	..	..	..	8	..	21,490	5,85,000
23	Punjab (I) . . . . .	12	..	..	..	..	..	..	..	..	..	..	40	..	81,330	22,14,000
24	Rajasthan . . . . .	15	7	..	..	..	..	..	..	..	..	..	..	..	81,590	22,21,000
25	Saurashtra . . . . .	..	..	9	..	..	..	..	..	..	..	84	..	..	22,110	6,02,000
26	Travancore & Cochin . .	..	..	..	..	..	..	..	..	..	100	..	..	..	91,840	25,00,000
27	U. P. . . . .	45	15	53	..	..	..	..	..	11	..	..	22	..	3,47,180	94,51,000
28	Vindhya Pradesh . . . .	..	5	..	5	..	..	..	..	..	..	..	..	..	23,660	6,44,000
	Total . . . . .	100	100	100	100	100	100	100	100	100	100	100	100	100	23,95,210	6,52,03,000

TABLE CXXXII.—SUPPLIES OF SALT IN PERCENTAGE FROM THE PRODUCING CENTRES TO DIFFERENT PARTS OF INDIA

S. No.	Area of distribution	Sambhar, Didwana Pachbadra	Kharghoda	Kuda (Dhragadhra)	Bombay	Tuticorin	Adirampatnam and Madras	Pennuguduru	Naupada and Orissa	Calcutta including imported salt	Mandi	Travancore	Kathiawad and Kutch	Khehra (West Pakistan)	Total	Total requirements	
																Tons	Mds.
1	Ajmer-Merwara . . .	100	..	..	..	..	..	..	..	..	..	..	..	..	100	3,670	1,00,000
2	Assam . . . . .	..	..	..	..	..	..	..	..	100	..	..	..	..	100	72,590	19,76,000
3	Bengal. . . . .	..	..	..	..	..	..	..	..	100	..	..	..	..	100	1,37,760	37,50,000
4	Bhopal & Panth Piploda	..	100	..	..	..	..	..	..	..	..	..	..	..	100	4,960	1,35,000
5	Bihar . . . . .	34	..	..	..	..	..	..	..	58	..	..	..	8	100	2,29,260	62,41,000
6	Bilaspur State . . .	100	..	..	..	..	..	..	..	..	..	..	..	..	100	660	18,000
7	Bombay . . . . .	..	20	3	77	..	..	..	..	..	..	..	..	..	100	2,15,600	58,69,000
8	Coorg . . . . .	..	..	..	..	100	..	..	..	..	..	..	..	..	100	1,470	40,000
9	Delhi . . . . .	62	..	..	..	..	..	..	..	..	..	..	..	38	100	8,300	2,26,000
10	East Pakistan . . .	..	..	..	..	..	..	..	..	100	..	..	..	..	100	73,470	20,00,000
11	French Settlement .	..	..	..	..	..	85	..	..	15	..	..	..	..	100	2,420	66,000
12	Himachal Pradesh .	38	..	..	..	..	..	..	..	..	50	..	..	12	100	5,880	1,60,000
13	Hyderabad . . . . .	..	..	..	56	..	22	22	..	..	..	..	..	..	100	1,08,370	29,50,000
14	Jammu & Kashmir . .	25	75	..	..	..	..	..	..	..	..	..	..	..	100	25,240	6,87,000

																	Tons.	Mds.	
15.	Kutch . . . . .	..	..	..	..	..	..	..	..	..	..	..	..	..	100	..	100	3,120	85,000
16.	Madhya Bharat . . . . .	27	36	31	6	..	..	..	..	..	..	..	..	..	..	..	100	44,820	12,20,000
17.	Madhya Pradesh . . . . .	..	25	..	57	..	..	..	18	..	..	..	..	..	..	..	100	1,23,240	33,55,000
18.	Madras . . . . .	..	..	..	1	33	38	21	7	..	..	..	..	..	..	..	100	4,76,040	1,29,59,000
19.	Mysore . . . . .	..	..	..	31	13	56	..	..	..	..	..	..	..	..	..	100	51,940	14,14,000
20.	Nepal . . . . .	25	..	25	..	..	..	..	..	50	..	..	..	..	..	..	100	44,080	12,00,000
21.	Orissa . . . . .	..	..	..	..	..	..	..	77	23	..	..	..	..	..	..	100	93,120	25,35,000
22.	Patiala & East Punjab States Union.	71	..	..	..	..	..	..	..	..	..	..	..	..	29	100	21,490	5,85,000	
23.	Punjab (I) . . . . .	68	..	..	..	..	..	..	..	..	..	..	..	..	32	100	81,336	22,14,000	
24.	Rajasthan . . . . .	87	13	..	..	..	..	..	..	..	..	..	..	..	..	..	100	81,590	22,21,000
25.	Saurashtra . . . . .	..	..	28	..	..	..	..	..	..	..	..	..	..	72	100	22,110	6,02,000	
26.	Travancore & Cochin . . . . .	..	..	..	..	..	..	..	..	..	..	..	100	..	..	..	100	91,840	25,00,000
27.	U.P. . . . .	60	7	12	..	..	..	..	..	16	..	..	..	..	5	100	3,47,180	94,51,000	
28.	Vindhya Pradesh . . . . .	..	31	..	69	..	..	..	..	..	..	..	..	..	..	..	100	23,660	6,44,000
	Total . . . . .																	23,95,210	6,52,03,000

\*The total requirement is computed on the basis of demand of salt as submitted by the Governments of the respective States.

2.2.2. The salt manufacturers of Bombay and Madras have protested against the zonal system on the ground that they have lost some of their original markets. As the first demarcation of the zones was based on incomplete data it was bound to leave some room for complaint, but the zones are not so rigidly and permanently fixed as to exclude adjustments in their demarcations in the light of actual experience in order to meet any legitimate grievances that the manufacturers may have. We understand that such adjustments are constantly made by the Salt Controller to remove any hardship that may have been caused to the manufacturers. It is likely that some border areas in the zones were fed formerly by both Bombay and Madras. So long as it does not involve long or wasteful haulage an adjustment could be made either by altering the boundaries of the zones or by creating a common belt in some of the zones where supplies from both these sources could be made. However, by far the largest part of the complaints and protests of the Bombay and Madras manufacturers appear to us to be due to the fact that there is competition between them in the production of lighter and still lighter varieties of salt. Notwithstanding the parity in the freight rates, the area which produces the lightest salt is able to find a buyer in a distant place because of the unearned large profit he could make by selling the salt in retail by measure. Once the sale of salt by measure is stopped, as recommended by us, a great deal of this unhealthy rivalry between the manufacturing centres will automatically disappear. Since the salt administration in the Indian States is taken over by the Salt Department from 1st of April 1950, salt producing regions in these States should also be brought under an equitable system of zonal distribution, particularly salt from Travancore which is surplus to the requirements of Travancore and Cochin and where further increase in production is hampered because of lack of markets. We also consider that the present maximum leads such as 1291 miles and 912 miles as shown in Table CXXX are excessive and efforts should be made to reduce them so that as far as possible salt does not have to move more than 750 miles to reach its destination.

2.2.3. We fully support the principle of zonal system and urge its continuation even when railway transport has eased. The Salt Department is to be commended for developing a system of zonal distribution which has worked satisfactorily on the whole and which, we understand, the provincial governments have urged the Department to continue. In a vast country like India, with limited transport facilities, the only method of equitable distribution of any commodity, particularly where the production of that commodity is widely distributed, is by means of rational zonalisation. The zonal system has enabled the railways to provide adequate transport facilities for rapid distribution of salt from the factories to all the consuming regions in the country and has to a large extent eliminated the tendency for speculative increase in prices due to bottlenecks in transport.

2.3 PRICES.—It is said that the prices of salt in India are high and because of it the needs of the population and livestock are not being met adequately. This statement is only partially true. As 70 per cent. of the salt is produced from sea brine and the bulk of it has to be transported inland it is inevitable that the cost of salt to places which are at considerable distances from the production centres must necessarily be high owing to the addition of freight. Another factor which is to some extent responsible for the higher price is the cost of gunny bags, which is higher than the price of the salt packed in them. In addition the bags are produced in only one centre *viz.*, Calcutta from where they have to be transported to the various production centres. In the chapters dealing with various production centres, we have indicated wherever possible the present cost and selling prices of salt. For easy reference they are given in Table CXXXIII.

TABLE CXXXIII.—COST AND SELLING PRICES OF Salt (NAKED) EX-WORKS

	Cost price		Selling price	
	Per ton	per md.	Per ton	Per md.
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
(a) Inland sources :				
(i) Sambhar . . . . .	8 8 0	0 5 0	16 9 4	0 9 9
(ii) Kharagoda . . . . .	13 3 7	0 7 10	21 4 3	0 12 6
(b) Rock Salt—Mandi . . . . .	33 3 0	1 3 6	54 7 0	2 0 0*
(c) Marine sources: . . . . .				
(i) Kathiawad & Kutch . . . . .	15 8 0	0 9 1	29 0 0	1 1 0*
to . . . . .	18 0 0	0 10 10		
(ii) Bombay . . . . .	35 11 6	1 5 0	45 15 0	1 11 0
to . . . . .	38 4 3	1 6 ;		
(iii) Travancore . . . . .	24 8 7	0 14 5	34 0 0	1 4 0
to . . . . .	27 3 7	1 0 0		
(iv) Madras . . . . .	8 8 0	0 5 0	31 6 9	1 2 5
to . . . . .	22 6 9	0 13 3		
(v) Orissa . . . . .	15 7 8	0 9 1	20 6 5	0 12 0

\*This price does not include the salt cess which is not levied at this centre.

It will be noticed that the cost of filling, forwarding charges, the salt cess, and the manufacturer's profit, account for an increase in the f.o.r. selling price (exclusive of the bags and the distributor's commission) from 32 per cent. in the case of Orissa to 95 per cent. in the case of Sambhar. The price at which salt is sold from Government owned works is fairly low and as we have commented in the chapters dealing with these works, it is often sold below the manufacturing cost since adequate provision is not made for such items of cost like depreciation overheads, administration, etc., in arriving at the true cost. In Bengal, which is dependant upon its supplies from the West Coast of India, steamer freight alone adds 100 per cent. or more to the f.o.b. selling price and when to this are added the clearing and forwarding charges at Calcutta it is found that salt which is sold at Rs. 29 per ton (Rs. 1-1-0 per maund) or less in bulk f.o.b. port of despatch, increases to Rs. 61-4-0 per ton (Rs. 2-4-0 per maund) when sold wholesale in the Calcutta market.

2.3.1. We do not suggest that the present selling prices of salt in India cannot be reduced. When the smaller works in different producing centres are combined into larger or co-operative units, efficient methods of manufacture are adopted, the works are more scientifically laid out and mechanical appliances wherever possible are introduced, appreciable reduction in the cost of manufacture can be expected and a better quality of salt produced. With the growing consciousness amongst labour for a higher standard of living which in due course must lead to the payment of better wages and the provision for amenities and social welfare schemes like unemployment benefit, health insurance, etc., the cost of salt is likely to increase. This can be balanced only, if the cost on other items are reduced by introducing labour saving devices together with more efficient methods of production. Considering the difference in the quality of brine available and the climatic conditions at the marine works and the inland works, the cost of production at the former is bound to be a little higher than at the latter. Even so, the price of marine salt should not exceed Rs. 13.61 to 20.41 per ton (Rs. 0-8-0 to Rs. 0-12-0 per maund) and that of inland salt Rs. 11.91 to Rs. 15.31 per ton (Rs. 0-7-0 to Rs. 0-9-0 per maund). These prices should be for salt of 96 to 98 per cent. sodium chloride content, expressed on dry basis, and should be correspondingly lower for salt of lower quality.

2.3.2 PRICES IN U.S.A.—In the United States of America, the average price of salt, including that sold in the form of brine, ex-works, is as under:

	(Per ton)		(Per md.)
	\$	Rs.	Rs. A. P.
1935-39 . . . . .	3.02	10.06	0 5 11
1944 . . . . .	3.11	10.37	0 6 1
1945 . . . . .	3.19	10.63	0 6 3
1946 . . . . .	3.33	11.10	0 6 7

(N.B.—\$ 1 = Rs. 3.33)

This low average price is, however, due to the fact that more than 50 per cent. of the salt produced in America is sold in the form of concentrated brine. The prices of different varieties of salt produced in America are given in Table CXXXIV.

TABLE CXXXIV.—PRICES OF SALT (IN BULK) EX-WORKS IN U.S.A.

	1945				1946			
	(Per ton)			(Per md.)	(Per ton)			(Per md.)
	\$	Rs. A. P.	Rs. A. P.	Rs. A. P.	\$	Rs. A. P.	Rs. A. P.	
(a) Salt in brine . . . . .	0.85	2 13 3	0 1 8	0.87	2 14 5	0 1 8		
(b) Rock salt . . . . .	4.14	13 12 10	0 8 1	4.37	14 9 2	0 8 7		
(c) Evaporated salt :								
(i) Solar . . . . .	4.30	14 5 4	0 8 5	3.99	13 4 10	0 7 10		
(ii) Vacuum . . . . .	8.58	28 9 7	1 0 10	8.62	28 11 8	1 0 10		
(iii) Open pan . . . . .	10.47	34 14 5	1 4 6	11.85	39 8 0	1 7 3		

(N.B.—\$ 1 = Rs. 3.33)

These prices are in bulk, ex-manufacturers' works. The prices of salt, packed in bags in New York are shown in Table CXXXV.

TABLE CXXXV.—PRICES OF SALT (PACKED) IN NEW YORK

	1939							
	(Per ton)		(Per md.)	(Per ton)		(Per md.)		
	\$	Rs. A. P.	Rs. A. P.	\$	Rs. A. P.	Rs. A. P.		
(a) Rock Salt :								
(i) In wagon loads . . . . .	15.12	50 6 0	1 13 7	15.90	53 0 0	1 15 2		
(ii) Less than wagon loads. . . . .	17.14	57 2 1	2 1 7	19.71	65 11 2	2 6 7		
(b) Evaporated Salt (Vacuum) :								
(i) In wagon loads . . . . .	17.14	57 2 1	2 1 7	17.58	58 9 7	2 2 5		
(ii) Less than wagon loads. . . . .	20.89	69 10 1	2 8 11	23.97	79 14 5	2 14 11		

(N.B.—\$ 1 = Rs. 3.33)

It will be seen that there is a substantial difference between the bulk price and the wholesale price in bags. The price in New York is not less than the selling price in many parts of India, the only important difference being that the American salt is 99 per cent. pure whereas the Indian salt averages only 92 to 94 per cent. A noticeable feature of the American salt prices is that there has been an increase of 10 per cent. or so on the prewar prices.

This is probably due to the fact that the production of salt in the U. S. A. was stepped up to a great extent because of war conditions. A larger production enabled the industry to keep down the prices.

2.3.3 *Prices in United Kingdom.*—We have been able to obtain prices of salt in England for the years 1939 and 1950. These are given in Table CXXXVI:

TABLE CXXXVI PRICE OF SALT (IN BULK) EX-WORKS IN UNITED KINGDOM

	1939			1950		
	(Per ton)		(Per md.)	(Per ton)		(Per md.)
	Sh.	Rs. A. P.	Rs. A. P.	Sh.	Rs. A. P.	Rs. A. P.
<b>Vacuum :</b>						
Dried . . . . .	35/-	23 5 4	0 13 8	68/2	45 7 1	1 11 51
Undried . . . . .	25/-	16 10 8	0 9 10	59	39 5 4	1 7
<b>Open pan :</b>						
Dried . . . . .	30/-	20 0 0	0 11 9	84	56 0 0	2 0 11
Undried . . . . .	27/6	18 10 8	0 11 0	81	54 0 0	1 15 9

It will be seen that there is a substantial difference in the prices of dried and undried salt and these prices are higher than the prices of corresponding quality of salt in U. S. A. Besides there is a big drop in the price of undried vacuum salt as compared with dried salt. On the other hand the differences between the dried and undried open pan salt is not as much. Unlike America, the prices in England have increased by 100 to 200 per cent. since 1939.

2.3.4. Having discussed in previous paragraphs, the prices of salt in U. S. A. and U. K., we have drawn up a list of wholesale and retail prices of salt in different States in India. These are shown in Table CXXXVII

TABLE CXXXVII SALT PRICES (PACKED) IN INDIA 1949

State	District	Wholesale	Retail
		Per md.	Per seer
		Rs. A. P.	Rs. A. P.
<b>ASSAM—</b>			
	Cuchar . . . . .	5 0 0	0 2 6
	Lakhimpur . . . . .	6 12 0	0 3 3
	Shillong . . . . .	6 10 0	0 3 0
<b>BIHAR—</b>			
	Champaran . . . . .	2 9 0	0 1 3
	Dhanbad . . . . .	4 10 0	0 2 6
	Gaya . . . . .	5 3 0	0 2 3
	Jamshedpur . . . . .	4 1 0	0 2 0
	Patna . . . . .	4 8 0	0 2 0
<b>BOMBAY—</b>			
	Ahmedabad . . . . .	1 5 1	0 0 9
		to 2 10 0	to 0 1 5
	Belgaum . . . . .	3 3 0	0 1 3
		to 5 4 0	to 0 2 3
	Bombay City . . . . .	2 2 0	0 2 0
	Broach . . . . .	1 14 0	0 1 0
		to 2 12 0	to 0 1 3
	Kaira . . . . .	1 12 6	0 1 0
	Khandesh (West) . . . . .	2 8 0	0 1 0
		to 10 0 0	to 0 4 0



TABLE CXXXVII.—*contd.*

State	District	Wholesale		Retail	
		per md.		per seer	
		Rs.	A. P.	Rs.	A. P.
	Nasik . . . . .	3	15 9	0	1 6
	Poona . . . . .	3	10 0	0	1 10
	Ratnagiri . . . . .	2	2 0	0	0 9
		to	6 0 0	to	0 2 6
	Sholapur . . . . .	2	8 0	0	1 3
		to	5 0 0	to	0 2 6
<b>MADHYA PRADESH—</b>					
	Akola . . . . .	3	14 0	0	1 9
	Amraoti . . . . .	3	1 0	0	1 6
	Bastar . . . . .	4	4 0	0	2 0
	Chanda . . . . .	4	7 0	0	2 0
	Chinwada . . . . .	3	3 0	0	1 6
	Jubbulpur . . . . .	2	12 0	0	1 3
	Nagpur . . . . .	3	13 0	0	1 9
	Wardha . . . . .	3	2 0	0	1 6
<b>MADRAS—</b>					
	Anantapur . . . . .	2	4 0	0	1 0
	Bellary . . . . .	3	9 0	0	1 9
	Chinglepet . . . . .	1	12 0	0	0 9
	Coimbatore . . . . .	2	0 0	0	1 0
	Guntur . . . . .	1	10 0	0	1 0
	Godavari (East) . . . . .	1	8 0	0	0 9
	Kanara (South) . . . . .	3	0 0	0	1 3
	Madras City . . . . .	1	6 0	0	0 7
	Malabar . . . . .	2	0 0	0	1 3
	Mathurai (Madura) . . . . .	1	12 0	0	1 0
	Ramanad . . . . .	1	7 0	0	1 0
	Tanjore . . . . .	1	6 0	0	0 9
	Tirunelveli . . . . .	1	9 0	0	0 9
	Tiruchirapalli . . . . .	2	11 0	0	1 3
	Vizagapatam . . . . .	1	9 0	0	0 10
<b>ORISSA—</b>					
	Balasore . . . . .	4	0 0	0	2 0
	Cuttack . . . . .	2	12 0	0	1 6
	Ganjam . . . . .	1	11 0	0	2 3
	Puri . . . . .	2	13 0	0	1 6
	Sambalpur . . . . .	4	8 0	0	2 3
<b>PUNJAB (I)—</b>					
	Ambala . . . . .	2	12 0	0	1 3
	Amritsar . . . . .	3	2 0	0	1 6
	Gurgaon . . . . .	2	15 0	0	1 6
	Hissar . . . . .	2	2 0	0	1 3
	Jullundur . . . . .	2	10 0	0	1 3
	Kangra . . . . .	3	2 0	0	2 0
	Ludhiana . . . . .	2	0 0	0	1 0
	Rohtak . . . . .	2	6 0	0	1 3
	Simla . . . . .	3	8 0	0	1 9
<b>UTTAR PRADESH—</b>					
	Agra . . . . .	2	1 0	0	1 0
	Allahabad . . . . .	2	15 0	0	1 6
	Banaras . . . . .	3	4 0	0	1 9
	Bareilly . . . . .	2	6 0	0	1 3
	Dehra Dun . . . . .	2	13 0	1	1 3
	Etawah . . . . .	2	5 0	0	1 6
	Fyzabad . . . . .	2	11 0	0	1 6
	Gharwal . . . . .	5	4 0	0	2 0
	Gorakhpur . . . . .	4	4 0	0	1 9
	Jaunpur . . . . .	3	12 0	0	1 6
	Jhansi . . . . .	2	10 0	0	1 2
	Kanpur . . . . .	2	6 0	0	1 3
	Lucknow . . . . .	2	10 0	0	1 6
	Mathura . . . . .	2	3 0	0	1 3
	Meerut . . . . .	2	7 0	0	1 7
	Nainital . . . . .	2	8 0	0	1 0
	Pilibhit . . . . .	2	5 0	0	1 3
	Saharanpur . . . . .	2	0 0	0	1 9
	Unao . . . . .	3	1 0	0	1 6

TABLE CXXXVII.— *contd.*

State	District	Wholesale per md.			Retail per seer		
		Rs.	A.	P.	Rs.	A.	P.
WEST BENGAL—							
	Birbhum . . . . .	3	11	0	0	2	0
	Burdhwan . . . . .	3	8	0	0	1	9
	Calcutta . . . . .	3	3	0	0	1	9
	Darjeeling . . . . .	6	8	0	0	3	0
	Jalpaiguri . . . . .	5	0	0	0	2	6
	Midnapur . . . . .	3	12	0	0	2	0
	Murshidabad . . . . .	3	8	0	0	2	0
	24-Parganas . . . . .	3	8	0	0	1	6

It will be seen that the prices differ substantially in different districts in the same State. For instance, in Bihar, the price ranges from Rs. 2-9-0 per maund at Champaran to Rs. 5-3-0 per maund at Gaya. This difference is due to the fact that Champaran gets its salt from Sambhar whereas Gaya obtains it from Calcutta. Similarly prices of salt in the hill station like Simla, Darjeeling and Shillong, are considerably higher than in the plains because of the heavy cost of transport. In West Bengal the price is high because there is little or no production in the State and it has to depend upon the West Coast ports of India for its requirements. In Assam, the prices are still higher, because Assam is not a producing centre either and salt has to be transported to it from Calcutta over a great distance. Some of the anomalous features in the wholesale prices are that salt supplied by Government inland works is cheaper than that from the privately owned factories. As compared with U. S. A. and U. K. the wholesale price of Indian salt for domestic consumption is not high; its quality is however poor. In U. K. and U. S. A. the industrial consumers have a great advantage inasmuch as they are able to get salt in brine of good quality at low cost from their rock salt mines. The Indian industrial consumers do not enjoy this advantage as the bulk of our salt is produced by solar evaporation and its quality is inferior. For Chemical industries, the salt produced has to be refined further, which adds to the cost of the raw material for the manufacturers. Unfortunately in view of small deposits of rock salt and that also in a comparatively inaccessible area, the Indian industries cannot hope to get salt in brine at a low cost but they have a right to expect that solar salt of the highest chemical purity will be manufactured in the country so that their cost of purification may be brought down. As stated earlier, it is possible to produce salt in India at a lower cost than at present by (a) consolidating the small uneconomic holdings into large compact block of production and (b) mechanising the processes as far as possible. In an Information Circular published by the Government of United States of America in 1939 it was observed:

“Winning salt by solar evaporation of sea water requires large acreages, not only near the source of supply but also near consuming centres, and must be done on a large scale to be profitable. For these reasons a number of small producers in some localities have consolidated into one company.”

Both in the interest of the Chemical industry and the general consumer India must follow the example of U. S. A and consolidate its production by reorganising the small licensees into economic units. Unless this is done, the price and quality of salt in India will continue to be a serious handicap to the industry.

2.4 RAILWAY FREIGHT.—The price of salt in India is also linked up with the cost of transport. In the Chapter on Kathiawad and Kutch we have already drawn attention to the somewhat high incidence of steamer rates from the West Coast ports to Calcutta. Similarly in the Chapter on Madras, we have discussed the handicaps felt by South India Salt Refineries Ltd. at Kanuparti in despatching their salt to Calcutta owing to high railway freight. The importance of railway freight to the price of salt at the consuming centres cannot be over emphasised. For an essential commodity like salt which is cheap in price and universal in demand, it is of the utmost importance that the transport charges should be as low as possible. Since all the railways are state owned, it is necessary for Government to examine carefully the need for keeping the freight rate on salt at as low a level as possible.

2.4.1. Prior to 1st October 1948, salt was classified by the Indian Railways of Class I for purposes of freight. Under this Class the maximum rate that could be charged was fixed at 0.380 pie and the minimum at 0.100 pie per maund per mile. The railways were however authorised to fix scheduled and station to station rates for wagon loads within these limits. Some Railways, for instance, quoted a scheduled rate of 0.300 pie per maund per mile for any distance; others quoted a telescopic rate which started with the maximum rate of the class of 0.38 pie per maund per mile for the first 75 miles and progressively went down to 0.100 pie per maund per mile for distances over 300 miles; still others started with an upper limit of 0.333 pie per maund per mile for the first 300 miles which progressively decreased to 0.100 pie per maund per mile for distances above 700 miles. The station to station rates for wagon loads were even lower than the scheduled rates and they were offered from all producing centres to principal centres of consumption. Since the World War II all these rates were subject to a surcharge of 12½ per cent. There was a great diversity in these rates among different Railways but little purpose would be served in discussing this diversity, since the rates have been revised and made uniform for all Railways from 1st October 1948. This revision was general and applied to all commodities. The surcharge was removed but in the new classification salt was upgraded from Class I to as under:

	<i>Classification</i>	
(a) Salt, not otherwise classified . . . . .	2 R.R.	(Railway Risk)
(N.O.C.) including hide salt.		
(b) Salt N.O.C., for wagon loads . . . . .	WL/1	
(c) Salt, refined, in bags . . . . .	7 R.R.	
(d) Salt, for table use . . . . .	12 R.R.	

With the introduction of these rates, there is no longer any room for scheduled rates to be quoted by individual Railways, but station to station rates are still in force, though they have been revised in an upward direction. Maximum rates for any distance have also been introduced.

2.4.2. The rates charged for the new classes are given in Table CXXXVIII:

TABLE CXXXVIII RAILWAY FREIGHT RATES FOR SALT

Class	Per maund Per mile (pies)			Maximum rate per md.
	1st 300 miles	plus next 300 miles	plus for distances beyond	
(a) 2 R. R. . . . .	0.54	0.49	0.45	Rs. A. P. 3 10 0
(b) WL/1 . . . . .	0.43	0.23	0.15	Nil
(c) 7 R.R. . . . .	0.78	0.73	0.68	5 9 0
(d) 12 R.R. . . . .	1.11	1.04	0.97	7 14 0

As a result of this revision the rate for less than wagon loads has gone up from 0.38 to 0.54 pie per maund per mile, an increase of 42 per cent. or after taking into account the war time surcharge of 12½ per cent. an increase of 26.3 per cent. This is only with regard to salt, not otherwise classified; in the case of refined salt or salt for table use the increase is much greater. In the case of salt despatched by wagon loads, the new rate WL/1 is also higher than the scheduled rates quoted by the different Railways previously. According to the present system of zonal distribution the average distance that salt travels within a zone is not probably more than 500 miles; a substantial part of it actually travels much less. Taking the average distance of 500 miles as a basis for comparison, we give in Table CXXXIX the increase in freight that has occurred in the transport of salt as a result of the revision. The cost of moving salt under three different scheduled rates are compared with WL/1 rate now in force:

TABLE CXXXIX.—COMPARISON OF RAILWAY FREIGHTS

Old Schedule rates—		Freight per maund for 500 miles
		Rs. A. P.
Type 1	0.30 pie for any distance plus 12½% surcharge = 0.3375	0 14 1
Type 2	0.38 pie for the first 75 miles	} plus 12½% surcharge
	0.20 pie from 76 to 300 miles	
	0.10 pie from 301 to 500 miles	
Type 3	0.333 for the first 300 miles	} plus 12½% surcharge
	0.20 from 301 to 500 miles	
Present rate—		
WL/1	0.43 for the first 300 miles	} . . . . .
	0.23 for the next 200 miles	
		0 14 7

It will be seen that the present WL/1 rate is higher than the highest of the previous scheduled rates; in some cases, as in type 2, the increase is more than 50 per cent.

2.4.3. It would be relevant to examine this increase in freight from another angle. Salt was classified in the previous classification as an item of food and was given the same classification as foodgrain viz., Class I. Foodgrains also were given scheduled and station to station rates for wagon loads which were similar to those for salt. When the classification was revised, whilst foodgrain was retained in Class I, salt has been upgraded to Class 2. The revised class rate is 0.49 for the first 300 miles, 0.45 for the next 300 miles and 0.40 for distances beyond with a maximum rate of Rs. 3-4-0 per maund. For wagon loads, however, foodgrains are given the following rates.

