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Department of Industries  
BOMBAY PRESIDENCY

**Notes on the Indian Textile  
Industry with Special  
Reference to Hand  
Weaving**

By

**R. D. BELL, C.I.E., I.C.S.**

**Bulletin No. 6**

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BOMBAY

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At a time when the discussion on the abolition or otherwise of the Cotton Excise Duty was going on rather furiously in the press and on the public platform, my predecessor, Mr. R. D. Bell, C.I.E., I.C.S., compiled a very useful series of tables with explanatory notes from various sources available in the Department of Industries to show what part the handloom industry still performed in the industrial activities of this country.

2. A few typed copies of these notes were sent out to those interested in the question, and, as the notes are still in demand by students of Indian economics and others, I have had them printed and published in the form of a departmental bulletin, as I believe these notes will serve as an eye-opener for those who often preach without study or investigation that handloom weaving is a dying cottage industry or that it has been killed by the competition of the cotton mill industry established in this country.

3. The competition of cotton mills with hand-weaving in this Presidency started nearly three-quarters of a century ago when the late Mr. Cowasjee Nanabhai Davar established the first cotton mill in Bombay in the year 1853. Since then in spite of the advantages of mass production of the well organised mill industry the handloom weaving industry has not declined for various reasons.

4. In the first place the handloom industry has been greatly profitted and stimulated by the sufficient supply of mill-spun yarns of regular counts and twists in place of the rough and knotty hand-spun yarns of uncertain counts. A large portion of the rural population or village dwellers which constitute about 90 per cent of the total population of this country still prefer the coarse but durable hand-made product, and there are still many specialised types of hand-made cloth used by the urban population in this country which cannot be economically produced on power looms. Only those hand-weavers who did not specialise in any kind of fine fabrics but wove only coarse and plain cloth like khadi or dungri have



found it very hard to face mill competition and have taken to working for wages in mills or elsewhere. Even in khadi the competition of the mills is very little, as in the villages it is produced from inferior cotton which cannot stand the rough treatment of mill machinery.

5. A handloom worker, being more intimately acquainted with the tastes and requirements of his customers than a weaving master of a cotton mill, can easily satisfy the demand of a rural area. The mill-made cloth has not yet penetrated in certain rural areas where the cost of transport is very great owing to the absence of railways, and the hand-woven cloth therefore continues to be in good demand in such places.

6. Beautiful solid bordered saris and dhoties and artistic cross bordered raiment of numerous patterns and variegated designs which cannot be produced economically on power looms are invariably produced on handlooms. In solid bordered hand-woven fabrics two different kinds and colours of weft are used for the body and for the borders. As for instance the body of a cloth may be white and its borders red, but the white weft passes through the body only without passing through the borders, while the red weft passes through the borders and not through the body. In this way if the warp used for the borders is also red then borders of beautiful and brilliant red are produced which are called "solid borders" in textile technology. This can be produced in a special kind of power loom called pick-and-pick loom but not without a great deal of wastage and difficulties.

7. Similarly sari headings are also woven in handlooms with so-called broken weft which is not possible to work economically in power looms. In such fabrics the weft does not pass through the whole width of the cloth but it passes through a certain width of the cloth and then a weft of another colour is inserted to give a peculiar effect. This kind of changing of weft at different places at every pick produces an unique design which it is not possible to produce automatically in a power loom.

8. The warp of a handloom weaver being only thirty to forty yards in length he can easily introduce new designs and new patterns in each piece of cloth of that length at the time of preparing the warp. This is not possible in a large cotton mill as the warp of a power loom is not only about as much as eight hundred yards long but a large number of such warp beams of only one pattern have necessarily to be prepared to cope with the mass production system with the result that a mill-owner cannot accept an order for a certain style of cloth unless it is of several thousand yards of one pattern.

9. The sphere of the hand-weaver therefore still remains unsurpassed and unsurped to a large extent by the mill competition in this country.

BOMBAY,  
*15th July 1926.*

F. E. BHARUCHA,  
Director of Industries.

## PREFACE

In the course of a debate on the Cotton Excise Duty in the Imperial Legislative Assembly on 20th March 1924, I quoted statistics to show the great importance, even now-a-days, of the Indian hand-weaving industry. The facts were so little known that they caused surprise and I received requests from several quarters for the complete statistics.

I have brought out the important features of the statistics in these notes. These were the basis of a lecture, entitled "Hand Weaving and Allied Crafts," which I gave to the Bombay European Textile Association in March 1923. The "Allied Crafts," viz., carpet-weaving, silver and gold thread manufacture, calico printing and dyeing, have been omitted from the present notes.

The statistics are by no means novel. The Indian Industrial Commission in Appendix I to its report gave statistical evidence regarding the development of hand-weaving in India. The importance of the industry is also explained in "Notes on Indian Piece Goods Trade" by A. C. Coubrough, C.B.E., which was published by the Government of India as No. 16 of their Bulletins of Indian Industries and Labour.

All the statistics are extracted from the following official publications :—

1. Monthly statistics of cotton spinning and weaving in Indian mills.
2. Annual statement of the Sea-Borne Trade of British India.
3. Accounts relating to the trade by land of British India with foreign countries.

The notes which were first compiled in 1924 have now been brought up to date. I am indebted to Mr. S. Y. Anandkar, Head Clerk of the Director of Industries, for revising the tables and to the Director, Mr. F. E. Bharucha, for arranging to publish the notes and tables.

BOMBAY,

R. D. BELL.

21st April 1926.

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## NOTES ON THE INDIAN TEXTILE INDUSTRY WITH SPECIAL REFERENCE TO HAND WEAVING

These notes cover the period of twenty-nine years, ending 1924-1925, since the introduction of the cotton excise duty in its present form in 1896-1897. In order to give a view of the handloom industry in proper perspective, I include in the notes and in the tables of statistics information relating to the mill industry and the import of foreign piece-goods.

### COTTON YARN

2. As the facts relating to the handloom industry are based on its consumption of yarn, the statistics of yarn production, imports and consumption are given in tables I and II.

3. **Yarn made in India.**—Table I shows the annual production of yarn in Indian mills after deducting the exports by sea and land. The balance is shown in the last column and represents the amount of *Indian* yarn available for use, year by year, in India for all purposes, viz., (1) in Indian mills, (2) on handlooms, and (3) for miscellaneous purposes.

4. The main points are—

(1) The mill production of Indian yarn has increased by 70 per cent since 1896-1897.

(2) Owing to the loss of the Eastern yarn market, exports by sea have greatly decreased. The best five years were 1901-1902 to 1905-1906 when the annual exports by sea averaged 264 million lbs. In the last five years (ending 1924-1925) they averaged only 59 million lbs.

(3) Owing to these two causes combined, the amount of *Indian* yarn available for use in India has increased by 200 per cent.

5. **Imports of Yarn.**—These are not important in quantity. The net imports available for use in India are shown in the last column.

The total of the last columns of tables I and II gives the total amount of yarn, both Indian and foreign, available annually for use in India. This total is given in column 2 of table IV.

### COTTON CLOTH

6. **Yarn consumed and cloth manufactured in Indian mills.**—Attention is invited to the explanatory notes which follow table III.

7. The chief point for notice in table III is that, since 1896-1897, the production of cloth in Indian mills has increased by 452 per cent.

### 8. Yarn consumed and cloth produced on Indian handlooms.—

Table IV. By deducting the mill consumption of yarn from the total amount of yarn available for consumption in India, we arrive at the amount of yarn available for the handlooms (Column 4). Some allowance should be made for the use of cotton yarn for other purposes, e.g., the making of rope, twine, etc. But this amount is not large and may be off-set against the quantity of handspun yarn which is still used on handlooms. Any error in estimating the amount of yarn available for handlooms cannot exceed ten per cent and does not affect the main conclusions.

9. **Conclusions from Table IV.**—(1) The handloom industry is not declining but has been steadily thriving since the introduction of the cotton excise duty in 1896-1897, when accurate statistics first became available.

(2) The handloom industry is still comparable in its output with the mill industry.

10. Before discussing these conclusions in detail, attention is invited to the last column of table IV which shows the production of cloth in millions of yards on Indian handlooms for comparison with the mill production (table III, Column 4). It should be noted that, while for mill cloth 1 lb. of yarn is taken as equal to 4·78 yards cloth, for handloom production (the bulk of which is coarse) 1 lb. yarn is taken as equal to only 4 lbs. cloth.

11. **Condition of the handloom industry up to 1915-16.**—It will be observed from table IV and the graph that the handloom industry was prosperous up to 1915-16, after which there was a temporary set back. In considering the figures it should be noted that they do not show the actual consumption of yarn by the handlooms year by year but only the quantities of yarn available for use on handlooms. One must allow for variations in the stocks held by mills and dealers and for lag in actual consumption. This is done by taking the figures for periods of five years. We then get the following remarkable results :—

Period.	Total consumption of yarn by handlooms in million lbs.
1896-1897 to 1900-1901 .. ..	1,058
1901-1902 to 1905-1906 .. ..	1,156
1906-1907 to 1910-1911 .. ..	1,294
1911-1912 to 1915-1916 .. ..	1,356

These figures show incontestably that *over four successive quinquennia the consumption of yarn by the handlooms increased by 28 per cent.* The effects of the war are dealt with later.

## 12. Comparison between the handloom and the mill industry.—

Only vague impressions exist in the popular mind regarding the present day importance of the handloom industry. The common impression is that it has had a glorious past but that it has been practically strangled to death by the competition of foreign piece-goods and Indian mill-made cloth and that it is now of little importance. Even careful scientific enquirers have accepted the opinion that hand-weaving is a decayed and still decaying craft. Prof. C. N. Vakil of the Bombay University in his book on "Our Fiscal Policy" has, in a careful historical account of this subject, inserted the following foot-note with reference to the fiscal position in 1882 :—

"It could have been argued that some protection to the Indian handloom industry existed but *it is well known that by this time this industry had ceased to be of any importance.*" - (The italics are mine.)

13. I am not aware of the existence of statistics enabling us to estimate the importance of the handloom industry in 1882 and it is unlikely that Prof. Vakil can produce statistics in support of his foot-note. I quote it to show how widespread and deep rooted is the belief which is accepted without hesitation by a scientific economist in a careful critical discussion.

14. I doubt whether any one can now make an accurate estimate of the handloom industry in 1882. But we do know that fourteen to nineteen years later (from 1896-1897 to 1900-1901) the Indian Mills used in the production of cloth 421 million lbs. of yarn (table III, Column 3), while the amount which went to the handlooms was 1,058 million lbs. or two and a half times as much as the mill consumption. There is no reason to suppose that this was a particularly flourishing period for handlooms or that any remarkable recovery had occurred since 1882. On the contrary, it was a period of bad famines when the hand-weaver suffered heavily as the records of famine relief show. The progress made in subsequent quinquennia, as shown in paragraph 11, also indicates that these five years were not extraordinarily good. It is worth repeating, if a heresy is to be slain, that *only a quarter of a century ago the output of the Indian handlooms was roughly 2½ times that of the Indian mills.*

## EFFECTS OF WAR

15. It will be seen from table IV, Columns 3 and 4, that the output of the mills increased steadily and much more rapidly than the handloom till, in the fourth quinquennium 1911-1912 to 1915-1916, they were practically equal :—

Yarn consumed in mills	..	.. 1,297 million lbs.
Yarn available for handlooms	..	.. 1,346 million lbs.

At this point the handlooms were finally beaten and not only beaten but probably severely crippled for the time being. Owing to the check on the imports after 1915-16 (table V, Column 5) and the enormous demand in India for textiles for war purposes, the mills used much more

of their own yarn and left so much the less available for handloom weavers. The figures for the quinquennium 1911-1912 to 1915-1916, compared with those of the next quinquennium explain how the handloom weaver was left, after 1915-1916, without a sufficient quantity of the raw material of his craft.

Period.				Total yarn available for consumption in India— Table IV, Column 2.	Yarn consumed by the mills— Table III, Column 3.	Yarn available for handlooms, Column 2-Column 3.
				Million lbs.	Million lbs.	Million lbs.
1911-1912 to 1915-1916	..	..	..	2,653	1,297	1,346
1916-1917 to 1920-1921	..	..	..	2,741	1,644	1,097
Difference ..	..	..	..	+ 88	+ 347	— 249

16. Another circumstance which hit the handloom weaver badly at this time was the scarcity and dearness of dyes. The pre-war net consumption of dyes in India over five years was 15,351 thousand lbs. valued on the average at Rs. 0'645 per lb. In 1915-1916 net imports had fallen to 693 thousand lbs. only and for the last three years of the war the annual average net imports were only 1,300 thousand lbs. or less than 9 per cent. of the pre-war figures. Meantime, prices soared and in 1916-1917 the average import value had risen to over Rs. 6 per lb. or ten times the pre-war figure. There is an important connection between village-dyeing and village-weaving which is outside the scope of these notes.

### POST-WAR RECOVERY

17. Sufficient time has now elapsed to enable us to estimate exactly the recovery made by the handloom industry since the armistice. In the last five years 1920-1921 to 1924-1925 more yarn than ever has been available for the handlooms, the annual average being 297 million lbs. as compared with 271 million lbs. during the prosperous quinquennium 1911-1912 to 1915-1916. This is no less than 40 per cent higher than the figures of the first quinquennium. Thus the industry is still increasing in output. This output too is still comparable with that of the mill industry. In the five years 1920-1921 to 1924-1925 the mills used 1,819 million lbs. of yarn while 1,485 million lbs. (or only 18 per cent. less) was available for the handloom weavers. But, if the mills continue to increase as they have done in the past, their output will soon be far ahead of hand-woven production.

### FOREIGN PIECE-GOODS

18. The imports of foreign piece-goods in India are given in table V. To allow for lag (as in the case of hand-woven goods) totals are given below by quinquennia :—

Period.	Total imports of piece-goods in million yards.
1896-1897 to 1900-1901 .. ..	9,661 (100)
1901-1902 to 1905-1906 .. ..	10,418 (108)
1906-1907 to 1910-1911 .. ..	10,698 (111)
1911-1912 to 1915-1916 .. ..	12,499 (129)
1916-1917 to 1920-1921 .. ..	6,564 (68)
Last five years 1920-1921 to 1924-1925 .. ..	6,936 (72)

19. The main features are (1) the steady increase in imports up to 1915-16 when the increase amounted to 29 per cent and (2) the great fall since 1915-1916. Imports for the last five years have been a little more than half those during the five years ending 1915-1916.

### CONSUMPTION OF CLOTH IN INDIA

20. Table V, Column 5, shows the net consumption of foreign piece-goods and table VI, Column 6, the net consumption of Indian piece-goods (mill-made and hand-woven). The totals are given in table VII and the annual averages by quinquennia are shown below :—

Quinquennia.	Net annual consumption of piece-goods in million yards.
1896-1897 to 1900-1901 .. ..	3,079 (100)
1901-1902 to 1905-1906 .. ..	3,485 (113)
1906-1907 to 1910-1911 .. ..	3,904 (127)
1911-1912 to 1915-1916 .. ..	4,667 (151)
1916-1917 to 1920-1921 .. ..	3,535 (115)
Last five years 1920-1921 to 1924-1925 .. ..	4,140 (134)

21. There was a remarkable increase of 51 per cent in apparent consumption over the first four quinquennia. It is likely, however, that the increase in the fourth quinquennium (1911-1912 to 1915-1916) was represented by increased stocks which were absorbed in the following quinquennium (1916-1917 to 1920-1921). The latest figures show that the increased consumption of cloth in India since 1896-1897 is 34 per cent.