Type	Rate per maund
WL/D for the Group I Rlys. . . . .	$\left\{ \begin{array}{l} 0.38 \text{ pie for the 1st 300 miles} \\ 0.28 \text{ pie for the next 300 miles and} \\ 0.18 \text{ pie for the distances beyond.} \end{array} \right.$
WL/DG for Group II Rlys. . . . .	$\left\{ \begin{array}{l} 0.38 \text{ pie for the 1st 150 miles,} \\ 0.28 \text{ pie for the next 150 miles and} \\ 0.15 \text{ pie for distances beyond.} \end{array} \right.$

Making a comparison between the rates for salt and foodgrains for a distance of 500 miles, as against a charge of Re. 0-14-7 per maund for salt the rate for foodgrains comes to Re. 0-14-2 per maund for WL/D and Re. 0-10-9 per maund for WL/DG. Except in the case of wagon loads on Group I Railways the cost of transport of salt is appreciably higher than that for foodgrains whether by wagon loads or otherwise. We, therefore, recommend that the classification for salt be revised and it be given the same classification and the same scale of charges as foodgrains. This might mean a small loss of revenue to the Railways, but it will make salt available more cheaply to consumers.

2.4.4. We also do not see any justification for classifying refined salt and table salt in Classes 7 R.R. and 12 R.R. respectively. The difference in price between edible common salt, refined salt and Table salt is not such as to warrant this substantial difference in railway freight. Although the cost of manufacture of refined and table salt would be higher than that of common salt obtained by solar evaporation, it is not such as to justify the levy of freight rates which are several times higher than that for common salt. It is advisable to remove this anomaly in freight as otherwise the manufacturers in India would lack the impetus to produce edible salt of good quality. If a separate classification for the refined and table salt is considered at all necessary, we recommend that both these varieties be classified under 2 R.R. This would provide a slightly higher freight rate than that for ordinary common salt for which we have recommended the restoration to its original class *viz.*, Class 1.

2.4.5. We have heard complaints that the present railway freights on salt are unduly high for industries which use salt as their principal raw material. Even as it is, Indian industries cannot hope to get salt of the same quality as is easily available in U. K. and U. S. A. at low enough rates. To ask the industry to pay a heavy railway freight on salt is to penalise it still further and to make the task of manufacturing chemicals at competitive prices more and more difficult. We would urge that special station to station rates should be introduced for the movement of salt for basic industries particularly those situated far away from the salt producing centres. Prices of manufactured chemicals have an important bearing on cost of production of most materials in the country and anything that increases the cost of the raw materials *ipso facto* raises the cost of the finished article with consequential hardship to the consumer. We are aware that in order to place the industries on their feet relief is being offered in the shape of protection. To our mind relief in the matter of cost of transport of industrial salt, is a measure that should receive the earliest consideration of the Railway authorities.

### 3. CONSUMPTION

3.1. PER CAPITA CONSUMPTION.—In Chapter II, Table II, we have given a statement of the world production of salt in 1946. Considering the population of U.S.A. and Great Britain, the production of salt in these countries is very

high and is an index of the industrial development of those countries. But of a production of 13.51 million tons (367.74 million maunds) in U. S. A. the consumption within the country was as high as 13.32 million tons (362.57 million maunds). On a population of 145 millions, the *per capita* consumption of salt in U. S. A. works out to about 206 lbs. In U. K. whilst the production was 3.23 million tons (87.92 million maunds), the consumption was 2.26 million tons (61.52 million maunds) giving the *per capita* consumption of about 103 lbs. for a population of 49 millions. The world production for 1946 was 42 million tons (1143.24 million maunds) and taking the population at about 2300 millions the *per capita* consumption comes to about 41 lbs. In comparison with these figures the average production in India of about 2 million tons (54.44 million maunds) is negligible considering the size of the country and the density of its population. On the present population of about 350 millions and a consumption of 2.30 million tons (62.60 million maunds) the *per capita* consumption in India works out to about 15 lbs. only. In Table CXL the consumption of salt for domestic, agricultural and industrial uses in U. S. A. and India is compared.

TABLE CXL TOTAL AND PER CAPITA CONSUMPTION OF SALT IN THE U. S. A. AND INDIA

	U.S.A.		India	
	Total million tons	Per capita lbs.	Total million tons	Per capita lbs.
(a) Domestic—				
(i) Table and other household use	0.63	9.73	2.01	12.86
(ii) Livestock . . . . .	0.71	10.97		
(b) Agriculture . . . . .	0.03	0.46		
(c) Fish curing . . . . .	0.07	1.08	0.02	0.13
(d) Meat packing . . . . .	0.61	9.42	Nil	Nil
(e) Dairy products canning and other food processing.	0.52	8.04	0.01	0.06
(f) Hides and leather . . . . .	0.26	4.02	0.07	0.45
(g) Industries (Including manufacture of chemicals.)	10.49	162.05	0.19	1.22
<b>TOTAL</b> . . . . .	<b>13.32</b>	<b>205.77</b>	<b>2.30</b>	<b>14.72</b>

The *per capita* consumption of salt for all requirements in the different parts of the country is estimated as under:

Region	Per capita Consumption lbs.
Punjab, Delhi, Kashmir . . . . .	8.80
U. P., Rajputana, Madhya Bharat . . . . .	10.60
C. P. Hyderabad . . . . .	11.00
Bihar, Bengal, Assam . . . . .	12.10
Bombay, Saurashtra . . . . .	12.70
Madras, Mysore, Travancore . . . . .	19.60

In the coastal areas the consumption is higher than in inland regions because they are rice eating and need more salt. Besides the salt used in the coastal areas of Bombay and Madras is moist and has a low sodium chloride content,

which would account for the higher figure of consumption.—Salt is also used for fish-curing in the coastal areas.

3.2. DOMESTIC CONSUMPTION.—The domestic consumption of salt covers the human requirements for table and other household uses as also the requirements of livestock. In India, however, separate figures of consumption for these requirements as also for agricultural uses are not available. The highest priority has to be given to the domestic requirements because the maintenance of good health of the people and the livestock depend on it. It is, therefore, desirable to examine in some detail the *per capita* requirements separately, for human use and for use by livestock.

3.2.1. HUMAN CONSUMPTION.—It is generally agreed that for maintaining good health, particularly in tropical countries, there should be an intake of at least  $\frac{1}{2}$  oz. of salt per day or about 11 $\frac{1}{2}$  lbs. a year. Opinions and practices, however, differ. In France, the requirement of salt is estimated at 300 grains (approx.  $\frac{2}{3}$  oz.) per day whilst during the war the American soldier's ration provided for 150 grains (about  $\frac{1}{3}$  oz.) per day, in addition to his substantial salt intake from his canned rations. The Bombay Government Manual for jails and hospitals prescribed different rations of salt varying from  $\frac{1}{2}$  oz. per day per head for non-vegetarians to 1 $\frac{1}{2}$  oz. per day for vegetarians. Rice eating populations need more salt than those who eat wheat. Also, in warm countries sodium chloride is lost by the body in perspiration and its consumption is therefore more than in cold climate. Persons engaged in strenuous manual labour require more salt than sedentary workers. According to medical reports, women need less salt than men and their requirement is taken as four-fifth of that of men; for children the quota of consumption is taken as half that of an adult male. Having regard to these differences of opinion, the optimum intake for India has to be necessarily fixed arbitrarily keeping in view the climate, food, habits and occupation in different parts of the country. An average intake of  $\frac{1}{2}$  oz. *per capita* per day appears to us to be low and a more reasonable figure would be  $\frac{3}{4}$  oz. per head for adult male; fourth-fifth of that for a female and  $\frac{1}{2}$  of the adult male ration for children upto 14. On this basis the total requirement of salt for human consumption in India works out as under;

Population in millions	Daily rate of consumption	Consumption per annum	
		Tons	Mds.
		in Millions	
Males . . . . . 106	$\frac{3}{4}$ oz.	0.81	22.05
Females . . . . . 104	$\frac{3}{5}$ oz.	0.64	17.42
Children . . . . . 140	$\frac{3}{8}$ oz.	0.53	14.43
<b>TOTAL . . . . . 350</b>	<b>TOTAL</b>	<b>1.98</b>	<b>53.90</b>

giving an average consumption of 12.67 lbs. *per capita* per annum.

3.2.2. CONSUMPTION BY LIVESTOCK.—Since their diet is comparatively poorer in salt content than the ordinary human diet, livestock needs as much salt, if not more, than human beings. At present no separate figure of consumption of salt in India by livestock is available, but we have calculated it on a very rough basis at 30,000 tons (8,16,600 maunds) per annum. In Table CXL the total domestic consumption in India including that for livestock and agriculture has been shown as 2.01 million tons (54.72 million maunds). As against this, the human consumption is estimated (*vide* 3.2.1.) at 1.98 million tons (53.90 million maunds) leaving a balance of about 30,000 tons (8,16,600

maunds) for the needs of the livestock and agriculture which is far below the normal requirements of even the livestock. It would be reasonable to assume that, like human beings, cattle living in the tropics need more salt than the cattle in cooler climates. Moreover, the Indian pasture is relatively poorer in mineral content and the greater deficiency of salt in the diet of our cattle has to be met by a larger intake of salt. The lack of salt in the cattle feed must necessarily tell upon the conditions of our cattle and undermine their productivity of milk. It is difficult to say how far the low condition of the Indian cattle and the notoriously low yield of milk as also the poor quality of hides, skin and meat are due to the deficiency in salt. It is undeniable that this starvation of salt must be an important contributory factor and this situation will have to be remedied sooner or later and in fixing our target of production, we must provide for an adequate supply of salt for livestock. To keep the livestock in good condition the Veterinary Research Stations in India calculate the average requirement of salt per head of cattle at about 38 lbs. and for goats and sheep at 10 lbs. per head per annum. The livestock populations of U. S. A. and India are estimated at 164 and 264 millions respectively as shown below:

	U.S.A. Millions	India Millions
Cattle . . . . .	78.56	176.99
Sheep and goats . . . . .	55.04	84.20
Hogs and other animals . . . . .	30.54	3.24
<b>TOTAL</b>	<b>164.14</b>	<b>264.43</b>

If salt for our livestock is to be provided on the basis of figures recommended by the research stations, the total requirement would exceed 3.3 million tons (90.64 million maunds) per year which exceeds the present total consumption of the country of 2.3 million tons (62.61 million maunds). The American figure of *per capita* consumption for livestock comes to only about 9.7 lbs. per head of cattle; even on this basis our livestock would require about 1.12 million tons (30.49 million maunds) a year.

3.3. INDUSTRIAL CONSUMPTION.—In America and England more than 70 per cent. of the total salt produced is consumed in industries. As compared with this figure the industrial consumption in India is woefully small being only about 8 per cent. It indirectly indicates the backward state of the industries in India.

3.3.1. In U. S. A. of the various industries using salt the chemical industry is the largest single consumer and accounts for 85 per cent. of the industrial consumption as shown in Table CXLI:

TABLE CXLI.—CONSUMPTION OF SALT BY DIFFERENT INDUSTRIES IN U. S. A. AND INDIA

	U.S.A.		India	
	Tons	Per cent.	Tons	Per cent.
Heavy chemicals, dyestuffs . . . . .	2,000	83.85	1,40,000	73.68
Soaps . . . . .	57,000	0.56	15,000	7.90
Other chemicals . . . . .	4,78,000	4.75	10,000	5.26
Miscellaneous . . . . .	10,91,000	10.84	25,000	13.16
	<b>1,00,68,000</b>	<b>100.00</b>	<b>1,90,000</b>	<b>100.00</b>



#### 4. Target of production.

4.1. The present consumption of salt in India is estimated at 23 lakh tons (626 lakh maunds). Production, on the other hand, is now reaching 22 lakh tons (599 lakh maunds) leaving a gap of 1 lakh tons (27 lakh maunds), which is expected to be bridged in the course of 1950-51. This figure of consumption does not however, provide for the necessary requirements of the population and livestock. During the next five years we estimate the consumption in the country to rise to about 30 lakh tons (816.6 lakh maunds) which would meet the full needs of human population and of the industries but only a partial requirement of the livestock. The probable distribution of these 30 lakh tons is indicated in Table CXLII.

TABLE CXLII.—TARGET OF CONSUMPTION IN INDIA BY 1955

	Tons	Mds.
	<i>(In lakhs)</i>	
Domestic consumption (Table & other household use) . . . . .	21.00	571.70
Livestock and Agriculture . . . . .	3.00	81.70
Fish curing . . . . .	0.50	13.60
Dairy products . . . . .	0.50	13.60
Hides and leather . . . . .	1.00	27.20
Industry—		
Paper . . . . .	0.25	
Alkali . . . . .	3.00	
Soap . . . . .	0.20	
Other chemicals . . . . .	0.25	
Miscellaneous . . . . .	0.30	
	4.00	108.90
	30.00	816.70

The figures for fish curing and tanning have been furnished by the Ministry of Agriculture and the Ministry of Industry and Supply respectively. The Heavy Chemicals Panel of the Government of India had estimated the requirements of salt for chemical industry at 5 lakh tons, but we have provided a reduced target of 3,00,000 tons based upon the slow rate of progress hitherto achieved. With regard to livestock, if American standards are to be followed the consumption would exceed 10 lakh tons, but as this can be reached only by stages we have provided a more likely figure of 3,00,000 tons.

4.2. We are satisfied that the production of salt in India can be stepped up by 1955-56 to cover this overall likely requirements of the country. The Indian salt industry should be on the alert to meet the progressive increase in demands and not to allow a situation to develop whereby once again large imports from abroad might become necessary. In Table CXXV we have given the potential capacity of the existing salt works in India as 40.26 lakh tons (1,096 lakh maunds). We have drawn up in Table CXLIII a forecast of the production that should be reached by the various works by 1955-56. Each of the manufacturing centres we have indicated in the Table could reach the quota apportioned to it without unduly straining itself. The Salt Department would, however, have to be vigilant and arrange to fill up the lacuna should any one of the centres be found lagging behind. We would reiterate that the figures we have given in the table are essentially a forecast of probable development within the next five years.

TABLE CXLIII.—FORECAST OF PRODUCTION OF SALT IN DIFFERENT CENTRES  
1955-56

	(Tons)	(Maunds)	
A. Inland Works : . . . . .			9,45,000
(i) Sambhar . . . . .	4,70,000	1,27,94,000	
(ii) Didwana . . . . .	35,000	9,53,000	
(iii) Pachbadra . . . . .	1,50,000	40,83,000	
(iv) Kharaghoda . . . . .	2,00,000	54,44,000	
(v) Kuda . . . . .	90,000	24,50,000	
(Dhrangadhra)			
B. Salt Mines (Mandi) . . . . .			65,000
C. Marine Works : . . . . .			20,65,000
(a) Kathiawad and Kutch—			
(i) Bhavnagar . . . . .	40,000	10,89,000	
(ii) Jaffrabad . . . . .	40,000	10,89,000	
(iii) Jamnagar (2 works) . . . . .	70,000	19,06,000	
(iv) Lavanpur . . . . .	45,000	12,25,000	
(v) Mithapur (including vacuum salt).	1,40,000	38,10,000	
(vi) Porbandar . . . . .	65,000	17,69,000	
(vii) Versamadi . . . . .	40,000	10,89,000	
(viii) Kandla . . . . .	75,000	20,42,000	
	5,15,000	1,40,19,000	
(b) Bombay (Circles)—			
(i) Dharasana . . . . .	40,000	10,89,000	
(ii) Bhayandar . . . . .	1,70,000	46,28,000	
(iii) Bhandup . . . . .	1,00,000	27,22,000	
(iv) Uran . . . . .	1,55,000	42,19,000	
	4,65,000	1,26,58,000	
(c) Travancore . . . . .	75,000	20,42,000	
(d) Madras (Circles)—			
(i) Naupada . . . . .	1,50,000	40,82,000	
(ii) Pennuguduru . . . . .	1,25,000	34,03,000	
(iii) Madras . . . . .	1,80,000	49,00,000	
(iv) Cuddalore . . . . .	90,000	24,50,000	
(v) Adirampatnam . . . . .	1,25,000	34,03,000	
(vi) Tuticorin . . . . .	2,50,000	68,06,000	
	9,20,000	2,50,44,000	
(e) Orissa—			
(i) Puri . . . . .	2,000	54,000	
(ii) Ganjam . . . . .	58,000	15,79,000	
	60,000	16,33,000	
(f) West Bengal . . . . .	30,000	8,17,000	
TOTAL . . . . .			30,75,000
			8,37,06,000

This estimated production exceeds 30 lakh tons but the following reservations have to be kept in mind:

- (a) The estimates for Mandi and Bengal depend upon the action that the Governments concerned take to initiate and promote the production of salt. The estimated production in Mandi depends upon the installation of the thermo-compression plant. Similarly, the production in Bengal depends upon the setting up of large size works on the Contai Seaboard.

- (b). With regard to Kandla Works in Kutch we have not provided for any substantial increase in output as the future of these works is uncertain. They may even have to be shifted to a new site in which case the production of 75,000 tons will disappear.
- (c) With regard to Kathiawad we are convinced that the production could be stepped up much above the target of 4,40,000 tons (1,19,78,000 mds). We have advisedly not encouraged this, because we do not advise the excessive concentration of production in any one centre with the concomitant increased burden on the transport system. Should any of the centres fail to achieve the estimated production, their quotas should be redistributed to other centres with a view to filling up this void.

4.3. IMPORT POLICY.—The increase in production is intimately linked with the policy followed by Government with regard to the import of foreign salt. Until the advent of the National Government, no regulated policy for restricting the imports was being followed. Imports were free and on several occasions larger quantities than were justified by the needs of the country were allowed to come into the country. This policy was pursued till quite recently and has discouraged the Indian salt industry from increasing its production adequately. The existing works, therefore, did not fully expand their manufacturing capacity and new works which could have been established did not come into being. This was largely due to the bitter experience of the Indian industry in the pre-war years, when in spite of protective duty on salt they were unable to stand up against competition from foreign imports, particularly from Aden which was excluded from the operation of the protective duty. In our first Interim Report we had drawn the attention of Government to regulate their policy regarding imports by integrating it with the production in the country and preventing indiscriminate large imports with detrimental repercussions on the indigenous production. This recommendation was accepted by Government and since the middle of 1948, imports are being regulated. By 1951 the Indian industry should achieve self-sufficiency and no imports of salt should be necessary thereafter. If Government pursue this policy, the Indian industry would be encouraged to increase its production and reach the target that we have forecast.

### 5. Summary of Recommendations.

- (a) The potential capacity of the existing salt works in India is estimated by us at 40,26,000 tons (10,96,00,000 mds.) (1.3.4)
- (b) In well designed marine works it is possible to produce solar salt of 98 per cent. sodium chloride content. (1.4.1)
- (c) The sale of salt by measure should be abolished. (1.4.4)
- (d) The fragmentation of holdings lead to uneconomic cost of production and the lowering of quality and yield. Smaller units should, therefore, be consolidated into economic units with a minimum area of 100 acres each. (1.5)
- (e) The number of labourers employed at present is excessive and leads to high cost of production. The system of employing labour by contractors also requires to be altered. The migratory character of labour employed in the salt works can be changed if the manufacturers were to stagger the work and find alternative employment for labour during the rainy season. (1.7.1 and 1.7.2)
- (f) The zonal system of distribution introduced by the Salt Department has done good work and should be continued, adjustments being made in the zones to reduce the maximum lead to 750 miles. As the Salt Administration in the

Indian States has been taken over by the Salt Department of the Government of India the production in those States should also be brought under an equitable system of zonal distribution. (2.2.2 and 2.2.3)

(g) The price of Indian salt as compared with prices in America and England cannot be considered excessive. There is however, room for reduction in the price of marine salt which should not exceed Re. 0-8-0 to Re. 0-12-0 per maund and for inland salt Re. 0-7-0 to Re. 0-9-0 per maund. These prices are for salt of 96 to 97 per cent. sodium chloride content. (2.3.2.)

(h) Railway freights play an important part in determining the wholesale and retail price of salt. The present classification of railway freight should be revised and salt put on the same footing as foodgrains. (2.4.3)

(j) The classification of refined and table salts should also be revised as the present rates are unjust to the manufacturers of these varieties. (2.4.4)

(k) Salt for industrial use should be given special station to station rates, so that it may become available to the industries at a lower cost. (2.4.5)

(m) The consumption of salt by livestock is negligible and every encouragement should be given to increase this consumption. (3.2.2)

(n) Salt production in India could be increased by 1955-56 to 30 lakh tons (816.6 lakh mds.) The increase should be equitably spread out in all centres and excessive concentration of production in one centre should be avoided. (4.2.)

(p) The policy followed by Government regarding the import of foreign salt has an important bearing on production in the country. Since the Indian industry will achieve self-sufficiency by 1951, no further imports are necessary thereafter. (4.3)

## CHAPTER XX

### MODEL FACTORIES AND RESEARCH STATIONS

#### 1. MODEL FACTORIES

1.1 GENERAL.—After examining a number of salt factories in India and their primitive state of development we have come to the conclusion that if the quality of salt is to be improved and the salt works are to continue to operate both economically and efficiently, it is desirable for Government to set up model factories in principal salt producing centres to serve as demonstration units for the guidance of both small and large manufacturers. The economic manufacture of salt by solar evaporation is governed by (a) high rate of evaporation, (b) low rainfall, (c) large acreage of low-lying and flat land adjacent to the source of brine and (d) soil of low permeability. Since salt is a low priced commodity its sales territory is largely limited by freight rates and its successful manufacture requires a market reasonably close to the place of production. It is, therefore, not economical to develop unlimited production in any one place despite its natural advantages but to make the industry as widespread as possible. In the paragraphs which follow, we describe briefly the layout for a model factory covering a total cultivated area of 100 acres which is, in our opinion, a minimum economic unit for solar works.

1.2 EVAPORATION.—The layout of a salt works depends on the composition of brine and its initial concentration. The composition of sea brine is more or less constant in all places and its density varies from 3 to 3.5° Be'. Before salt starts crystallising out, sea brine has to be reduced to 10 per cent. of its original volume. Table CXLIV shows the reduction in the volume of sea brine on concentration to different densities:

(See Table CXLIV next page)

TABLE CXLIV—REDUCTION IN VOLUME OF SEA BRINE TO DIFFERENT DENSITIES

Deg	Bé	3°9	6	10	15	16	17	18	19	20	21	22	23	24	25	29.5	32	33	34	35	36	38.5	38*	38.3
8.9	100																							
9	62.29	100																						
10	36.72	58.95	100																					
11	33.11	53.15	90.39																					
12	29.50	47.86	80.33																					
13	26.72	42.89	72.76																					
14	24.91	39.99	67.84																					
15	23.11	37.10	62.94	100																				
16	21.81	34.22	58.08	92.06	100																			
17	19.83	31.84	54.01	85.82	93.07	100																		
18	18.52	29.78	50.44	80.15	86.92	93.40	100																	
19	17.37	27.89	47.80	75.15	81.49	87.66	93.76	100																
20	16.39	26.17	44.65	70.92	76.91	82.64	88.49	94.89	100															
21	15.24	24.46	41.50	65.94	71.50	76.78	82.26	87.74	92.96	100														
22	14.26	22.90	38.84	61.67	66.91	71.90	77.00	82.12	87.00	93.58	100													
23	13.44	21.58	36.60	58.16	63.02	67.76	72.56	77.41	82.00	88.20	94.26	100												
24	12.78	20.51	34.81	55.31	59.98	64.45	69.01	73.60	77.98	83.90	89.64	95.10	100											
25	12.18	19.47	33.03	52.48	58.24	61.15	65.48	69.84	73.98	79.60	85.06	90.24	94.86	100										
29.5	1.901	8.052	5.177	8.224	8.921	9.558	10.27	10.95	11.60	12.47	13.33	14.15	14.87	15.88	100									
32	1.426	2.29	3.884	6.170	6.691	7.19	7.69	8.21	8.70	9.36	10.00	10.61	11.15	11.76	75.00	100								
33	1.827	2.13	3.614	5.746	6.232	6.69	7.17	7.65	8.10	8.72	9.31	9.89	10.39	10.95	69.85	93.13	100							
34	1.206	1.933	3.284	5.218	5.658	6.08	6.51	6.94	7.36	7.91	8.40	8.97	9.43	9.94	63.43	84.57	90.80	100						
35	1.088	1.747	2.963	4.709	5.106	5.36	5.88	6.27	6.64	7.14	7.63	8.09	8.51	8.97	57.24	76.32	81.94	90.24	100					
36	0.970	1.557	2.642	4.198	4.552	4.89	5.24	5.59	5.92	6.37	6.80	7.23	7.59	7.99	51.02	68.03	73.65	80.44	89.15	100				
38.5	0.819	1.315	2.230	3.503	3.843	4.13	4.42	4.72	4.90	5.37	5.74	6.09	6.40	6.75	43.68	57.44	61.67	67.92	75.26	84.43	100			
38.0*	0.898	0.681	1.070	1.681	1.844	1.98	2.12	2.26	2.39	2.58	2.76	2.92	3.07	3.24	20.67	27.55	29.59	32.59	36.12	42.52	47.98	100		
38.3	0.082	0.132	0.228	0.361	0.385	0.41	0.44	0.47	0.50	0.54	0.58	0.61	0.64	0.67	4.8	5.75	6.17	6.80	7.50	8.45	10.00	20.86	100	

\* Drop in density on separation of solids.

The horizontal columns in the table indicate the various initial densities of the brine and at the top of each vertical column the initial volume has been given an index figure of 100. The figures below the index figure indicate the corresponding percentage of volume at different stages of evaporation. For example, if we start with a brine at 3.9° Be' and concentrate it, the volume would be reduced to 62.29 per cent. at 6° Bé, 24.91 per cent. at 14° Bé, 12.78 per cent. at 24° Be', 1.901 per cent. at 29.5 Be', 0.970 per cent. at 36° Bé and 0.819 per cent. at 38.5° Bé. The last concentration is, however seldom reached by mere solar evaporation. Similarly a brine of 18° Be' will be reduced to 93.76 per cent. when the density rises to 19° Be', 10.27 per cent. at 29.5° Bé, 5.24 per cent. at 36° Bé and 4.42 per cent. at 38.5° Bé. The table is thus useful in determining the relative reduction in volume of any given density of brine during the stages of concentration. The table can also be used backwards to find out the corresponding volume at lower densities. For instance, to work out the corresponding volume at 10° Be' of say 100 volumes of brine at 18° Be', the vertical column corresponding to 10° Be' should be referred to. It will be seen that 100 volumes of brine at 10° Be' is reduced to 50.44 volumes at 18° Be'; in other words 100 volumes of 18° Be' brine would have been obtained from  $\frac{100 \times 100}{50.44} = 198.25$  volumes of 10° Be' brine.

1.2.1 One feature in the Table deserves special explanation. As it deals with the evaporation of sea brine, which has a number of salts dissolved in it, every separation of the solid effects a change in density. Each one of these solids has its own point of saturation at which it begins to separate out from the brine. At certain critical stages, the separation of the solids actually lowers the density; this is particularly noticeable at 38.5° Be' when the separation of salts is so high that the density is gradually brought down to 36° Be'. On subsequent evaporation, the density again rises to 38.3° Be' at which stage the volume of the brine is only 0.082 per cent of the original.

1.3 COMPONENTS OF THE FACTORY.—The layout is designed for a model factory producing (a) gypsum, (b) common salt, (c) crude salt (for subsequent purification or recharging into the cycle of operations) and (d) mixed salts of potassium and magnesium. The components of the factory are (i) reservoirs, (ii) condensers, (iii) slush washing pans, (iv) common salt crystallisers, (v) crude salt crystallisers, (vi) mixed salt crystallisers (vii) channels and (viii) ridges, pathways, storage yards etc. It may not be possible in all factories to undertake the production of mixed salts in which case, the bitters left, after the recovery of crude salt, could be discharged as waste material and the area earmarked for the mixed salt may be redistributed according to the needs of the rest of the production.

1.3.1 *Reservoirs*—For a factory of 100 acres, the reservoirs should cover an area of 36 acres and wherever possible should be filled with sea brine by tidal inflow. The reservoir serves three important functions (a) the sedimentation of suspended impurities, (b) concentration of the brine in the initial stage and (c) storage of the brine. The average depth of brine in the reservoir should be about 18 inches which would give a total volume of  $36 \times \frac{18}{12} \times 43560 \times 6.25 = 1,47,01,500$  gallons where

Area	=	36 acres
Average depth of brine	=	18 inches
One acre	=	43,560 sq. ft.
One cubic ft.	=	6.25 gallons.

For ready reckoning the volume impounded may be taken as 1,44,00,000 gallons or 4,00,000 gallons per acre. Assuming an average evaporation of 0.25 inch per day, the daily evaporation will come to 2,00,000 gallons for an area of 36 acres. Using this data, we can calculate the rise in the density of the brine in the reservoir, during storage of one month, which is the probable period required for preparing condensers, crystallisers, etc. at the commencement of the

manufacturing season. The total evaporation in a month will, therefore, be 60,00,000 gallons. In addition, there is a loss by percolation of 1,50,000 gallons per day (assumed at 1 per cent of the total volume impounded). If the depth in the reservoir is kept constant at 18 inches by replenishing the brine periodically the density of the brine in the reservoir at the end of the month will be about 5° Be'; if however, the reservoir is not replenished, the density will rise considerably higher. A greater rise in the density can be secured by reducing the depth of the charge, but in no case should it be allowed to exceed 10° Be'. If the daily discharge into the condensers is 2,50,000 gallons, the density in the reservoir can be maintained at 5° to 6° Be'. Once the regular charging of the condensers has commenced, the quantity of brine to be replenished daily in the reservoir will have to be of the order of 6,00,000 gallons (condensers 2,50,000 + evaporation 2,00,000 + percolation 1,50,000). The reduction in volume by evaporation being 2,00,000 gallons or 33·3 per cent, the density in the reservoir will be maintained between 5° and 6° Be'. In the early part of the season, the density may tend to go lower, but as the season progresses, the rate of evaporation will be higher. The figures we have given are, therefore, based on average conditions.

1.3.2 *Condensers*—The brine should be transferred to the condensers as far as possible by gravity, but if this is not possible a pump should be installed. Manual labour may have been cheap in the past for the lifting of brine, but mechanical devices are now cheaper and should be preferred. As the reservoir will deliver 2,50,000 gallons a day or 173 gallons per minute, a pump with a delivery load of about 550 gallons per minute (or 2 pumps each of 275 gallons) working 8 hours a day should suffice. To raise the density of brine of 5° to 6° Be' to 22° to 23° Be', it has to be evaporated down to about 20 per cent. of its volume. This has to be done in three stages. In the first stage, the brine is evaporated to 10° Be'; in the second to 14° Be' and in the third to 23° Be'. The three stages of the condensers should be worked in series. To handle 2,50,000 gallons of incoming brine daily, a total area of 47 acres is required, of which the first stage will occupy 23 acres and the second and third stages 12 acres each. In the first stage 2,50,000 gallons of brine of 5° to 6° Be' is let in daily (173 gallons per minute) to a depth of about 8 inches. Assuming an evaporation of 0·20 inch per day the daily evaporation will be  $23 \times \frac{0.2}{12} \times 43560 \times 6.35 = 104360$  gallons or 72 gallons per minute, leaving a balance of 101 gallons per minute. The volume is reduced to  $\frac{101}{173} \times 100 = 58.34$  per cent which corresponds to a rise in density to 10° Be'. Allowing for a percolation loss of 5 per cent, the outflow to the second stage condenser would be about 96 gallons per minute or 1,38,000 gallons per day. Assuming an evaporation of 0·17 inch per day for brine of this density and calculating in the same manner as above, the daily evaporation will be about 46,300 gallons or 32 gallons per minute. The volume is reduced to  $\frac{64}{96} \times 100 = 66.66$  per cent. which corresponds to a rise in density to 14° Be'. Allowing for percolation loss of 5 per cent, the discharge to the third stage condenser will be 61 gallons per minute or about 88,000 gallons per day. Assuming an evaporation of 0·13 inch only for a brine of 14° Be' the average evaporation per day will be about 43,500 gallons or 30 gallons per minute. The volume is reduced to  $\frac{31}{61} \times 100 = 50.83$  per cent. which corresponds to a rise in density to 23° Be'. After allowing for a percolation of 5 per cent, the crystallisers would receive 29 gallons per minute or 42,000 gallons per day.

1.3.3 *Crystallisers*.—The crystallisers should cover an area of 11 acres. Assuming the rate of evaporation to be about 0·14 inch per day for brine of 23° Be', the average evaporation per day will be about 35,000 gallons. This means a reduction in the volume to about 16 per cent. or a rise in density to 28° to



29° Be'. This density can be reached in the course of a single day only if the daily inflow of 42,000 gallons of 23° Be were to be uniformly distributed to a depth of 0.18 inch over the total crystallising area of 11 acres. In actual practice, however, the crystallising pans should be charged to a minimum depth of 2 inches in which case it would take about 11 days for the density to rise to 29° Be'. At the beginning of the season, the rate of evaporation is lower and the first crop of crystals is not ready for harvesting till 15 days after the initial charging, but as the manufacturing season advances the rate of evaporation increases and the crystallisers are ready for harvesting in a shorter period of six to seven days. The division of the crystalliser area into pans is dependant upon the irrigation system that is to be followed. Where the single irrigation system is adopted, we have recommended in Chapter V paragraph 5.4.1 that the width of the crystallisers should be between 35 to 40 ft. and that the length of the pan may be determined according to local convenience. In the multiple irrigation system, the size can be as large as local conditions will permit. In some of the solar works in America a single crystallising pan measures 10 acres; in India, the largest size we have seen is at Kandla where it is about three-fifth of an acre. For the model factory we do not suggest that the entire 11 acres of the crystallising area should be laid down as a single pan because in that case the lifting of salt would have to be done with the help of a mechanical harvester. As the harvester can complete this work within a few days and would have to remain idle for the rest of the year, the return on its capital investment would not be commensurate with its initial cost. We therefore, recommend that where the multiple irrigation system is adopted in the model factory, the size of the crystallisers should not be less than  $\frac{1}{2}$  and more than 1 acre.

1.3.4 *Crude salt crystallisers.*—In the crystallisers, on an average, about 7,200 gallons of bitterns at 29° Be' will be produced daily. Allowing for percolation loss at 5 per cent., the quantity of bitterns available for charging into the crude salt pans will be about 6,800 gallons per day. The crude salt pans should be located as near the salt crystallisers as possible and the area should be about 0.5 acre. Assuming the rate of evaporation to be about 0.14 inch per day, the average evaporation per day will be about 1,600 gallons which corresponds to a reduction in volume to about 76 per cent. or a rise in density to about 32° Be'.

1.3.5 *Mixed salt crystallisers.*—The bitterns on further concentration by solar evaporation from 32° to 34° Be' will deposit a mixed salt containing potassium and magnesium salts along with some sodium chloride. We see a potentiality of using this mixed salt as a source of potash fertilizer, but for the present we cannot find our way to recommend that this should be attempted in all the model factories as a general routine practice. It has to be determined how far and which magnesium salts will be tolerated in a fertilizer. The composition of the double salts of magnesium and potassium is subject to fluctuations depending upon the composition of the bitterns and the temperatures that prevail at the time of separation. The research stations which we are dealing with in the subsequent paragraphs should be asked to investigate the question of an economic recovery of Epsom Salt and of the potassium salts for use as manures.

1.3.6 *Channels*—During its journey from the reservoir to the condensers it is preferable to send the brine through a winding channel to aid evaporation. The utility of a long channel, as an auxiliary area for accelerated evaporation, is of value only up to the condenser stage. Thereafter, the channels should not be circuitous or lengthy as the advantage gained by securing extra evaporation might be lost owing to leakages. It is desirable that the crystallisers and condensers are in contiguous areas to avoid lengthy channels. Also all feeding channels should be distinct and separate from the discharge channels and there

should be no possibility of using one for the other. The final bitterns, in case they are not otherwise utilised, should be discharged as far as possible directly into the sea so that the magnesium chloride and other salts contained in them get no chance to work their way back into the factory. These bitterns should on no account be discharged into the creek or channel from which supply of initial brine is obtained. As long as these bitterns directly find an outlet into the sea, they would not materially alter the composition of the sea water, but their admixture with the incoming brine at any stage may jeopardise the quality of salt produced in the factory. In factories which may be located at some distance from the sea it would not be economical to carry separate bitterns discharge channels all the way to the sea. In such areas the only solution is to discharge them either into a low lying area at some distance from the factory or into deep pits where they can seep into the subsoil. As most of the factory sites would be subject to flooding during the rains, the bitterns that might remain behind in these sumps would be flushed out by flood waters into the sea.

**1.3.7. Pathways and Ridges.**—Pathways and ridges are an important feature in a well laid out salt factory. The distinction between a ridge and a pathway is that the former serves chiefly as a partition and is provided for dividing large areas into separate compartments or, sometimes, as a diverting barrier to give the flow of brine a circuitous course. The ridges and pathways should be made of consolidated earth and given a slope to correspond to the proper angle of repose of the clay used. Where the compartments are large and where wave action develops the ridges and pathways and more particularly the latter will have to be reinforced by stone pitching at the base to prevent erosion. The ridges should be broad enough to permit people to walk on them for purposes of inspection and repairs; they need not be more than 2½ ft. broad and may be less, depending upon the extent of traffic which they will have to bear. Pathways, on the other hand, besides serving these functions are required for heaping the salt and allowing it to drain before it is transferred to stores. The pathways should be also much broader and not less than four feet in width. Where tracks are laid to convey salt by trollies, the pathways will have to be made proportionately wider. It is also imperative that the surface of the pathways should be properly consolidated so that the heaped salt does not pick up clay from it. An area of 5.5 acres hitherto unassigned should be sufficient for providing the channels, ridges, pathways embankments, etc., and should also accommodate the storage yard, a small laboratory and an office.

**1.3.8** To summarise, the areas of the components of the Model Factory will be as follows:

	Acres
(a) Reservoir . . . . .	36.0
(b) First stage condenser . . . . .	23.0
(c) Second stage condenser . . . . .	12.0
(d) Third stage condenser . . . . .	12.0
(e) Common salt crystalliser . . . . .	11.0
(f) Crude salt crystalliser . . . . .	0.5
(g) Channels, pathways, ridges embankments . . . . .	2.0
(h) Storage yards, office laboratory, etc. . . . .	3.5
	100.0

The relative areas of the reservoir, condensers and crystallisers are based on the assumption that sea brine with a density of 3° to 3.5° Be' will be used. If, however, brine of higher initial concentration is available, suitable alteration in these areas should be made to suit the concentration. It should also

impermeability and the intensity and direction of the prevailing winds for the orientation of the crystallisers and condensers. In Figure 9 we give an illustrative model layout for the factory. Figure 10 indicates some details of the layout of the condensers and crystallisers and the relative position of the channels, pathways and ridges. As the layout of a factory will depend upon the contours of the land where it is to be located the diagrams are merely illustrative and not intended to be a scale plan of the layout. The relative areas for the different components should be adhered to without any change though the orientation may have to be adopted to suit the site. It should however be emphasised that the changes in the rate of evaporation as the season advances will not necessitate any alteration to be made in the relative areas of reservoirs, condensers and crystallisers.

FIG. 9—PLAN SHOWING LAY OUT OF MODEL FACTORY.

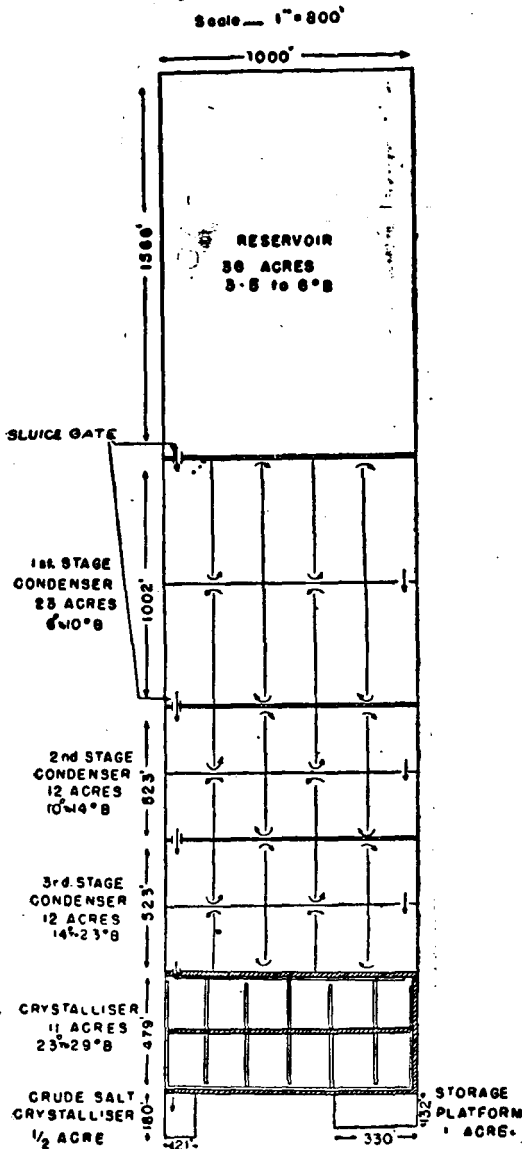
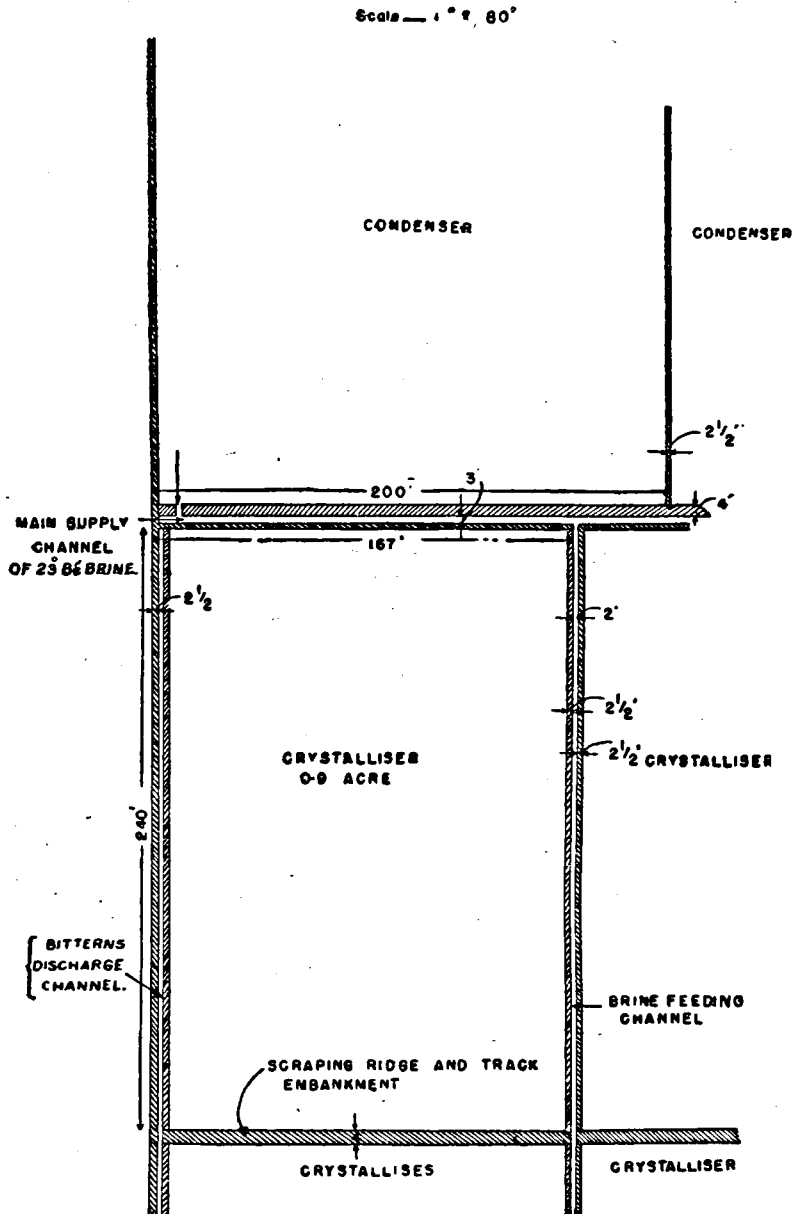


FIG. 10.— PLAN SHOWING DETAILS OF CONDENSERS &amp; CRYSTALLISERS.



1.4 CONTROL OF OPERATION.—If the model factory is to serve as a model it should be so both in its layout as also its method of operation. We discuss below some of the more important practices that should be adopted in the different components of the model factory for securing efficiency and good quality of salt.

1.4.1 *Reservoir and condensers.*—The reservoir should be filled with brine early in the season and used for concentration during the period the condensers and crystallisers are being repaired and got ready for operation. In the reservoir nothing that is of economic value separates out and it requires little

attention beyond ensuring that there is no leakage of brine. In laying out the condensers, it is usual to allow the brine to follow the natural undulations of the ground so that it spreads over the whole area in the form of a sheet not exceeding 8 inches. Any unevenness in the ground should be levelled out in order that isolated puddles of brine may be avoided. The process of levelling is an expensive item of initial cost but it has to be incurred. As the condensers occupy a large area, it is usual to break them up into small sections by ridges in order to make the brine flow gently in a zigzag manner and to ensure a uniform evaporation over the entire area. In the first stage condenser, the calcium carbonate contained in the sea brine gets deposited and some of the organic matter also settles out as slime. These are of no economic value but they help in making the floor of the condenser impervious. In the second stage, the algae die out and settle in the form of a red organic sediment. In the third stage 85 per cent. of the calcium sulphate contained in the sea water gets deposited in the form of needle like crystals of gypsum. The third stage condenser should be therefore, prepared with greater care than the first or second stages and its floor should be tamped thoroughly because it holds a high density brine on which much time and labour has been spent and because the bulk of the gypsum separates out in it. Since gypsum is not lifted except towards the close of the manufacturing season, the condenser bed, unlike the crystalliser, does not require any further attention during the season. In new works, the first year's crop of gypsum should not be harvested. Much of it will have been used up in making the condenser floor impervious and what is left may be allowed to remain on the bed. In subsequent years gypsum should be harvested towards the close of each manufacturing season where the single irrigation system is adopted as, otherwise, it is likely to be washed away during the rains. In areas of scanty rainfall, the lifting of the gypsum may be carried out from the third and succeeding year of manufacture. Only a portion of the condenser need be cut out for this purpose for a few days according to convenience.

1.4.2 *Crystallisers*.—The preparation of the crystalliser bed requires much greater attention than the floor of the condensers. As the crystallisers are charged with high density brine, almost ready for deposition of salt, their floor should be carefully prepared, tamped and hardened. To prevent the development of fissures, the bed should not be allowed to dry up after tamping. For this purpose, the crystallisers should be charged initially with whatever density brine that is readily available, though the subsequent charging should only be with brine of 23° Be'. The depth of charge should be two inches for the single irrigation system while for the multiple system it may be as much as six to eight inches. Whether the crystallisers are designed for the single or multiple irrigation system there should be a gentle gradient in the bed of the crystallisers to permit the bitterns to drain out completely, without leaving behind puddles of mother liquor. A newly laid crystalliser bed is not impervious and it requires two to three years to mature during which period the clay gets saturated with the soluble solids in the brine. Small crystals of these salts get formed in the clay and by their interlocking help to make it impermeable in due course. When the bed is disturbed during the season by rainfall or other causes the top surface is partially broken up and gives a slush which is surcharged with sodium chloride. Such slush is too soft to be puddled or tamped; it is often scraped and thrown away, and its sodium chloride content is thus lost. For crystallisers made in sandy soil, plastic clay has to be brought in at some expense and applied to the beds as a top dressing. The loss of this clay and of sodium chloride in the form of slush can be prevented if a small area, called the slush pan, is interposed between the third stage condenser and the crystallisers. This pan need not be tamped and the slush can

be thrown in it for lixiviation with brine from the third stage condenser to recover the sodium chloride and to restore the plastic quality of the clay for use again in the crystallisers. This innovation has been devised and operated in the model salt factory in Travancore and is reported to have given good results. Its use is recommended. Strictly speaking, the slush pan forms a part of the third stage condenser and the area required for it should be taken from the third stage condenser area. Its extent will depend upon local conditions, but it need not be more than half an acre for a model factory of 100 acres. It should be deeper by 4 inches than the condenser or the crystalliser in order that it may provide adequate room for the washing of the slush.

1.4.3 *Harvesting of salt.*—The method of harvesting will vary with the system of irrigation adopted. Where the single irrigation system is preferred the salt can be harvested only by batches, but where the multiple irrigation system (which is a better system to adopt) is followed the salt should not be harvested till a crust of 3 to 4 inches is formed. The common impurities in Indian salt are gypsum, soil picked up at the time of harvesting and magnesium salts. In the model factory, the gypsum will be kept out by charging the crystallisers with only 23° Be' brine. The insoluble impurities of clay and dirt can be prevented if a little care is exercised at the time of lifting the salt. To some extent this contamination is inevitable in the single irrigation system, but even there if the beds are properly prepared and the necessary care taken, a good deal of these impurities would be avoided. The method of scraping the salt as soon as a thin crust is formed is responsible for much of these impurities; if the crust is allowed to grow to a greater thickness this contamination would decrease proportionately. Even where single irrigation system is followed there are parts of the season when continuous fair weather prevails: during these periods the salt should not be scraped and the crust allowed to accrete for two or more charges of brine. The contamination with magnesium salts accrues when the bitterns are not removed regularly. If the bitterns were drained out from the pans when the density rises to 29° Be' and fresh brine of 23° Be' charged again before the scraping of salt, the contamination would be considerably reduced. When a crop has formed, the bitterns should be drained away and brine at 23° Be', which is very near saturation with respect to sodium chloride and which would not dissolve any further quantity of it should be let into the crystallisers. The crystals can then be scraped either immediately or before the density of the brine exceeds 26° Be'. In this manner the crystals of salt get a wash with brine in which the content of magnesium salts is very much lower than that of bitterns at 29° Be'. Moreover, there is one other advantage in this operation. Several crystallisers reach 29° Be' simultaneously and it is not possible to scrape all of them at the same time; while some of them are being scraped, the density in the others will continue to rise and may go up to even 31° or 32° Be' before their turn for scraping comes. By letting out the bitterns at 29° Be' and letting in fresh brine of 23° Be', the density in the crystallisers will not go above 26° Be' during the period between scraping of the first crystalliser and the last crystalliser in the series.

1.4.4 *Laboratory.*—In order to control the production at each stage, as also to see that salt of the required quality is produced it is necessary to attach to the model factory a small laboratory where occasional analyses of brine and regular analyses of different products *viz.* gypsum, common salt, mixed salt, etc. could be carried out as a routine procedure by a competent chemist. The laboratory will have to work in close co-operation with the production side of the factory and should be in a position to guide the manufacturing operations at each stage. The functions of the laboratory are described in greater detail in Chapter XXI on Standardisation and control of quality.

1.4.5 MECHANICAL AIDS.—Simple labour saving devices should be introduced as far as possible. Pumps should be installed for lifting the brine where necessary; transport within the factory should not be done by head loads but by trolleys pulled by locomotives. We are not recommending the installation of a washery, as we are convinced that the salt produced by the method prescribed by us will easily exceed 97 per cent. sodium chloride content and which for some time to come, will more than meet the requirements of edible salt in India. We are also not recommending the installation of a crushing mill, but if it were required for meeting the demand of the market in which the model factory is situated it could be installed without any difficulty.

1.5 YIELD OF SALT.—The yield of salt depends mainly on the number of days in which crystallisation takes place. In a manufacturing season of 8 months, crystallisation can be carried out for at least 6 months, if not more. In dry areas where the manufacturing season lasts for about 10 months, the crystallisation period could even be 9 months. In paragraph 1.3.3 the daily evaporation in the crystallisers is assumed at 35,000 gallons or 24.3 gallons per minute. Theoretically-speaking, 24.3 gallons of brine at 23° contains 72.29 lbs. of sodium chloride as shown in the following formula.

$$24.3 \times 10 \times 1.19 \times \frac{25}{100} = 72.29 \text{ lbs.}$$

where

100

24.3 is the volume in gallons

1.19 is the specific gravity

10 × 1.19 is the weight of 1 gallon in lbs. and

25 is the percentage of salt content of 23° Br' brine.

On this basis the yield of sodium chloride per minute is 72.29 lbs. or 46.5 tons per day from the crystallising area of 11 acres. As however, the yield per acre is generally calculated for the entire area under cultivation, it follows that for an area of 96 acres in the model factory, viz., (reservoir 36, condensers 47, crystallisers 11 and channels, ridges etc. 2) the yield works out to 0.48 ton of sodium chloride per day per acre. Besides sodium chloride, this salt will contain about five per cent. moisture and two per cent. of other impurities. The calculated 0.48 ton of sodium chloride will, therefore, in actual practice, correspond to  $0.48 \times \frac{107}{100} = 0.513$  ton of undried common salt. Provision has however to be made for losses that will occur in the collection and handling of salt. Taking the actual recovery of salt at only 80 per cent., the quantity of salt which would reach the storage will be  $0.513 \times \frac{80}{100} = 0.410$  ton. For lifting season of 180 days the production will be  $0.410 \times 96 \times 180 = 7085$  tons or say 7000 tons. Where the lifting season is less than 180 days the production will be correspondingly lower. These estimates of yield are on the conservative side. The average rate of evaporation in several of the factories in India is likely to be higher than the figures we have adopted for these calculations. The production of 7000 tons that we have indicated is the minimum that should be expected from a model factory situated in an area where fair weather of 8 months and lifting season of 6 months obtain. It is difficult to hazard an opinion, as to whether the yield would vary to any appreciable degree by the method of irrigation adopted. In an experiment which was carried out by the Model Factory in Travancore, it was reported that the yield was not significantly affected by following either of the systems of irrigation. We recommend that a detailed investigation on this question be made at one of the experimental research stations proposed by us, to determine whether the yields vary significantly with either of the systems and if so to find out the optimum conditions of operation.

1.5.1 In the crude salt pans sodium chloride contaminated with magnesium salts will crystallise out. On the assumption that the bitterns contain 16 per cent. sodium chloride, the quantity of sodium chloride that will be deposited will be about 1.4 tons per day. The magnesium salts that will crystallise out will be about 7 to 8 per cent. of the weight of sodium chloride deposited. In addition there will be about 15 per cent. moisture in the salt extracted. The yield of crude salt, therefore, will be about 1.7 tons per day. This crude salt will have to be subjected to washing with a view to removing partially the magnesium salts. This will entail a working loss of about 25 per cent. and the quantity of washed salt that will be available will be about 1.25 tons per day or on a working season of 180 days about 225 tons for the season in addition to 7,000 tons of salt obtained from the salt crystallisers.

1.6 LOCATION.—For a large country like India a single model factory will not be adequate. With varying climatic conditions and the difference in the methods of manufacture adopted, model factories should be established in different producing centres and we recommend that 7 model factories should be located as follows:

Dadar Range (Bombay)	1
Shiroda Range (Bombay Presidency)	1
Travancore	1
Tuticorin (Madras South)	1
Ennore (Madras City)	1
Naupada (Madras North)	1
Astarang (Orissa)	1
	7

Considering the progress that has been made by the producers in Kathiawad and Kutch we have not recommended the establishment of a model factory for this region but the existing factories in this region should be encouraged to exchange information on technical matters and to co-operate with the proposed model factories by giving them the benefit of their experience. The 7 model factories will be all on the sea coast, because of the important part sea salt plays in the total production in the country. The climatic conditions in Bombay, Shiroda, Ennore, Naupada and Astarang are similar; due to the heavier rainfall in these places, these factories will have to work on the single irrigation system. As Tuticorin has conditions similar to those prevailing in Kathiawad and Kutch where the multiple irrigation system has established itself and proved a success, the factories at Tuticorin should be set up to work on the multiple irrigation method. At Travancore the existing model factory should be shifted to a more suitable site and extended to 100 acres as described more fully in the Chapter on Travancore. As Travancore has two manufacturing seasons in the year, the multiple irrigation system should be followed in the longer season and single irrigation system in the shorter. In selecting the locations of these factories we have kept in view the fact that at many of these centres, Government already own salt works which hitherto have been leased to private parties and which should now be taken over by Government and run as model factories. This applies to the three Government owned factories in Bombay (Dadar Range), Shiroda and Tuticorin and Government will not have to incur any large scale capital expenditure on laying them out as model factories; the existing factories will have necessarily to be extended, but this cost will be comparatively small. With regard to the remaining 4 localities, the Government of India might have to take over some of the existing salt works after paying compensation for the cancellation of the unexpired portion of the leases. Alternatively Government may be able to locate them on Government lands suitable for the production of salt.



## 2. Research

2.1 In at least 3 of the model factories, *viz.*, in Bombay, Travancore and Madras, we recommend that research units should also be set up. These units should investigate methods for improving the quality and the yield of salt in the marine salt works as also the recovery of byproducts. They should form a part of the model factory and provision should be made to set aside a small portion not exceeding 5 per cent. of the area under cultivation for field experiments by the research unit. The Government factory in Bombay which Government have agreed to convert into a model factory should have the research unit attached to it. The Travancore University has done a certain amount of work on salt research problems and we, therefore, recommend that the Travancore model factory should have a research unit attached to it in order that it may continue to get the benefit of collaboration from Travancore University. It is important to have a research unit on the East Coast and we have recommended that it should be located at Madras so that it may serve the salt works in the Madras State as also in Orissa. For the research units of Bombay and Madras we should, however, make it clear that they should have freedom to conduct field experiments in any of the model factories in the removal and recovery of sodium sulphate and other salts found in the brine there, should be of a mobile nature capable of transferring their activities from one station to another.

2.2 A separate research station should also be set up at Sambhar. In the Chapter on Sambhar, we have drawn attention to a number of problems of technical nature which call for urgent solution. This research station should, therefore, concern itself in the solution of these problems particularly the removal and recovery of sodium sulphate and other salts from the brine there. This station should also handle the problems arising in the other inland Government salt factories at Didwana, Pachbadra and Kharaghoda.

2.3 Mention has been made in paragraph 8.2 in the Chapter on Sambhar of the interest which the Salt Research Committees of the Council of Scientific and Industrial Research has evinced in investigations on salt and its byproducts. The function of this Committee will be presumably in the field of both fundamental and applied research on salt and its byproducts. There should be no overlapping of effort between the Research Committee and Research units in the model factories. There should be therefore close collaboration between these two agencies. Problems of a fundamental nature which might be met with by the research units could with advantage be transferred to the Research Committee who would be in a position to harness the talent available in the Universities, Research Institutions and the National Laboratories. Similarly, the research units at the model factories should be utilised by the Research Committee for arranging field experiments and large scale trials bearing on the results of these laboratory investigations. In our opinion this collaboration is both necessary and vital in the interest of the Salt industry.