### EXPORT TRADE

22. It is worth noting the marked increase in the export by sea of Indian made piece-goods since the war (table VI, Column 4). The pre-war figures were 90 million yards annually; in the last five years the average has been 162 million yards.



## SUMMARY SINCE 1896-97

23. (i) The Indian mill production of cloth has increased steadily year by year ; the total increase is 452 per cent.

(ii) Handloom production had increased by 28 per cent by 1915-1916 ; the increase to-day is 40 per cent.

(iii) The net imports of foreign piece-goods—after nearly twenty years of steady increase—have greatly diminished and have recently been 28 per cent below the level of 1896-1897 to 1900-1901.

(iv) The total Indian consumption of all classes of piece-goods—mill-made, hand-woven, and imported—has increased by 34 per cent.

(v) If we assume that the exports of Indian-made cloth (table VI, Columns 4 and 5) are practically all mill-made goods, the following table shows the consumption in India of mill-made cloth, hand-woven cloth and foreign piece-goods :—

	Figures in millions of yards per annum.	
	First five years, 1896-97 to 1900-01.	Last five years, 1920-21 to 1924-25.
Mill-made cloth (table VI, Column 2 minus Columns 4 and 5).	301 (10 per cent)	1,565 (38 per cent)
Hand-woven cloth (table IV, Column 5) ..	846 (27 per cent)	1,188 (29 per cent)
Foreign piece-goods (table V, Column 5) ..	1,932 (63 per cent)	1,387 (33 per cent)
Totals (table VII) .. .. .	3,079 (100)	4,140 (100)

This table shows :—

(1) The Indian consumer of cloth relies at present on three sources of supply which are not very unequal.

(2) The proportion of the total demand supplied by Indian mills has risen from 10 to nearly 40 per cent, while

(3) over the same period the consumption of foreign piece-goods has fallen from 63 per cent to 33 per cent of the total consumption.

(4) There is also a slight improvement in the percentage consumption of hand-woven cloth.

MISCELLANEOUS FACTS REGARDING HAND-WEAVING  
IN INDIA

24. Weaving population.—The census figures from 1871 were examined by the Indian Industrial Commission and it seems probable that they do not represent the actual state of affairs. At the census of 1921 an enumeration of handlooms was made in two provinces.

Madras.—In the Madras Presidency the number of handlooms actually at work was found to be 170,000.

**Bihar and Orissa.**—In Bihar and Orissa there were 128,400 handlooms besides 34,700 in the feudatory states. The economics of hand-weaving in this province are interesting. The yarn used is mostly coarse counts (12s, 16s and 20s) and the value of the annual output was estimated in 1921 to be five crores. Imports of mill-made cloth and foreign piece-goods were valued at  $7\frac{3}{4}$  crores annually. The average rate of consumption of clothing by the thirty-eight million people of the province was thus only Rs. 3-4-0 per head against the all India average of nearly Rs. 6. In what appears to be so poor a province there would seem to be a good market for Indian mill piece-goods. Yet the handlooms of the province still supply the needs of 40 per cent of its population.

**Bombay.**—The vitality of hand-weaving is indicated by its survival in Bombay City, the very fortress of mill-dom; hundreds of weavers still ply their shuttles under the shadow of the Bombay mills. Weavers are attracted even from the United Provinces by the money to be earned in the handloom karkhanas of Bombay City. Sholapur, an important mill centre, has a very large and thriving handloom industry.

25. **Competition with mills.**—Government experts who have studied the hand-weaving industry for many years were agreed at a conference held at Patna in December 1921 that the hand-weaver can compete with the millowner in weaving the higher and the lower counts but not in the medium counts.

One factor in favour of the handloom is the great number of specialised types of cloth of which conservative Indian custom decrees the use and which, either from their quality or the nature of the demand, do not offer opportunities for mass production in mills. There are no statistics to show what is the production of any particular cloth on handlooms but there are figures for the export of one special type, *viz.*, Madras shawls or handkerchiefs.

Table VIII.

Period (each five years).	Exports in lakhs of pieces.
1889-1890 to 1893-1894 .. .. .	71
1894-1895 to 1898-1899 .. .. .	82
1899-1900 to 1903-1904 .. .. .	80
1904-1905 to 1908-1909 .. .. .	99
1909-1910 to 1913-1914 .. .. .	102
[1911-1912 to 1915-1916 .. .. .]	103
This is the culminating period before the war imposed a check.]	
1914-1915 to 1918-1919 .. .. .	76
1919-1920 to 1923-1924 .. .. .	109

Over the twenty-seven years ending 1915-1916 when the war imposed a check, the export of Madras handkerchiefs had increased by 53 per cent. Since the war exports have been greater than ever and the last two years have beaten all records.

26. **Use of imported yarn.**—It has been suggested that the abolition of the 5 per cent import duty on imported yarn would confer a great benefit on the handloom industry. The use of imported yarn is, however, often exaggerated. The net imports (table II, Column 5) into India during the last five years were a record but averaged only 48 million lbs. annually. There are no statistics available to show how much of this is used in mills and how much by hand weavers but the total imports may be compared with the amount of mill-spun yarn that was available annually for the handlooms during the same period, *viz.*, 297 million lbs. An examination of pre-war figures shows that the hand-weavers' consumption of foreign yarn is only 10 to 12 per cent of his total consumption.

The importance of imported yarn cannot be entirely estimated however by the total weight imported. On yarn of fine counts the hand-weaver expends a very much larger amount of labour per lb. of material used than on coarse yarn. The following examples were quoted by the Industrial Commission (the figures are pre-war). In the manufacture of a turban cloth made of 100s counts 1·3 lbs. of yarn, costing Rs. 3-4-0, were used and the labour charges came to Rs. 5-8-0 equivalent to Rs. 4-3-8 per lb. of yarn, while in the manufacture of cloth from 20s counts 3½ lbs. of yarn costing Rs. 2 were used and the labour charges amounted to Rs. 1-9-0 or slightly over 7 annas per lb. These examples are extreme cases. In an intermediate example of a *dhoti* made from 60s counts the cost of the yarn was Rs. 1-8-0 and the cost of the labour Rs. 1-2-4 per lb. These facts explain why the use of silk in weaving though small in amount provides a relatively very large amount of employment.

Details of the imports of yarn—pre-war and post-war—are given in table IX. It will be noticed that in the five post-war years the import of high counts was not exceptional and that a surprisingly large amount of 16s to 20s is included.

## CONCLUSIONS

27. The facts cited above are sufficient to prove that the handloom industry of India is still of great importance in the national economy. It provides the country with nearly one-third of its requirements of cloth; it is steadily, if slowly, increasing its output; and it is still comparable as regards output with the mill industry. All the highest classes of textile weaving in India are done solely on handlooms. It is evident that the hand-weaving industry is still of great importance in the economic and social life of the country, and it will be interesting to watch whether it is affected by the abolition of the excise duty.

The mill industry and the handloom industry are not really antagonistic to one another. A great part of the output of the handlooms is composed of specialised types of cloth which are not suitable as regards quantity

or quality for mass production. The amount of *direct* competition between the mills and the handlooms is at present restricted.

The handlooms provide an enormous market for mill-spun yarns. Probably, the greatest improvement in the handloom industry has been the provision of ample quantities of mill-spun yarns of all counts and of regular twist and strength in substitution for the irregular and usually coarse hand-spun yarns of former days.

But the hand-weaving industry should not be measured entirely in terms of mere production. Like other village crafts it is peculiarly suited to the sentiments, habits and caste customs of the Indian worker, who usually prefers the hardships of village life and a cottage craft to the evils which unfortunately often accompany industrialism in India as elsewhere. One of the worst evils of the industrial system in large Indian cities is its disintegrating influence on the worker's family life and this family life is left unimpaired by the circumstances in which crafts are carried on in Indian villages. The protection of the handloom weaver may be just as necessary as the preservation of the peasant cultivator. Government have by legislation, cheap loans, the operations of the Departments of Agriculture and Co-operation and other means, done much for the improvement of the small agriculturists. Some day the village craftsman may receive a corresponding measure of attention.

Finally, the hand-weaver is often not merely a worker but a craftsman and an artist. Apart from all questions of design, quality and variety, there is something in the very "feel" of hand-woven cloth, which makes an appeal to the public in all countries.

Other aspects of the weaving industry—*e.g.*, the technical and business difficulties of the hand-weaver and the assistance already given to him by Government through co-operative societies and weaving schools and demonstrations—are outside the scope of these notes. Those interested will find them treated in the annual reports of the Registrar of Co-operative Societies and the Director of Industries.

TABLE I  
Cotton Yarn (Indian)

Year.	Mill production.	Exports by sea.	Exports by land.	Net consumption in India.
	(In million lbs.)			
1896-97 .. .. .	423 (100)	196	3·0	224 (100)
1897-98 .. .. .	462	200	3·1	259
1898-99 .. .. .	512	220	3·0	289
1899-1900 .. .. .	514	241	3·0	270
1900-01 .. .. .	353	118	4·1	231
1901-02 .. .. .	573	272	6·4	295
1902-03 .. .. .	576	249	6·3	321
1903-04 .. .. .	579	252	8·0	319
1904-05 .. .. .	578	248	7·7	322
1905-06 .. .. .	681	298	6·9	376
1906-07 .. .. .	654	244	7·1	403
1907-08 .. .. .	638	216	7·7	414
1908-09 .. .. .	657	235	7·3	415
1909-10 .. .. .	627	227	6·5	393
1910-11 .. .. .	610	183	7·7	419
1911-12 .. .. .	625	151	9·7	464
1912-13 .. .. .	688	204	11·0	473
1913-14 .. .. .	682	198	8·9	475
1914-15 .. .. .	652	134	8·8	509
1915-16 .. .. .	722	160	7·9	554
1916-17 .. .. .	681	169	8·5	503
1917-18 .. .. .	660	122	8·4	529
1918-19 .. .. .	615	64	8·7	542
1919-20 .. .. .	636	152	8·5	475
1920-21 .. .. .	660	83	5·6	571
1921-22 .. .. .	693	81	7·1	605
1922-23 .. .. .	706	57	6·5	643·5
1923-24 .. .. .	617	39	7·3	570·7
1924-25 .. .. .	719 (170)	37	8·6	673·4 (300)

Exports by sea:—

Note.—Best period 1901-02 to 1905-06 .. .. .

Last five years .. .. .

Annual average

.. .. . 264

.. .. . 59

Decrease .. .. . 205

TABLE II

## Cotton Yarn (Foreign)

Year.	Imports.	Re-exports.		Net consumption in India.
		By sea.	By land.	
		(In million lbs.)		
1896-97 .. .. .	50.2	1.4	3.1	45.7
1897-98 .. .. .	58.3	1.8	3.5	53.0
1898-99 .. .. .	45.5	1.5	4.8	39.2
1899-1900 .. .. .	42.6	1.9	3.6	37.1
1900-01 .. .. .	34.8	1.2	3.5	30.1
1901-02 .. .. .	38.3	1.7	5.0	31.6
1902-03 .. .. .	33.7	1.4	4.4	27.9
1903-04 .. .. .	28.0	1.2	3.7	23.1
1904-05 .. .. .	30.6	1.3	3.9	25.4
1905-06 .. .. .	45.8	0.9	4.1	40.8
1906-07 .. .. .	37.7	0.8	4.7	32.2
1907-08 .. .. .	37.3	1.0	5.6	30.7
1908-09 .. .. .	41.5	0.7	5.8	35.0
1909-10 .. .. .	40.3	1.0	4.6	34.7
1910-11 .. .. .	32.5	1.0	4.4	27.4
1911-12 .. .. .	42.0	0.8	6.5	34.7
1912-13 .. .. .	50.0	0.8	8.5	40.7
1913-14 .. .. .	44.2	1.0	7.3	35.9
1914-15 .. .. .	42.9	0.7	8.2	34.0
1915-16 .. .. .	40.4	0.8	7.9	31.7
1916-17 .. .. .	29.5	1.5	5.2	22.8
1917-18 .. .. .	19.4	0.6	5.5	13.3
1918-19 .. .. .	38.1	1.1	5.0	31.4
1919-20 .. .. .	15.1	2.9	4.3	7.9
1920-21 .. .. .	47.3	0.3	3.3	43.7
1921-22 .. .. .	57.1	0.6	3.0	53.5
1922-23 .. .. .	59.3	1.5	4.8	53.8
1923-24 .. .. .	44.6	1.5	3.6	39.5
1924-25 .. .. .	55.9	1.0	4.4	50.5

TABLE III

*Yarn Consumed and Cloth Manufactured in Indian Mills*

Year.	Cotton cloth manufactured in Indian Mills. lbs. mill.	Mill consump- tion of yarn. Cel. 2 × 25/28.	Cotton cloth manufactured in Indian Mills. Yards mill.
1896-97 .. .. .	83 (100)	74	354
1897-98 .. .. .	91	81	389
1898-99 .. .. .	102	91	436
1899-1900 .. .. .	98	87	419
1900-01 .. .. .	99	88	422
1901-02 .. .. .	120	106	511
1902-03 .. .. .	123	109	524
1903-04 .. .. .	138	123	589
1904-05 .. .. .	159	141	678
1905-06 .. .. .	164	146	700
1906-07 .. .. .	166	148	708
1907-08 .. .. .	189	168	808
1908-09 .. .. .	192	171	824
1909-10 .. .. .	229	204	963
1910-11 .. .. .	246	219	1,043
1911-12 .. .. .	267	238	1,136
1912-13 .. .. .	285	254	1,220
1913-14 .. .. .	274	244	1,164
1914-15 .. .. .	277	247	1,136
1915-16 .. .. .	352	314	1,441
1916-17 .. .. .	378	322	1,578
1917-18 .. .. .	381	340	1,614
1918-19 .. .. .	350	312	1,451
1919-20 .. .. .	384	342	1,640
1920-21 .. .. .	367	328	1,581
1921-22 .. .. .	403	360	1,732
1922-23 .. .. .	405	362	1,725
1923-24 .. .. .	401	359	1,702
1924-25 .. .. .	458(552)	410	1,970

*N. B.—See explanatory notes attached.*

### EXPLANATORY NOTES ON TABLE III

Column 2 is taken from the monthly statistics of cotton spinning and weaving in Indian mills. The figures include hosiery but the quantity included on this account is negligible and amounted in the last three years to only 0·13 per cent of the total.

Column 4 expresses the figures in column 2 in millions of yards of cloth. Since 1906-07 the figures in column 4 have been reported in the publication just mentioned, the basis of conversion from column 2 being 1 lb. cloth = 4·27 yards. For years previous to 1906-07 the figures in column 4 have been calculated by me on this basis also.

Column 3 shows the mill consumption of yarn as deduced from the production of cloth given in column 2 on the basis of 100 lbs. of yarn producing 112 lbs. of cloth. The increase of 12 lbs. after weaving is due, after allowing for wastage, to the extra weight added in the sizing and finishing processes. The percentage increase of 12 is taken as a general average for all India and a few remarks are necessary to explain the adoption of this figure.

The figure of 12 per cent was adopted in 1918 by the Indian Industrial Commission on the authority of the following memorandum supplied by Sir B. D. Mehta of the Empress Mills, Nagpur.