## 3. Management

3.1 The model factories are designed to accelerate the change-over from the present primitive methods of production to a scientific system of manufacture for the production of a better quality of salt at cheaper cost. The cost of installing and operating the model factories should be borne by the Government of India. The production of the factories should bring a fair return on the capital outlay if they are run strictly on commercial lines. Notwithstanding the higher overhead charges that may have to be incurred in running them, it would be possible to show a profit within three years if the methods prescribed by us are followed. These factories should be run under the direct supervision

of the technical staff of the Salt Department and at the factory the staff should consist of one Superintendent, who should be technically qualified (either an Engineer or a Chemist, but preferably a Chemical Engineer), one Chemist, one Foreman or Supervisor, one Accountant and the necessary clerical, skilled and unskilled staff. In course of time we expect that there will be frequent demands on the model factory from the salt factories in the neighbourhood for technical advice and guidance. It will then be necessary to provide an officer with the status of a Deputy Superintendent (Rs. 200—350) at each of the model factories whose main duty will be developmental in character, i.e., to go round the salt works for giving advice in the manufacture of salt and in the relaying of the works.

3.2 In such of the model factories where research stations have been recommended, additional staff will have to be provided. The research staff should be treated as distinct and separate from the general factory staff but should work under the administrative control of the Superintendent of the model factory. So far as the technical work is concerned, their activities should be co-ordinated by the Technical Adviser to the Salt Controller. Since the work at the research stations will be largely of a chemical character, it is necessary that the Superintendents of the model factories should be able to appreciate the character of the work done by the research staff. While the Superintendents are not expected to take active part in carrying out the research programme, they should be kept informed of the work done by the research unit in order to avoid conflict between the manufacturing and the research activities of the factory. We recommend that only one research chemist should be appointed at each research station in the first instance. This chemist may be designated Senior Assistant Chemist and paid a salary on the scale of Rs. 275—650. The minimum qualification for the post should be a First Class M.Sc. degree or Research degree, preference being given to men with experience in research in salt or in Physical Chemistry. As and when the research work develops, Assistant Chemists may be appointed on the scale of Rs. 200—350. For the Assistant Chemist also an M.Sc. or an equivalent degree should be the minimum qualification.

3.2.1 The staff at the research station at Sambhar would have to be on a larger scale than the other three research stations, in view of the manifold problems that await solution in the inland salt works of Rajputana and Khargoda. This research station should be in charge of a Senior Chemist on the scale of Rs. 350—800 and he should be assisted by one Senior Assistant Chemist and one Assistant Chemist on the scales of Rs. 275—650 and Rs. 200—350 respectively.

#### 4. Capital Expenditure

4.1 The capital expenditure on the model factory and research station will vary from factory to factory. When the existing Government-owned factories are to be converted, the capital expenditure will chiefly lie in relaying the works and in fitting up analytical and research laboratories. If the capital cost incurred by private factories in different parts of the country is any criterion, the capital cost of a model factory should not exceed Rs. 1,500 per acre or Rs. 1.5 lakhs per factory. Where a research unit is to be located, the capital cost of the factory may increase to Rs. 2 lakhs. For Sambhar a sum of Rs. 75,000 has been provided for the extension of the existing analytical laboratory building and its equipment. As the research laboratory is proposed to be a distinct and separate unit from the analytical laboratory and as it may be necessary to make pilot plant experiments, the research laboratory at

Sambhar will have to be built and equipped on a larger scale, than those in the model factories. We consider that a minimum sum of Rupees one lakh would be necessary for the Research laboratory at Sambhar.

## 5. Summary of Recommendations

- (a) Owing to the primitive stage of development in the salt industry it is necessary for Government to set up model factories in principal salt producing centres. (1.1)
- (b) A model factory should have an area of 100 acres and should be designed to produce (i) gypsum, (ii) common salt, (iii) crude salt and (iv) mixed salts of potassium and magnesium. (1.3)
- (c) The respective areas of the components of the model factory are
- |   |             |
|---|-------------|
| (i) Reservoirs                                | 36 acres    |
| (ii) Condensers                               | 47 "        |
| (iii) Common salt crystallisers               | 11 "        |
| (iv) Crude salt crystallisers                 | 0.5 "       |
| (v) Channels, pathways, ridges, & embankments | 2 "         |
| (vi) Storage yards, office laboratory etc.    | 3.5 "       |
|   | 100.0 acres |

These relative areas are based on the assumption that sea brine of a density of 3° to 3.5° Be' will be used. If brine of higher initial concentration is available suitable alteration in these areas should be made to suit the concentration. (1.3.8).

- (d) The model factory should be model both in its layout as well as the method of operation. The practices to be adopted in the factory for securing efficiency and good quality of salt are given in paragraphs 1.4.1 to 1.4.5 and they should be followed. (1.4).
- (e) The yield of salt from model factory should be about 7,225 tons (7,000 tons from salt crystallisers + 225 tons from crude salt pans). This yield is from a working season of 180 days of lifting. (1.5 and 1.5.1)
- (f) There should be 7 model factories in India, two in Bombay State, three in Madras State and one each in Travancore and Orissa. (1.6)
- (g) In the 3 model factories of Bombay, Travancore and Madras, research units should also be set up for investigating methods for improving the quality and yield of salt. (2.1)
- (h) A separate research station should also be set up at Sambhar. (2.2)
- (j) The Salt Research Committee of the Council of Scientific and Industrial Research and these research units in the model factories should work in close collaboration with each other, in order that there is no overlapping of work. (2.3)
- (k) The cost of installing and operating the model factories should be borne by the Government of India. (3.1)
- (m) The staff at the model station and for the research units should be as recommended in paragraphs 3.1, 3.2 and 3.2.1
- (n) The capital expenditure of the model factories without research units is estimated at Rs. 1.5 lakhs per factory; with the research units the cost will be Rs. 2 lakhs per factory. The research unit at Sambhar will cost Rs. 1-lakh in addition to the amount of Rs. 75,000 provided in the Chapter on Sambhar for extending the analytical laboratory there. (4.1)

## CHAPTER XXI

### STANDARDIZATION AND CONTROL OF QUALITY

#### 1. Introduction

1.1 When the Committee started its work, no attempt had been made in India to standardise the quality of salt and to lay down specifications for its various grades. Some of the physical characteristics of salt produced in the Government salt works were regulated from time to time by the Salt Department, but no serious attempt was made to regulate the overall quality of production. One of the conditions in the Excise and Modified Excise system of licensing in Madras stipulates that the Salt Department can destroy any salt which on standard prescribed was very low—90 per cent sodium chloride—and there was at no time adequate machinery to enforce this rule systematically. Except under conditions of extraordinary inefficiency it would be difficult to produce solar salt of such low sodium chloride content from sea water without an admixture of a large percentage of insoluble matter. A reference to Chapter XIX Table CXXVI giving the analysis of salt produced in different centres shows that by fixing the limit at 90 per cent. sodium chloride the manufacturers had no incentive to produce salt of better quality.

1.2 We found during our tours that with a few rare exceptions, the manufacturers do not employ a chemist and they have no facilities for getting their product analysed. The only analytical data that they could show related to those samples which had been occasionally collected by the Salt Department and analysed for them by the laboratories of the Central Board of Revenue. No method of collection of the samples was prescribed and, generally only picked samples which appeared on visual examination to be the best were sent for analysis. No record was kept of the particular source in the works from where the samples were drawn and the results of analyses were not communicated to the manufacturers till after the year's operations were over when they could be of little use. The manufacturers themselves, in the absence of technical men on their staff, have no idea as to how the result of analysis should be interpreted and cannot use the results of analyses for keeping a control over the quality of their production.

#### 2. Requirements

2.1 Common salt is essentially sodium chloride and its quality is determined by its sodium chloride content; the higher the percentage the purer the salt. In America and other advanced countries, salt of as high as 99.9 per cent. purity is manufactured and offered for sale. The presence of salts like magnesium chloride, calcium sulphate, sodium sulphate and sodium carbonate is considered undesirable and their traces are at best treated as unavoidable impurities. Magnesium chloride and sulphate being hygroscopic are looked upon as particularly undesirable impurities. To make salt for table use free flowing and to prevent it from caking, magnesium carbonate or calcium phosphate, subject to a limit of 1 per cent. is added to it. The quality of salt depends upon the quality of the brine used and apart from the sodium chloride content it is co-related to its physical characteristics, *viz.*, its colour and particle size. The colour of salt is required to be as white as possible and this is easily achieved when salt is manufactured by artificial evaporators where discolouration by insoluble impurities like clay or dirt does not occur. In the case of solar salt,

the colour can be controlled to a large extent by not disturbing the bed of the crystallisers at the time of scraping and by washing the crystals either in the pans or subsequently in a mechanical washery. The size of the crystals is also controlled in order to suit the requirements of the consumers. For table use, the finer the crystals the better the quality of salt. In artificial evaporation, crystallisation is carefully regulated so that small, uniform size, solid, cubic crystals are obtained. In the solar evaporation process, however, the size of the crystals depends upon the method of collection of crop and is apt to vary considerably. Where the single irrigation system is practised the crystals are generally small but hollow, but under multiple irrigation the crystals are large and compact. To obtain a uniform size, the crystals are sometimes ground by passing them through roller mills and sieving them through sieves of different meshes. When salt is screened, the coarser crystals are purer than the finer ones and by successive grinding and screening the quality of the salt retained on the sieve progressively improves. Rock salt is also crushed and sieved to classify it in respect of its grain size.

2.2 In India, apart from lack of standards, there are peculiar misconceptions about the quality of salt required for various uses. It has been argued that since in many other countries, national standards have not been laid down for common edible salt, there is no need to prescribe any such standard for India. The fact of the matter is that in these countries the standard of common salt is so high that there is no need to prescribe a rigid specification for it. It has been suggested that solar salt is a natural product and does not need to be and cannot be bound by specifications and standards. A plea has been advanced that the common impurities in salt are not harmful and that on the contrary they are essential to the human system and their removal would render the salt unwholesome in the same manner as the removal of vitamins from food materials. The contamination with calcium sulphate which results from carelessness in the proper fractionation of salt during its separation from brine is looked upon as a blessing in disguise under a mistaken notion that it provides calcium for the body.

2.2.1 It is commonly believed that crudest salt that is produced including any salt that gets dirty and becomes too unsightly for sale for human consumption, is good enough for fisheries. In fact the only distinction between edible salt and salt for fisheries is that the latter should be in larger crystals so that it may not dissolve too rapidly and leak out whilst fish are being dried. The presence of magnesium salt is reported to spoil the texture of the fish tissues and therefore should be avoided in the preservation of fish. It is because of the ignorance of this principle, fish cured in India is held to be of poor quality and is consumed only by the poorest people. If salt of good quality and large crystals were used, the preserved fish would not spoil during storage and would fetch a higher price both in the Indian and export markets.

2.2.2 The chemical industries which employ salt as a raw material are in a nascent state in India. Contrary to the belief of the salt manufacturers, salt which is unfit for human consumption is equally unsuitable for most industrial uses. There are several instances to our knowledge where chemical manufacturers are incurring high cost in the purification of the salt used by them to make it suitable for their manufacturing process. In the electrolytic process, the presence of sulphates is a serious drawback, which can be removed only by the addition of barium chloride which is a costly chemical. This adds to the cost of the chemicals produced and it is essential for the country's economy that the industries should obtain salt of good quality. The quality of salt for agricultural purposes has to be determined from entirely different considerations. Insoluble impurities do not render salt unfit for agricultural purposes, but the soluble impurities, particularly magnesium salts should be excluded above a certain percentage.

2.3 In view of the general ignorance about the quality of salt required for different uses we had recommended in our Interim Report that the standardisation of salt be referred to the Indian Standards Institution. This recommendation was readily accepted by Government and a reference was made to the Indian Standards Institution who have formulated a draft specification for edible common salt. Before we consider this draft it would be worth while to examine the standards for edible salt that prevail in different countries and the specifications that have been laid down for salt for different uses. In some of the countries no national specification has been drawn up not because there has been no need for it, but because the average quality of salt is so high that it is not considered necessary to define the minimum purity in the form of a national specification. In U. K. for instance, the quality of salt generally marketed is so high that the British Standards Institution has fixed a specification for dairy salt only.

### 3. Foreign standards and specifications for salt

3.1 The composition of a typical sample of rock salt in England has been given in Table XLIII in the Chapter on Mandi Mines. It should, however, be noticed that this variety of salt, even though it contains 95.6 per cent. sodium chloride, is used as it is for only a limited purpose, such as salt lick for cattle and for the smelting of copper ores. For edible and other purposes such as electrolyses, salting out of soaps, oil refining, dye-stuffs, explosives and butter and margarine industries it is refined either in vacuum evaporators or in grainer pans and the average composition of these two varieties of salt is given in Table CXLV.

TABLE CXLV—COMPOSITION OF EVAPORATED SALT MANUFACTURED IN U.K.  
(Percent. on dry basis)

	Pure Vacuum Salt	Open Pan Salt
Sodium chloride . . . . .	99.930	98.85
Calcium sulphate . . . . .	Trace	0.85
Magnesium sulphate . . . . .	Not specified	Not specified
Magnesium chloride . . . . .	Trace	0.03
Sodium sulphate . . . . .	0.056	0.25
Insolubles . . . . .	Not specified	0.02

3.2 The composition of solar salt manufactured in Utah (U.S.A.) is given in Table CXLVI. This salt is refined by a process of kiln drying and successive grinding and sieving before it is marketed for edible purposes. The composition of refined salt is also shown in the table for purpose of comparison.

TABLE CXLVII—COMPOSITION OF CRUDE AND REFINED SOLAR SALT FROM UTAH (U.S.A.)

	Crude	Refined
Sodium chloride . . . . .	93.86	99.7
Calcium sulphate . . . . .	0.41	0.204
Magnesium sulphate . . . . .	Nil	Nil
Magnesium chloride . . . . .	1.91	0.034
Sodium sulphate . . . . .	3.78	0.055
Insoluble . . . . .	0.04	0.010
	100.00	100.000

3.3 In Tables CXLVII and CXLVIII are given the specifications of Table and Dairy salt as prescribed in some countries. We are also giving in Table CXLIX specifications for salt for specific uses as prescribed in different countries.

TABLE CXLVII—SPECIFICATION FOR TABLE SALT (FOR ALL HOUSEHOLD PURPOSES)  
(Percent. on dry basis)

	U.S.A.	Australia				South Africa
		New South Wales	Victoria	New Zealand		
Sodium chloride (Min.)	97.5	Not specified.	Not specified.	Not specified.		98.4
Calcium sulphate (Max.)	1.4	0.5	0.6	1.4	Calcium (Max.)	0.2
Calcium chloride (Max.)	0.5	0.25	0.25	0.5	Magnesium (Max.) Sulphate (Max.)	0.2
Magnesium chloride (Max.)						0.5
Copper (Max.) . . .	..	..	..	..		0.00025
Lead (Max.) . . .	..	..	..	..		0.002
Arsenic (Max.) . . .	..	..	..	..		0.0001
Fluorine (Max.) . . .	..	..	..	..		0.01
Tin (Max.) . . .	..	..	..	..		0.0285
Insolubles . . .	0.1	..	0.3	0.1		0.5

TABLE CXLVIII—SPECIFICATION FOR DAIRY SALT  
(Percent. on dry basis)

	U.S.A.		U.K.		South Africa
Sodium chloride . . (Min.)	97.5		99.7		98.4
Calcium sulphate . (Max.)	1.4	Calcium		Cal.	0.2
Calcium chloride . . "	0.5	Magnesium Sulphate	0.01	Mag.	0.2
Magnesium chloride . . "			0.03	Sul.	0.5
Iron . . . . . "	..		0.002		0.002
Copper . . . . . "	..		0.0002		0.00025
Arsenic . . . . . "	..		0.0001		0.0001
Lead . . . . . "	..		0.0005		0.002
Fluorine . . . . . "	..		..		0.01
Tin . . . . . "	..		..		0.0285
Insoluble matter. . . "	0.1		0.03		0.05

TABLE CXLIX—SPECIFICATIONS OF SALT FOR SPECIFIC USES  
(Percent. on dry basis)

	Fish Curing (South Africa)	Hide Curing (South Africa)	Industrial (South Africa)	Roads (U.S.A.)
Sodium chloride (Min.) . . .	98·6	92·3	95 to 98·4	98
Calcium (Max.) . . . . .	0·1	0·3	0·2 to 0·65	..
Magnesium " . . . . .	0·1	0·2	0·2 to 0·55	..
Sulphate " . . . . .	..	4·5	0·5 to 3·5	..
Sodium carbonate . . . . .	..	0·08	0·0 to 0·1	..
Iron . . . . .	..	0·01	..	..
Insoluble . . . . .	0·1	0·5	0·05 to 0·3	..

3.4 In addition to the above standards, it would be instructive to review briefly the average compositions of salts used for different purposes in foreign countries. This is shown in Table CL.

TABLE CL—AVERAGE COMPOSITIONS OF SALT FOR DIFFERENT USES  
(Percent. on dry basis)

	Fishery (U.K.)	Fishery and Pickle (U.S.A.)	Electro- lysis (U.S.A.)	Butter (U.S.A.)	Table (U.S.A.)
Sodium chloride . . . . .	99·15	99·5 to 99·7	98·56	99·80	99·70
Calcium sulphate . . . . .	0·55	0·25 to 0·38	0·40	0·13	0·20
Sodium sulphate . . . . .	0·25	0·1 to 0·5	..	0·03	0·06
Magnesium chloride . . . . .	0·03	0·03 to 0·04	..	0·03	0·03
Insolubles . . . . .	0·2	0·02 to 0·04	0·57	0·01	0·01
Unspecified . . . . .	..	..	0·49	..	..
	100·00		100·00	100·00	100·00

These tables will show the importance that is attached to the purity of salt not only for domestic uses but also for industrial purposes. Even for the treatment of road surfaces in U.S.A. the sodium chloride content is fixed at 98 per cent. compared with which, in India some of the manufacturers are reluctant to make salt higher than 90 per cent.

3.5 The draft prepared by the Indian Standards Institution for Edible Common Salt is given in Appendix 'C'. It provides for a minimum sodium chloride content, on moisture free basis of 96 per cent; matter insoluble in water not more than 1 per cent. and matter soluble in water, other than sodium chloride not more than 3 per cent. The specification also lays down some of the physical characteristics of salt, *viz.* colour and visible impurities. The moisture content of the salt has also been specified and a formula proposed for



rebate in price on account of excessive moisture. The draft gives in detail the methods of tests and prescribes how the result of analysis should be reported. It also includes methods of sampling of salt from packages. It will be finalised in the light of comments received during circulation and then issued as a tentative standard for two years.

3.5.1 Even for a tentative standard we consider that the minimum sodium chloride content of 96 per cent. is on the low side and should have been fixed at 95 per cent. Another defect is that no limits are laid down for individual common impurities like magnesium and calcium salts and carbonates and sulphates. No provision has also been made for the drawing of samples from bulk consignments in shiploads and wagonloads. We recommend that the Indian Standards Institution should examine these suggestions and make good the deficiencies in the draft specification before it is adopted. The method of analysis prescribed and the method of calculation enunciated will help to solve many controversies and difficulties which arise when different laboratories estimate the constituents of salt by different methods and estimate the probable composition of salt in terms of components in different ways. It is imperative that analysis of salt should be carried out by the same method in all the laboratories and that the composition should be calculated in the same manner so that the reports made by different laboratories may be directly comparable.

#### 4. Control of Quality

4.1 While standardization is of vital importance in fixing the quality, it is also necessary that the standards fixed are enforced. Unlike other industries, the salt industry in India has always been subject to control by the Governments of the country. As a result of the integration of the former Indian States, all production of salt has come from 1st April, 1950 under the administrative control of the Salt Department and it should be possible for this Department to enforce the prescribed standard and to see that salt falling below it is not allowed to be marketed. The Salt Department should, therefore, arrange to collect systematically samples of salt regularly from the various factories and have them analysed in the Department's laboratories. Salt which is found to be below the standard should either be denatured or destroyed by being thrown back into the condensers so that it should not find its way into the market and be sold as edible salt. In addition to this control we also recommend that edible salt be brought under the provisions of the Food Adulteration Acts of the different States to ensure that the quality of salt does not deteriorate by adulteration on its way to the consumer.

4.2 More important than any of these measures is the quality control that the manufacturers should establish in the method of production. The proper removal of gypsum, appropriate fractionation of salt and a rigid control over regular elimination of bitterns will lead to the production of salt which will in no case fall below 96 per cent. sodium chloride content. For this to be done effectively, it will be necessary to adopt the following routine:

- (a) the density of the brine should be taken daily with the Baume hydrometer at the inlet into the reservoir, the outlet into the condenser, the outlets at the different stages of the condensers and in the crystallising pans;
- (b) brine of 23° Be' fed into the crystallisers should be analysed once a month to ensure that gypsum is being properly eliminated in the condensers. Similarly the bitterns discharged from the crystallisers should be analysed once a month, in factories employing the single irrigation method and at each time of discharge in those employing the multiple irrigation method;

- (c) representative samples of salt should be drawn from the pans during each harvest. For this purpose, double handfuls should be taken from each lot of about 100 mds., mixed and quartered to obtain a representative sample;
- (d) one sample for each lot of about 5,000 mds. should also be drawn from the storage heaps at least once in the year;
- (e) the larger factories should set up their own control laboratories where analyses could be made promptly and action taken to rectify the defects which might be disclosed by the analyses. Small factories which cannot afford to maintain fully equipped laboratories should at least carry out visual rapid tests for assessing the quality of the product. The draft specification prepared by the Indian Standards Institution gives detailed methods of systematic analyses but we would suggest that suitable rapid methods of assay be also developed, after research work if necessary, and made available in the form of a code of practice for the guidance of the salt manufacturers;
- (f) records of densities and analyses should be maintained. The Salt Department should examine how far and to what extent the maintenance of these records can be made obligatory as a condition of the grant of licences.

##### 5. Summary of Recommendations

(a) The minimum sodium chloride content of 96 per cent. proposed in the draft of the Indian Standards Specification for edible salt is on the low side and should be raised to at least 97.5 per cent. Likewise maximum limits should be prescribed for individual common impurities like magnesium and calcium salts and for carbonate and sulphates. A method of drawing samples from bulk consignments should also be provided. The Indian Standards Institution should examine these suggestions and make good the deficiencies in the draft specification before it is adopted. (3.5)

(b) The Salt Department should arrange to collect systematically samples of salt regularly from the various factories and have them analysed. Salt found below the standard should either be denatured or destroyed and its sale as edible salt prevented. The provisions of Food Adulteration Act should be applied to edible salt. (4.1)

(c) The larger factories should set up their own control laboratories and the small manufacturers should at least carry out visual rapid tests for assessing the quality of their product. Suitable rapid methods of assay should be developed after research, if necessary, and made available in the form of a code of practice. (4.2)

(d) Routine records of densities and analyses should be maintained in each factory and the Salt Department should examine how far and to what extent the maintenance of these records can be made obligatory as a condition of the grant of licences. (4.2)

## CHAPTER XXII

### SALT ADMINISTRATION

#### 1. Salt Department

1.1 The Salt Department originally formed a part of the Central Board of Revenue under the Ministry of Finance, but with the abolition of the salt excise duty it was transferred to the Ministry of Industry & Supply and reorganised. The headquarters of the Department is at New Delhi and the Salt Controller is the head of the Department. He is assisted by three Deputy Salt Controllers, one at Bombay, one at Madras and one at New Delhi, and 9 Assistant Salt Controllers with a number of Superintendents, Circle Officers, etc. The General Manager of the Rajputana Salt Works is also given the status of a Deputy Salt Controller. The organisation of the Department is shown in figure 11.



with technical personnel to give scientific guidance to either the Government-owned or privately-owned salt works. The collection of the cess, which appears to be the principal function of the Department should in our opinion occupy a secondary place in its activities. The principal function of the Department should be to see

- (a) that the country becomes self-sufficient in salt as early as possible;
- (b) that the quality of salt improves from the low figure of 90 to 92 per cent. sodium chloride content to about 96 to 98 per cent. as quickly as possible;
- (c) that technical guidance is given to the manufacturers, particularly the backward manufacturers, in modifying the layout of their works with a view to obtaining a higher yield and a superior quality of salt;
- (d) that the production of salt at the Government salt works is conducted on proper commercial basis;
- (e) that the model salt factories and the research stations when set up, as recommended by us, are conducted efficiently; and
- (f) that salt is distributed economically and equitably throughout the country.

1.3 To perform these functions adequately, the organisation of the Salt Department will have to be modified considerably. Its present character of a collector of revenues be changed to that of a development department. In accordance with the Government of India's Resolution on Industrial Policy of 6th April, 1948, certain basic industries of importance amongst which salt is included, are to be planned and regulated centrally in the national interest. A department which has to implement this policy of Government must have a different orientation from the one which has been handed down to it as a legacy from the days when its chief function was to collect the salt excise duty. The present state of the industry is admittedly unsatisfactory, though it has to be acknowledged that some of the manufacturers have progressed well ahead of even the Government salt works. To set the whole industry on a proper and efficient footing and to bring about a rapid improvement, the Department should progressively improve its personnel so that it could guide the industry and not fall behind its more progressive elements. The recruitment of the technical personnel and their training in the field will take time. We do not suggest that the permanent staff now employed by the Salt Department should be disbanded but that they should be given intensive training so that they may be able to assist in guiding the industry on proper lines. In all future recruitments technical qualifications should be insisted upon so that in course of time, the Department may be able to shoulder its new duties efficiently.

1.4 We recommend that the Salt Department should be reconstituted as under:—

- (a) The head of the Department should be the Salt Controller, who need not necessarily be a technical person, but who nevertheless must have knowledge of the salt industry and its problems.
- (b) The Salt Controller should be assisted by one Technical Adviser and two Deputy Salt Controllers. There should also be a statistical department where statistics of production, cost of manufacture, distribution, prices etc. are regularly collected and maintained.

- (i) The Technical Adviser should be a man of high technical qualifications and should have wide experience and practical knowledge of salt manufacture. The function of the Adviser will be to organise the industry on a rational and scientific basis, and to advise the Salt Controller in regard to the layout of the works, control of quality and all technical matters pertaining to the development of the industry. He must direct all investigations at the research stations and be held responsible for applying the results of his research to the salt factories. A person of high qualifications will be necessary to fill this post and as men of this calibre are very few, the appointment of the Adviser should be made on a contract basis for a period of five years. The Technical Adviser should be subordinate to the Salt Controller but his status should be higher than that of the Deputy Salt Controllers.
- (ii) Of the two Deputy Salt Controllers, one should be in charge of production and the other in charge of distribution. The Deputy Salt Controller (Production) should preferably be a man of technical qualifications with practical experience in the manufacture of salt. His function will be to plan production throughout the country with a view to meeting the demands for all varieties of salt. The Deputy Salt Controller (Distribution) need not necessarily be technically qualified, but should possess administrative experience. He should plan the transport of salt so that long haulage, delays in transit, cross movements and high cost of transportation are avoided and the salt produced in different parts of the country reaches the consumer at economic rates. The two Deputy Salt Controllers should work in close collaboration with each other and it would be the function of the Salt Controller to co-ordinate their activities.
- c) The posts of the Deputy Salt Controllers at present held in Bombay and Madras should be changed to that of Regional Salt Controllers; an additional Regional Salt Controller should be posted at Calcutta. The three Regional Controllers will work under the direction of the Deputy Salt Controllers and deal with both production and distribution of salt within their jurisdiction. The Regional Salt Controller at Bombay will have jurisdiction over the salt works in Bombay Province, Kathiawad, Kutch and the two model salt factories proposed for Bombay. The Regional Salt Controller at Madras will have jurisdiction over the salt works in Travancore and in the Madras State, excluding the Circles of Naupada and Pennuguduru. He will also have jurisdiction over the three model factories in this region. The Regional Controller at Calcutta will have jurisdiction over the salt works in Bengal, Orissa and the Naupada and Pennuguduru Circles as also the two model factories in this region.
- d) The Regional Salt Controllers will have under them Assistant Controllers and Circle Officers. The function of the Assistant Controllers will be to supervise the production and distribution of salt in their respective areas and to implement the directive of the Salt Adviser in remodelling the salt works and enforcing standards of quality. The Assistant Controllers should be men of technical experience well versed in the method of manufacture of salt. The Circle Officers should also be men with technical qualifications.