#### “MEMORANDUM

“The Annual Reports of the Bombay Millowners’ Association give statistics of the production and distribution of cotton yarns manufactured in Indian mills. The following is an extract from the Report for 1916 :—

“The quantity of yarn produced in India during the official year 1915-16 amounted to 722,424,579 lbs. Of this amount, 314,512,996 lbs. were consumed in the production of 352,254,556 lbs. of cloth and 160,231,736 lbs. exported to foreign countries during the official year 1915-16 leaving a balance of 247,679,847 lbs.’

“The Association assumes in the above that every 100 lbs. of yarn used in weaving give out a cloth production of 112 lbs. Accepting this authority, the factor for turning cloth into yarn is  $\frac{100}{112}$  or  $\frac{25}{28}$ , i.e., multiply the weight of cloth in pounds by 25, and divide by 28 and you get the weight of the yarn which goes to the making of that cloth.

“The balance of yarn left after deducting the quantities exported and consumed by mills is not all consumed by hand weavers. A small proportion of this must be used for making rope, twine, etc. In a paper which he read before the First Indian Industrial Conference of 1905, Sir Vithaldas Thackersay estimates this proportion to be about 10 per cent of the balance. The remainder of course must ultimately find its way to handlooms.”



The Bombay Millowners' Association was consulted again in April last regarding the use of the factor  $\frac{100}{112} = \frac{25}{28}$  and the Secretary then gave the following information.

"With reference to the method of calculating the weight of yarn used in the production of cloth my Committee are inclined to think that the extra weight added in sizing and finishing should be taken as 10 per cent instead of 12 per cent.

"The allowance to be made for waste at all machines from the end of the spinning process to the end of the weaving process may be taken as approximately 5 per cent.

"Thus in calculating the amount of yarn used in the production of mill-made cloth (column 6 of statement II of Appendix I to the report of the Indian Industrial Commission) an approximately correct figure will be obtained by deducting 5 per cent from the figure shown in column 5 (of the same Appendix)."

These remarks mean that the figures entered in column 3 of the Table above are too low and in consequence the figures in column 4 of Table IV are too high.

It does not seem, however, that the modifications in the figures suggested by the Bombay Millowners' Association, though correct for Bombay, are applicable to all India. The Secretary of the Ahmedabad Millowners' Association on being addressed stated, on behalf of his Committee, as follows:—

"Ahmedabad mills put on 100 per cent. of size on warp yarn. Making allowance for the size that disappears in the process of weaving the percentage of size retained would come to about 30 per cent.

"The estimate of the average percentage of wasted yarn in the process of weaving would come to about 3 per cent."

The last figure seems unduly low. Enquiries have been made in other directions and the practice of various mills in different places discussed. I have come to the conclusion that as regards the whole of India there is no need to change the basis of calculation adopted in 1918 by the Indian Industrial Commission. I have assumed, therefore, that in India as a whole 100 lbs. of yarn produce on the average 112 lbs. of mill-made cloth, after allowing *both* for loss of weight by wastage of yarn and for increase of weight due to sizing and finishing—

Thus

$$\left. \begin{array}{l} 1 \text{ lb.} \\ = 4.27 \text{ yards} \end{array} \right\} \text{ cloth} = \frac{25}{28} \text{ lbs. yarn.}$$

This gives 1 lb. yarn = 4.78 yards cloth (mill-made).

It may be added that Mr. Coubrough in his "Notes on Indian Piece Goods Trade" mentioned in the preface assumes that one yard cloth (mill-made) = 0.21 lbs. yarn or 1 lb. yarn = 4.76 yards cloth. So that his basis of conversion is practically the same as that of the Indian Industrial Commission.

TABLE IV

*Yarn Consumed and Cloth Produced by Indian Handlooms*

Year.	Total yarn available for consumption in India.	Mill consumption of yarn.	Yarn available for handlooms.	Cloth produced on handlooms.
	Mill. lbs.	Mill lbs.	Mill lbs.	Mill yds.
1896-97	270	74	196	784
1897-98	312	81	231	924
1898-99	328·2	91	237	948
1899-1900	308	87	221	884
1900-01	261	88	173	692
1901-02	326	106	220	880
1902-03	349	109	240	960
1903-04	341	123	218	872
1904-05	348	141	207	828
1905-06	417	146	271	1,084
1906-07	435	148	287	1,148
1907-08	445	168	277	1,108
1908-09	450	171	279	1,116
1909-10	428	204	224	896
1910-11	446	219	227	908
1911-12	499	238	261	1,044
1912-13	514	254	260	1,040
1913-14	511	244	267	1,068
1914-15	543	247	296	1,184
1915-16	586	314	272	1,048
1916-17	526	322	204	816
1917-18	543	340	203	812
1918-19	574	312	262	1,048
1919-20	483	342	141	564
1920-21	615	328	287	1,148
1921-22	657·5	360	297·5	1,190
1922-23	697·3	362	335·3	1,341
1923-24	610·2	359	251·2	1,005
1924-25	723·9	410	313·9	1,256

Column 2 gives the totals of column 5 Table I and column 5 Table II.

Column 5 is based on column 4 by taking 1 lb. yarn = 4 yards cloth.

TABLE V

## FOREIGN PIECE-GOODS

Year.	Imports.	Exports		Net consumption in India.
		By sea.	By land.	
		(In million yards.)		
1896-97	1,997	13	52	1,932
1897-98	1,861	13	48	1,800
1898-99	2,069	12	57	2,000
1899-1900	2,191	68	69.8*	2,054
1900-01	2,003	62	66*	1,875
1901-02	2,190	72	76*	2,042
1902-03	2,107	56	65*	1,986
1903-04	2,033	67	63*	1,903
1904-05	2,288	63	73*	2,152
1905-06	2,463	67	61*	2,335
1906-07	2,318	62	63*	2,193
1907-08	2,532	63	67*	2,402
1908-09	1,993	49	73*	1,871
1909-10	2,193	52	71	2,070
1910-11	2,308	68	78	2,162
1911-12	2,438	76	100	2,262
1912-13	3,023	67	108	2,848
1913-14	3,197	62	93	3,042
1914-15	2,446	35	83	2,328
1915-16	2,148	41	88	2,019
1916-17	1,934	97	65	1,772
1917-18	1,556	85	65	1,406
1918-19	1,212	114	53	1,045
1919-20	1,081	89	56	936
1920-21	1,510	61	44	1,405
1921-22	1,090	74	36	980
1922-23	1,593	75	51	1,467
1923-24	1,486	61	51	1,374
1924-25	1,823	54	59	1,710

\* Incomplete.

TABLE VI

INDIAN PIECE-GOODS

Year.	Cotton cloth manufactured in India.		Exports.		Net consumption in India.
	In mills.	On hand- looms.	By sea.	By land.	
	(In million yards.)				
1896-97 .. ..	354	784	75	32	1,031
1897-98 .. ..	389	924	62	35	1,216
1898-99 .. ..	436	948	61	29	1,294
1899-1900 .. ..	419	884	70	42	1,191
1900-01 .. ..	422	692	69	42	1,003
1901-02 .. ..	511	880	73	47	1,271
1902-03 .. ..	524	960	70	39	1,375
1903-04 .. ..	589	872	76	49	1,336
1904-05 .. ..	678	828	87	48	1,371
1905-06 .. ..	700	1,084	92	37	1,655
1906-07 .. ..	708	1,148	77	38	1,741
1907-08 .. ..	808	1,108	74	38	1,804
1908-09 .. ..	824	1,116	78	35	1,827
1909-10 .. ..	963	896	94	32	1,633
1910-11 .. ..	1,043	908	100	34	1,817
1911-12 .. ..	1,136	1,044	81	37	2,062
1912-13 .. ..	1,220	1,040	87	38	2,135
1913-14 .. ..	1,164	1,068	89	41	2,102
1914-15 .. ..	1,136	1,184	67	43	2,210
1915-16 .. ..	1,441	1,048	113	48	2,328
1916-17 .. ..	1,578	816	264	45	2,085
1917-18 .. ..	1,614	812	189	45	2,192
1918-19 .. ..	1,451	1,048	149	38	2,312
1919-20 .. ..	1,640	564	197	42	1,965
1920-21 .. ..	1,581	1,148	146	24	2,558
1921-22 .. ..	1,732	1,190	161	26	2,735
1922-23 .. ..	1,725	1,341	157	29·4	2,880
1923-24 .. ..	1,792	1,005	165	36	2,596
1924-25 .. ..	1,970	1,256	181	49	2,996

TABLE VII

## TOTAL CONSUMPTION OF PIECE-GOODS (IMPORTED, MILL-MADE AND HAND-MADE) IN INDIA

Year.	In million yards.		Remarks.
	Yards.	Averages.	
1896-97	2,963	3,079	
1897-98	3,016		
1898-99	3,294		
1899-1900	3,245		
1900-01	2,878	3,485	
1901-02	3,313		
1902-03	3,361		
1903-04	3,239		
1904-05	3,523		
1905-06	3,990		
1906-07	3,934	3,904	
1907-08	4,206		
1908-09	3,698		
1909-10	3,703		
1910-11	3,979		
1911-12	4,324	4,667	
1912-13	4,983		
1913-14	5,144		
1914-15	4,538		
1915-16	4,347	3,535	
1916-17	3,857		
1917-18	3,598		
1918-19	3,357		
1919-20	2,901		
1920-21	3,964		
1921-22	3,715	4,140	
1922-23	4,347		
1923-24	3,970		
1924-25	4,706		

TABLE VIII

*Handkerchiefs and Shawls (Indian) Exports*

Year.	In the piece		Value.	Remarks.
	No.	Rs.		
1889-90	1,224	645		
1890-91	1,869	805		
1891-92	1,938	803		
1892-93	1,031	428		
1893-94	997	443		
1894-95	1,233	584		
1895-96	1,464	624		
1896-97	2,058	816		
1897-98	1,760	707		
1898-99	1,654	683		
1899-1900	1,275	505		
1900-01	1,424	510		
1901-02	1,742	694		
1902-03	1,745	738		
1903-04	1,771	771		
1904-05	2,613	1,212		
1905-06	1,893	915		
1906-07	1,180	618		
1907-08	2,116	1,029		
1908-09	2,124	1,067		
1909-10	1,886	974		
1910-11	2,124	1,172		
1911-12	2,869	1,525		
1912-13	1,950	1,136		
1913-14	1,395	816		
1914-15	1,538	858		
1915-16	2,541	1,467		
1916-17	1,874	699		
1917-18	716	401		
1918-19	890	759		
1919-20	2,100	2,082		
1920-21	2,562	3,261		
1921-22	903	867		
1922-23	2,254	2,482		
1923-24	3,124	3,491		
1924-25	3,927	4,564		

The figures are in thousands.

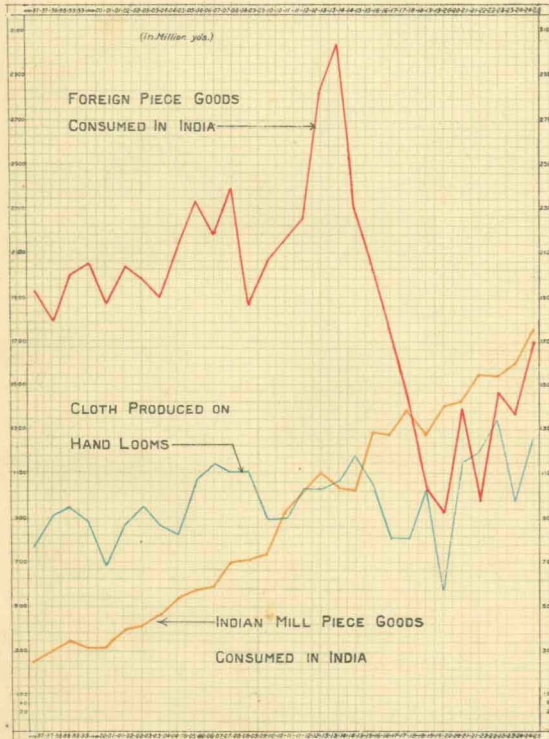
TABLE IX

## DETAILS OF IMPORTS OF YARN—PRE-WAR AND POST-WAR

(DETAILS FOR RE-EXPORTS ARE NOT AVAILABLE)

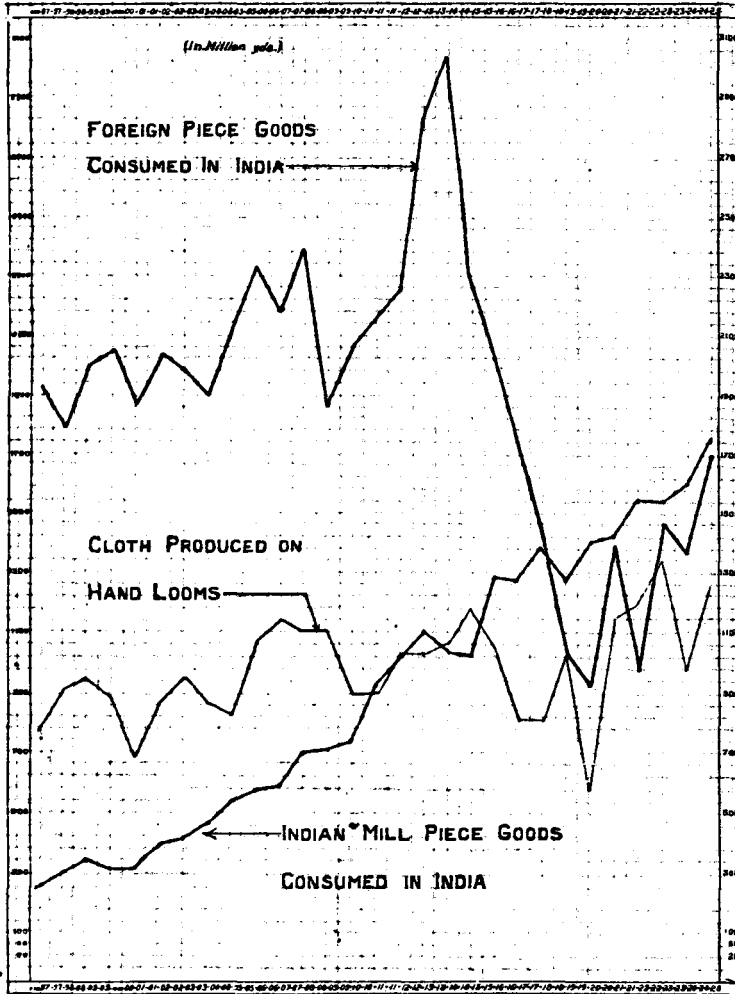
Description of Yarn.	Figures in thousands of lbs.	
	Pre-war.	Post-war.
	Average of five years 1909-10 to 1913-14.	Average of five years 1920-21 to 1924-25.
Grey Nos. 1 to 15 .. .. .	208	205
Grey Nos. 16 to 20 .. .. .	372	7,841
Coloured Nos. 1 to 20 .. .. .	812	284
Grey Nos. 21 to 25 .. .. .	152	375
Coloured Nos. 21 to 25 .. .. .	847	304
Grey Nos. 26 to 30 .. .. .	2,555	2,744
Coloured Nos. 26 to 30 .. .. .	829	182
Grey Nos. 31 to 40 .. .. .	9,215	17,661
Coloured Nos. 31 to 40 .. .. .	13,998	7,085
Grey Nos. 41 to 50 .. .. .	2,429	2,027
Coloured Nos. 41 to 50 .. .. .	589	160
Grey Nos. 51 to 60 .. .. .	3,664	2,374
Grey Nos. 61 to 100 .. .. .		
Grey over 100 .. .. .	920	109
Coloured over 50 .. .. .		
Total Greys .. .. .	18,595	35,338
Total Coloureds .. .. .	17,995	8,447
Grey two folds .. .. .	5,225	4,136
Coloured two folds .. .. .		
White bleached .. .. .		
Mercurised .. .. .		
Unspecified .. .. .		52
Grand totals .. .. .	41,815	52,860

APPENDIX





APPENDIX





Government of Bombay  
DEPARTMENT OF INDUSTRIES

Report  
on the  
Village Tanning Industry  
in the  
Bombay Presidency

BY

Y. R. GAITONDE, B.A. (HON.), B.Sc.,  
DIP. LEATH. TECH. (London),  
Silver Medallist (London City and Guilds),  
Member, S. I. L. T. Chemists

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## FOREWORD

Government were pleased to appoint Mr. Y. R. Gaitonde in the year 1927 as a special officer to carry out a survey of the Tanning Industry of the Bombay Presidency. Mr. Gaitonde took up the duties of his post on the 15th of September of that year, toured all over the Presidency and completed his work in May 1928.

2. The importance of the Hides and Skins Trade and Tanning and Leather Industries may be gauged from the following few facts : Mr. Gaitonde has estimated that 15 lakhs hides, 3 lakhs sheep skins and 40 lakhs goat skins of the aggregate value of Rs. 2 crores are produced annually in the Presidency. In 1927-28 raw hides and skins of the value of Rs. 81 lakhs were exported from Bombay and Rs. 147 lakhs from Karachi. So far as Karachi is concerned, bulk of the hides and skins came as usual, no doubt, from the Punjab and the U. P., etc. In the same year half-tanned hides and skins of the value of Rs. 108 lakhs were exported from Bombay and Rs. 10.75 lakhs from Karachi. The value of imported manufactured leather articles, after allowing for re-exports, was Rs. 59.2 lakhs for Bombay and Rs. 4 lakhs for Karachi. Under the occupation "tanning" the census of 1921 shows 12,268 males engaged as tanners, the total number including dependents being 37,707. It will be noted, however, that castes, such as Chambhars, Mochis, Mochigars, Sochis, Kalals, Khatiks, Mahars, Holiyas, Dheds, Dhors, Mangs and Madigs, though not included as tanners, do general leather work. The total number of the above, according to the census of 1921, is 6,97,796, and the total including dependents comes to 13,95,375.

3. Mr. Gaitonde's Report, which is both interesting and informative, is published in its original form except for a few minor corrections and alterations. The views expressed are

those of the Surveyor ; it is not necessary for the Department of Industries to pronounce on them here. It is hoped that the Report will be of service to the Hides and Skins Trade as well as to the Tanning and Leather Industries and that it will stimulate their further development in the Presidency.

P. B. ADVANI,  
Director of Industries.

OLD CUSTOM HOUSE,  
Bombay, 22nd October 1929.

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Map showing the principal Tanning Materials produced in each district of the Bombay Presidency.	

## CHAPTER I

### RAW HIDES AND SKINS

1. Most of the hides available in India are of animals raised for agricultural and other domestic purposes, while a small number of hides and most of the skins are of animals that are killed by the butcher for food.

2. Skins from large, full grown animals such as cows, buffaloes, horses, etc., are usually called "hides." A large number of our cows are small in size; hides of such animals are called "kips." Skins of very young animals such as calves and of goat, sheep, deer, etc., are called "skins."

Only hides and skins, the supply of which is regular and abundant, are of interest to the tanning industry.

3. The raw hides in the Bombay Presidency are, as in other parts of India, generally hides of cows, and buffaloes and skins of calves, goats and sheep. Hides of horses and camels and skins of neilgai and deer, etc., are also available in small numbers.

These hides and skins could be classified under two heads:—

- ✓ 1. Halali (slaughtered).
- ✓ 2. Mudadari (deads).

• A large portion of the Halali hides and of the hides of good quality from the Mudadaris are exported and the rest are used by the advanced tanners, while the hides of inferior quality are tanned by local tanners.

The value of hides and skins depends upon the condition in which they come to the tanners. It is most unusual for hides and skins to be tanned immediately after the animals are slaughtered and flayed and they cannot be kept in good condition without special treatment for more than a few hours after flaying. This treatment is called curing or preserving.

4. The most important factors which count in valuing hides and skins are:—

- (1) Proper flaying, *i.e.*, no butcher's cuts (gashes made with the butcher's knife) and holes.
- (2) Even grain, *i.e.*, no branding, thorn or goad marks, scratches or defects on the grain side due to any disease or putrefaction.
- (3) Proper preservation.
- (4) Substance, weight, size, quality (texture), and so on. These things mostly depend upon the class of the breed of animals and other natural conditions under which the animals are reared.

In the first three items, any defects could be attended to and avoided easily.

In the last item, some improvements, where the hides are of very loose texture near the shoulders and bellies or are of poor substance, could be brought about by crossing the animals with better breed. This question is, however, the concern of the Agricultural Department.

5. **Production of hides and skins.**—Accurate figures of hides and skins produced in the Presidency are not available. But from the general information gathered from various officials and persons in the trade, I would say that about 1,500,000 hides, 300,000 calf skins and 4,000,000 goat and sheep skins are produced annually. Out of these 150,000 hides, 22,000 calf skins and 22,000,000 goat and sheep skins are produced in the various municipal slaughter-houses; some are from animals slaughtered for sacrifice and the remainder are from dead animals. During cattle epidemics and famines the number of hides and skins is greatly increased.

Statements II and III give exports of hides and skins from Bombay and Karachi. A number of these are, no doubt, from outside the Presidency, but the figures give an idea of the business transacted.

6. **Flaying.**—Flaying plays a very important part in the matter of price which may be obtained for hides and skins. The flayers in the Presidency know their work, but owing to their carelessness and want of forethought, a lot of money is lost to the trade.

As the value of the hide is small compared with that of the meat, many butchers do their work very carelessly. In order to get every bit of meat the butcher makes cuts in the hide, but if he were careful he could recover all the meat without damaging the hide. During my investigations, in many places I was told that the hides from slaughter-houses, especially from the commissariats, are worse flayed than those from the local butchers.

Even if the hide is good in all other respects but has a few butcher's cuts and holes, it is at once sorted as 2nd or 3rd class and it is sometimes rejected. A few cuts in a hide make its value less by Rs. 4 or Rs. 5.

7. During the war, the Indian Munitions Board with the help of local Governments made some attempts to improve the quality of hides and skins by bringing home to the flayers the importance of careful flaying, etc.; and in many places some valuable success was obtained. After some years Government work in this direction was stopped, with the result that things have again more or less reverted to their original state in many places. Still it is interesting to note that in some places the flayers have realised the value of good flaying with the result that in those places better flayed hides are produced.

This shows that if active steps are again taken by Government with the co-operation of the hides and skins merchants and tanners, the flayers under a certain amount of pressure will strive to do their work well.

Until a few years ago the same defects were prevalent in European countries. As far as I know, in the British Isles these defects have been minimised by the co-operation of the different federations of hides and skins merchants, tanners and butchers.

Here the people interested in this trade are unable to take concerted action in the matter and hence it would be advisable for Government to take the initiative and save the Presidency from a heavy loss.



8. When an animal dies in a village what happens is this :—

In order to get rid of the carcase the owner drags away the dead animal to a particular place. When the village Mahar gets the information, he comes with one or two other Mahars and drags it a long distance further. When the dead animal is thus dragged along the rough ground its grain gets scratched and then putrefaction sets in.

9. Now the village Mahar is never a tanner and hence he does not understand the value of the hide from a tanner's point of view. As a rule he has some sort of right over the hides from the dead animals in his village. He often sells his yearly output of hides to a petty hide dealer or the village Chambhar in consideration of an advance. As the village Mahar gets a fixed price in advance, he cares very little whether he produces well or badly flayed hides. When the animal is flayed, often the hide is left there in dirt, blood, etc., for some time till the meat is disposed of. There is often an interval of a day or two between the death of the animal and the Chambhar's or hide merchant's acquisition of the hide. The result is that the hide gets nearly decomposed as it is not even washed or cleaned.

10. **Branding.**—The second drawback which lessens the value of a hide is branding. Branding is resorted to by agriculturists (1) as a remedy against many forms of cattle disease, (2) as a protection against theft of the living animal.

Certain local diseases in the body may be cured by branding, but in that case branding the whole of the body or the side is not necessary. In such cases a few dotted brands on the affected part may well serve the purpose and at the most  $\frac{1}{4}$  or  $\frac{1}{2}$  square foot of hide may be damaged but not the whole. In certain diseases it has been proved that branding is no remedy.

Goad marks on the animals used for draught purposes also lessens the value of a hide. Sometimes the animal is so mercilessly goaded that it bleeds and not only is the hide damaged but the poor animal suffers great torture.

11. **Curing or preserving.**—If hides and skins cannot be tanned while they are still fresh, they must be specially treated in order to preserve them. This must be done in such a way that they can be easily soaked back to the original soft condition, when they are to be tanned,

12. In this Presidency hides are mainly preserved in three ways :—

- (1) Air dried.
- (2) Wet salted.
- (3) Arsenicated.

When a hide dealer who understands the value of proper drying, buys a hide in the fresh state he washes it in water and removes any dirt from it, then throws it on the ground in the morning, when the sun is not too hot. When the sun begins to get very hot he picks it up and throws it on a bamboo pole in the shade where the hide is dried gradually.

This he does when he is not able to send the hide to a big hide merchant within a short time, but when he can do the latter or when he wants to send it a short distance he spreads the hide on the ground and applies salt to it on the flesh side. It is then rolled up in a bundle and after allowing excess of brine to drain off, it is packed in a gunny bag and in this wet salted condition it is sent to a big hide dealer or a tanner.

Sometimes when hides are to be kept for a considerable time before tanning they are given a coat of salt and are dried on the ground, flesh side up. However, it is not usual in this Presidency to preserve hides in dry salted condition.

In Karachi some of the hides which are to be exported are turned into "Farma" (framed hides). For this they use fresh, wet salted and air dried hides, but free from butcher's cuts or any other damage. In Ahmedabad a few "Farmas" are produced, and in some other places only when the merchants get definite orders for such hides. The "Farmas" are also called "arsenicated."

Hides which are to be turned into "Farma" if they are in fresh or wet salted condition, are washed properly and if in air dried condition thoroughly soaked to bring them back to soft condition. All the dirt and adhering flesh are removed. They are then stretched on bamboo frames and tied with strings; then a little arsenic solution is sprinkled over each hide and they are then dried, sorted, pressed and packed in bales for export. Some exporters after washing and cleaning the hides dip them in a weak solution of arsenic (one hide at a time) then stretch and dry them as mentioned above. Every exporter has got his own formula for the arsenic solution.

13. Though hides preserved in the abovementioned ways are satisfactory yet a great number of them which are preserved by village Mahars or Dheds are carelessly treated; and especially those which are air dried.

First, after flaying, the hide is not properly cleansed and the adhering flesh and fat are not removed. Then it is thrown on the rough ground in the hot sun with the result that the hide is badly damaged especially where it is folded and has adhering flesh and fat. The hide is sold by weight and hence in some places it is given a coat of earth, ash, etc., not only to give extra weight but to hide the butcher's cuts. Some dry it on a pole in the hot sun to avoid any damage caused by spreading it on the earth not thinking that even a hot pole damages the part of the hide which is laid on it during the drying. Now if the hide after removing the dirt and all the adhering flesh is spread on a level piece of ground, in the morning sun and then put in the shade, where the ground is not so hot, it will be saved from much damage.

Better results could be obtained if, after careful flaying, all the dirt is washed off from the hide and then unnecessary flesh and fat are removed. It could then be dried slowly and uniformly by hanging it on a wall or some frame or on a pole in the shade.

14. **Skins.**—Skins are mainly preserved in the following three ways :—

- (1) Wet salted.
- (2) Dry salted.
- (3) Air dried.

In many important villages, taluka and district towns there are sub-agents of big exporting firms, and local petty skin merchants, who collect skins by buying them from the neighbouring villages, from the local slaughter-houses and Khatiks daily for cash or by monthly contracts and in the weekly bazars held in the various places in the neighbourhood. The skins which are thus collected are then sorted according to their size, weight and quality. They are then salted with common salt after which they are forwarded to the big collecting centres in wet salted state. These centres are Karachi, Sukkur, Hyderabad, Ahmedabad, Bhusaval, Dhond, Bombay, Belgaum and Ahmednagar.

15. The goat skins are sorted in two general classes, (1) for tanning in India and (2) for export in raw condition.

Those which are to be tanned in India are sent to the local tanneries in wet salted condition.

Some of the skins which are meant for export, are cut along the bellies and are trimmed by removing tail, head, shanks, etc., to give a square pattern, according to the various standards for export in different countries. They are then washed, the adhering flesh is removed, and they are folded along the ridge with the flesh side out. A mixture of salt and khari earth (which contains sodium sulphate) is applied and they are then dried on the ground in the morning sun and during the hot part of the day in the shade. When they are dry a coat of some saline solution is put on the flesh side, rubbing it in with the hand. They are now put on poles and allowed to dry again but during the hot part of the day they are kept in the shade. When they are dry, the hair side is brushed and they are then packed in bundles and pressed in bales for export.

Some goat skins are exported in case state. Here the skins are not cut along the bellies, but the flesh side is turned out and they are folded along the ridge and then treated as above.

Some goat skins are exported in wet salted condition in barrels.

16. A large number of sheep skins is tanned locally. Those which are exported, are either exported in dry salted condition or as "papras." In the latter case the skins are washed and cleaned and allowed to sweat till the wool is loosened. After pulling off the wool they are pickled in a solution of alum and salt ; after allowing the excess of the solution to drain off, the skins are packed in a barrel, when they are ready for export.

**17. Defects in skins which require particular attention.—**

(1) Many skins are damaged owing to the cuts and holes made when skinning.

(2) In some of the big slaughter-houses, such as those at Bombay and Poona where there are different owners of the animals slaughtered daily, certain marks are made on the skins by cutting the hair, in order to distinguish the skins belonging to the respective owners. The person who does this, has no interest in the skin and, when there is no supervision of the owner, he cuts the hair so carelessly that often the skin is scratched and the grain gets damaged.

(3) After skinning, the skins are left in blood and dirt and then they are removed without washing to be sold to the local skin merchants or in the local skin markets. A few hours pass before the skins are sold ; meanwhile putrefaction sets in, which loosens the hair and spoils the grain.

(4) In some cases the Khatik purposely applies some blood to the skin to hide the defects on the flesh or on the grain side. When the blood gets dry, the hair cluster together and the flesh contracts and thus the defects beneath the hair on the grain or in the flesh are hidden. This application of blood further spoils the skin as it helps the growth of putrefactive bacteria.

(5) Many skins are spoiled in villages when they are dried in the hot sun, as they have to be preserved somehow when a skin merchant or a tanner is not at hand.

**18. Season for hides and skins.**—The important season for hides and skins is the period from October to March. Hides and skins produced in these months possess good substance and are of better quality than those produced during the rest of the year. After the monsoon, there is sufficient fodder and when the animals are properly fed, they improve, with the result that the quality of their hides also improves. The sun is not so hot during these months, and hence hides and skins when kept out for drying sustain less damage during these months than in the other seasons.