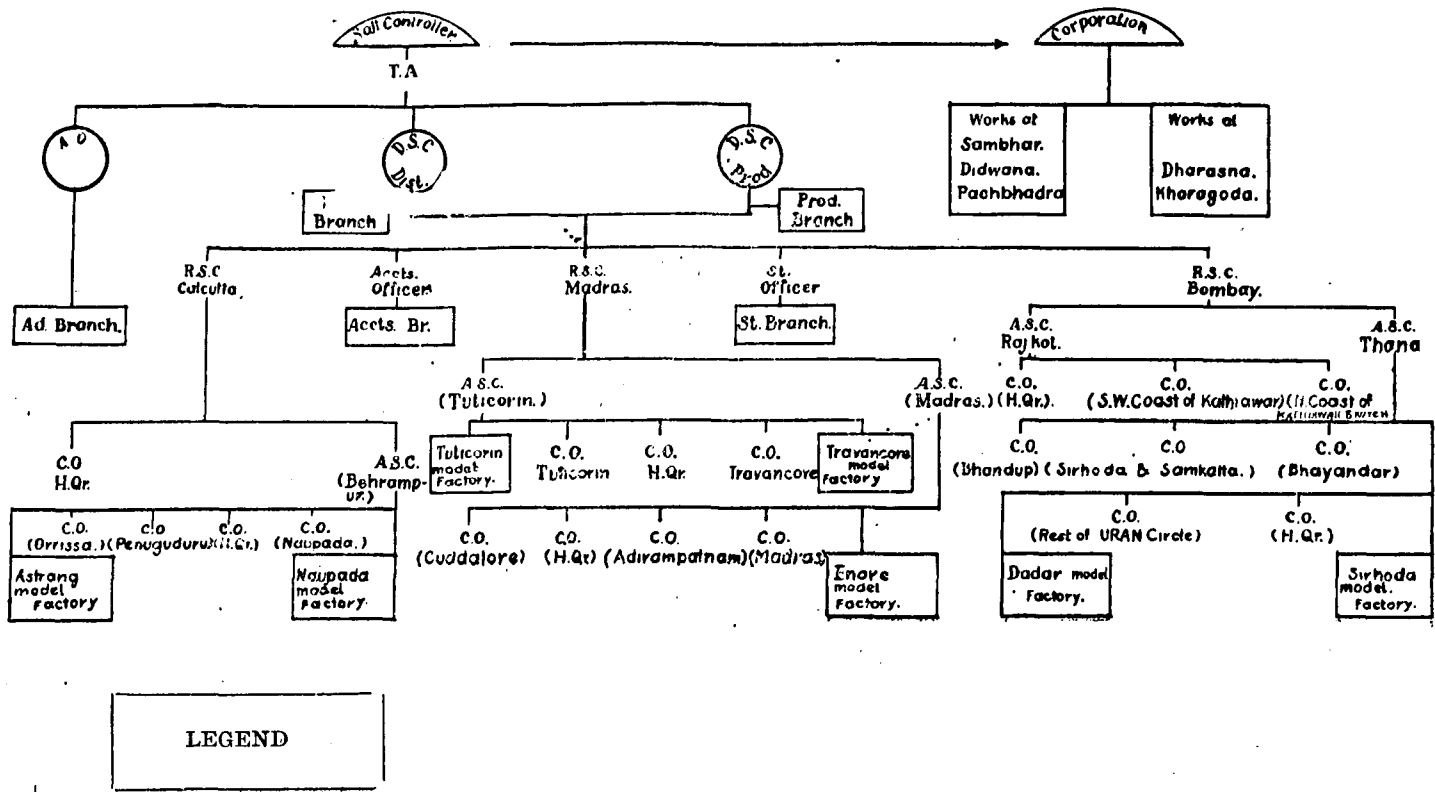
- (i) The Regional Salt Controller of Bombay should have 2 Assistant Salt Controllers :one for Kathiawad and Kutch with headquarters at Rajkot and the other for the rest of the salt works in Bombay with headquarters at Thana. The Assistant Salt Controller at Rajkot should have three Circle Officers under him, one at headquarters, one for Kutch and the northern coast of Kathiawad and one for southern and western coast of Kathiawad. The Assistant Salt Controller at Thana should have five Circle Officers, one at headquarters, one each at Bhyander, Bhandup and Uran and one exclusively for the Shiroda and Sanikatta ranges.
- (ii) The Regional Salt Controller of Madras should also be assisted by two Assistant Salt Controllers, one with headquarters at Tuticorin, for the Travancore and Tuticorin works and the other with headquarters at Madras for the works in the Madras, Cuddalore and Adirampatnam Circles. The Assistant Salt Controller at Tuticorin should be assisted by three Circle Officers, two to be posted at Tuticorin and one in Travancore. The Assistant Salt Controller at Madras should be assisted by four Circle Officers, two at Madras, one in the Cuddalore Circle and one in the Adirampatnam Circle.
- (iii) The Regional Salt Controller at Calcutta should be assisted by one Assistant Salt Controller. As the production in Bengal is extremely small, we are not recommending an additional Assistant Controller for Bengal proper, because the Regional Controller should be able to look after the production of the salt works in Bengal. The Assistant Salt Controller should be stationed in Behrampore and he should have under him four Circle Officers, one at headquarters, one for the Orissa factories and one each for the Naupada and Pennuguduru Circles. There will be also one Circle Officer posted in Calcutta who will assist the Regional Controller on the distribution side. As and when the salt industry develops at Contai, a separate Circle Officer should be provided for this area.
- (e) We are not dealing with the subordinate staff as this will have to be fixed by the Salt Department to suit its requirements. Where the Circles are very large it may be necessary appoint Range Officers for the different ranges, but we do not wish to make any specific recommendations on this question, as their appointment will largely depend upon the extent and number of works in each Circle. For instance, while it may be necessary and advisable to appoint only a Range Officer at Contai under the Circle Officer at Calcutta, it may not be at all necessary to appoint any Range Officer at Kathiawad and Kutch in view of the fact that the works in this area are extensive and compact and could be served by the two Circle Officers.
- (f) There are 198 Inspectors in the Salt Department at present excluding those who have come into the Department as a result of assumption of administrative control over the salt works in the former Indian States. In view of the reorganisation of the Department which we have proposed and the change in the method of collection of cess which we describe in subsequent paragraphs we do not consider it necessary to have such a large band of Inspectors whose major function, at present, appears to be merely the collection of the cess. The function of the Inspectors should be

that of assisting actively the Circle Officers in the production and distribution programme of the Department and the number of Inspectors should be fixed with due regard to the reduction in this work.

- (g) The Salt Department maintains at present a large Watch and Ward staff. We have not been able to secure separate figures of the number employed purely for watch and ward purpose and that employed as peons, etc. in the various offices of the Department. The number of such subordinate staff will depend upon the needs of the Department in the light of our recommendations on Watch and Ward which we make in subsequent paragraphs.
- (h) In Chapter XX we have dealt with the question of the staff to be maintained at the model factories and research stations and they will be additional to the staff recommended in this Chapter. A chart showing the revised personnel of the Salt Department is given in fig. 12.



FIG. 12 PROPOSED SET UP OF SALT DEPARTMENT



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2. Salt Cess.

2.1 A general cess on all salt production excluding that at Kathiawad, Kutch and Mandi was instituted in April, 1947, when the excise duty on salt was abolished. The cess was levied at two rates (a) at Re. 0-3-6 per maund.

on production from all Government-owned salt works (b) at Re. 0-2-0 per maund on the production of all privately-owned salt works. In the Indian States, only Travancore followed the practice of the Government of India and levied a cess of Rs. 0-2-0 per maund. The cess levied by the Salt Department is intended to meet (a) the payment of compensation to the Indian States under treaty obligations and (b) the establishment charges of the Salt Department, including the cost of Watch and Ward staff placed by the Department for guarding private salt works. The higher rate of cess on the production of Government salt works is partly intended to meet the treaty payments to the Indian States and partly to reduce the difference between the selling price of salt from Government factories and private factories.

2.2 The budgetted administrative expenditure of the Salt Department for the year 1949-50 was Rs. 62.63 lakhs and its detailed distribution is shown in Table CLI:

TABLE CLI.—BUDGETTED ADMINISTRATIVE EXPENDITURE OF THE SALT DEPARTMENT, 1949-50

	Rupees in lakhs.
(a) Compensation to Indian States under Treaty obligations . . . . .	23·20
(b) Office of the Salt Controller (Hqrs.) . . . . .	3·92
(c) Regional Offices of the Deputy Salt Controllers and their divisional and Circle Offices . . . . .	10·60
(d) Assistant Salt Controller's office at Calcutta and the Circle Offices under him . . . . .	3·03
(e) Office of the General Manager, Rajputana Salt Works including the Circle Offices . . . . .	8·06
(f) Office of the Assistant Salt Controller, Kharaghoda . . . . .	2·99
(g) Watch & Ward Department & peons . . . . .	10·83
	62·63

Since the administration of the salt works in Travancore, Kathiawad, Kutch and Mandi has been taken over by the Salt Department from 1st April, 1950, the annual expenditure of the Department is likely to be increased by Rs. 2.40 lakhs. The estimated revenue for the year 1949-50 from the cess was Rs. 66.48 lakhs. With the salt works in Travancore, Kathiawad, Kutch and Mandi also paying the cess the total revenue is expected to exceed Rs. 80 lakhs. Since the expenditure under items (e) and (f) of Table CLI was included in the manufacturing cost of the salt produced in the Government works and was recouped from the selling price the Salt Deptt. received from the cess about Rs. 15 lakhs more than its budgetary expenditure in 1949-50. During 1950-51, the surplus will be of the order of Rs. 26 lakhs.

2.3 The cess has been objected to by the salt manufacturers in all the provinces and they would like it to be abolished. Their objections are fourfold. Firstly they do not see any necessity for continuing the Salt Department when the salt excise duty has been abolished. They look upon the supervision of the Salt Department as superfluous and they feel that they do not obtain advantages commensurate with the contribution they make by way of cess. Secondly they do not see the necessity of Government keeping their Watch and Ward personnel which is a relic of the days when the collection and safeguarding of salt duty were the principal functions of the Salt Department. Many of the manufacturers are of the view that this Watch and Ward is unnecessary and uncalled for as they can engage their own watch and ward for the protection of their salt works if and when they find it necessary. Thirdly they complain that a discrimination is being made against them inasmuch as no cess is levied from unlicensed manufacturers who cultivate salt in less than 10 acre plots. Fourthly the levy of a cess is considered as indefensible as

the former levy of excise duty. The industrial consumers of salt have also objected to this cess and have pointed out that industrial salt which was exempt even from salt duty has now been taxed and the cost of an essential raw material has thereby risen.

2.4 Owing to the present backward state of the industry we are convinced that the Salt Department must not only continue, but be improved especially on the technical side, to help the industry, and the cost of the Department must necessarily be borne by the industry. There is, however, no justification for the Government to make a profit out of this cess and the rate of cess can be reduced substantially as indicated below.

2.4.1 At Government salt works, the cess of Re. 0-3-6 per md. is levied to meet a part of the administrative expenditure of the Salt Controller's Headquarters and to recover in full the various forms of payment made to former Indian States under Treaty obligations as compensation for surrendering the right to manufacture salt. This amount for the year 1949-50 was estimated at Rs. 23.20 lakhs as shown in Table CLI. (Item (a)). We have stated in subsequent paragraphs how these treaty payments came to be made and what their present position is. We understand that the continuance of these payments is under review by the Government of India and it is possible that they may cease. Whatever decision might be taken on this issue, we are of opinion that the recovery of these treaty payments by levying a cess on the production at Government salt works is not justified.

2.4.2 We agree with the manufacturers that there is no necessity for maintaining a departmental Watch and Ward staff at their works when salt is no longer subject to excise duty. We recommend that this Watch and Ward staff be withdrawn from the private salt works and that the manufacturers may provide their own Watch and Ward if they so desire. Out of the total expenditure of Rs. 11 lakhs per annum on Watch and Ward and peons we understand that the expenditure on Watch and Ward proper comes to about Rs. 9 lakhs and this would be saved if this recommendation is accepted.

2.4.3 If three items from the budgetary expenditure of the Salt Department are deducted as shown in Table CLII, the resulting expenditure would be reduced to Rs. 19.38 lakhs. Even after providing the anticipated increase in the establishment expenditure as a result of (1) taking over of the salt administration in the former Indian States, and (2) the cost of maintaining the research stations, the total cost is not likely to exceed Rs. 28 lakhs.

TABLE CLII—ANALYSIS OF BONAFIDE EXPENDITURE OF SALT DEPARTMENT  
CHARGEABLE TO CESS

	Rupees in lakhs
Budgetary expenditure (1949-50) . . . . .	62.63
Deduct cost of administration at Government salt works . . . . .	11.05
Deduct Treaty payments . . . . .	51.58
	23.20
	28.38
Deduct cost of Watch and Ward staff for private salt works . . . . .	9.00
	19.38
Add estimated cost of salt administration in the Indian States . . . . .	2.40
	21.78
Add estimated cost of Research Stations (nett expenditure) . . . . .	6.00
	27.78
TOTAL . . . . .	27.78
Say . . . . .	28.00

2.5 The production of salt in India is at present in the neighbourhood of 21 lakh tons (572 lakh maunds) and it is expected to go up during this year to 23.9 lakh tons (650 lakh maunds). Estimating a cess at the rate of only one anna per maund, on the entire Indian production it would yield a sum of Rs. 40.62 lakhs which would more than meet the administrative expenditure of the Salt Department and also provide for a rebate on salt consumed by industries as discussed in the following paragraph.

2.5.1 There is some justification in the grievance of the industrial consumers of salt that the present cess has become a burden to industry and salt has become more expensive than it used to be when it was supplied free of duty. The chief industry where salt is an essential raw material is the heavy chemical industry and the levy of a cess on salt even at a low rate of Re. 0-1-0 per maund would make a significant addition to the manufacturing cost. There may be other industries where salt may form an essential raw material, but the incidence of cess on their costs of production is not likely to be significant. In the paper, dairy, soap, tanning and other such industries the proportion of salt consumed is so small that a cess of Re. 0-1-0 per maund, as recommended by us, would make no material difference to the cost of the final product. We, therefore, recommend that the heavy chemical industry, especially the alkali industry, be allowed a rebate equal to the cess collected on the salt it actually consumes. The requirement of salt by the heavy chemical industry will not exceed for some time to come 3 lakh tons (81.66 lakh maunds) and the refund of cess will amount to Rs. 5.10 lakhs per annum. This will reduce the nett revenue from cess to Rs. 35.52 lakhs as against an estimated administrative expenditure of Rs. 23 lakhs. This still leaves a surplus of about Rs. 7.5 lakhs which should be an adequate safeguard against abnormal fall in production owing to unfavourable climatic conditions. Furthermore, this will serve as a reserve, in case Government decide to give the benefit of rebate of cess on salt consumed by other organised industries. In this estimate we have assumed that there will be no longer any need for imports. At present, the imported salt is exempted from the payment of cess. We recommend that if imports continue, they should be also subjected to the levy of cess. We also recommend that the rate of the cess be reviewed every five years and adjusted so that Government do not suffer any loss nor do they make any substantial profit.

2.6 At present an elaborate staff is maintained for collecting the cess. This is a continuation of the practice when the excise duty at a much higher rate was collected. The cess is now collected whenever salt moves out of a factory which may be daily or even several times in a day. For the low cess we have recommended, we suggested a simplified procedure of collection. Every salt works should be asked (a) to remit the cess due every month or quarter as the case may be, and (b) to file the returns of despatches during the period, together with treasury receipts for payments made on account of the cess. There are at present separate salt treasuries at some places merely for the collection of the cess. If our recommendation for remitting the cess once a quarter is accepted the cess may be paid by the manufacturers directly into the State treasuries and sub-offices and separate salt treasuries may be abolished. The amount of the cess should be entered by manufacturers as a specific item in all invoices relating to the sale of salt and it should also find a specific entry in all their account books. An additional safeguard that may be introduced is that whenever salt is despatched by any public transport such as railways, steamers, etc. it should be made a condition that a *challan*, on an official form, to be supplied by the Salt Department, should be submitted along with the forwarding documents showing the amount of cess due to the

Salt Department on such consignments. The *challan* should be serially numbered and one copy of it should be submitted to the appropriate Circle Officer. In the case of transport of salt by carts or private vehicles a similar *challan* should be submitted to the Circle Officer. This system is not novel. In almost every Province the sales tax is collected in this manner and the dealers are asked to make their remittance and to file their returns. The returns should be checked by the Circle or Range Officers and if any discrepancies are found they should be reconciled. We realise that some evasion may take place in the case of transport by private vehicles, but since the bulk of the salt moves by rail or sea, we do not think that the extent of evasion would be serious. It is always possible, from the statements of quantities of salt produced and the estimated productive capacity of the factory to check any flagrant evasion in the payment of cess. Necessary penal measures for any evasion of the cess may be prescribed in the licence form and flagrant or repeated evasions shall be penalised by the cancellation of the licence. The loss by evasion will be small as compared to the expenditure that would otherwise have to be incurred in continuing the present elaborate system of collecting the cess.

### 3. Treaty Payments to Indian States.

3.1 When the salt duty was in force it yielded a substantial revenue of Rs. 10 crores to the Central Exchequer. It became an established policy of Government to restrict the sources of production to as few centres as possible and to suppress potential sources of manufacture, particularly in Indian States with a view to safeguard the Government's revenue. An annual compensation was, in consequence, given to some of the Indian States in lieu of the privileges which they were thus asked to relinquish. The payment of the compensation was of three categories:

- (a) ground rent for the lease by the Government of India of the salt sources belonging to the States;
- (b) compensation for prohibiting the production of salt and the consequential loss of potential revenue to the State; and
- (c) payments, in lieu of duty, on salt consumed in the State.

The Budget provision for 1949-50 on account of these treaty obligations is shown in Appendix D. It amounted to Rs. 36.95 lakhs of which a sum of Rs. 13.75 lakhs was payable on account of rent and royalty and was included in the cost of production of salt in the Government salt works. The balance of Rs. 23.20 lakhs was met from the cess levied on the sales from Government salt works. We have dealt with the priority of this charge in paragraph 2.4.1. Though the salt duty was abolished in April, 1947, the question of payment of compensation to the States has not reached final solution and the Government of India have continued to pay compensation on the old basis under stand-still agreements. Whilst payment under item (a) will have to be continued those on account of item (b) and (c) have lost their significance with the abolition of the salt duty. The continuation of these payments does not appear to us to be justified.

### 4. Statutory Corporation.

4.1 The Government salt works in Rajputana and Kharaghoda are at present operated by Government under the supervision and control of the Salt Department. The day to day administration of the Rajputana works is entrusted to the General Manager at Sambhar, who holds the status of Deputy Salt Controller, whilst at Kharaghoda this duty is performed by an Assistant Salt Controller. Policy matters regarding production, distribution, prices etc. of salt at these works are determined by the Salt Controller, who also exercises a general supervision. Before the abolition of the salt duty, supervision was

exercised by the Central Board of Revenue whose primary interest was not so much to see to the development and growth of these salt works, but to devise measures for collecting the salt excise duty. In the Chapters on the Rajputana works as also on Kharaghoda, we have commented on the unsatisfactory condition of these works and pointed out the need to incur a substantial capital expenditure on them in the next few years if these works are to be put in a better condition. The manner in which these salt works have been managed by Government is not a recommendation for State control of industry. In our opinion, the management of large works through an administrative office in Delhi is not feasible unless the Salt Controller or a senior officer of the Department devotes his time exclusively to the management of these works. There is also the obvious disadvantage arising out of the fact that ordinary rules of governmental procedure do not always lead to the maximum of efficiency in the conduct of a business concern. Government at present is paying large sums of money under Treaty Rights to the successors of the former Jaipur and Jodhpur durbars for the lease of the salt works of Rajputana. These treaty payments have always acted as a burden on the cost of the salt produced in these works. Moreover, under the agreement, these States gave to the Government of India only the right to manufacture common salt, the by products being specifically excluded from the terms of the lease, their exploitation being left in the hands of the two States. It is undesirable that there should be two separate authorities, one to exercise the right to manufacture salt which is the main product and the other to exploit the by-products.

4.2 Taking all these factors into consideration, we have come to the conclusion that a more satisfactory control and supervision of these works as also their further development could be best achieved if they were entrusted to a Statutory Corporation to be created for this purpose to whom the entire responsibility of production, development and distribution of salt and the by-products should be handed over. This Corporation may be jointly financed or owned by the Governments of India and the Rajasthan Union, the former should have a preponderantly larger share in view of their (a) having invested considerable capital in the Rajputana Works and (b) bringing under the control of the Corporation the works at Kharaghoda and Dharasana in which the Rajasthan Government have no vested interest. We understand that the Government of India have been thinking in the same terms and have had discussions with the Government of Rajasthan Union for the purpose of creating a Statutory Corporation for the Rajputana Works only. We consider that the large Government works at Kharaghoda and Dharasana be also brought under the purview of the same Corporation. According to the agreements at present in vogue a budget provision of Rs. 22.23 lakhs was made for payment under different counts to the Jaipur and Jodhpur States. On the basis of an average production of 4,59,180 tons (1,25,00,000 maunds) of the three Rajasthan Works the incidence of these payments amounts to Rs. 4-13-0 per ton (Re. 0-2-10 per maund) which is excessive. If the Government of Rajasthan is to be a partner in the Statutory Corporation and share in the profits the present agreement should be revised and a further agreement should be entered into under which they should be entitled to receive only ground rent for the salt sources leased out to the Corporation. This ground rent should not be more than 2 pies per maund of salt produced.

4.3 The Corporation should be given the entire assets and liabilities of the existing works and they should (a) work the salt sources for the purpose of manufacture of salt and its by-products, (b) control the sale and distribution of salt and its by-products, (c) expand and develop these works in order to meet the increasing demand for salt in the country, and (d) undertake the

manufacture of other chemicals from salt and its by-products. The Corporation should be managed by a Board of Directors who should consist of representatives of the Governments of India and Rajasthan; a representative from the salt industry should also be appointed to assist the Corporation in the management of these works on a business like basis. The salt produced by the Corporation should be sold at a reasonable margin of profit which may be 10 per cent. of the capital employed in the works after making full provision for the total cost of manufacture including depreciation, interest, overheads, administration and other charges. From the profits, adequate provision should be made for reserves for the future development of the works and the balance of the profits to be shared between the two Governments in the proportion of their shares.

## 5. System of Licensing.

5.1 In what was known as British India the manufacture of salt by any person could only be done under grant of a licence to him by Government. In the Indian States this system was not uniformly followed. In Kathiawad and Kutch, licences were not issued by the State Governments, but a general permit was granted in the form of industrial concessions to certain approved manufacturers; in Travancore, on the other hand, a system of licensing similarly to that in vogue in the Madras Presidency, was followed. In 1948, permission was given to small producers to undertake the manufacture of salt without licence in what is known as 10 acre concession. This is dealt with in detail in paragraph 5.5. From 1st April, 1950, with the assumption by the Government of India of administrative control over salt in all parts of India, the system of licensing will presumably be applied uniformly to all the States.

5.2 Prior to 1920, licences were issued by the Regional Boards of Revenue at Bombay, Madras and Bengal because the collection of the salt duty was entrusted to them. These Boards were not purely provincial, but were regional boards exercising jurisdiction in more than one province. In 1920, salt was declared a Central subject and the Central Board of Revenue gradually took over the control and administration of salt factories throughout the provinces. By 1926, most of the factories had come under the Central Administration, though in Orissa and Bengal, the change was completed only in 1938. As the Regional Boards of Revenue were originally responsible for the grant of licences, conditions in the licences varied from one province to another. Even when the administration was unified under the Central Board of Revenue the original conditions of licence continued to be in force. Even in the same region, different systems of licensing are followed and this is particularly noticeable in the Madras area where three different systems of licensing exist *viz.* (a) the Monopoly system, (b) the Excise system and (c) the Modified Excise system. In Bombay the system prevailing is very similar to the Excise system of Madras. In South Orissa which formerly formed a part of Madras Presidency both the Excise and the Modified Excise systems are in vogue. North Orissa, however, follows a system similar to the Excise system of Madras.

5.2.1 *The Monopoly System.*—According to this system, the manufacturer was given a licence to manufacture salt on the following conditions:

- (a) the quantity of salt to be manufactured (*dittam*) and the price to be paid for it (*kudivaram*) are stipulated annually at the commencement of the manufacturing season, by the Salt Department;
- (b) the licensees have to maintain and repair the salt factories at their own expense and store and deliver all their production as required by the Department;

- (c) the licensee has to manufacture salt of good quality to the satisfaction of the officer in charge of the factory; and
- (d) in case the licensee fails to exercise due diligence in manufacture or commits any default, he may be fined or his licence may be suspended or cancelled.

This system is almost extinct and the only two factories in Madras working under this system, are being shortly brought under the Modified Excise System.

5.2.2 *Excise System.*—In the Excise system the licensees are allowed to manufacture as much salt as they desire and they could also sell it direct to the public after paying the excise duty, subject to the following conditions:

- (a) the licensee has to exercise due diligence in manufacture and to work the factory to its full capacity;
- (b) no salt which is inferior to the standard laid down from time to time by the Department is allowed to be stored. The Department has the power to get any salt analysed and destroy any salt which on analysis is found to fall below the prescribed standard;
- (c) the licensee has to adopt such methods of manufacture and layout as the Department directs and comply with rules in respect of storage and sale of salt;
- (d) the licensee has to maintain the factory as well as the roads, channels, etc. within the limits of the factory in good repair and to the satisfaction of the Department. If he fails to comply with these conditions the necessary repairs can be carried out by the Department at his cost; and
- (e) the licence is liable to be cancelled if no salt is manufactured for two successive manufacturing seasons.

5.2.3 *The Modified Excise System.*—The Modified Excise system was brought into force only in 1926. Its terms are similar to the Excise System, but an additional stipulation has been introduced by which the Salt Department is entitled to a lien on a percentage of salt produced by the licensee upto a maximum of 50 per cent. The licensee has to keep in reserve, at the disposal of the Department, this specified percentage and the Department has the option to purchase this reserve at such rate as it may decide from time to time.

5.3 The terms of the licence also include comprehensive and rigorous conditions for the collection of salt duty and the Department's main function was that of policing the salt works rather than helping the industry. In Appendix 'E' we attach a comparative statement showing the conditions of licences in Bombay, Madras, Orissa, Bengal and Travancore. Since the Excise duty has been removed many of the conditions of these licences are out of date and need to be revised and simplified. The functions of the Salt Department now should be one of rendering guidance and assistance to the industry in improving the quality of salt and increasing its output. We recommend that the terms of the licence be made uniform in all areas and they should conform to the following:—

- (a) the licence should be given for a period of 20 or 25 years;
- (b) there should be no restriction on the quantity of salt to be manufactured or the working period of a factory during the year;
- (c) the licence should specify the relative areas to be reserved for reservoirs, condensers and crystallisers; proper channels for the inlet of the brine and the outlet of the bitterns should be provided. These should be on the lines of the recommendations made by us in the Chapter on Model Factories and Research Stations. We look upon this as the most important condition for obtaining the yield and quality of salt:



- (d) in the crystallisers the brine should not be allowed to go above 29.5° Be' and the bitterns should be discharged regularly. The bitterns should be so discharged that they do not contaminate the incoming brine nor do they get back into the works. Where crude salt is also manufactured, the bitterns from the crude salt crystallisers should be discharged at 32° Be';
- (e) the minimum quality of the salt should be specified in the licence. This refers to the sodium chloride content on a dry basis and which is at present fixed at 92 per cent. As it is intended to improve the quality to 96 per cent. and above over a period of years, the minimum sodium chloride content specified in the licence should be progressively increased;
- (f) if salt of a specified quality is not manufactured Government should have the right to direct that such salt should not be sold for edible consumption and it should be sold only after being suitably denatured;
- (g) the recovery of gypsum should also be made a condition of the licence, but no royalty need be charged on it;
- (h) in case of recovery of other by-products, clauses in the licence should be incorporated for their manufacture and a royalty should be levied at the rate not exceeding 2½ per cent. of the ex-works selling price of these by-products;
- (j) in the interest of maintaining the quality of salt produced, the Salt Department should reserve the right after due notice to the licensee to carry out such maintenance and repairs to the works at the cost of the licensee in the event of his failure to perform these obligations;
- (k) the licence should prescribe the returns that the licensee should submit. These returns should contain information on (i) the density of brine charged into the condensers and crystallisers, (ii) the date of commencement of various operations including the harvesting of salt, (iii) production and sales and (iv) cost of manufacture;
- (l) provision should be made for penalty or cancellation of the licence (i) if the licensee fails to manufacture salt for two consecutive seasons, (ii) for non-payment of dues and (iii) for persistent default in the fulfilment of the condition of the licence.

5.4 The lands on which salt is cultivated can be divided into four categories:

- (a) where the lands are owned by the salt works;
- (b) where the lands belonging to the Government, either Central or Provincial, are leased out to parties for laying out salt works;
- (c) where the lands and the salt works are owned by Government themselves and either operated by Government or given out on lease of short or long duration to private manufacturers. In many instances, the owners of private works also do not manufacture salt, but farm them out to one or more lessees on payment of an annual rent;
- (d) where the Government of India have taken on lease lands from Indian States for establishing Government salt works.