Skins produced during the monsoon have a peculiar defect inasmuch as their grain is affected by tick marks.

## CHAPTER II

### TANNING MATERIALS

1. Abundant quantities of tanstuffs are available in this Presidency and there is no district in the Presidency where a tanning material of some class is not found. Only a very small portion of these tanning materials is used for tanning.

Very little is known about the quality, effect and nature of the tannage produced by the various tanning materials and hence their right application is not understood by the majority of the tanners in this Presidency.

Out of the various tanning materials used, turwad bark, babul bark, and myrabolans are used in larger quantities than other materials.

2. The application of turwad bark is understood to a certain extent only by the tanners, who are imported from Madras ; while the application of babul bark and myrabolans is understood to a certain extent by the Dhors.

Owing to certain peculiar properties of turwad bark, it forms the basis of all the export tannages ; and hence it is the only tanning material which is used extensively in most of the large tanneries.

Though no doubt turwad bark is a very important tanning material in this Presidency and owing to its peculiar properties it is used in tanning hides and skins, that are exported as " half tanned " leather, that does not mean that it is the only tanning material, and that no other materials can be used where hides and skins are tanned for export. Tanning materials such as babul bark, ghatbor, myrabolans and so on, are abundantly available in certain districts and are much cheaper (per unit of tannin per maund) than turwad bark. Certain properties of theirs such as colour, ratio of tan to non-tans, penetrating power, etc., may be different from those of turwad ; but certainly if experiments are made there seems every possibility that these tanning materials mixed in certain proportions or perhaps, together with some other cheap materials, may give as good results as turwad bark.

3. I think that experiments in this direction will have to be made before long or more attention will have to be paid to cultivate turwad plants throughout the Presidency, as one of the efforts towards the development of the tanning industry. If this is done, the cost of production of " half tanned " leather will be much reduced, and this will help to increase our export trade of " half tanned " leather.

#### Notes on the tanning materials used in the Presidency

4. **Turwad (*Cassia auriculata*), Turwar, Aval, etc.**—Turwad is a wild shrub with yellow flowers grown in certain open tracts ; one can see it in certain parts of the Presidency along the railway line. When two or three years old, the branches or twigs which spring from the root are cut down. The coppiced root sends out a very large number of roots and a new harvest can be taken after a year. It is chiefly collected between the months of November and May. The chief centres, where it is grown largely in this Presidency are Nasik, Khandesh, Ahmednagar, Dharwar, Bijapur, Poona and some parts of Gujarat. A large quantity of it also comes from Hyderabad (Deccan), Marwar, etc.

The right of collection of this bark is farmed out on one to five years contract in various Divisions.

5. The average tannin content in the bark is 18 per cent. and soluble non-tans 14 per cent. The tannin in turwad bark is of catechol class.

The principal characteristics of this bark are as follows :—

- (a) Quickness of penetration.
- (b) Light cream colour of the tanned leather.
- (c) Softness of the tanned leather.
- (d) Ease with which it can be used.

6. Turwad is a very important tanning material. It gives a light cream colour to the leather and hence it forms the basis of all the export tannages. It is also used for tanning skins for local requirements. It gives a fairly soft and mellow leather, as well as a leather of light colour, which is suitable for the manufacture of boot uppers, lining and other dressing leathers. The great drawback of the turwad tannage is, that when the leather is exposed to light it gets darkened very quickly, becoming dull reddish brown and then it loses its strength. In the report published by the Society of Arts (London) "leather for book-binding," leather tanned by turwad bark was specially condemned, as unsuitable for this purpose, due to the red rot taking place after a few years. The darkening of the colour is greatly reduced by treating the leather with an infusion of myrabolans.

The colour produced by the bark of big shrubs is darker than that produced by the bark of small shrubs; therefore latter is preferred for tanning skins for export where colour is the first consideration.

7. Many of the turwad shrubs have recently been cut for making manure and sometimes the shrubs are so badly cut down, that turwad bark is becoming very costly. Before the war the price of turwad bark, was about Rs. 2-8-0 to Rs. 3 per maund; to-day it varies from Rs. 5 to Rs. 10 per maund.

8. **Babul (*Acacia arabica*).**—The bark of the felled babul trees constitutes the most important tanning material throughout the whole of the Presidency. No doubt, some bark from the living trees is stripped off by the local tanners for their use, yet babul bark is mainly a bye-product from the yearly fellings of trees for timber or firewood. Only a small portion of the bark of these trees is stripped off, as could be seen from the large stocks of babul firewood with the bark on in some important cities like Bombay, Poona, etc.

9. The trunk bark is much stronger in tannins but it contains more colouring matter and hence a tanner prefers the bark of branches; though this bark contains a smaller amount of tannins, it gives a lighter colour to the leather.

Unlike turwad, it is available practically all over the Presidency excepting a few districts in the Konkan. In the greater part of Gujarat, it is the only tanning material, whilst in Sind and the Deccan it is the chief tanning material, though used in conjunction with other tanning materials.

The bark obtained from trees three to ten years old is held to be the best. On an average  $2\frac{1}{2}$  seers of bark are obtained per maund of wood. The season for collecting babul bark is from October to June.

Though babul bark is abundant and only a small portion of it is utilised for tanning, yet in some places it is very costly. The chief reasons for this may be want of organisation, and the cost of carting. The tanners generally buy the bark from Mangs or Dheds who collect it by bargaining for a head-load or a cart-load.

In certain districts it is available for as little as annas twelve per maund (82 lbs.), whilst in others as much as Rs. 2 are paid for the same quantity.

10. Babul bark when used by itself gives a harsh and hard leather of a reddish dark colour. To minimise these defects certain other materials, such as myrabolans and ghatbors are used in mixture with it. Owing to the heavy cost of turwad bark, babul bark is being increasingly used.

The average tannin content in babul bark is about 12 per cent. and soluble non-tans 8 per cent. The tannin in babul bark belongs to catechol class but it gives a blue-black with iron salts, thus acting like a mixed tannage in which respect it resembles oak bark.

Though at present it is rarely used in leather meant for export, it would be interesting and valuable to make experiments in that direction as the cost of tannage with turwad bark is increasing day by day owing to the high price of the turwad bark.

11. The pods of babul also contain tannin, but their use is not common as their infusion becomes quickly putrefied.

Some Sindhi tanners use the infusion of babul pods in the preliminary stage in tanning. It acts as a bate and delimiting agent as the tannin which it contains is not precipitated by lime.

12. **Myrabolan (*Terminalia chebula*) Hirda.**—Myrabolans are one of the principal Indian tanning materials, which in addition to their local use are largely exported.

Myrabolans are entirely a forest product and are one of the most valuable of the minor sources of forest revenue. The right of collection of myrabolans is sold every year to contractors by auction. The bulk of the production of myrabolans in this Presidency comes from the forests in the Central and Southern Divisions.

Generally myrabolans are collected between the months of November and March.

There are different varieties of myrabolans produced in India and each variety, though it contains the same class of tannin, has got some peculiar

properties of its own. Myrabolans are not always used for the same purpose of tanning and hence each variety has got its importance for the purpose which it serves.

The principal varieties in this Presidency are known as R's (Rajapores) and V's (Vengurlas).

13. The fruit which is immediately collected after it is fully ripe is supposed to be the best. Half-ripe or over-ripe fruit contains less tannin than the ripe one.

The export tanners use myrabolans as mentioned in chapter III, para. 11, as a bleaching agent after the leather has been tanned with turwad bark. They are also used by the local tanners in conjunction with other tanning materials such as babul bark, ain bark, jambul bark, etc. The tannin in myrabolans is of pyrogallic class, and hence the leather tanned does not become red when exposed to light.

14. Figures of total production of myrabolans per year in the Presidency are not available to me. Statement I which shows exports of myrabolans will give an idea of the importance of trade in this material.

✓ 15. **Ghatbor (Zizyphus Xylopyra) Gothar, Jungle ber, Mullu kare.**—It is a kind of fruit, which looks like a small plum. The dry fruit possesses a reddish brown colour. It contains a large hard stone covered with thin flesh. The chief sources of supply of this material are the forests in the Panchmahals, Khandesh and Nasik districts.

The right of collection of ghatbor is included in the annual contract of collecting the minor products in the forests. It is generally collected between the months of November and May.

It is one of the principal tanning materials used in the Panchmahals and Khandesh districts both for tanning hides and skins. Its use is hardly known to tanners in other districts.

Its infusions contain glutinous matter, but in its early stage the liquor penetrates the hide very rapidly.

16. A very small portion of the available quantity of ghatbor is used at present. It is much cheaper than myrabolans or turwad bark. If the fruit, when not ripe but in a matured green state, is taken down from the tree and allowed to dry on the ground the unbroken fruit does not dry out properly, with the result that it gets fermented by heat when kept in a heap and turns into a useless slimy mass. If the fruit is left to dry on the tree or on the ground where it falls when ripe, worms and borers attack it and leave an almost tannin-less product.

The best way is to collect the fruit while green between the months of October and December, to break each fruit and dry it out thoroughly. In this state it may remain in good condition for several months.

17. The leather tanned with ghatbor alone gives a good colour, but is very spongy and tender.



The average tannin content of green dried flesh of ghatbor is about 30 per cent.

An infusion of ghatbor begins to ferment slowly after about a week and it acts as a gentle bate.

Taking into consideration its penetrating power, self-bating property, the light colour which it produces and its price, it would make a very important tanning material, if used in admixture with some other tanning materials. Experiments in this direction would be very interesting and useful.

**18. Ain (*Terminalia tomentosa*) Sein, Matti, Sadada, etc.—**

Ain bark is produced from ain trees which are grown in abundance in the forests of the Northern, Central and Southern Divisions. Formerly the Chambhars used to strip off the bark from the living trees for their own use but now in some places they are not allowed to do so, as it is injurious to the growth of these trees. Hence some of the Chambhars in these places are now using jambul bark instead.

The ain tree is one of the important sources of timber and hence if its growth is hampered, it causes a great loss to the forest revenue. The bark of felled trees is available in large quantities. Though the bark from the trunks of old trees contains very little tannin, owing to the growth of ross (rough outside bark) which contains no tannin, yet a lot of bark containing tannins can be obtained from the branches.

In some places the Chambhars manage to get the bark somehow or other. It costs them about annas 8 to annas 12 per head-load.

19. Ain bark is chiefly used by the Dhors and Chambhars in the Southern Division, but it is never used by itself as it gives a hard cracky dark coloured leather. It is mostly used in admixture with some other materials such as myrabolans, dhavadi leaves, etc.

20. **Jambul (*Eugenia Jambolana*) Neral.**—The bark of jambul trees is only used in certain places in Kanara, Ratnagiri and Kolaba Districts, especially where ain bark is not procurable. It contains less tannin than ain bark and has less affinity for hide fibre. But in the absence of ain bark, that is the only easily procurable tanning material in those places. The colour of jambul bark tanned leather is reddish. In admixture with jambul bark behara fruits or aonla leaves are used.

21. **Aonla leaves (*Phyllanthus emblica*) Amli, Avala.**—The leaves of aonla trees are used by Chambhars in certain districts along the coast line. They use this material in admixture with myrabolans or ain, jambul or kazu bark. It is collected by the Chambhars from the aonla trees grown in the villages and hence they have not to pay for it. The use of aonla leaves is very limited.

22. **Sachud.**—They are galls from a tree called Suru. In certain places in Larkana District these galls are used together with babul bark. The use of these galls is very limited.

23. **Behara (*Terminalia bebrica*).**—It is a fruit from behara tree. A large quantity of this fruit is available in certain districts. A few Khatiks in the Panchmahals District use it for tanning goat and sheep skins for local use. Chambhars in certain villages in Ratnagiri District use it in a limited quantity together with ain or jambul bark.

24. **Mangrove (*Rhizophoraceæ*) Kandal.**—A small quantity of this bark is used by a few Chambhars in the Kolaba, Thana and Ratnagiri Districts in admixture with aonla leaves or jambul bark or myrabolans. The mangrove tree grows alongside the rivers in certain places near the coast in these districts.

25. **Dhavadi leaves (*Anogeissus latifolia*) Dindul, Dindal, Dhava.**—Dhavadi leaves are used by certain Chambhars in the Thana, Kolaba and Ratnagiri Districts. The trees grow wild in these districts. Dhavadi leaves when used alone, give greenish pale colour, but they are often used in admixture with ain or jambul bark. The use of Dhavadi leaves is very limited.

26. **Divi Divi (*Caesapinia coriaria*).**—A divi divi tree is about 20 to 30 feet high. These trees are cultivated in certain parts of Kanara, Dharwar and Belgaum Districts to a very small extent. Some of these trees are cultivated along the roads in these districts. The tree grows rapidly, gives good shade and its pods serve as a good tanning material. The dried pods contain about 40 to 45 per cent. of tannin, which lies almost entirely in the husk of the pod.

It is quite a good tanning material ; its only drawback is that its infusion ferments rapidly but perhaps this fermentation could be lessened by the use of antiseptics. It gives a good colour to the leather and produces firm and glossy flesh. The quantity of divi divi available at present is limited and only a small portion of the available quantity is used by a few local Dhors and Chambhars in the abovementioned districts. Its cultivation along the road side would be useful and valuable as the divi divi tree gives good shade and produces an important tannin material.

Experiments in the use of divi divi in admixture with certain other tanning materials available in the Presidency would be interesting and might give some valuable results.

### CHAPTER III

#### TANNERIES IN THE PRESIDENCY AND METHODS OF TANNING IN USE

1. Tanning like all ancient industries has developed in the course of ages by empiricism. The last century, however, witnessed not only a vast development in pure science, but also the commencement of a new era in industries, and just as science has applied itself to the manufacture of soap, dyes, metals and so on, so also has the manufacture of leather

become a branch of Chemical Technology. Though Science has come to the aid of the Tanning industry in the West, most of the tanning work in this Presidency is still done by purely empirical and 'the rule of thumb' methods. The conditions and the processes in most of the tanneries are the same, as when they were started many years ago.

2. Now I will classify our tanneries and then enumerate briefly the various methods of tanning followed by the tanners in the Presidency.

The tanneries in this Presidency may be divided into two classes :—

- (1) Tanneries where mechanical power is used.
- (2) Tanneries where mechanical power is not used.

3. There are about 50 tanneries in this Presidency in each of which more than ten workmen are employed. The buildings of these tanneries are one storied, very often in the form of sheds round a courtyard.

4. Mechanical power is used in only three of these tanneries. In one of these three tanneries which is conducted by a scientifically trained person only chrome leather is manufactured, while in the other two both vegetable and chrome leather are produced. The latter two tanneries lack scientific guidance. In these factories some of the principles and processes in modern tanning are observed ; yet there is plenty of room for further improvement. This could be achieved only by proper scientific guidance as the tanners do not know the properties of many chemicals that are used in chrome tanning.

5. In the remaining tanneries where mechanical power is not used, all the work is done by hand. These tanneries can be further divided into two groups :—

- (1) Tanneries where hides and skins are tanned for export trade ;
- (2) Tanneries where hides and skins are tanned for local use.

Besides these large tanneries, there are a number of small tanneries in various places in the Presidency where all the work is done by hand, and there are village tanners practically in every village in the Presidency.

6. The tanning of hides and skins for export trade is the most important branch of the tanning industry in the Presidency. Hides and skins are tanned with vegetable tanning materials by vat or pit process where turwad bark is used as the principal tanning material.

In most of the export tanneries, tanning is done by tanners from Madras under the guidance of a Madrasi mistry.

The important centres, where hides and skins are tanned for export are Dharavi near Bombay, Kurla, Karachi, Hyderabad (Sind), Belgaum, Poona and Surat.

7. In the tanneries which prepare leather for local use mostly hides and occasionally a few skins are tanned either by bag process or vat process. Some of the tanned leather in these tanneries is further dressed and finished. Practically all the labour in these tanneries comes from Dhors and Chambhars.

Leather produced in small tanneries is either sold locally or sent to large centres such as Bombay, Poona, Karachi, etc., while leather produced by the village tanners is invariably consumed locally for making country footwear and other leather articles.

Most of the hides tanned by small tanners are tanned by the bag process, except in certain parts of Gujarat, where they are tanned in small kunds.

8. I will now enumerate the methods in tanning where vegetable tanning materials are used and then deal with chrome tanning.

The former can be classified into two main groups:—

- (1) Methods used in tanning hides and skins for export trade ;
- (2) Methods used for tanning hides and skins for local supply.

9. **Export Tannage. Pit or vat method.**—In all tanneries where leather is produced for export trade the processes of manufacture are more or less the same. This kind of leather is called "half tanned" leather.

As shown in chapter I, hides and skins are received by tanners in various conditions.

Dry goat skins are soaked in clear water for a day or two and wet salted skins for one night. In some places the water is changed several times, while in others not at all or only once. Fresh skins are only rinsed.

Sheep skins after soaking are first washed in clear water. In some places they are then given a paint of lime and sodium sulphide on the flesh side, while in other places a paint of thick lime paste alone is applied. They are then folded along the flesh side, so that the wool may not come in contact with the paint and left in a pile till the wool is sufficiently loosened to be easily pulled out.

The wool is then pulled out on a beam (kund). It is then washed once or twice in clear water, dried and sorted. Wool of superior quality is mostly exported, while the rough wool together with hair is sold locally or to jails for making blankets.

10. Goat skins after soaking and sheep skins after dewooling are given lime in pits, where they are handled every day for seven to ten days, after which they are unhaired on a beam (kunda) and then again they are given fresh lime for four or five days. They are then "scudded" (worked on the grain side to remove any short hair, pigments, lime-soap, etc.), fleshed and washed in clear water till they become flaccid and free from most of the lime, and then scudded once again.

11. The skins are now ready for tanning. They are thrown into a tub where weak turwad bark is spread between each skin, about twenty to thirty pounds of bark per kodi (20 skins) being given. The skins remain in this for eight or ten days, being handled daily; they are then taken out, squeezed and worked on the flesh side over the beam. They are then given a new layer or fresh but stronger bark about the same quantity

as before for eight to ten days, taken out, squeezed and worked on the flesh. The contact of bark with the pelts causes the latter to be pitted and discoloured in the first layer. These pits and discolourations disappear to a great extent after the second layer. Some tanners instead of giving two layers of eight to ten days give three layers for five or six days each using the same amount of bark.

After this, in order to improve the colour still more and probably to minimise the discolouration on exposure to light, the leather is finished and bleached in a myrabolan liquor. The liquor is made by steeping two or three pounds of myrabolans per kodi in a little boiling water overnight and diluting it with cold water to the requisite volume. The skins are left in this liquor for two or three days, then taken out and squeezed free from excess of liquor and worked well on the beam. After this a coat of "til" oil (a few tanners use safflower or groundnut oil) is given. They are then allowed to stand in a pile for some time for the oil to be absorbed and when the oil has been absorbed they are hung up to dry on hooks or ropes. While the skins are still slightly damp, they are taken down and set out with a brass slicker on a wooden table and then finally dried.

12. After the skins have been carefully dried, they are ready to be softened and finished. They are then laid in a pile and beaten by a heavy iron bar; then they are folded with the flesh side out and struck against a large stone, just as a dhobi washes clothes. Afterwards they are staked by being pulled, flesh side down, over a vertical stake on which a half moon shaped steel blade is fixed. Then they are sorted, staked again and fluffed with a sand stone by hand to smoothen the flesh. Finally they are trimmed, classified, pressed and baled for export to the London sales.

13. Kips (cow hides) and calf skins for export are tanned in a similar way except that, being of greater thickness, weight, and size, they are put in lime for a longer time and are given more changes in tanning, larger quantities of lime and tanning materials being used.

The first lime is given for ten to fifteen days and the second lime for four or five days. Four to six layers of bark are given, each for about a week and one or two myrabolan layers each for four or five days according to the thickness and weight of the hides. Some tanners besides using turwad bark use a small quantity of babul or bawa bark.

14. Although mostly fresh and wet salted hides are tanned for the export trade, many hides in sun-dried condition are also tanned for the same purpose. The latter are soaked for a longer time (24 to 30 hours). Then they are coated with a thin lime paste on the flesh side, allowed to stand in a pile for a few hours, and then thrown into lime pits with fresh water.

In one or two places the pelts, after being drenched with bran, are scudded well, washed and then tanned.

In most of the tanneries, fleshing is done by a rampi or khurpi (a semi-circular iron plate with a sharp edge) laying the hides flat on the ground.

The hides are hung between two horizontal bars (which act as a pair of clips) and then they are staked by hand with a half moon shaped steel blade.

15. **The bag method.**—The second important method of tanning is the bag method. The principal processes in this method adopted throughout the Presidency are practically the same with a little change here and there. The leather tanned by bag method is consumed locally.

✓ The hides used in this tannage as a rule are sun-dried. In some places they are soaked in clear water and in some places in old soaks. They are then given a paint of lime paste, left some time in a pile, then thrown into pits with fresh water and lime and handled every second day, for ten to twenty days. They are then unhaired by a shimpi and then put back into a new lime liquor for five to fifteen days before fleshing. In some places they use old lime liquor "bettered". After fleshing, the hides are washed with one or two changes of water and the grain cleaned by scudding.

16. After scudding, the pelt looks clean and white. Some tanners wash the pelt in old weak tan liquors, but it is usually put into vats or kunds which contain a tan liquor made of a certain amount of babul bark and myrabolans. In some places they use only finely chopped babul bark in this first liquor and in some only myrabolans. In different places, the quantities of bark and myrabolans vary very much, but as a rule five to twenty pounds of babul bark and three to ten pounds of myrabolans are used per hide. The hides are handled two to five times during this period and are then given a new layer with a similar amount of tanning materials, for the same number of days. After taking the hides out from the second liquor they are squeezed till they are sammed, (semi-dried). Each hide is then stitched so as to form a cylindrical bag (usually a buffalo's hide is in sides and a cow's whole). The end of the bag is kept open at the neck, through which it is partially filled with crushed babul bark and myrabolans. The bag is then hung up on a horizontal beam over a shallow pit and water is poured on the tanning material in the bag. As the water percolates through the tanstuff, it extracts tannin and this tan liquor is forced by gravity through the fibres of the distended hide, which effects the tannage. The percolated liquor which is collected in the pit beneath, is poured repeatedly on the top of the tanstuff in the bag, which gets stronger. After two to four days the bag is taken down, the open end at the neck is sewn up and an opening is made at the butt end. The bag is then hung up again, this time the butt end being on the top and the same procedure as before is followed. After two to four days, the bag is taken down and the stitches are removed and the exhausted tanstuff

is thrown away. The leather is flattened and dried in the sun. In some places the leather, after the sewing has been cut, is thrown into the liquor and left in it for one to four days, to remove the air stains, and this treatment generally brightens the colour. In some places during drying, the flesh side which is on top, is covered with a layer of the spent material to avoid damage. In other places a coat of khari earth and mud is given for the same purpose, and for increasing the weight.

17. In some places in Sind and Gujarat, after soaking in water for a day or two, the hides are placed in a kund containing a mixture of ankhadeka doodh (which is collected by breaking off the tips of the ankhadeka plant) and salt for ten to thirty days according to the nature of the hides till the hair and flesh are loosened. Many other plants contain a juice of similar nature and where it is not possible to get the milk separate from the plant (such as the jawasi plant), the plant is dried, crushed and powdered. This powder, together with salt and water is used as above. Sometimes bajri or jawari or mataki flour is added to this mixture. Sometimes the hides after unhairing are treated separately with this flour and salt in a paste-like mixture for four to six days. The treatment with bajri or jawari flour is akin to the drenching process.

The hides are then usually tanned by the bag process on lines similar to those mentioned above.

18. Some tanners keep the hides in the tan liquors only for about a week. In this period the tan liquor has not sufficient time to penetrate completely the substance of the hide, with the result that the interior of the hide remains "green". In this condition the hides are taken out, and five to ten pounds of salt per hide are rubbed into the flesh side. They are then dried. Leather tanned by the bag process is mainly used for sole leather, mots, pakhals, gin washers, and jutas, etc.

19. **Pot tannage.**—Goat and sheep skins are tanned in small quantities practically all over the Presidency. Sheep skins are mainly used as lining leather. Goat skins are finished as "Red Morocco" and are used as upper leathers for chadhavas or jutas. The most common colour is red. The most outstanding characteristic of this red leather is that its colour is wonderfully fast.

20. The processes followed in producing this kind of leather are as follows :—

The skins after soaking are treated with ankhadeka doodh and salt for five to ten days, then unhaired and fleshed. After this they are drenched in bajri or jawari flour and salt and then tanned with turwad or babul bark. The whole process is very crude and there is no standard method. Then the skins are dyed with a red dye prepared by boiling peepul lac with some tannin-containing leaves (such as dhavadi leaves) and khar. When the sheep skins are long woolled, naturally the wool is more valuable than the pelt. In such cases sometimes the wool is removed by soaking

the skins in water till thoroughly soft and then spreading them on the ground with the flesh side down, if necessary keeping them wet, until a slight putrefaction takes place, and the wool becomes sufficiently loose to be pulled off. After the wool is pulled off, the skins are either limed or treated with ankhadeka doodh, salt, etc.

21. **Chrome tanning.**—Only hides are tanned by chrome tanning at present in our tanneries. Before the hides are ready for tanning, they are treated more or less in a similar way as they are treated for export tannage. In one tannery sodium sulphide is used in liming. After the pelts have been drenched, scudded and washed, they are pickled either with sulphuric acid and salt or with alum and salt. Then the pickled pelts are tanned by "single bath" process, where "basic" solution of chrome salts is used.

22. Some of this chrome leather is used for gin washers or sole leather and some for upper leathers. In the latter case the leather after tanning is shaved, dried, damped back, staked on a staking machine, neutralised, dyed, fatliquored, struck out, dried and then finished.

On the whole I may say that except in a few large tanneries the general conditions in the tanning industry in this Presidency are crude and primitive.

23. **Finished leather.**—In a few places leather tanned by bag process is curried for harness and belting. The processes are very simple. The dried leather is damped back, shaved and scoured, then set out and a little dubbin (a mixture of tallow and oil) is rubbed into the flesh as well as into the grain and the hides are then hung up till dry. They are left in a pile for a short time to become mellow and then cleaned on the flesh and the grain.

24. In a few places dressing leather is produced. The methods adopted vary very little in different districts.

The hides after being taken from the tan tubs are squeezed out to free them from excess of liquor, set out, then oiled and dried. They are then damped back, shaved by hand or machine to the necessary substance and again given a bath of turwad bark to complete the tannage and to get an even colour. The hides are then removed from this tan liquor and well scoured. They are then dipped and handled in a dye solution for a short time partially dried and set out on a marble or wooden table and hung up to dry after a light coat of oil has been applied to the grain. When dry, they are flattened on a table and stained with a stronger solution of the same dye with a brush. The dye is worked in with a slicker. They are again hung up to dry and this process of staining and drying is repeated till the right shade is obtained.

Where stiff leather is required, as for trunks, the flesh side is made smooth and clean by a sand stone or a whitening slicker, but where soft leather is required this process is preceded by staking.

Finally the grain side is glassed and then polished with a piece of cloth.



## CHAPTER IV

OUTSTANDING DEFECTS IN THE PROCESSES IN USE IN THE TANNING  
INDUSTRY OF THE PRESIDENCY

1. In the last chapter I described the various processes of tanning in use in the Presidency. Apart from the methods adopted and processes used the quality of the finished product depends on various other factors also. As for instance the quality of water available plays an important part in the production of a certain quality of leather; same remarks apply to the quality and conditions of raw materials with which the tanners have to deal. If they do not get suitable raw materials or if they get damaged raw materials they will not be able to get good results out of them. I have already referred to some of these matters in the chapter on raw materials. In this chapter, therefore, I will discuss the important principles underlying the chief processes in tanning, and then point out certain defects in the various processes followed by our tanners. I will then suggest what steps should be taken to remove these defects.

2. **Soaking.**—The first process in tanning is soaking. Hides and skins received in a tannery contain much material unsuitable for leather manufacture which would introduce serious complications if not removed as early as possible in the process. All reasonable steps must, therefore, be taken to get rid of every undesirable constituent as soon as same can be done efficiently.

The first step is usually to wash the fresh hide or skin in order to remove blood and dirt. If it has been salted or dried, a more thorough soaking is needed to remove the salt and to restore the hide to its original soft and permeable condition.

When hides and skins come to the tannery in fresh condition, this operation is very simple. In our tanneries though fresh stock is tanned, yet many tanners have to deal with dried hides and skins. A large portion of this stock is dried in the hot sun without any consideration of the bad effect of this on the hides; even before drying some parts of them are putrefied owing to the negligence of the people who do this work. Such dried hides require more drastic treatment than fresh stock. So the first important thing to do is to sort the hides and skins and then to give them treatment according to their condition. Completely dried hides absorb cold water extremely slowly, and as such hides are invariably contaminated with proteolytic bacteria, the use of water alone (as the average temperature of water here is about 26°C.) is very risky unless the process is very carefully watched. In such cases to hasten the required effect the addition of small quantities of an acid or alkali to the soak water is necessary.

As most of the tanners here are ignorant of this principle they suffer heavy losses when handling such material. I have heard of many cases where tanners in the Presidency have lost much money. They treat

hides in any condition in the same way, without sorting them according to their quality and state; and as they find the sun-dried hides are not softened in a short time they prolong the soaking, without even changing the water, which further increases the effects of bacteria.

3. In some places they use stale soak into which tannery waste of every description is allowed to run, to hasten the soaking. This is still more dangerous, as in such cases hides already damaged in certain parts are further decomposed. In some districts they usually throw the hides into a hole in the ground at the side of a water reservoir in which the water is never changed. Hides before being put into lime must be uniformly softened. Now in the case of dried hides, it is not possible to achieve this result by soaking them, but they have to be given some mechanical treatment to soften the hardened tissues. After the hides become somewhat soft by soaking for a few hours, they are "broken over" on a beam with a blunt knife. This treatment helps further softening to take place in a short time. They are then soaked again for a short time and this process of "breaking over" is repeated once or twice till the hides become sufficiently soft; after this they are washed in clear water and cleaned, when they are ready for liming.

4. In the case of hides which are already affected by bacteria, as well as in the case of dried hides a small quantity of formic acid or sodium sulphide or bisulphite of soda in the soak liquor is advisable.