5.4.1 *Lease of Government Lands.*—When lands belonging to either the Central or Provincial Government are leased out for salt manufacture, the terms of the lease vary from region to region. Even in the same region there is difference in the terms fixed by the Central Government and those

by the Provincial Government. In Bombay, for instance, the Provincial Government has leased out the lands on a long tenure of 99 years. Whilst in Madras, the Central Government lease out their lands for periods varying from 5 to 25 years. The rate of ground rent also varies from place to place. We consider that in the interest of the industry as a whole it would be advisable to have a uniform procedure both with regard to the duration of the lease and the ground rent charged. We recommend that the lease be given for renewable periods of 25 years and the ground rent be collected on the outturn at the rate of Re. 0-4-6 per ton (2 pies a maund) or a minimum fixed charge per acre whichever is higher. If the rent is determined as a fixed minimum charge, it should be fixed with due regard to climatic and other factors and particularly the minimum yield per acre that may be expected if the works are operated on right lines. We suggest the following figures to serve as the basis for assessing the minimum yield per acre of cultivated area for the salt producing zones in India:

	Yield per acre	
	Tons	Mds.
(a) Kathiawad and Kutch . . . . .	50	1,360
(b) Bombay . . . . .	27·5	750
(c) Travancore :—		
(i) Sea brine . . . . .	50	1,360
(ii) Tube well brine . . . . .	80	2,180
(d) Madras :—		
(i) Naupada, Pennuguduru, Madras & Cuddalore . . . . .	40	1,090
(ii) Adirampatnam—		
(a) Sea brine . . . . .	50	1,360
(b) Pit brine . . . . .	110	2,990
(iii) Tuticorin . . . . .	150	4,080
(e) Orissa . . . . .	22	600
(f) West Bengal . . . . .	18	500

5.4.2 *Short-term Leases of Salt Works.*—We have come across many instances where salt works belonging to Government and to private parties have been farmed out on short-term leases extending over one to three years. This practice is harmful to the salt industry and should be stopped as early as possible. The present licensing rules provide that salt works cannot be sublet or leased without the permission of the Salt Department, but apparently such permission has been easily forthcoming in the past. Government also have been resorting to this practice. We recommend that the leasing or subletting of salt works on Government lands should not be permitted as a general rule. The lessee has no interest either in maintaining the works or improving them with the result that the works and the quality of salt produced continue to deteriorate. We are suggesting this salutary check to debar the owners from leasing out their works. Under exceptional circumstances, when it becomes necessary for an owner to lease out his works, the Salt Department may, in the interest of continuity of production, give its permission for a limited period after satisfying itself that the new lessee is in a position to manufacture salt and observe all the terms of the licence. On the expiry of this period should the original owner be not in a position to resume manufacture, the Salt Department should consider the possibility of transferring the lease of the lands permanently to a new lessee.

5.5 *CONCESSION TO SMALL PRODUCERS.*—In 1931, under the Gandhi-Irwin Pact, Government had permitted the manufacture and collection of salt, for purpose of local domestic consumption, by villages immediately adjoining areas where salt could be collected or made. Such salt could not be transported except by headloads and could not be sold for purpose of trade outside the village

limit. On 23rd April 1948, about the same time as this Committee was formed, the Government of India issued a Press Note (Appendix F) outlining a new policy for increasing the production of salt by small scale producers. In accordance with this policy individuals or groups were permitted to produce salt freely in any land to which they had lawful access and by whatever process they desired, viz. by either solar evaporation or boiling of brine or scraping or excavation and extraction of saline earth, the only restriction being that the total area of lands which could be so utilised by any individual or group should not be more than 10 acres. Licences under the Central Excise and Salt Act 1944 were dispensed with and this type of production of salt was virtually taken out of the purview of the Salt Department. Government, however, reserved the right to take preventive measures in case the quality of salt produced by these small manufacturers was unwholesome for human consumption.

5.5.1 In the implementing of this policy several anomalies and difficulties were encountered from the very start. As has been stated repeatedly in this report, all the salt producing areas, except Kathiawad and Kutch, have a large number of small licensees who operate areas, even less than one acre. It was, therefore, incongruous that while these established manufacturers were expected to take out licences, the new concessionaires were exempted from this obligation. This was a legitimate grievance of the small licensees. There was also the obvious temptation for the new concessionaires to start in the name of several members of the family a series of small salt works each limited to 10 acres, but in the aggregate extending over large areas. These small 10 acre works, individual units merely in name, are in fact large salt works organised and operated with the intention of evading the provisions of the Central Excise and Salt Act. Furthermore, the production in these 10 acre concessions is exempted from the levy of the salt cess and this has given birth to another abuse which could not have been foreseen by Government. Enterprising salt traders began to finance hereditary salt workers to set up these small concession works in contiguous areas in return for the exclusive right to purchase their production and evade payment of the salt cess. To minimise these abuses, the Salt Department had to issue a clarification in February, 1949, that if more than one concession works were grouped in a particular area and their total acreage exceeded 10 acres such works would be treated as a factory and they would be required to take out licences and be subjected to all the regulations governing the licensed factories.

5.5.2 We have had occasions, during our tours, to visit some of these small concessions, particularly in the Madras Presidency and it confirmed our misgivings of Government's policy in attempting to increase the production of salt by means which are open to abuse and which are bound to lead to a deterioration in the quality of salt. Even in the licensed factories we have repeatedly referred to the small size of a large number of holdings which are being fragmented still further. These small holdings are incapable of producing salt either economically or of a good quality. It is inherent in the nature of things that for the production of salt by solar evaporation large areas must be set apart to achieve efficient operation. In small works of 10 acres and less it is not possible to produce good quality salt at an economic cost. If a 10 acre works is to produce good quality salt, it should reserve about 1½ acres under crystallisers. From such a small area, the production, even under the most ideal conditions, would be subject to many fluctuations and would be so small as to render the enterprise uneconomic and wasteful of both solar and human energy. We fully appreciate the historical background that led to the formulation of this policy, but the economics of salt production call for consolidation of

holdings rather than their fragmentation and in any effort to encourage hereditary labourers to become producers of salt, the economies inherent in the manufacturing process should be kept in view. We have, therefore, no hesitation in recommending that the policy of Government should be modified and these concessionaires should be asked to form themselves into co-operative societies so that they may group together into economic units of a minimum of 100 acres or more. If there is to be a proper control over the quality of salt produced in these concessions—and Government have already safeguarded themselves in the notification of 23rd April 1948—they should be brought under the system of licencing. Government can adopt a liberal attitude in regard to the issue of such licences. Unless such a control is exercised over all the salt produced in the country, measures calculated to improve the yield and quality of salt in the factory areas will be sabotaged and will only lead to a systematic evasion of the intentions of Government.

5.6 Manufacture of salt at present is regulated under the Central Excise and Salt Act 1944, which brought up-to-date and unified the previous provincial legislations for the control of manufacture of salt. As has been pointed out in several places, all previous legislation and orders were biased in favour of safeguarding the salt duty. With the abolition of duty, salt has been taken away from the jurisdiction of the Central Board of Revenue and brought under the Ministry of Industry & Supply because salt is now rightly looked upon as an important basic industry for the country. The present needs of the salt industry, however, require a fresh legislation not based on the penal and revenue aspects but on the development aspect. To exercise a better control on the production and quality of salt and to make the procedure uniform in all areas, we recommend that salt be removed from the operations of the present Central Excise and Salt Act and brought under the legislation proposed for the regulation of industries.

## 6. Salt Advisory Committee.

6.1 We had recommended in our Interim Report that Government should take the industry into its confidence and set up a Standing Advisory Committee on Salt consisting of representatives of the Government of India (from the Ministries of Industry & Supply, Commerce and Transport), manufacturers, consumers and also of importers, if Government so desired. This Committee should meet periodically and advise Government on all questions dealing with (a) production in the country, (b) distribution, (c) imports and (d) exports, if any. Periodical meetings of such a Committee would, in our opinion, enable Government to review in consultation with all interests concerned

- (a) the position of supply and demand in the country;
- (b) the regulation of imports of foreign salt and
- (c) the steps to be taken to increase production with a view to attaining
  - (i) self-sufficiency and
  - (ii) surplus in production to permit exports.

With such an Advisory Committee, coming into existence, the manufacturers would be able to know in advance the quantity of salt to produce each year and plan their programme accordingly. At the same time Government would be able to draw up their programme of imports of foreign salt to meet deficits in supply, if any, in consultation with the manufacturers. Such a Committee could also discuss the question of the quality of salt produced and by friendly discussion and persuasion bring about a change in the mentality of some of the manufacturers who still persist in manufacturing salt of inferior quality. The presence of consumers' representative would safeguard the interest of the common man which must be paramount in this as in any other industry and

would ensure that no attempt was being made by the manufacturers and the salt trade to create scarcity conditions in order to push up the price of salt. The Advisory Committee could with profit review the prices charged at different manufacturing centres and its relation to the selling price in different parts of the country. It is not possible to delineate all the functions of a Committee of this character and how it can most profitably serve the purpose for which it is constituted. It will not always be possible to maintain an even balance between all the interests represented on such a Committee. For obvious reasons the deliberations of the Committee cannot be anything more than recommendatory in character.

6.2 Government have accepted our recommendation and a Salt Advisory Committee has been set up consisting of representatives from the Parliament (representing consumers' interest), manufacturers and importers.

## 7. Manufacturers' Associations.

7.1 The salt manufacturers in different parts of India have formed themselves into local associations to protect their interests. A list of these associations is shown in Appendix 'G'. Whilst it is desirable that the manufacturers should gather together to exchange views for the promotion of the industry and to safeguard their interests it has to be recorded with regret that in many cases these associations have developed a limited and parochial outlook which does not permit them to look at the problem of the industry as a whole on an all-India basis. By forming a number of small local associations they have reduced their utility and importance to speak with authority on behalf of the industry as a whole. If the salt industry in this country is to advance rapidly and a widespread improvement is to be brought about in the present quality of salt, a big responsibility has to be shouldered by the manufacturers in bringing about this change voluntarily and in advance of any control measures that Government might consider necessary. If the industry were to set its house in order it could render more effective service to the country than could be achieved by executive control through governmental agencies. Government also would then be in a better position to ascertain genuine requirements and assist the industry. No attempt has been made to form provincial or regional federation of the local associations, except in Madras where they have federated into one single association, *viz.* the Madras Provincial Salt Industrialists Association. What is, however, required is a federation of an All-India character to which the existing associations would be affiliated and which could speak authoritatively on behalf of the industry as a whole. The formation of such a federation should be welcomed by Government who could then contact the industry through a single representative body instead of their having to deal with a group of associations each holding different views (from the other) and each vying with another for Government's patronage and recognition. We understand that some of the associations have begun to claim an all-India character and have started making efforts to affiliate to themselves other smaller associations. In its very nature, an attempt of this character is likely to meet with failure because the smaller associations would be afraid that by such a merger they would merely liquidate themselves and become subservient to more powerful organisations and interests. This would not serve the purpose that we have in view. What is needed as a first step is a voluntary federation of the small local associations into regional associations. These regional associations should then come together and form an All-India Federation. In order that this may be done, Government might have to take the lead and convene a conference of the salt manufacturers from different parts of India where this suggestion might be discussed and evolved. We commend this suggestion to the attention of the Government and of the salt manufacturers.

## 8. Summary of Recommendations.

(a) The present organisation of the Salt Department should be modified and its present character of a collector of revenues should be changed to that of a development department. (1.3)

(b) The re-constitution of the Department should be as shown in paragraph 1.4. (1.4)

(c) The salt cess should be reduced from its present differential rates to a uniform rate of Re. 0-1-0 per maund and to be levied on the entire Indian salt, if any. (2.5)

(d) The heavy chemical industry especially the alkali industry should be allowed a rebate equal to the cess collected on the salt it actually consumes. (2.5.1)

(e) The present elaborate staff for collecting the salt cess should be discontinued in favour of a simplified procedure of collection as recommended in 2.6. (2.6)

(f) The payments under Treaty Rights to former Indian States as compensation for prohibiting production of salt and in lieu of duty on salt consumed in the States, do not appear to be justified in view of the abolition of the salt duty. (3.1)

(g) (i) The management of Government salt works should be entrusted to a Statutory Corporation in order to obtain satisfactory control and supervision of these works. Such a Corporation should be jointly owned by the Governments of India and Rajasthan Union. (4.2)

(ii) On the creation of the Corporation the present payments made to the Rajasthan Union under Treaty Rights should be revised and a fresh agreement arrived at for the lease of the salt sources to the Corporation. (4.2)

(iii) The Corporation should be managed by a Board of Directors consisting of representatives of the Government of India, the Government of Rajasthan Union and of the salt industry. (4.3)

(h) The present terms under which licences for the manufacture of salt are issued are rigorous and should be revised and simplified. (5.3)

(i) (i) Wherever Government lands are leased out for salt manufacture, a uniform procedure with regard to the duration of the lease and the ground rent to be charged should be adopted. (5.4.1)

(ii) Leasing or subletting of salt works on Government lands should not be permitted as a general rule. (5.4.2)

(k) The policy of Government in giving 10 acre concessions should be modified. The concessions that have already been given should be merged into co-operative societies each having a manufacturing unit of a minimum of 100 acres and should be brought under the system of licensing. (5.6.2)

(l) A Salt Advisory Committee consisting of representatives of the Government of India, the manufacturers, consumers and importers should be set up. (6.1)

(m) The small local associations of manufacturers should be induced to federate into regional associations which could then come together to form an All-India Federation of salt manufacturers. Government might have to take a lead in bringing about this consumation. (7.1)

## CONCLUSION

In conclusion we wish to reiterate our conviction that it is within the reach of the salt industry to meet not only the country's present low requirements of salt but also to attain at the end of the next five years the target of production that we have envisaged. The industry has the means and the resources for substantial development and we see for it a great future. It will be the duty of the Government to extend all facilities to the industry in its development on a regulated and planned basis and to co-ordinate the interests of the manufacturers, the traders and the consumers, as discussed in detail in this report.

P. A. NARIELWALA,  
*Chairman.*

K. L. MOUDGILL,  
*Member.*

M. D. MITHAL,  
*Member.*

SHIV CHARAN DAS,  
*Member.*

B. SHAH,  
*Secretary.*

New Delhi, the 27th April, 1950.

APPENDIX 'A'  
QUESTIONNAIRE

*Factory details—*

1. State the name of your factory and its owners.
2. How long has your factory been in existence?
3. Is your factory on lease to you or worked by you as owners? If on lease, please state the rent you pay and the terms of your lease.
4. Do you operate your factory on a licence? If so, please state the name of the licensing authority, the licence fees paid and the principal terms of the licence including its duration.
5. Please state the amount of capital invested by you at the inception of your works and the present capital. If there is any increase in the capital indicate the reasons.
6. What is the total area of your works in acres? Please give separately the area in acres of year (a) reservoirs, (b) condensers, (c) crystallising beds, (d) platforms, sieving grounds, storage, etc.
7. Please give the size of your crystallising pans in feet and their total number. If the size varies, please mention the variations.
8. Is the floor of your crystallising beds made (a) of natural earth, (b) lined with cement, (c) asphalt lined or (d) treated in any special way?
9. What is the effect of any specially lined crystallisers on (a) quality, (b) quantity of yield?
10. What is the storage capacity of your works? How do you store your salt, in the open or in closed godowns? If stored in open yards, what is the likely loss as a result of washing off by rains?
11. Indicate the source of your brine (*viz.*, sea water, or inland lakes or wells—pits or tube wells) and its density at its intake into reservoirs or condensers.
12. Do you employ any mechanical means in your manufacturing process such as (a) pumps, (b) trolleys, (c) washing plant, (d) crushing plant, (e) any other?
13. Please indicate the capacity of your washing and crushing plants, if any.
14. What steps do you take to protect your works against rains and what preparatory measures have to be employed by you each year before starting manufacture? Please state the amount of money spent by you annually on such preparatory work.

*Methods of Manufacture—*

15. Please describe briefly the method of manufacture employed by you. Do you resort to only solar evaporation or any artificial evaporation at any stage of the process?
16. Have you any meteorological data of (a) rainfall, (b) rate of evaporation, (c) humidity, (d) maximum and minimum temperatures, (e) wind velocity recorded during the different months of the year? If so, give the available information against each year for the last 10 years.
17. What is the duration of your manufacturing season? Please state when you start the works each year and when you stop the operation.
18. What is the time taken for the intake brine to evaporate and deposit its first crystals of salt?
19. How often do you remove salt from pans? State, if possible, the thickness of the salt layer just before it is taken out.
20. Is the salt washed at any stage for removal of impurities? If so, what do you employ, fresh water, sea water or brine?
21. What is the average annual yield of salt in Bengal maunds or tons per acre of crystallising area and per acre of the total works?
22. Mention the different grades of salt manufactured in your works and give their qualities and analyses.
23. Can you improve the quality of your salt so as to conform to 98 per cent. Sodium Chloride on dry basis? If so, what steps would you have to take to bring about this improvement?
24. Do you make any refined or table salt? If so, describe your process and state the quantity manufactured annually during the last ten years.



25. Do you operate any evaporator for production of vacuum salt? If so, please describe briefly your plant, its size and your manufacturing cost of vacuum salt as compared with the cost of solar evaporation. Please also give an analysis of your vacuum salt.

26. How often do you eliminate the bitters? Do you utilize them for the recovery of any by-products?

27. Do you recover any of the following by-products in your works? If so, describe briefly the method employed by you in their manufacture:—

- (a) Gypsum, (b) Bromine, (c) Magnesium sulphate (Epsom salt), (d) Sodium sulphate (glauber salt), (e) Potassium Chloride, (f) Magnesium Chloride.

*Production—*

28. Please give your factory's production of salt, month by month, for the last 10 years.

29. Can you increase your production? If so, how soon and to what extent? What assistance, if any, is required for carrying out this expansion and what do you estimate as the cost of extending your works?

30. State your average cost of production per ton (or per 100 Bengal maunds)—(a) now, (b) during 1935—40, (c) during 1940—45.

31. Please show the break-up of your cost per ton or 100 Bengal maunds under the following heads:—

- (a) cost for obtaining brine into reservoirs,
- (b) labour,
- (c) power and fuel,
- (d) maintenance (including repairs and betterment),
- (e) supervision,
- (f) overheads,
- (g) rents, rates and taxes,
- (h) interest,
- (i) depreciation,
- (j) any other miscellaneous charges.

If you are washing and crushing the salt, please also indicate separately your approximate washing and crushing charges, under the above-mentioned heads.

32. Do you believe that your cost could be reduced by (a) improved method of manufacture, (b) revised lay-out of your works, (c) mechanisation wherever feasible. If so, what is the extent of reduction you anticipate?

33. Please state your annual production in tons of the by-products manufactured by you during the last 10 years.

34. Please give the cost of these by-products individually and under the same heads as shown in question No. 31. [For item (a) show the cost of obtaining bitters into the respective by-product plants.]

*Distribution—*

35. How do you pack your salt, (a) loose or in bags, (b) crushed, or uncrushed? If bagged, please state the different sizes of packing and the nett quantity of salt in each packing in lbs.

36. What are the areas in which you distribute your salt? How far are these areas from your works?

37. How is your salt transported to the markets, by (a) rail, (b) country-craft, (c) steamers or (d) carts? Please state the freight and handling charges borne by you per Bengal maund or ton for the last ten years. How far are your works from the nearest port or railhead?

38. Do you meet with any difficulties with regard to transport of your salt? Are there any Government restrictions in the salt reaching the markets?

39. Describe briefly your organisation for distribution. Do you distribute salt directly to wholesalers or to retailers? Do you prefer distribution through Central or Provincial Government agencies?

40. What is your cost of distribution per Bengal maund or ton?

41. Please indicate the quantity of salt sold by you during the last 10 years and your wholesale selling prices per Bengal maund or ton ex-works during this period.

42. Please give, if possible, the retail prices of your salt during the last 10 years.

43. Do you meet with any competition from imported salt? How do the prices of imported salt compare with those of yours? Do you need any protection,

44. Do you export any salt outside India? If so, give the name of the countries and the amount of salt exported to each country during the last 10 years.

(V.B.—As Pakistan is now a foreign territory, your sales to Pakistan should be shown here.)

45. What steps do you suggest for keeping the price of salt both wholesale and retail at a fair remunerative level?

46. What percentage of profit should in your opinion the manufacturers add to their cost in arriving at a fair selling price?

*Staff and Labour—*

47. Please state the number of persons employed in your works under the following heads :—

- (a) administrative,
- (b) technical—(i) chemists, and (ii) engineers (civil, mechanical or electrical),
- (c) labour—(i) skilled and (ii) unskilled.

48. Is your labour of permanent nature or migratory?

49. Where do you draw your labour from? Is it local or imported?

50. Please state the daily wage you pay your skilled and unskilled labour.

51. Please give your scales of salaries for your administrative and technical staff.

*Technical assistance—*

52. Have you any facilities for carrying out research? If so, have any steps been taken by you so far to improve the method of manufacturing salt?

53. Are you in favour of establishing a central research station and model factories?

54. Have you any suggestions to make regarding the founding of the research stations and model factories. Should there be one or more of each? What would be the most suitable location for those?

55. Are you prepared to make any financial contribution either annually or lump sum towards the founding of central research stations and model factories?

56. Are you in favour of a cess on salt for maintaining such research station and model factories? If so, what in your opinion should be a reasonable cess?

57. Are you agreeable to receive technical assistance to increase the production at your works and improve the quality of your salt? If so, would you be prepared to pay for the technical guidance? State the basis of such payment by you.

*General—*

58. Are you members of any association of manufacturers? If so, state the name of the Association and its functions.

59. Does your association offer any technical assistance in the manufacture of salt?

60. Would you be prepared to operate your works on a co-operative basis by a voluntary merger with neighbouring works in order to improve the yield and quality of salt and lowering the cost of production?

APPENDIX 'B'

1. MUTUAL SOLUBILITIES OF SODIUM CARBONATE ( $\text{Na}_2\text{CO}_3$ ) AND SODIUM CHLORIDE ( $\text{NaCl}$ )  
IN 100 PARTS OF SOLUTION (AQUEOUS) AT DIFFERENT TEMPERATURES

(System  $\text{H}_2\text{O} + \text{NaCl} + \text{Na}_2\text{CO}_3$ )

Solid Phase	Liquid Phase					
	0°C		25°C		35°	
	% $\text{Na}_2\text{CO}_3$	% $\text{NaCl}$	% $\text{Na}_2\text{CO}_3$	% $\text{NaCl}$	% $\text{Na}_2\text{CO}_3$	% $\text{NaCl}$
$\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}$	6.6	0.0	22.7	0.0		
	4.3	4.5	19.6	5.6		
	3.7	8.2	18.8	10.8		
	3.1	12.3				
	2.8	20.2				
$\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}, \text{Na}_2\text{CO}_3, 7\text{H}_2\text{O}$			19.0	11.8		
$\text{Na}_2\text{CO}_3, 7\text{H}_2\text{O}$			18.4	13.0	32.9	0.0
					31.5	2.0
$\text{Na}_2\text{CO}_3, 7\text{H}_2\text{O}, \text{Na}_2\text{CO}_3, \text{H}_2\text{O}$					31.00	2.5
					30.2	2.9
$\text{Na}_2\text{CO}_3, \text{H}_2\text{O}$					16.8	16.1
$\text{Na}_2\text{CO}_3, \text{H}_2\text{O}, \text{NaCl}$						
$\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}, \text{NaCl}$	2.8	24.2				
$\text{NaCl}$	1.1	25.1	7.9	21.3	7.4	21.7
	0.0	26.3	0.0	26.4	4.0	24.0
					0.0	26.6

APPENDIX 'B'(contd.)

2. MUTUAL SOLUBILITIES OF MAGNESIUM CHLORIDE (MgCl<sub>2</sub>) AND SODIUM CHLORIDE (NaCl)  
IN 100 PARTS OF SOLUTION (AQUEOUS) AT DIFFERENT TEMPERATURES.

(System H<sub>2</sub>O + MgCl<sub>2</sub> + NaCl)

Solid Phase	Liquid Phase					
	0°C		25°C		105°C	
	% MgCl <sub>2</sub>	% NaCl	% MgCl <sub>2</sub>	% NaCl	% MgCl <sub>2</sub>	% NaCl
MgCl <sub>2</sub> , 6H <sub>2</sub> O	34.55	..	35.47	..	42.78	..
MgCl <sub>2</sub> , 6H <sub>2</sub> O, NaCl	33.90	0.72	35.80	0.21	42.78	Tr
NaCl	27.95	1.47	29.92	1.12	37.14	0.84
	19.34	6.19	24.40	4.11	34.55	1.10
	15.16	9.77	20.00	6.01	27.82	3.74
	7.48	17.93	16.84	8.79	26.69	4.17
			10.22	15.01	22.51	6.67
			5.95	19.50	13.09	14.44
			2.75	23.24	6.66	21.83
		26.29		26.27	1.66	26.35
						28.29

APPENDIX 'B' (contd.)

3. MUTUAL SOLUBILITIES OF SODIUM CHLORIDE (NaCl) AND POTASSIUM CHLORIDE (KCl)  
IN 100 PARTS OF SOLUTION (AQUEOUS) AT DIFFERENT TEMPERATURES

(System  $H_2O + NaCl + KCl$ )

Solid Phase	Liquid Phase					
	16.03°C		25°C		50°C	
	% KCl	% NaCl	% KCl	% NaCl	% KCl	% NaCl
KCl	25.35	—	26.99	..	30.04	..
			19.29	8.65		
			17.65	10.74		
			15.30	14.12		
KCl + NaCl	9.83	20.40	11.20	20.36	14.59	19.26
NaCl	..	26.32	10.32	20.84	..	26.80
			7.03	22.68		
			3.59	24.53		
				26.49		

APPENDIX 'B' (contd.)

4. MUTUAL SOLUBILITIES OF SODIUM CHLORIDE (NaCl) AND SODIUM SULPHATE (Na<sub>2</sub>SO<sub>4</sub>)  
IN 100 PARTS OF WATER (H<sub>2</sub>O) AT DIFFERENT TEMPERATURES

Temperature Degrees Centigrade	NaCl (in 100 parts of water)	Na <sub>2</sub> SO <sub>4</sub>
10	0.00	9.14
	4.28	6.42
	9.60	4.76
	15.65	3.99
	21.82	3.97
	82.13	4.15
	30.11	4.34
	32.27	4.59
	33.76	4.75
21.5	0.00	21.33
	9.05	15.48
	17.48	13.73
	20.41	13.62
	26.01	15.05
	26.53	14.44
	27.74	13.39
	31.25	10.64
	31.80	10.28
	32.10	8.43
	33.69	4.73
	34.08	2.77
	35.46	0.00
25	0.00	28.74
	2.74	26.57
	8.15	23.15
	19.86	20.52
	24.58	14.86
	31.21	9.95
	32.02	9.61
27	0.00	31.10
	2.66	28.73
	5.20	27.17
	7.90	26.02
	16.13	24.83
	18.91	21.39
	19.64	20.11
	20.77	19.29
	32.33	9.53
30	0.00	39.70
	2.45	38.25
	5.61	36.50
	7.91	35.96
	10.61	31.64
	12.36	29.87
	15.65	25.02
	18.44	21.30
	29.66	19.06
	32.43	9.06

## APPENDIX 'B' (concl'd.)

4. MUTUAL SOLUBILITIES OF SODIUM CHLORIDE (NaCl) AND SODIUM SULFATE ( $\text{Na}_2\text{SO}_4$ )  
IN 100 PARTS OF WATER ( $\text{H}_2\text{O}$ ) AT DIFFERENT TEMPERATURES

Temperature Degrees Centigrade	NaCl (in 100 parts of water)	$\text{Na}_2\text{SO}_4$
33	0.00	48.48
	1.22	46.49
	1.99	43.16
	2.64	44.09
	3.47	42.61
	12.14	29.32
	21.87	16.83
	32.84	8.76
	33.99	4.63
	34.77	2.75
35	0.00	47.94
	2.14	43.75
	13.57	26.26
	18.78	19.74
	31.91	8.28
	35.63	0.00

## DRAFT FOR COMMENTS

## INDIAN STANDARDS INSTITUTION (ISI)

## HEAVY CHEMICALS (INORGANIC) SECTIONAL COMMITTEE (CDC 3)

## TENTATIVE DRAFT INDIAN STANDARD SPECIFICATION

## FOR

## EDIBLE COMMON SALT

## FOREWORD

Common salt is produced in India from different sources and its present output exceeds two million tons. Owing to the diversity of sources and variations in practices of manufacture and storage, the quality of salt has shown undesirable variations.

A request for laying down standards for edible salt was made by the Director of Industries, Bombay. The need for standards was also felt keenly by the Salt Experts Committee, appointed by the Government of India in April 1948, who noted in the course of their visit to the salt works in India that the salt at present produced in some part of the country is of poor quality due to a number of reasons. In the opinion of this Committee the quality of the salt could be improved easily and if some standards were laid down, it would help the progressive manufacturers in improving the quality and output of material produced by them. The Government of India also appreciated this viewpoint and desired that the formulation of specifications for common salt should be expedited.

The standard formulated by the Sectional Committee has prescribed the requirements in such a manner that the clause relating to adjustment of weight due to variations of moisture content would be remunerative to manufacturers of high grade salt and at the same time accommodate the backward sections of the industry for a temporary period. The Sectional Committee desires that this standard should be considered as a tentative standard which would be revised after a period of two years when manufacturing conditions are expected to improve.

The Sectional Committee gratefully acknowledges the assistance derived from the existing literature on the subject supplied by the Central Board of Revenue Control Laboratory, the Council of Scientific & Industrial Research and other organisations.

## 1. SCOPE—

1.1 This standard lays down the requirement for edible common salt used for dietary purposes.

1.2 This standard is intended chiefly to cover the technical provisions relating to the purchase of the material; but it does not include all the necessary provisions of a contract.

## 2. FORM AND CONDITION—

2.1 Common salt shall be a crystalline solid, white or pale pink or light gray in colour, free from visible contamination with clay, grit, and other extraneous adulterants and impurities.