\*The use of a solution of caustic soda (one to two parts per thousand) or of sodium sulphide (one and a half to five per thousand) as suggested by Eitner, seems at present likely to supersede all other methods of softening from their simplicity and safety.

5. **Liming.**—The next process is liming. The necessity of this process is that the hair and certain epidermic structures on the grain and unnecessary flesh on the flesh side are to be removed before the hide is ready for tanning; also it must be swollen to a certain degree whereby the fibres which constitute the hide are distended. This helps the tan liquor to penetrate into the hide rapidly and evenly.

6. Now this process is also followed by the tanners here with the same view, but it is questionable whether they have understood the principle underlying the process.

Lime as it comes to the tanneries is in big lumps. When those lumps are put in water, heat is liberated. In order to avoid the bad effect of this heat on the hide, the first thing is to see that the lime is completely dissolved and that no lumps are left in the lime-pit when the hides are thrown into it. I have observed that many tanners pay little heed to this point with the result that lumps of lime are left undissolved in the pit and cause burns to those parts of the hides which come in contact with them, by the heat produced when those lumps get dissolved.

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\* Principles of Leather Manufacture—page 162, Second Edition (Procter).

7. As old lime effects the loosening of the hair in a short time many tanners use it for all kinds of hides without thinking of the effect on the leather produced. Such old lime usually contains ammonia and other products, and bacteria, which assist in loosening the hair and if the process is prolonged some of the hide substance is also dissolved and the grain of the hide is affected. This makes the leather soft, and of loose and damaged grain. In cases where soft leather is required perhaps careful use of old lime is advisable, but in cases where firm leather (sole leather) is required the use of old lime should be kept within very narrow limits. As this is not understood by ignorant tanners, the leather they produce is of poor quality.

8. In the case of sole leather short and sharp liming is necessary to avoid the loss of hide substance. The least possible loss of hide substance is to be aimed at by the tanner of sole leather. This enhances its wearing quality and also its weight which is the most important factor for a tanner, as such leather is sold by weight. They try to get weight by other methods but they overlook this important point. The liming they give to hides varies from twelve to thirty days; they commonly use old lime liquor. The effect of this process in a tropical place where the temperature of the lime liquor is about 80° to 90° F is simply disastrous, with the result that much of the hide substance is dissolved and simply wasted. If it were preserved it would not only save a quantity of leather but would also improve its quality. The leather produced in this way is soft, loose and spongy. In order to increase the weight of the leather they use many adulterants such as earth and salts which they rub into the flesh before drying.

Now if a little sodium sulphide is used this will loosen the hair and swell the hide and will help to get all the desired effects in this kind of leather in a short time, without having to continue the liming for too long a time.

9. The chief characteristic of upper leather is that it should be soft. Tanners try to produce soft leather without giving any consideration to the other necessary qualities of such leather. Upper leather must be soft but at the same time its grain must be firm and tight. Loose grain, sponginess and tenderness are the outstanding defects of most of the leather produced in this Presidency.

To produce good upper leather, hides must be properly soaked, very lightly limed and bated before they are tanned. The tanner here, in order to get soft leather uses a stale soak and gives prolonged liming with the result that all the above mentioned faults are found in this leather.

10. **Deliming and bating.**—In many respects though lime is a very useful and satisfactory means of loosening hair, its complete removal from the hide, at least from the grain surface, when it has done its work is necessary, because its action on tannins is most injurious.

After liming, the hides have to be unhaired, fleshed, scudded and washed well in several changes of water to remove the lime. Then they are bated and drenched in the case of upper leather so that soft leather may be obtained. The latter are very complicated processes and require very careful attention.

11. When soft leather is required, the skin must be brought down from a swollen to a soft and flaccid condition. Some tanners who produce soft leather here have tried to adopt improved methods but owing to their ignorance of the reactions taking place in the various processes, they have, instead of improving the quality of their leather, suffered heavy losses. They have had, therefore, ultimately to abandon these methods.

12. In the case of sole, belting and gin washer leather, no softening is desired; but the removal of lime is necessary. At the same time if a little lime is left inside the pelts, it helps the tannage and penetration of the liquor much more rapidly. In order to remove most of the lime, mere washing in water is not sufficient, as lime has a strong attraction for fibres and hence a little acid such as hydrochloric, sulphuric, lactic, or boric, etc., is necessary during the deliming process. No such process is followed by the tanners here. They trust that the water used in washing and the acids present in the tan liquors are sufficient to enable the complete removal of lime; hence in many cases the lime, limesoap and other dirt on the grain is not removed from the pelt in washing and scudding and the resulting leather has a hard feeling and dark patches on the grain.

✓ 13. **Tanning.**—There are two important conditions essential to successful tanning: (1) the natural physical structure of the skin must be changed but little, (2) the degree of tannage must be as nearly uniform as possible.

✓ The tanning process consists in soaking the pelts in infusions of various vegetable products containing bodies of the class known as "Tannins" which have the power to combine with the skin-fibre and to convert it into leather.

✓ If in the beginning strong infusions are used, they would act too violently on the surface of the skin, hardening and contracting it, so that the subsequent tannage of the interior would be impeded and the "grain" or outer surface would be drawn and wrinkled. To avoid this, at first weak infusions which have been already partially exhausted on goods in a more advanced stage must be used, and then gradually stronger infusions may be given.

This principle seems to be barely understood by tanners here. The tanning processes followed are on the whole very crude. Much of the leather tanned here is exported to countries in Europe simply because turwad bark has certain peculiar properties which produce saleable leather. Otherwise leather produced by other tanning materials under the present conditions would be hardly saleable in those countries.

14. As mentioned before after washing the hides in water in order to get rid of some of the lime they are treated with infusions of tanning materials containing free bark which is spread between the hides. Now as the bark comes in contact with certain parts of the grain of the hides, those parts of the hides are tanned with stronger liquor with the result that they are pitted and discoloured. As far as possible the first liquor should be weak and of uniform strength without any tanning materials inside. If there is any tanning material in the pits it ought to be such as is almost exhausted. Of course, such exhausted material is suitable here as the hides are thrown into a tub or pit and this material separates the hides from each other. If the hides are suspended in a pit there is no necessity for such materials. Later on when the hides are partially tanned, the ground materials are essential to keep up the strength of the liquors. However, here we find that in many tanneries fresh materials are used from the beginning. In some tanneries so little water is used that the hides are treated from the beginning in strong infusions, whereby the outside parts of the hides are tanned rapidly with strong liquors and the interior portions are left green or partially and unevenly tanned. The hides tanned in this way possess a harsh and hard feeling and are not uniformly tanned and when bent they are easily cracked.

15. Then in the bag process, the tan liquor is forced through the fibres, which makes the leather porous and spongy as the fibres are separated. The leather produced is not solid and that is why our sole leather is uncomfortable to wear and is worn out rapidly.

16. **Finishing.**—The mere conversion of hides and skins into leather is not as a rule sufficient to make them suitable for use. Different kinds of leather require to undergo different operations, following the actual tannage. There are innumerable kinds of finished leather which require a special series of operations after tanning.

A few general processes common to large classes of leather are :—

Bleaching, retanning, dyeing, fat-liquoring, stuffing, seasoning, glazing, graining, etc.

As far as this Presidency is concerned very little finished leather is produced, and what little is produced is of a poor quality.

If we take a side of finished upper leather the following defects are observed. It possesses loose grain, it does not have an even shade of dye but has patches here and there, and it does not have equal substance, that is, it is not uniformly thick.

If we take a roller skin, the same defects are observed, the grain is loose, there is no uniformity in thickness, it is not sufficiently elastic, and the grain is uneven. The most essential characteristics of the roller leather are that it must be uniformly thick and it must possess tight, firm and smooth grain and a certain elasticity.

In the case of our belting leather, it is not firm but very "stretchy", hence when used on pulleys it always slips off. It possesses very little tensile strength and has no uniform thickness.

I consider that steps should be taken to study the causes of these defects in order to improve the quality of leather of various kinds mentioned above.

17. **Waste.**—A great deal of waste takes place in our tanneries. Tanning materials once used are thrown away without knowing what amount of tannins are left in them. Fresh used tanning material is not completely exhausted of its tannin. Turwad bark contains 15 to 18 per cent. tannins, while babul bark contains 12 to 14 per cent. and myrabolan 25 to 30 per cent. In various places it is estimated that the spent tan materials which are thrown away, contain as much as 6 to 10 per cent. tannins. If now 4 to 7 per cent. of the recoverable tannin is wasted, there must be a heavy loss in the whole of the Presidency.

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## CHAPTER V

### TANNERS AND LEATHER WORKERS

1. In ancient India, there existed guilds of artisans following various crafts. There were about eighteen such guilds and some references are found as to the existence of a guild of leather workers. It seems, therefore, that a certain amount of importance was attached to the leather trade, as leather and its products were indispensable to the community. It is not known, however, how far this trade was organised at that time. Perhaps the tanners and leather workers were only responsible for supplying the local demand for footwear, mots, pakhals, thongs, straps, etc., in their respective villages, where they were able to get all the locally produced hides and skins and the tanning materials from the surrounding jungles in accordance with certain arrangements with the village Panchayats or the village heads. Owing to the modern facilities of communications and the rapid growth of trade both internal and external the old system seems to have been completely upset.

The trade, however, seems still to be hereditary, the son following the father as Dhor or Chambhar, the village tanner or Mochi, the maker of footwear for the village.

Though the modern development in commerce and trade has affected the trade of these village tanners and leather workers, yet the industrial development seems to have had hardly any effect on the methods of work of the people:

2. Generally speaking the tanning methods followed in villages are primitive and crude. In some big cities, however, both tanners and leather workers have adopted some modern processes and the resulting improved quality of their products has naturally benefitted them.

In some places, where formerly the tanners did not use lime in the dehairing process, they are using it today and where formerly they produced very crude leather, today they are trying to improve it, and are producing some finished leather by staining for boot and shoe uppers. Some tanners are trying to produce belting and harness leather and, roller leather for cotton mills, etc. In some cases their production is of a very inferior quality, but they seem anxious to know how they could improve the same. Judging by their efforts and the slight improvements in the quality of their production and considering their hereditary intelligence and their liking for the trade, it seems that if they are given proper help and scientific guidance the quality of their products would improve, with the result that their economic condition would also improve.

3. The large and wide-spread demand for hides and skins for the local tanneries and for export has raised their prices. The hide dealer is able to pay in advance when necessary and pay a higher price than the village tanner. The result is that the local tanner who was formerly at least sure of getting hides produced in his own village can at present get only the rejected ones because for good hides he can afford to pay neither the high price nor any advance.

Even when he can find the money to pay the high price he never attempts to do so, for he knows that after tanning it he will not be able to realise even his cost. This is largely due to his ignorance of the modern developments in the processes and technique of the industry.

4. The village tanner, therefore, deals only with the rejected hides. Those which he buys from his own village Mahar, are in wet condition and he is able to make something out of them but as the hides which he buys from outside in sun-dried condition are mostly damaged, he is invariably a loser. He does not understand the nature of such hides and tries to treat them in the same way as he treats the local wet hides. His primitive methods of soaking and liming further spoil the hides and the poor tanner does not realise from the sale of tanned leather even half the price, which he pays for the raw material.

5. Another difficulty experienced by the village tanners is in connection with tanning materials. Formerly these people were able to collect tanning materials from the jungles nearby and it used to cost them nothing but their own labour; owing to forest restrictions such is not the case now. The contractors who collect the tanning materials do not care to sell them in small quantities to the village tanners even when they are ready to pay the retail price prevailing in large centres like Bombay, Belgaum, etc. Prices for materials like Turward Bark and myrabolans are relatively high and almost beyond the reach of the village workers. Owing to the difficulties enumerated above many tanners have given up their hereditary profession and are seeking other outlets for their labour in agriculture, cotton mills, gin factories and railways, etc.

6. The tanning industry on the whole is not at all properly organised except in a few cases where the owners of large tanneries, who are mostly of the Memon or Bohra communities have become prosperous owing to their keen business intelligence and because they are producing leather on a large scale. On the other hand, there are many instances where tanneries have been closed chiefly for want of proper organisation, and owing to the present wasteful methods and the lack of skilled and steady labour.

7. There are only a few places in the Presidency where there are fairly large colonies of tanners but as mentioned in the previous part of this chapter at present only a few people are doing tanning. Each tanner works for himself aided by his brother or other relatives and usually in lighter parts of his work by the women and children of the family.

The leather which they produce, is sold to the local leather merchants or Mochis. In some places they themselves make certain articles and country footwear which they sell locally or send to neighbouring places.

8. The position of leather workers who are not tanners is not so much affected as they buy ready made leather for the articles they produce. The only thing they have to do is to study the local market and produce different kinds of footwear and other articles in demand. It is interesting to note that one can at present get a good pair of boots or shoes made by a Mochi. Foreign competition has led them to imitate properly foreign goods. In certain cases the quality of leather used is deteriorating as the public want cheaper goods. They care very little about the quality of leather of the articles so long as the outward appearance is nice. In big centres such as Bombay, Karachi, Hyderabad (Sind), Ahmedabad, Surat, Poona, etc., there are several boot and shoe shops where a large number of men are engaged who are either paid on piece work or by the day. Some of these shops are equipped with Singer Sewing Machines, Welting and Polishing Machines, but in the majority of the shops except for the stitching of uppers, all the other work such as pattern cutting, polishing, lasting, etc., is done by hand. Many a Mochi also works entirely on his own account, helped by the other members of his family.

**9. The chief classes who work in different branches of leather industry.**

1. Mochis .. Makers of boots, shoes, harness, etc. (Sind, Gujarat and Deccan).
2. Sochis .. Mostly interested in making 'Deshi Jutas' (Sind).
3. Chambhars .. Chiefly tanners (Chamdias in Gujarat), tanners and footwear makers elsewhere.
4. Dhors .. Chiefly tanners of hides and makers of leather articles required for agricultural purposes (Deccan).
5. Jatias .. Tanners of hides (Sind).



6. Calals .. Tanners of skins (Sind).
7. Khalpas .. Chiefly tanners of hides in Gujarat as Dhors in the Deccan.
8. Madrasi tanners .. Foremen and workers in tanneries where "half-tanned" leather for export is produced.
9. Khatiks .. Tanners of skins, especially for Red Morocco and book-binding (Gujarat and Deccan).
10. Dabgars .. Makers of drums, dabas and other raw hide goods.

10. **Mochis.**—Mochis are leather workers. They are found in large numbers in Gujarat. There are various classes of Mochis such as Kathiawari, Gujarati, Cutchi and so on; all of them are Hindus. As a rule Mochis are not tanners. There are also a few Muhammadan Mochis in Sind and Gujarat.

Though all of them are called Mochis, each class as a rule is chiefly interested in manufacturing particular kinds of leather articles. Marwari Mochis are mostly interested in making "Deshi Jutas", and saddlery for horse and camel. Cutchi Mochis are interested in making shoes, boots, and sapats.

In large centres, some of them work in shops on piece work or by the day and some work entirely on their own account helped by the other members of their family.

Lately the term Mochi has become so general that anybody who makes boots and shoes and other leather articles is called a Mochi.

11. A Mochi buys leather from leather merchants or from local tanners in "crust state" and softens and dyes it himself if necessary. On the whole Mochis are very hard working people. Some of them are very good at their work and can copy faithfully any pattern or shape of imported boots, shoes, and other articles.

In villages, a Mochi is usually a leather worker as well as an agricultural labourer.