## 3. MOISTURE—

3.1 Unless mutually agreed upon between the purchaser and the vendor common salt shall not contain moisture in excess of six per cent. of the weight of the undried sample when determined according to the method described in Appendix B.

3.1.1 In case of consignments containing moisture in excess of or less than the limit prescribed in 3.1, the weight of common salt to be credited shall be calculated according to the following formula:—

$$N = W (100 - M)$$

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Where—

$M$  = the moisture per cent. in the sample.

$W$  = the weight of the salt delivered.

$N$  = the weight of the salt to be credited.



**4. COMPOSITION—**

4.1 When analysed according to the procedure described in Appendix C, common salt shall conform, on moisture-free basis, to the following composition:—

4.1.1 Sodium Chloride (NaCl) shall be not less than 96 per cent.;

4.1.2 Matter insoluble in water shall be not more than one per cent.;

4.1.3 Matter soluble in water other than sodium chloride shall be not more than 3 per cent.

**5. PACKING—**

5.1 The material shall be supplied in packages mutually agreed upon between the purchaser and the vendor.

**6. SAMPLING—**

6.1 Samples for testing shall be taken in accordance with the provisions of Appendix A.

**APPENDIX A**

(Clause 6)

**SAMPLING OF EDIBLE COMMON SALT****1. SCALE OF SAMPLING—**

1.1 The number of packages selected at random for sampling shall be not less than the cube root of the total number of packages in the lot. For convenience the following table is given showing the number of samples to be selected from various lots:—

No. of packages in consignment	No. of packages selected	No. of packages in consignment	No. of packages selected
2 to 8	2	217 to 343	7
9 to 27	3	344 to 512	8
28 to 64	4	513 to 729	9
65 to 125	5	730 to 1000	10
126 to 216	6	1001 to 1331	11

**2. PROCEDURE—**

2.1 A sufficient number of samples from different parts of each package to give a representative sample not exceeding 1 lb. (or 450 g.) shall be drawn from a number of packages, selected at random.

2.2 For drawing the samples from packages containing the material in a loose condition such as sacks, an auger shall be used as a sampler. The auger shall be introduced into the package from different points with a view to drawing a fully representative sample.

2.3 The composite sample shall be prepared by mixing the representative samples from all packages selected for sampling.

2.4 Three test samples of not less than 1 lb. (or 450 g.) each shall be prepared from the composite sample by coning and quartering and transferring to clean air-tight glass bottles from contamination. The test samples shall be marked with the lot number of the consignment sampled, date of sampling and other particulars.

2.5 One of the test samples bearing the seals of the purchaser and the vendor shall constitute the referee sample in case of dispute between the parties to the contract.

**APPENDIX B**

(Clause 3)

**DETERMINATION OF MOISTURE****1. METHOD—**

1.1 Accurately weigh a dry Erlenmeyer flask about 14 to 15 c.m. high and of about 250 m.l. capacity together with a dry funnel inserted into the neck. Transfer into the flask about 20 g. of salt and spread it so as to form a thin layer at the bottom. Replace

the funnel and again weigh the flask and funnel accurately. Remove the funnel and heat the flask in an air oven at 140° to 150° C for 4 hours, when there should be no water drops on the sides of the flask. Replace the funnel. Cool in a desiccator and weigh. Find out the loss in weight, and express it as percentage of the weight of the undried salt.

## APPENDIX C

(Clause 4)

### ANALYSIS OF EDIBLE COMMON SALT

#### 1. METHOD—

1.1 Examine qualitatively the solution of common salt for the radicals present and estimate quantitatively some or all of them, excepting sodium, depending upon the nature of radicals present. Calculate the percentage of sodium chloride as described in 7.

#### 2. MATTER INSOLUBLE IN WATER—

2.1 *Procedure.*—Accurately weigh 10 g. of the sample, dried as described in Appendix B, and dissolve it in about 250 m.l. of water in a beaker. Filter the solution through a tared filter paper and wash the residue free from soluble salts. Dry the residue at a temperature of 105° to 110° C to constant weight. From the weight of the water insolubles obtained as the difference in the weight of the filter paper, calculate, on a moisture free basis, the percentage of matter insoluble in water.

#### 3. DETERMINATION OF TOTAL CHLORIDE—

##### 3.1 Reagents.

3.1.1 *Standard Silver Nitrate Solution*, approximately 0.1 N.

3.1.2 *Potassium Chromate Solution*, approximately 1 per cent.

##### 3.2. Procedure.

3.2.1 Dissolve about 5.5 g. of the sample, dried previously as described in Appendix B, and accurately weighed, in distilled water. Filter and wash the insoluble residue thoroughly. Make up the filtrate and washings accurately to 1000 m.l.

3.2.2 Pipette out accurately 25 m.l. of the solution of the sample as prepared under 3.2.1 and dilute to about 100 m.l. in a 250 m.l. beaker. Titrate the solution with standard silver nitrate solution using 10 drops of potassium chromate solution as an indicator. From the volume of silver nitrate solution used for the titration, calculate the weight of chloride in 25 m.l. of the sample solution on the basis that 1 m.l. of 0.1 N silver nitrate solution is equivalent to 0.00585 g. of sodium chloride. Find the weight of total chloride in the whole solution and express it as the percentage of chloride in the sample on moisture free basis.

#### 4. DETERMINATION OF SULPHATE (SO<sub>4</sub>)—

##### 4.1 Reagents.

4.1.1 *Barium Chloride Solution*, 10 per cent.

4.1.2 *Dilute Hydrochloric Acid*, 4N.

4.2 *Procedure.*—Pipette out 25 m.l. of the solution of the sample as prepared under 3.2.1 into a 500 m.l. beaker and make up the solution to about 250 m.l. with distilled water. Acidify with dilute hydrochloric acid and boil. Add to the boiling solution a slight excess of barium chloride solution and continue boiling to obtain a granular precipitate of barium sulphate. Let stand for four hours and filter the solution through a tared sintered glass crucible. Wash the precipitate till it is free from chlorides, dry to constant weight at 105° to 110° C.

4.3 *Calculation.*—From the difference in the weights of the crucible calculate the weight of sulphate by multiplying with the factor 4.4115. Express the weight as the percentage of sulphate present in the sample on moisture-free basis.

#### 5. DETERMINATION OF CALCIUM—

##### 5.1 Reagents

5.1.1 *Standard Potassium Permanganate Solution*, approximately 0.1 N.

5.1.2 *Saturated Ammonium Oxalate Solution.*

5.1.3 *Dilute Sulphuric Acid* (1 : 4 by volume)

##### 5.2 Procedure.

5.2.1 Transfer exactly 100 m.l. of the solution prepared under 3.2.1 into a 500 m.l. beaker. Dilute to 250 m.l., add an excess of ammonium chloride solution and boil. Make the boiling solution ammoniacal and add, with stirring, an excess of hot saturated ammonium oxalate solution. Continue boiling till the precipitate becomes granular. Let stand for one hour, filter and wash with hot water. Preserve the filtrate and washings for estimating magnesium, if present, as under 6.

5.2.2 Pierce the apex of the filter paper with a stirring rod and wash the precipitate and the rod into a beaker with hot water. Then wash the filter paper a few times with warm dilute sulphuric acid. Add about 30 m.l. of dilute sulphuric acid to the washings, dilute to about 250 m.l., heat to 60° C and titrate while hot with standard potassium permanganate solution.

5.3 *Calculation*—Calculate the quantity of calcium present on the basis that 1 m.l. of 0.1 N  $\text{KMnO}_4$  solution is equivalent to 0.00204 g. of calcium and express the result as percentage of calcium in the sample.

## 6. DETERMINATION OF MAGNESIUM—

### 6.1 *Reagents.*

6.1.1 *Microcosmic Salt Solution or Disodium Hydrogen Phosphate Solution*, 10 per cent.

6.1.2 *Dilute Ammonium Hydroxide.*

### 6.2 *Procedure.*

6.2.1 Add to the filtrate and washings from 5.2.1 a 10 per cent. solution of microcosmic salt or disodium hydrogen phosphate followed by 50 m.l. of ammonium hydroxide. Stir the solution well and scratch the sides of the beaker with a glass rod. Set the beaker made overnight. Filter through a tared Gooch crucible and wash the precipitate with a dilute solution of ammonia. Dry the precipitate at 100 °C.

6.2.2 Heat the crucible at first over a low flame and then slowly increase the flame and continue till the precipitate is white indicating that the salt has been converted to magnesium pyrophosphate. Cool in a desiccator and weigh.

6.3 *Calculation.*—Calculate the magnesium by multiplying with the factor 0.218 and find the weight of magnesium present in the total weight of the sample taken. Express the result as percentage of magnesium in the sample.

## 7. DETERMINATION OF SOLUBLE CARBONATES—

7.1 *Method.*—If soluble carbonates are present, estimate them volumetrically in the original undried substance.

### 7.2 *Reagents.*

7.2.1 *Standard Sulphuric Acid*, approximately 0.1 N.

7.2.2 *Phenolphthalein Indicator.*

7.2.3 *Methyl Orange Indicator.*

7.3 *Procedure.*—Accurately weigh about 10 g. of the sample and dissolve it in 100 m.l. of freshly boiled and cooled distilled water. Titrate the solution against standard sulphuric acid using methyl orange as indicator.

7.4 *Calculation.*—Calculate the soluble carbonates present in the weight of the sample taken in terms of  $\text{CO}_3$  radical, on the basis that 1 m.l. of 0.1 N sulphuric acid is equivalent to 0.003 g. of carbonate ( $\text{CO}_3$ ). Express the results as percentage.

## 8. CALCULATION OF RESULT—

8.1 Where calcium, magnesium, chloride and sulphate radicals are present, combine all the calcium with the sulphate radical and express the result as percentage of calcium sulphate. If there is excess of the sulphate radical over what is required for calcium, combine the excess with magnesium and express the result, as percentage of magnesium sulphate. If, even after the whole of the magnesium is accounted for as sulphate, there remains some sulphate not accounted for, combine the balance of the sulphate with sodium and express the result as percentage of sodium sulphate. In such a case assume that calcium and magnesium chlorides are absent, and calculate the whole of chlorine as sodium chloride, and express it as percentage.

8.2 If after all the calcium has been accounted for as sulphate, and the balance of the sulphate radical is not sufficient to fix the magnesium, combine it with a part of the magnesium and express as percentage of magnesium sulphate. Calculate the balance of magnesium as magnesium chloride and deduct the chlorine corresponding to it from the chlorine content. Calculate the residual chlorine as sodium chloride.

8.3 If after all the sulphate is accounted for as calcium there is any surplus of calcium, calculate it as calcium chloride and express it as percentage. Express the magnesium also as percentage of magnesium chloride. Deduct the chlorine corresponding to these chlorides from the total chlorine found experimentally, and calculate the residual chlorine as percentage sodium chloride.

8.4 If soluble carbonates are present in the salt, calculate and express as percentage of calcium carbonate. If there is excess of the carbonate over what is required for calcium, combine the balance with magnesium and express as percentage of magnesium carbonate. If there is still a balance left, calculate it as sodium carbonate and express it as a percentage. Carry out the rest of the calculation as described under 8.1, 8.2 and 8.3.

APPENDIX 'D'

*Budgetary provision of payments to Indian States for 1949-50 on account of royalty and compensation*

S. No.	Name of State	Amount provided in 1949-50	Remarks
		Rupees	
1	Alwar . . . . .	88,300	
2	Bharatpur . . . . .	1,50,000	
3	Bikaner . . . . .	10,000	
4	Bombay-Compensation payable to Government . . . . .	36,000	
5	Bombay-Compensation payable to private parties . . . . .	12,000	
6	Bundi . . . . .	8,000	
7	Dewas (Junior) . . . . .	413	
8	Dewas (Senior) . . . . .	412	
9	Datia . . . . .	10,000	
10	Dholpur . . . . .	25,788	
11	French Government in India . . . . .	4,60,000	
12	Gwalior . . . . .	3,12,500	
13	Indore . . . . .	61,875	
14	Jaora . . . . .	2,500	
15	Jhalawar . . . . .	2,500	
16	Jaipur . . . . .	5,38,309	
17	Jodhpur . . . . .	9,61,395	
18	Jaipur & Jodhpur States Royalty payable to . . . . .	7,23,100	
19	Kishangarh . . . . .	25,000	
20	Kotah . . . . .	19,175	
21	Karauli . . . . .	5,695	
22	Lawa . . . . .	750	
23	Madras-Compensation to private parties . . . . .	6,000	
24	Narsingh Garh . . . . .	618	
25	Rajgarh . . . . .	619	

## APPENDIX 'D' (contd.)

S. No.	Name of State	Amount provided in 1949-50	Remarks
26	Ratlam . . . . .	Rupees 1,000	
27	Sitamau . . . . .	2,000	
28	Sailona . . . . .	413	
29	Samthar . . . . .	1,450	
30	Shahpura . . . . .	5,000	
31	Tonk . . . . .	20,000	
32	Udaipur . . . . .	2,04,150	
	Total or say	36,94,962 36,95,000	

APPENDIX 'E'

Comparative Statement of terms and conditions of licence in different States.  
(The relevant number of clauses in the respective licence forms is indicated within brackets)

MADRAS	BOMBAY	ORISSA AND BENGAL	TRAVANCORE
<p><b>I SALT ACT</b></p> <p>(A) The licence is granted subject to the provisions of the Madras Salt Act, 1889, as amended by later Acts and of any rules under that Act which may from time to time be made by the competent authority. (1)</p> <p>(B) The powers conferred on the Collector of Salt Revenue (hereinafter called the Collector) under the conditions that follow may also be exercised by any officer from time to time empowered by him in that behalf. (2)</p>	<p>(A) The licence is granted subject to the provisions of Bombay Act II of 1890 and of any other enactment relating to the salt revenue at the time in force and of any rules or orders duly made and promulgated, or communicated by competent authority under the said Act or any other such enactment as aforesaid relating to the manufacture, storage, removal or sale of salt or to the conservancy or regulation of the land within the limits aforesaid. (9)</p>	<p>(A) The licence is granted subject to the provisions of the Indian Salt Act, 1882 (XII of 1882) and of any rules made thereunder, and all the provisions of the said Act and rules shall be strictly observed by the licensee, his agents and servants. (1)</p>	<p>(A) The licence is granted subject to the provisions of the Travancore Salt Act III of 1088 (Malabar Era), and the licensee shall be bound by all rules which have been passed or which may hereafter be passed under the said Act or under any laws relating to salt revenue which may hereafter be passed. (1)</p> <p>(B) The powers conferred on the excise Commissioner under the conditions prescribed in the licence may also be exercised by any officer empowered by him in that behalf under section 5 of the Act. (2)</p>
<p><b>II STIPULATIONS REGARDING</b></p> <p>(A) The licensee shall engage, in conjunction with the other licensees of the salt factory :</p> <p>(i) to construct and maintain (at his own expense) in good repair and to the satisfaction of the Collector all roads, channels, reservoirs, embankments, drying grounds</p>	<p><b>LAYOUT OF FACTORIES</b></p> <p>(A) The licensee shall not make any alteration in the disposition (as it exists, if the land is already under salt manufacture, or as it may be finally settled before commencement of manufacture) of the land within the aforesaid limits by forming new pans, or enlarging or altering existing pans, or in any other</p>	<p>(A) The number of boilers or solar evaporating pans specified in the schedule shall not be altered or the locality of the factory changed without the written sanction of the Collector, (For <i>punga</i> process only). (2)</p> <p>(B) (i) The licensee shall construct and maintain at his own ex-</p>	<p>(A) The licensee shall obtain brine from the sea by using the existing channels and reservoirs and constructing others, if found necessary, and shall, in case of dispute as to the use or construction of channels or reservoirs, abide by the order of the officer in charge of the Division subject to an appeal to the Excise Commissioner, whose decision shall be final. (36)</p>

platforms and other works within the factory used or intended to be used for the manufacture and storage of salts, and also all works, wherever situated, for the protection of the factory from inundation or for the supply of brine ;

(ii) that in case of any dispute arising as to the liability of the licensee under clause (i) above, the matter shall be referred for the orders of the Assistant Commissioner of the Division and his decision shall be final ;

(iii) that if the Collector considers that there has been any failure on the part of the licensees of the salt factory to fulfil their liabilities under clause (i) above, or, with the sanction of the Central Board of Revenue, whenever it appears desirable that any such work should be undertaken by the Salt Department, or whenever the licensees of a factory themselves desire that any of the works which they have to execute should be undertaken by the Salt Department on their behalf, the Collector may cause such works to be executed and may recover from the licensee his portion of the cost thereof in such proportions as may seem fit ;

(iv) to pay such a cess per maund of salt removed as the

manner without first obtaining the written permission of the Collector. (2)

pense in good repair and to the satisfaction of the Collector all roads, channels, reservoirs, embankments, drying grounds, platforms and other works within the factory used or intended to be used for the manufacture and storage of salt and also all works wherever situated for the protection of the factory from inundation or for the supply of brine ;

(ii) If any dispute arises as to the liability of the licensee under clause (i) of this condition, the matter shall be referred for the orders of the Collector and his decisions shall be final ;

(iii) If the Collector considers that there has been any failure on the part of the licensee of the salt factory to fulfil his liability under clause (i) of this condition or with the sanction of the Commissioner of Excise and Salt, whenever it appears desirable that any such work should be undertaken by the Salt Department or whenever the licensee of a factory himself desires that any of the works which he has to execute should be undertaken by the Salt Department on his behalf, the Collector may cause such work to be executed and may recover from the licensee his portion of the cost thereof in such proportion as may seem fit.



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Collector may fix as sufficient to cover all or any of the following charges or portions thereof :

- (a) The interest at 5 per centum per annum on the capital cost of the works constructed at the expense of Government within the factory of any of the descriptions, or for any of the purposes mentioned in clause (i) supra.
- (b) The expenditure incurred by Government on account of works executed under clause (iii) supra.
- (c) So much of the annual expenditure incurred by Government on the establishment maintained at the factory or place of storage for the purposes of guarding the salt and of realising the revenue thereon as may exceed such percentage as the Central Board of Revenue may fix on the duty levied on the salt therein sold in preceding official years and as has not been recovered by Government. (For Excise and Modified Excise only). (15)

The licensee shall adopt such methods of manufacture and shall lay out the reservoirs, condensers and pans on such lines as the Collector may from time to time direct and shall comply with any rules made under the Act regarding the storage and sale of salt. (10)

- (C) A sketch plan of the salt works of the licensee including the place of storage together with a specification of apparatus and implements to be used shall be submitted to the Collector for approval and no alteration in such works place, apparatus or implements shall be made without his previous sanction. (25)

## III CONTROL OF MANUFACTURING OPERATIONS, QUALITY OF SALT, ETC.

- (A) The licensee shall commence and close manufacture within such dates as may be prescribed by the Collector, and shall at the

- (A) The manufacture of \*salt only shall be allowed, that is, salt manufactured by the process of

- (A) The licensee shall commence and close manufacture within such dates as may be prescribed by the Excise Commissioner.

commencement of each manufacturing season intimate in writing to the officer in charge of the factory the number and extent of the pans he intends to work in that season. (3)

(B)

(i) The licensee shall manufacture the quantities of salt specified in the Factory Register against his name at the rates of *Kudivaram* therein prescribed, and in the manner laid down from time to time under the orders of the Collector and shall take care that it is of good quality, to the satisfaction of the officer in charge of the Factory and shall be responsible for its safe delivery. (For Monopoly System only). (4)

(ii) The licensee shall, in any year in which notice shall be given to him by the Collector, manufacture salt with due diligence to the full capacity of his holding. (For Excise and Modified Excise system only.) (4)

(C) No salt shall be scraped on Sundays except with the special permission of the officer in charge of the factory. (5)

(D) The licensee shall manufacture salt of a quality not inferior to the standard prescribed by the Collector of Salt Revenue,

\* kind of salt to be specified.

† process of manufacture to be specified. (2)

(B) After every third scraping the pans shall be entirely emptied and the litters thrown away and fresh brine run in before scraping is resumed. No salt shall be scraped when the density of the brine in the pans exceeds 30° B $\bar{S}$ . (4)

(C) On the close of manufacture, the licensee shall drain off all brine from his condensers and crystallising beds to the satisfaction of the Works Officer in such a manner as to prevent the formation of spontaneous salt. If any salt subsequently forms in the pans of the licensee, the Works Officer may destroy such salt at the licensee's expense. (6)

(D) No salt other than salt capable in the judgment of the Collector of bearing the duty imposed by or under the law for the time being in force, shall be manufactured. (23)

Except for reasons which shall be deemed satisfactory by the Excise Commissioner the licensee shall not fail to work all his pans every year to their full capacity. (3)

(B) As an ordinary rule no salt shall be scraped on Sundays. But, if the weather be threatening the officer in charge of the factory may, in his discretion, allow scraping to be carried on and may require the full attendance of the establishment staff etc., on Sundays as on week days. (5)

(C) Should the Excise Commissioner be of opinion that the salt manufactured is of bad quality and therefore unacceptable the Excise Commissioner may cause it to be destroyed at the expense of the licensee. (8)

(D) On the close of manufacture, the licensee shall drain off all brine from his condensers and crystallising beds to the satisfaction of the officer in charge of the factory in such manner as to prevent the formation of spontaneous salt. Should salt form in his pans subsequently the officer in charge of the factory may destroy it at the licensee's expense. (9)

(E) In case of dispute arising as to the liability of the licensee under section 29 of the Salt Act in respect of the construction and maintenance of the roads,

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<p>subject to the approval of the Central Board of Revenue. (6)</p> <p>(E) Should the quality of salt be considered to be below standard, the Factory Officer may refuse permission to store the salt, pending decision by the Inspector whether the salt shall be stored and if the Inspector decides that salt shall not be stored, the Factory Officer may destroy such salt by throwing it back into the channels or reservoirs at the expense of the licensee. (For Excise and Modified Excise system only). (7)</p> <p>(F)</p> <p>(i) Should the licensee manufacture salt in contravention of the methods of manufacture laid down or should the quality of the salt manufactured be found bad the licensee shall be liable to forfeit all rights to <i>kudicaram</i> thereon and the Factory Officer may destroy such salt by throwing it back into the channels or reservoirs, provided that the licensee may appeal to the Inspector against the decision of the Factory Officer that the quality of the salt is bad and that the decision of the Inspector shall be final. (For Monopoly system only). (8)</p>			<p>channels, reservoirs, embankments, drying grounds, platforms and other works for manufacture and storage of salt and also all works for the protection of the factory from inundation or for the supply of brine the matter shall be referred for the order of the Excise Commissioner whose decision shall be final. (13)</p> <p>(F) If the salt scraped for delivery to Government be not of the approved quality it shall be open to the Excise Commissioner to decline to take delivery of it on behalf of the Government. If however, it is of an acceptable quality, the licensee shall sell it to the public only at a rate not less than the Government selling price prevailing at the time. If the Excise Commissioner is of opinion that the quality of salt scraped is such that it could not be accepted or sold to consumers, it will be destroyed at the cost of the licensees by being dissolved in water. (33)</p>

On the close of manufacture the licensee shall drain off all brine from his condensers and crystallising beds to the satisfaction of the officer in charge of the factory in such a manner as to prevent the formation of spontaneous salt. Should salt form in his pans subsequently the officer in charge of the factory may destroy it at the licensee's expense. (For Excise and Modified Excise system only). (8)

#### METHOD OF STORAGE, SALES, COLLECTION OF DUTY ETC.

All salt scraped shall be removed to the drying ground within such time as the Collector may prescribe. The officer in charge of the factory may order all salt not so removed to be thrown back into the pans. (9)

1) The salt shall be removed from the pans to the drying grounds and from the drying grounds to the place of storage under such rules as may from time to time be prescribed by the Collector and the licensee shall be bound to allow all other licensees and their labourers such reasonable rights of way over the ridges of his pans as may be necessary for the carrying out of such rules. (10)

2) (i) The salt manufactured shall be stored in such places and in such manner as the Collector may from time to time authorise and direct. If the licensee shall fail to store his

(A)

(i) All salt manufactured in accordance with this licence shall be weighed or measured daily as the Collector may direct and shall be placed in a bonded warehouse under lock and the key shall remain in the possession of the licensee or his authorised agent. (For Orissa and Bengal only.) [i (viii)].

(ii) Subject to the directions as the Salt Department may give, the Superintendent or Inspector shall from time to time cause such salt to be weighed in his presence and removed from the bonded warehouse. The licensee shall within 24 hours subsequent to such weighing and before removal of the salt pay the duty leviable thereon if it has not been paid before. (For Orissa and Bengal only) [i (xi)].

(A) All salt scraped shall be removed to the drying grounds within such time as the Excise Commissioner may prescribe. The Officer in charge of the Division may order all salt not so removed to be thrown back into the pans. No salt shall be removed to the drying ground until the quantity scraped has been estimated by the officer appointed for that purpose. No salt shall be scraped from any pan or set of pans after the estimating officer has completed estimation for the day for that pan or set of pans. The daily hour at which estimation shall begin at the factory will be fixed by the officer in charge of the Division. (6)

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<p>salt, the officer in charge of the factory shall take such steps as he may consider necessary for its storage, and the cost of such storage shall be recovered from the licensee. No salt so stored shall be removed from the factory until the cost of such storage has been paid by, or has been recovered from the licensee, and if the cost of such storage is not paid within one year after it has been stored, the salt shall become the property of Government and the Collector shall deal with it as he pleases. (For Excise system only). (11)</p> <p>(ii) The licensee will manufacture salt of good quality only and sell to Government the whole or any portion of the salt manufactured in his pans at Rs. . . per garce. If Government elect not to purchase salt manufactured in his pans the licensee shall be at liberty to store it on his own behalf and sell it as he pleases. The licensee shall work his pans every year to their full capacity if called upon to do so and if he fails to do so to the satisfaction of the Assistant Commissioner this licence shall be liable to be cancelled. If the factory be closed or converted</p>		<p>(B) The salt shall be removed from the pans to the drying grounds and from the drying grounds to the place of storage in accordance with such directions as may from time to time be issued by the Collector. (7)</p> <p>(C) The Collector may, by order in writing require licensees to protect salt manufactured by him in such manner as the Collector shall consider sufficient in any place appointed by the Collector for the storage or keeping of salt for the factory or for the salt works of the licensee, to reheap and secure in such manner as he may direct any portion remaining out of a heap or store which has been opened, or to construct or repair to the Collector's satisfaction any embankment, platform, building or works required or set apart for the purpose of storage, and if the licensee shall fail to comply with such order within fifteen days of the receipt thereof, the Collector may do what is required or may sell or destroy salt so left unprotected or unstored and may recover the expense incurred in doing so from the licensee, (8)</p>	<p>(B) The salt shall be removed from the pans to the drying grounds and from the drying grounds to the place of storage under such rules as may from time to time be prescribed by the Excise Commissioner and the licensee shall be bound to allow all other licensees and their labourers such reasonable rights of way over the ridges of his pans as may be necessary for the carrying out of such rules as may from time to time be prescribed by the Excise Commissioner under this condition. (7)</p> <p>(C) The salt manufactured shall be stored in such places and in such manner as the Excise Commissioner may from time to time authorise and direct. If the licensee shall fail to store his salt the officer in charge of the Division may at his option either destroy the salt or take such steps as he may consider necessary for its storage and the cost of such destruction or storage as the case may be shall be recovered from the licensee, (10)</p>

into a monopoly factory the licensee shall be entitled to no compensation, but in the latter case shall be allowed to work his pans under the Monopoly system. (For Modified Excise system only). (11)

(D) The salt shall be weighed both when stored and when sold, under the supervision of the officers of the Salt Department, with the scales provided by Government for the purpose, in such manner and at such times as the Collector may from time to time direct. (12)

(E) The Collector may, by order in writing, require the licensee to protect salt manufactured by him in such manner as the Collector shall consider sufficient in any place appointed by the Collector for the storage or keeping of salt for the factory or for the salt works of the licensee, to reheap and secure in such manner as he may direct any portion remaining out of a heap or store which has been opened, or to construct or repair to the Collector's satisfaction any embankment, platforms, building, or works, required or set apart for the purpose of storage, and if the licensee shall fail to comply with such order within ten days of the receipt thereof, the Collector may do what is required or may sell or destroy salt so left unprotected or unstored and may recover the expenses incurred on doing so from the licensee. (13)

(D) No salt shall be removed from a factory without a permit authorising its removal or otherwise than in accordance with the following rules :

(i) An application in the form prescribed by the Collector, signed by the licensee and the purchaser of the salt presented to the officer in charge of the factory together with a Treasury receipt for the amount of the duty on the salt at least the day before the delivery of the salt is required. The duty and other charges shall be those in force at the time of the removal of the salt from the factory. An order for the delivery of the salt in the form prescribed by the Collector will then be sent to the weighing officer.

(ii) When the weighment and bagging of the salt is completed the weighing officer will fill up and sign the permit which will be countersigned after check-weighment by the officer conducting the check-weighment who will then allow the removal of the salt.

(iii) The permit must be produced and delivered up to the officer in charge of the guard at the gate.

(D) The salt manufactured by the licensee shall be weighed both when stored and when sold under the supervision of the officers of the Excise Department with scales provided by the Government for the purpose in such manner and at such times as the Excise Commissioner may from time to time direct. (11)

(E) The Excise Commissioner may by order in writing require the licensee to protect that salt manufactured by him in such manner as the Excise Commissioner shall consider sufficient in any place appointed by the Excise Commissioner for the storage or keeping of salt for the factory or for the salt works of the licensee, to reheap and secure in such manner as he may direct any portion remaining out of a heap or store which has been opened or to construct, or repair to the Excise Commissioner's satisfaction any embankment, platform, building or works required or set apart for the purpose of storage and if the licensee shall fail to comply with such order within ten days of receipt thereof the Excise Commissioner may do what is required or may sell or destroy salt so left unprotected or unstored and may recover the cost from the licensee. (12)

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(F) No salt shall be removed from a factory without a permit authorising its removal or otherwise than in accordance with the following rules:

- (i) An application in the prescribed form, signed by the licensee and the purchaser of the salt or their authorised agents, must be presented to the officer in charge of the factory together with the shroff's receipt for the amount of the duty on the salt and the cess thereon at least the day before the delivery of the salt is required. The duty and other charges shall be those in force at the time of the removal of the salt from the factory. An order for the delivery of the salt in the prescribed form will then be sent to the weighing officer.
- (ii) When the weighing and bagging of the salt is completed, the weighing officer will fill up and sign the permit, which will be countersigned after check-weighment by the officer conducting the check-weighment, who will then allow the removal of the salt.
- (iii) The permit must be produced and delivered up to the officer in charge of the guard at the gate.

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(iv) Should any bag appear to have been tampered with after check-weighment, the guard officer will detain the whole consignment for the order of the factory officer who shall be at liberty to re-weigh it.

(v) Purchasers of salt shall provide all labour necessary for the weighing and check-weighment of salt.

(vi) The licensee shall furnish the labour for conveying, replacing and cleaning the machines and weights to be used in the weighing and removal of salt as may be directed by the officer supervising weighing shall be responsible for all damage other than fair wear and tear done to the machines or weights in the removal of his salt. (9)

(E) Whenever the licensee applies for a permit to remove salt from the factory, he shall be bound to declare in the application the price at which the salt has been sold and the full consideration given or agreed to be given therefor. (11)

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(F) When salt belonging to the licensee has been in store for more than five years, the Excise Commissioner may direct it to be sold by auction and if no bid is obtained for it may order its destruction and recover the cost from the licensee. The sale proceeds shall be paid to the licensee or his representative or if neither the licensee nor his representative can be found shall be credited to Government. (20)

(G) No salt shall be removed from a factory without a permit. (22)

(H) The licensee shall conform himself to the following rules of procedure in regard to the removal of salt from the factory:

- (i) An application in the prescribed form signed by the licensee and the purchaser of the salt or their authorised agents must be presented to the officer in charge of the factory together with the amount of the duty due on the salt and the cess thereon, if any, before 8 A.M. on the day of purchase. The cashier will endorse upon the receipt the hour of payment. An order for the delivery of the salt in such form as the Excise Commissioner may prescribe in this behalf will be sent by the

(iv) Should any bag appear to have been tampered with after check-weighment, the guard officer will detain the whole consignment for the orders of the factory officer, who shall be at liberty to re-weigh it.

(v) When credit is given for the payment of duty, the same course will be followed save that the shroff's receipt will not be required. The order for the delivery of the salt will be issued by the factory officer after entry has been made of the issue in the credit register.

(vi) No permit will be granted for the removal of less than 2 maunds of salt at one time, except as a sample, for which purpose one maund of salt may be removed from each heap on one occasion only.

(vii) Purchasers of salt shall find all labour necessary for the weighment and check weighment of salt.

(viii) No removal of salt shall be made on Sundays or authorised holidays or on days on which the state of the weather is in the opinion of the Factory Officer such as to render removal inadvisable.

(ix) On other days removals of salt shall be made on such days and at such hours as may be fixed by the Collector. All

(F) Whenever the licensee holds a permit for the removal of salt from a salt factory he shall be bound to superintend either in person or by his servant or agent the weighing out of the same, and the person actually superintending such weighment shall be bound to prevent the removal of any quantity in excess of that for which the permit has been granted and may test the weights and scales used in the weighment thereof. (12)

(G) When salt belonging to the licensee has been in store for more than five years the Collector may direct it to be sold by auction, and if no bid is obtained for it may order its destruction and recover the cost from the licensee. The sale proceeds shall be paid to the licensee or his representative and if neither the licensee nor his representative can be found, shall be credited to Government. (16)

(H) On the cancellation or suspension of the licence, all salt remaining in any salt works of the licensee shall be stored in the appointed place within fifteen days of the date of such cancellation or suspension; and all salt manufactured in any such salt works, which shall be in store at such date or shall subsequently be brought into store as hereinbefore provided shall be removed on payment of duty

officer in charge of the factory to the weighing officer.

(ii) When the weighment and the bagging of the salt are completed, the weighing officer shall make an endorsement on the reverse of the delivery order testifying to the fact of the completion of the delivery, sign the same and hand it over to the officer in charge of the factory who will conduct the check-weighment and issue the permit signed by him. the salt will then be removed.

(iii) One copy of the permit must be produced and delivered up to the officer in charge of the guard at the gate.

(iv) Should any bag appear to have been tampered with after check weighment, the guard officer shall detain the whole consignment for the orders of the Inspector who will be at liberty to re-weigh it.

(v) No permit will be granted for the removal of less than 16 maunds of salt at one time.

(vi) The weighment shall be made in bags containing 2 maunds each.

(vii) Purchasers of salt shall find all labour necessary for the weighment and the check-weighment of salt.



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salt weighed out for removal must be removed before sunset.

(x) The licensee shall furnish the labour for conveying, replacing and cleaning the machines and weights to be used in the weighment and removal of salt as may be directed by the officer supervising weighment. He shall be responsible for all damage other than fair wear and tear done to the machines or weights in the removal of his salt. (14)

(G) Whenever the licensee applies for a permit to remove salt from the factory he shall be legally bound to declare in the application the price at which the salt has been sold and the full consideration given or agreed to be given therefor. (18)

(H) Whenever the licensee holds a permit for the removal of salt from a salt factory he shall be bound to superintend either in person or by his servant or agent the weighing out of the same, and the person actually superintending such weighment shall be bound to prevent the removal of any quantity in excess of that for which the permit has been granted and

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within six months of such date; the Collector may cause any salt which may not be so stored after such period of fifteen days or which may remain in store after the expiry of such period of six months, to be stored or to be put up to auction and sold if the price offered be equal to the duty leviable thereon, the Collector may cause the salt to be destroyed in such manner as he shall think fit, and if the Collector causes such salt to be stored, the cost of such storage, including the expenses of transport, if any, shall be recovered from the licensee under the Bihar and Orissa Public Demands Recovery Act, 1914, as a public demand payable to the Collector. (For Orissa and Bengal only). (28)

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(viii) No removal of salt shall be made on authorised holidays or on days during which, in the opinion of the officer in charge of factory, the state of the weather is such as to render the removal inadvisable. All salt weighed out on any day must be removed before sunset on that day.

(ix) The licensee shall furnish the labour for conveying, replacing and cleaning the machines and weights to be used in the weighments and removal of salt as may be directed by the officer supervising weighment. The licensee shall be responsible for any damage other than fair wear and tear done to the machines or weights in the removal of his salt. For the purpose of cleaning, the materials will be supplied by the factory officer. (23)

(J) The licensee shall deliver to Government annually before the end of month each year 9 maunds of salt per cent. of the pan area owned by him in the factory of the quality not inferior to the best quality manufactured in the other factories of Thamaraculam. The Officer in charge of the Divison shall, in case he desires to do so, have the priority of right to select the whole or any portion of such salt before the

may test the weights and scales used in the weighment thereof. (19)

(J) The Collector may call on the licensee to store in such manner as he may direct any sifted or refuse salt manufactured by him which may be lying unstored, or, at the option of the licensee, to destroy the same; and if the licensee, shall fail either to store or to destroy such salt within ten days of the receipt of the order to do so, the Collector may cause such salt to be destroyed and may recover the cost of such destruction from him. The Collector shall determine whether any salt is sifted or refused for the purpose of this condition. (20)

(K) The licensee shall not claim from Government compensation for only loss or damage to stored and unstored salt belonging to him and lying at the salt factory unless it be proved that such loss or damage was caused by the wilful act or neglect of an officer of the Salt Department employed at the factory. (21)

(L) The Salt Revenue Officer in charge of any salt store may refuse to permit the removal of any salt stored therein which he may consider not to be so

salt manufactured by the licensee during any season is offered for general sale. (28)

(K) If the salt manufactured by the licensee in any year falls short of the quantity above prescribed. Government may accept delivery of the salt actually manufactured on condition that the balance shall be made good and delivered during the next following year together with the quantity due for that year. But it will not be obligatory upon the Government to take delivery of prescribed quantity of salt. (29)

(L) The quantity of salt which the licensee has to deliver to Government, as detailed above, may be taken delivery of and removed by the Govt. at their option in instalments or in one lot and it will not be open to the licensee to object to the salt remaining on the storage platforms until its removal provided such salt is taken delivery of and removed by the Govt. before the close of salt transporting season of the next following year. (30)

(M) The licensee shall not claim *Kudivila* for any salt until the same is actually taken delivery of by the Government and he will be paid *Kudivila* at the rate of two and three fourth ( $2\frac{3}{4}$ ) annas per maund for the

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capable, pending the decision of the collector and all salt adjudged by the collector to be inferior shall be destroyed in his presence, or in the presence of such officer as he may depute for the purpose, in such manner as he may direct. [23(b)]

- (M) when salt belonging to the licensee has been in store for more than five years the Collector may direct it to be sold by auction and if no bid is obtained for it may order its destruction and recover the cost from the licensee. The sale-proceeds shall be paid to the licensee or his representative, or if neither the licensee nor his representative can be found, shall be credited to Government. (27)

salt so taken delivery of within forty-five days of taking delivery of the salt. (31)

- (N) The surplus salt remaining with the licensee after delivery to the Government of the quantity prescribed under clause 28 supra will be removed by him for sale at any place in Travancore at prices not lower than the Government selling price prevailing at the time, at such place, on payment to Government the full duty together with such cess for every maund of salt as the Government may fix under the Salt Act, III of 1088 or any statutory modification thereof. (32)

## V. RECOVERY OF GOVERNMENT CHARGES

- (A) The licensee shall engage to pay such rent or assessment as the collector may fix for the use of lands and buildings either belonging to Government or assessable to Government revenue and occupied by the licensee for the purpose of the manufacture and storage of salt, and in proportion to

- (A) The licensee shall pay on demand such sum as may at any time be determined by the Collector on account of (i) the expenses of any survey that may be ordered by him of the land and (ii) of preparing maps thereof. (3)

- (A) All sums recoverable from the licensee under the Act, or in any way due to Govt. from him on account of the salt revenue may be deducted by the Collector from any money owing to the licensee which may be in the hand of the Collector under his disposal or control or may be

- (A) The licensee shall engage to pay such rent or assessment as the Govt. may fix for the use of lands and buildings either belonging to Government or assessable to Government revenue and occupied by the licensee for the purpose of manufacture and storage of salt. (19)

the size of his holding in the factory for the Government land used for any purpose incidental to the manufacture of salt. (16)

(B) Whenever any charges are due for rent or assessment or expenditure incurred by Government upon the licensee's salt, such salt shall not be removed from the factory until the whole of such charges have been paid. (17)

(C) All sums recoverable from the licensee under the Madras Salt Act, 1889, as amended or in any way due to Government from him on account of the salt revenue may be deducted by the Collector from any money owing to the licensee which may be in the hands of the Collector or under his disposal or control or may be recovered by the Collector by attachment and sale of the licensee's salt remaining within the limits of the factory. If not so recovered, such sums may be recovered by Collectors of districts on application from the Collector of Salt Revenue as if they were arrears of Land Revenue. (29)

(B) The licensee shall pay ground rent at the rate of . . . or such other rate as may from time to time be fixed by the Collector, under the orders of Government. (7)

(C) The licensee shall pay monthly advance Rs . . . on account of the cost of the establishment employed for guarding his salt works and that in the event of his failing to make punctual payment of any money so payable, the amount due shall be recoverable by the Collector by distraint and sale of any salt belonging to the licensee or in any other manner authorized by the law. (12)

recovered by the Collector by attachment and sale of the licensee's salt remaining within the limits of the factory. If not so recovered such sum may be recovered by the Collector of the district on application from the Collector of Salt Revenue as if they were arrears of land revenue. (18A)

(B) On or before the first day of each month during which or any part of which—

(i) the manufacture of salt is in progress, or any salt remains unstored, in the licensee's salt works, or

(ii) any salt manufactured by the licensee remains in store in any Salt Store, the licensee shall, unless he has been exempted by Government from the payment of such costs in whole or in part for any period, pay into such Government Treasury or sub-treasury as the Collector shall appoint, such sum as the Collector shall direct on account of the cost (including the pres-

(B) Whenever any charges are due to Government under the Salt Act III of 1088 or the rules passed thereunder, upon the licensee's salt, such salt shall not be removed from the factory until the whole of such charges have been paid. (21)

(C) The licensee shall have the use of all platforms, reservoirs channels and other salt works belonging to Govt. and situated within the limits of the factory subject to an annual payment of Rs. 5/- per acre on account of rent, in proportion to the size of each licensee's holding of the factory. (27)

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ribed pensionsry and leave allowance contributions) of the guarding establishments maintained by Government at such Salt Works or Salt Store:

Provided that, if the salt works of two or more licensees are so situated that they can be effectively supervised by a single guarding establishment or if two or more licensees store their salt in a single salt store, one establishment only may be employed for the guarding of such Salt Works or Salt Store as the case may be, and the cost of such establishment shall be recovered from the several licensees in such proportions as the Collector may direct:

Provided further that if, after the expiry of the period of a licence it is ascertained that the aforesaid cost of the Government guarding establishments actually employed at the Salt Works and Salt Store during the period of the currency of the licence, or the licensee's proportion of such cost, as the case may be has not exceeded five per centum to the revenue derived by Government during such period from the levy of duty on salt manufactured in

## VI. ENFORCEMENT AND CANCELLATION

(A) The Collector may, after giving one month's notice, cancel the licence for any salt works at which no salt shall have been manufactured during the two manufacturing seasons last preceding. (For Excise and Modified Excise systems only).  
(4)

(B) In case of the licensee failing to exercise due diligence in manufacture or committing any default (in the weightment of salt clause 12), the Collector may impose upon the licensee

(A) The licensee shall make his own arrangements to acquire possession of the ground on which he is permitted to manufacture salt, if the said ground is not already in his possession, and if salt is to be manufactured on the said ground for the first time, he shall complete all preliminary arrangements, in time to commence the manufacture of salt within two years from the date of this licence, failing which the licence will be recalled.  
(1)

(A) The licensee shall produce his licence immediately for inspection when called upon to do so by an officer not below the rank of Inspector or by an officer deputed by such officer for the purpose. [1 (6)]

(B) The manufacture of salt shall be allowed only at \_\_\_\_\_ in the district of \_\_\_\_\_. The licence shall lapse if the manufacture of salt is not started by . . . . . (3)

the licensee's Salt Works and issued from the Salt Store\* for consumption on payment of duty, the whole amount paid by the licensee on account of the cost of the guarding establishment as to aforesaid shall be refunded to him; and that, if it is ascertained that such cost or proportion thereof has exceeded five per centum of such revenue, five per centum of such revenue shall be returned.  
(24)

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a fine not exceeding one-tenth of the total *Kudivaram* payable to him on the quantities to be manufactured by him, or suspend the licence for such period as the Collector may think fit, or cancel the licence one month after notice. (For Monopoly System only). (13)

(C) The Collector may cancel the licence granted to the licensee if the licensee shall have been convicted of any offence under the Madras Salt Act, 1889, as amended or may suspend or cancel the licence in case of breach of the conditions thereof. (22)

(D) Whenever the licence granted to the licensee is suspended, the Collector may grant a temporary licence for manufacture in the licensee's salt works, or flood them with water, or take any other measure he may think fit to prevent injury to manufacture in neighbouring salt works or the spontaneous generation of salt. (23)

(E) The licensee shall agree that, if the salt works or part of the factory is closed in the manner provided in the Act, or if his licence is cancelled or suspended, all salt manufactured in his salt works which may then be in store or any other of his property which

(B) If the whole or any portion of the land within the limits aforesaid is taken up for a public purpose as defined in Act X of 1870 (Repealed by Act I of 1894) the licensee shall not have any claim to compensation for the consequent deprivation of liberty to manufacture salt on the land so taken up. (6)

(C) The licence shall continue in force from the... until the... and no longer, but shall be liable to be revoked, suspended or withdrawn at any time by competent authority under any of the provisions of Bombay Act II of 1890 or of any other enactment relating to salt revenue at the time being in force. (12A)

(C) The Collector may cancel the licence granted to the licensee if the licensee shall have been convicted of any offence under the Act, or may suspend or cancel the licence in case of breach of the conditions thereof. (14)

(D) The licensee agrees that if the salt works or part of the factory is closed in the manner provided in the Act or if his licence is cancelled or suspended, all salt manufactured in his salt works which may then be in store or any other property of the licensee which may then be within the limits of the salt factory shall be removed on payment of the duty payable on such salt within six months of the date of such closing or of the cancellation or suspension of such licence, for which purpose only the licence shall continue in force; and if the licensee shall fail so to remove such salt or property, it shall be forfeited to Government and disposed of as the Collector may think fit. (15)

ity then be within the limits of the salt factory shall be removed on payment of the duty thereon within six months of the date of such closing or of the cancellation or suspension of such licence, for which purpose only the licence shall continue in force and if the licensee shall fail so to remove the salt, it shall be forfeited to Government and disposed of as the Collector may think fit. (26)

(F) The licensee shall agree to observe and keep all further conditions for the continuing of his licence which the Collector shall prescribe, and shall when called upon, deliver up his licence for amendment or for the issue of a fresh licence in accordance therewith. (33)

## VII. GENERAL

(A) The licensee shall agree to register his usual address in a register to be kept at the factory office and keep the Asst. Inspector informed of all changes in the address. (24)

(B) The licensee shall agree that whenever a notice has to be served upon the general body of the licensees of the factory, the exhibition thereof for not less than seventy-two consecutive hours on a prominent part of the factory office shall be a full and sufficient service of the same on the licensee. (25)

(A) The licensee shall not use the land within the aforesaid limits for any purpose unconnected with the manufacture and storage of salt. (4)

(B) The licensee shall not without the written permission of the Collector sublet, sell, mortgage or otherwise alienate, wholly or in part, the privilege granted by the licence of manufacturing salt on the land within the aforesaid limits. (5)

(A) (i) The factory premises shall be kept in good repair to the satisfaction of the officer-in-charge of the Circle so as to afford full security for the Govt. revenue [1(ii)]

(ii) The licensee shall maintain a daily register showing the quantity of salt manufactured, sold, and removed from factory in the prescribed form.  
[1(iii)]

(A) The licensee shall not employ as servants men against whom frauds have been proved, and if any frauds are proved on the part of the servants with his connivance or privity, he shall in addition to any penalty that may by law be imposed on him in that behalf also forfeit his pass. (14)



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<p>C)</p> <p>(i) All officers of the Salt Deptt. and all Gazetted Officers of other departments shall have free passage over the works and be at liberty to examine the salt in store at any time.</p> <p>(ii) The licensee and his servants shall have access to the places where salt may be manufactured and stored only during such hours as the Collector may fix for the purpose. (28)</p> <p>(D) The licensee shall agree not to have any pecuniary dealings of any kind whatever with any of the officials of the Salt Department. (30)</p> <p>(E) If any frauds are proved on the part of the licensee or on the part of his servants with his connivance or privity, he shall, in addition to any penalty that may by law be imposed in that behalf, also forfeit his pans; and he shall not employ as servants men against whom frauds have been proved (31)</p>	<p>(C) The licensee shall produce the license whenever called upon by an officer of the Salt Department. (8)</p> <p>(D) The word 'licensee' shall be deemed to include the licensee, his heirs, executors and administrators. (10)</p> <p>(E) The licensee shall act in all respects in conformity with the terms of the agreement executed by him under date . . . by virtue of which he is placed in possession of the pans. (11)</p> <p>N. B.—Additional conditions are inserted when the licensee is a lessee of Government salt pans.</p>	<p>(iii) Every diary, register book of accounts and the like connected with the business of the licensed works shall at all times be open to the inspection of an officer not below the rank of an Inspector or of any officer deputed by such officer for the purpose. (For Orissa &amp; Bengal only). [1(vii)]</p> <p>(B) (i) The licensee shall employ a manager well versed in salt manufacture and approved by the Collector. (For Orissa &amp; Bengal only) (4)</p> <p>(ii) A duplicate of the licence lost or destroyed during the period of its currency shall be obtainable on payment of the quarter of the original licence fee. (For Orissa and Bengal only). (4)</p> <p>(C) The licensee shall not bear the cost of temporary quarters for the preventive staff. (5)</p> <p>(D) An appeal shall lie from any order of the Superintendent to the Collector from any order of the Collector and from any order of the Salt Department not being an order passed on second appeal, to the Central Board of Revenue. (For Orissa &amp; Bengal only) (6)</p>	<p>(B) The licensee shall register his usual address in a register to be kept at the factory office and keep the officer in charge of the factory informed of all changes in the same. (15)</p> <p>(C) All officers of the Excise Department and all Gazetted Officers of other departments shall have free passage over the works and be at liberty to examine the salt in store at any time. (16)</p> <p>(D) That the licensee and his servants shall have access to the places where salt may be manufactured and stored only between sunrise and sunset or at other time with the previous sanction of the officer in charge of the factory. (17)</p> <p>(E) The licensee shall not have pecuniary dealings of any kind whatever with any officers of the Excise Department. (18)</p> <p>(F) The licensee shall obey all lawful orders issued by the officer in charge of the factory relating to the manufacture and storage of salt and to the general discipline of the factory subject to appeal to higher authorities. (24)</p> <p>(G) The licensee shall agree to observe and keep all further conditions for the continuing of his</p>

(F) The licensee shall obey all lawful orders issued by the officer in charge of the factory relating to the manufacture and storage of salt and to the general discipline of the factory subject to appeal to the higher authorities. (32)

(E) No appeal shall lie from any order passed by the Central Board of Revenue or from any order passed by the Salt Department or Collector on second appeal. (For Orissa & Bengal only). (7)

(F) The licensee shall not claim from Govt. compensation for any loss or damage to stored or unstored salt belonging to him and living at the salt factory unless it is proved that such loss or damage was caused by the wilful act or neglect of an officer of the Salt Department employed at the factory. (13)

(G) (i) All officers of the Salt Department and all Gazetted officers of other departments shall have free passage over the works and be at liberty to examine salt in store at any time.

(ii) The licensee and his servants shall have access to the places where salt may be manufactured and stored only during such hours as the Collector may fix for the purpose. (17)

licence which the Excise Commissioner shall prescribe, and shall when called upon, deliver up his licence for amendment or for the issue of a fresh licence in accordance therewith. (25)

(H) Whenever a notice has to be served upon the general body of the licensees of the factory, the exhibition of the notice for not less than seventy-two hours on a prominent part of the factory office shall be a full and sufficient service of the notice on the licensees. (26)

(J) The licensee shall report to Government, within a month from the date thereof, every case of alienation or transfer of salt pans and no such alienation or transfer shall be valid as regards the Government unless ratified by Government. These restrictions do not apply to hypothecations. (34)

(K) If the Government deem it necessary to acquire any other lands, premises or structures adjoining the factory for its extension, the licensee shall purchase such lands himself or the Government will acquire the same and the licensee shall pay the cost thereof and also as assessment at the rate of (six) annas per acre per year. The cost and the assessment to be paid by the licensee shall be in the proportion the size of his holding bears to the total area of the holdings of all the licensees together. (35)

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(H) (i) Except with the written consent of Government, the licensee shall not assign underlet or part with the possession of the lands in which he has been allowed to manufacture salt or any portion thereof and shall not transfer by sale, mortgage, gift or lease or otherwise, the power hereby granted to him. Nor shall the licensee take any partner or partners into the business carried on by him under the licence, except with the previous sanction of the Commissioner of Excise and Salt. (18)

(ii) The licensee shall work the factory directly under his supervision and shall provide supervisors capable of understanding and carrying out such methods of manufacture as may be prescribed by the Collector for production of salt of good quality. [18 (c)]

(J) The licensee shall not have any pecuniary dealings with any of the officials of the Salt Department. (19)

(K) If any frauds are proved on the part of the licensee or on the part of his servant with his connivance or privity, he shall in addi-

(L) The licensee shall not use the factory for any purpose other than salt manufacture except with the previous sanction of the Government. (37)

(M) That the licensee shall sign and deliver to the Excise Commissioner or to any other officer empowered by him in that behalf, a *muchilika* or engagement to observe the above stated conditions of his licence in a form, which are not inconsistent with the Act of these rules and which shall be prescribed by the Excise Commissioner and which shall be as nearly as may be a counterpart of his licence. (38)

(N) The co-owners of any salt factory worked under a joint licence issued in name of all the co-owners of that factory shall be bound to appoint a common agent to work their factory, such agent being selected and duly authorised by all the co-owners. In case of disagreement between the various co-owners in the selection or appointment of such an agent, however, the Department will accept and recognise as the common agent of all the co-owners any person selected and duly authorised by a majority of co-owners who have a clear majority according to the interest they have in the factory and such agent shall be equally responsible to all the co-owners of the factory concerned. (39)

tion to any penalty that may by law be imposed in that behalf also forfeit his pans and he shall not employ as servants men against whom frauds have been proved. (20)

(L) The licensee shall obey all lawful orders issued by the Works Officer and Store Officer relating to the manufacture and storage of salt and to the general discipline of the factory subject to appeal to the higher authorities. (21)

(M) The licensee agrees to observe and keep all further conditions for the continuing of his licence which the Collector shall prescribe and shall when called upon deliver up his licence for amendment or for the issue of a fresh licence in accordance therewith. (22)

(N) The licence shall be subject to such further conditions as the Collector may from time to time prescribe for the protection of the Government revenue. (23)

(P) Any wilful breach of the conditions of his licence by the licensee or by his servants with his connivance and privity, or by his heirs, administrators may cause suspension of the licence at the discretion of the Collector in addition to any penalty which may by law be imposed for such breach. (27)

## APPENDIX 'F'

### PRESS NOTE

#### *Policy to step up salt production*

#### *Small scale manufacture not subject to licensing*

The Government of India are formulating comprehensive measures to step up indigenous production of salt so that India attains complete self-sufficiency in this vital commodity in as short a time as possible. Details of the Government plan including a licensing system for large scale manufacturers and measures to encourage production by cooperative societies will be released to the Press shortly.

2. Meanwhile Government consider that the first instalment of the plan should be made public immediately so that small scale manufacturers may take full advantage of the current salt season.

3. Henceforth individuals or groups may freely produce salt in any land to which they have lawful access for this purpose and by whatever process they desire, i.e. construction of pans and solar evaporation or boiling of brine or scraping or excavation of saline earth or natural formations of salt provided that the total area of land covered by the salt works set up by any individual or group is not more than 10 acres. No licences are needed and no applications for licence need be sent to any Government authority in such cases. The provisions of the Central Excise and Salt Act, 1944, will not stand in the way of the right of the small scale manufacturer mentioned above.

4. It will be appreciated that Government's new policy is greatly in advance of the concession which was given as a result of the Gandhi-Irwin Pact in 1931 to villagers. At that time the Government of India merely permitted manufacture and collection of salt by local residents in villages immediately adjoining areas where salt could be collected or made. Even this small concession was hedged in with restrictions. The salt produced could not be sold for purposes of trade outside the villages nor could it be carried except on foot. Under Government's new policy salt produced in units covering not more than 10 acres will not be subject to any restrictions by way of storage, transport and sale.

5. As, however, salt has an intimate bearing on human health, Government attach considerable importance to the quality of the salt produced by small scale manufacturers without licence. While the high quality of salt produced by large-scale factories will automatically set a standard inviting emulation by small scale manufacturers, Government reserve the right to take suitable preventive measures against the sale of unwholesome salt for human consumption.

## APPENDIX 'G'

### LIST OF SALT ASSOCIATIONS

#### MADRAS

1. The Madras Provincial Salt Industrialists Association, 82, Govindappa Naick Street, Madras.
2. The Madras Salt Merchants and Manufacturers Association, 56, Govindappa Naick Street, Madras.
3. The Naupada Group Salt Licensees Association Ltd., Naupada.
4. The Nellore District Salt Manufacturers and Licensees Association, Stonehousepet, Nellore.
5. The Salt Merchants & Licensees Association, Vedaranyam.
6. The Tuticorin Salt Manufacturers & Merchants Association, Tuticorin.
7. The Cheyur Salt Licensees Association, Cheyur.

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1. Indian Salt Manufacturers Association, C/o. Tata Chemicals, Bombay House, Bruce Street, Bombay.
2. The Bombay Salt Merchants & Shillotries Association, 583, Chira Bazar, Bombay.
3. The Uran Salt Merchants and Shillotries Syndicate, *Uran*, (District Colaba).
4. The Nagarbail Saza Sanikatta Salt Owners' Association Ltd., Sanikatta, District North Kanara.

#### WEST BENGAL

1. Calcutta Salt Association Ltd., New Custom House, Calcutta.
2. Calcutta Salt Merchants Association, 5, Garstin Place, Calcutta.

#### TRAVANCORE COCHIN

1. The South Travancore Salt Development Association, Nagarcoil.

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