Artistic work and embroidery which are required in certain kinds of footwear and leather articles are mostly done by women.

A certain class of Hindu Mochis in Sind are called "Jusias". Sochi is another name for a Marwari Mochi.

12. There is another class of Mochis called Hindustani Mochis, who are mostly found in Larkana and Jacobabad. Here the term Mochi is somewhat misleading as these people are both tanners and shoe makers. Many of them are also agriculturists or work as agricultural labourers.

13. **Chambhars.**—The Chambhars are another class of workers in leather; there are various kinds of Chambhars such as Gujarati Chambhars or Chamdias, Lingayats, Ghatis, and Konkanis; and each of these classes does a particular kind of work.

Chambhars from Gujarat are usually tanners of hides and skins as well as shoe makers. Lingayat and Ghati Chambhars tan skins for "Red Morocco" and are chiefly interested in making Bramhani jodas. They are found mostly in Ghat Districts. Konkani Chambhars, who come from Konkan (Kolaba, Ratnagiri and Kanara) are tanners of hides and skins and are chiefly interested in making vahanas. Though the Chambhars are workers in leather they hardly seem to have attempted to make boots and shoes. With a few exceptions, they are as a rule a very easy going class.

Lately many of them have given up their hereditary trade and are working as labourers on the land or as operatives in cotton mills, and other factories.

14. **Dhors.**—Dhors are tanners and suppliers of mots, pakhals and other leather articles required for agricultural purposes. They are found in the Central and Southern Divisions but are practically unknown in the Southern coast districts. As a rule they are tanners of hides. As a class they thoroughly understand the bag process of tanning. Some of them work on their own account, while some work in tanneries on piece work or by the day.

Large colonies of these people are found in Poona, Baramati, Nipani, Satara, Belgaum, Dharwar, Hubli, etc. They sell most of their leather to dealers from Bombay or Poona who either dress it for harness, sole, or belting leather or send it to other dealers in centres such as Ahmedabad, Surat and Karachi, &c.

15. **Jatias.**—Jatias, also called Bhambis, are a class of tanners in Sind. As a rule they are tanners of hides, as the Dhors in the Deccan, and tan the hides by bag process. Large colonies of these people are found in Hyderabad (Sind), Shahadadpur, Tando Adam and Jacobabad. Those who can afford it work on their own account while a few work in tanneries on piece work or by the day. Besides being tanners, Jatias are one of the chief labouring classes in these places. They sell their outturn either to local Mochis or leather merchants. In the lighter work they are helped by their women.

16. **Calals.**—Calals are tanners of skins in certain parts of Sind. Their biggest colony is in Hyderabad. They are also found in small numbers in some other towns of Sind. It is interesting to note that these people consider themselves superior to Jatias and hence they do not use lime in the depilating process but use acid saline depilants such as a mixture of ankhadeka doodh, jawari flour and salt. Their women help them in the lighter work of their trade.

They are also one of the chief labouring classes in the places where they have their colonies.

17. **Khatiks.**—These people slaughter goats and sheep and also skin them. A few Khatiks are also interested in tanning skins. They tan chiefly goat skins and finish them as "Red Morocco" and they tan

sheep skins for book-binding, and lining leather, etc. They mostly use a mixture of ankhadeka doodh, jawari flour and salt as a depilant.

18. **Dabgars.**—The chief trade of Dabgars is to collect hides and skins from villages and to sell them to the agents of hide and skin merchants in big centres or to tanners. They never do tanning, but are interested in making articles out of raw hide such as dabas for oil, balance pans, and so on. They are mostly found in Gujarat.

19. Besides the above mentioned classes, there are other people such as Mangs, Dheds, Mahars, and Hulswars, who mostly skin the animals and also some times work as labourers in tanneries in big centres.

## CHAPTER VI

### DEMAND FOR LEATHER AND MANUFACTURED LEATHER ARTICLES

1. Considering the vast population the demand for leather goods is yet relatively small. But it is steadily increasing and there is yet a big scope for expansion in the leather trade. There is a good demand for sole leather, various kinds of upper leathers, gin washer leather, leather for harness and saddles, and belting leather, etc., a large portion of which is satisfied from imports from outside the Presidency.

Though there are a large number of Mochis and Chambhars in this Presidency, the quantity of boots, shoes and sandals coming from abroad and outside the Presidency is remarkably large.

It is very difficult to get even an approximate idea of the demand for leather consumed in the districts and to determine how much of it is imported and how much is locally produced. In the Chapter on District Classification, I have, however, tried to give some idea of the leather consumed in the various large centres in this Presidency.

Statement V will give an idea of the imports of finished leather and articles made from it. Many of these imported articles are, no doubt, products of specialised factories, yet there can be little doubt that if our Tanning Industry is developed on modern scientific lines, many of them can be replaced by articles made locally.

Apart from the imports from abroad, large quantities of leather and leather goods come into this Presidency from the other parts of India. It is, however, difficult to get any idea of such imports.

2. **Footwear.**—The demand for all kinds of footwear is steadily increasing. Various shapes and patterns in boots, shoes slippers and sandals etc. are in demand.

In Sind shoes, slippers, chadhavas and sapats, in Gujarat, shoes, slippers and chadhavas; and in the Deccan, boots, shoes, slippers, jodas, chappals and vahanas, are more commonly used.

Boots and shoes come from abroad as well as from Northern India especially from Agra and Cawnpore, in large quantities. A large number is also produced by Mochis in the Presidency.

Leather used for making shoes is of Indian manufacture for cheaper qualities and of European or American manufacture for shoes of better quality. Both vegetable and chrome leathers are used for uppers. Boots and shoes are mostly used by people who wear European dress. Slippers are used on a large scale especially in cities and towns.

3. There are many varieties of jodas. Bramhani jodas are chiefly made out of "Red Morocco" leather which is used as upper leather. This leather is tanned and finished by the Chambhars themselves who make the jodas, or by the Khatiks who sell it to the Chambhars. Bag tanned buffalo or heavy cow hide is used for soles. A pair of jodas costs from Rs. 1-8-0 to Rs. 5-8-0.

4. In chadhavas also there are different shapes which mostly depend upon where and for what class of people they are made. The general appearance of a chadhava is similar to that of a slipper with some modification in shape. Uppers of some chadhavas are embroidered with brass wire or coloured cotton or silk.

5. Sapats are mostly used by women in Sind. For uppers, either leather (mostly patent leather plain or embroidered leather) or velvet (plain or various designs) is used but soles are invariably made out of leather. A pair of chadhavas or sapats costs from Rs. 1-8-0 to Rs. 4-8-0.

6. Chappals, vahanas, jutas, sandals, belong more or less to the same class of footwear. At first the soles are made and then on the top leather bands or straps are stitched so that the footwear should fit properly.

According to the different adjustments of these bands or straps and the thickness of the soles, this type of footwear is called by one or the other of the terms mentioned above.

Chappals have generally thinner soles than vahanas or jutas. Sandal is an English term applied to any one of these three and sometimes even denotes any kind of Indian footwear, where straps and bands are used for uppers.

Juta is a vague term. It means the common country footwear of the province. Thus in Sind chadhavas are called jutas by the country folks whereas in the Deccan vahanas or chappals are called jutas. A pair of chappals or vahanas costs anything between Re. 1 and Rs. 3.

7. Next to footwear the chief articles manufactured from leather in demand are :—

1. Mots or kos,
2. Gin washers,
3. Pakhals, water buckets, etc.,
4. Saddlery and harness,
5. Miscellaneous.

8. **Mots or kos.**—Practically all over the Presidency except in Sind mots are used for drawing water from wells for irrigation and other purposes.

There are two kinds of mots, one is called "sondia" and the other ordinary. The former is worked by two or four bullocks or buffaloes. This kind of mot is more commonly used on large agricultural fields, where a good supply of water is required.

Leather tanned with bag process with babul and myrabolans is used for a mot. The cow hides are tanned as a whole to get a circular piece. If a whole piece is not available, the circular piece is made by stitching up pieces.

A mot is repaired again and again, and in this way generally lasts for two or three years; when it is worn out it is used for making water buckets or cheap sandals or for repairing work.

The cost of a "sondia" mot varies from Rs. 15 to Rs. 25, while that of an ordinary mot from Rs. 8 to Rs. 12.

9. **Gin washer rollers.**—Broach is one of the principal distributing centres of gin washers where they are manufactured on a large scale. They are also made in various other places such as Nadiad and Bombay.

In different parts of India the season for ginning is different, so the washers are produced throughout the year. For the cheaper kind of washers local tanned leather from Khalpas and Chambhars is used while for the better class chrome leather is used. The composite washers, which are made from thin splits of chrome leather are in great demand as they are supposed to give better work and are cheaper.

A washer roller made out of vegetable tanned leather weighs about 50 lbs. and its price varies from Rs. 20 to Rs. 30. A composite washer roller weighs about 40 lbs. and its price varies from Rs. 25 to Rs. 30, while a washer roller made out of whole pieces of chrome leather weighs about 40 lbs. and its price varies from Rs. 40 to Rs. 50.

A great amount of chrome washer leather is also imported from Madras.

10. **Pakhals.**—These are large water bags which are used to carry water on the backs of bullocks or buffaloes and are seen often in some big towns throughout the Presidency. Small bags are used by men called Bhistis (water carriers). Leather used for making these pakhals is tanned with babul by bag process.

Pakhals are either made by the tanners or shoe makers.

The cost of a small water bag varies from Rs. 4 to Rs. 8 while that of large bags varies from Rs. 12 to Rs. 20.

11. **Saddlery and harness.**—Many of these articles are imported and many of them are also made in large centres such as Bombay, Poona, Ahmedabad, Karachi, from locally tanned leather or from imported leather.

A large amount of tonga harness is made in various districts for local use and each district has some peculiarity as far as shape and pattern is concerned ; but the same kind of leather is used throughout.

12. In Sind "nats" or camel saddle cloths are made in large quantities. Artistic work of a high quality is noticeable in these nats. They are brilliantly and elaborately embroidered with red, yellow, green and various other coloured cotton or silk thread as well as with gold and silver threads. The floral and geometrical patterns show considerable taste and skill. Most of this artistic work is done by women. Hyderabad (Sind) is the chief centre of this kind of manufacture. The price of nats varies from Rs. 15 to Rs. 750.

Some of the horse saddlery is also made in artistic designs.

13. **Miscellaneous.**—Portmanteaus, trunks, attaché cases, bags for different purposes are produced in large quantities in various important centres such as Bombay, Sholapur, Belgaum, Karachi and Ahmedabad. A large quantity of these articles are also imported from Cawnpore and Mysore.

The demand for these articles is increasing rapidly. The price of these articles varies according to the size of the article and the kind and quality of the leather used in making it.

14. A large number of articles such as whips, bell belts for cattles, straps, thongs for yoking bullocks, ropes for strapping up carts, leather belts, bed straps and ropes for buckets, etc., is made out of leather. Most of these articles are meant for local requirements. Some of them are made by Dhors, some by Chambhars and some by Mochis.

## CHAPTER VII

### SUITABLE CENTRES FOR THE DEVELOPMENT OF THE TANNING INDUSTRY

1. One of the most important factors on which success in manufacturing depends, is a suitable location.

The fact that locations that were good enough in the past are not suitable now is shown by the migration of many large concerns and the establishment of new concerns in places far removed from the old centres of industry. In locating a new factory the owners should look ahead into the future. Conditions are changing, so that a location good to-day may not be good ten years hence.

2. Some of the most important questions to be considered for the development of any industry are (A) with respect to materials (1) cost of obtaining suitable raw material delivered at the factory ; (2) permanence of the supply from its present source ; (3) where other supply may be had if the present source fails ; (4) cost of transportation of finished goods to the various markets ; (5) transportation by rail, by water,

trucks, and so on ; (6) cost of fuel ; (7) suitable and sufficient supply of water ; (B) with respect to estate (1) first cost ; (2) taxes, present and prospective ; (3) room for extension and for the accommodation of workmen ; (C) with reference to labour (1) availability of an abundant supply of skilled and unskilled labour at as low price as possible ; (2) conditions for keeping workmen satisfied ; (3) if the old village homes of the labourers are near such centres, the labour will be steady.

3. Taking into consideration the various facts mentioned above, I may suggest that the following centres in this Presidency may be found suitable for the future development of the tanning industry :—

Sind ..	.. Karachi, Hyderabad, Sukkur and Tando-Adam.
Gujarat ..	.. Ahmedabad, Nadiad, Surat and Godhra.
Central Division ..	.. Ahmednagar, Devlali, Poona, Baramati, Karhad and Sholapur.
Southern Division ..	.. Belgaum, Nipani, Bijapur or Bagalkot, and Hubli.
Bombay and Kurla.	

## CHAPTER VIII

### DISTRICT CLASSIFICATION

1. It is important, I think, that the nature and extent of the leather industry in each district should be known. I shall, therefore, attempt at the risk of some repetition to describe briefly this industry as it is divided geographically.

#### SIND

##### KARACHI

2. The tannery area is situated about a mile and a half from the Karachi City. The locality is called "Lyari". It is about two miles from the nearest railway station. Bullock and camel carts and motor lorries are in use for transport.

There are ten tanneries, out of which only three do tanning on a somewhat large scale.

There are also some small huts scattered over the locality in which tanning is carried out on a very small scale by individual tanners on their own.

They produce chiefly vegetable tanned leather. A fairly large amount of this leather of good quality is exported. The remainder which is of fourth class or which is rejected is sold locally for the country footwear.

Mostly cow and buffalo hides, calf, goat and sheep skins are tanned. The cow hides and skins are tanned in pits and tubs, while buffalo hides

are tanned by bag tannage. Besides this, some horse hides as well as camel hides are cut into pieces, and they are then tanned by bag process.

In one tannery some lizard skins for export are tanned either by vegetable or alum tannage. Hardly anybody seems to be interested in manufacturing finished leather.

3. Skilled labour is dearer here than in the other centres in the Presidency. It has to be imported from Madras. For the work in lime-yard and tanning with turwad bark, tanners from Madras are superior to local tanners and naturally the former demand more money, when they have to come to such a long distance. Many workers are drawn from Jatias or Bhambis. These people are tanners by caste but they are not so good at their work as the Madrasis. It is interesting to note, however, that some of them are rapidly becoming more skilled by working together with their brother tanners from Madras.

4. The principal tanning materials used are turwad and babul bark and myrabolans. The tanners who do export trade use turwad bark in combination with myrabolans; sometimes a little babul bark is also used. The rest use only babul bark and a small quantity of myrabolans. They have to get turwad bark and myrabolans from other places, the former from Bombay, Marwar, etc., and the latter chiefly from Bombay. Babul bark is the only principal tanning material which is abundantly available in Sind.

Some tanning is also done in the cantonment where there is a colony of Chambhars. These people tan chiefly heads and other pieces rejected by the exporters.

5. In the "Lyari" locality there are also five large godowns of hide and skin exporters. Here the hides and skins are further cured, sorted, and pressed in bales before exporting.

Karachi is the second biggest exporting port for raw hides and skins in India, where there are a number of Indian and European firms who are interested in this trade.

Besides the raw hides and skins from the local slaughter-houses, a large number comes from the various neighbouring districts, as well as from the other parts of the province, the Punjab, the United Provinces and Marwar, etc.

In some cases the flaying of these hides and skins is of a fairly good standard but in some it is of a very poor standard. The prices of the raw hides and skins vary according to their weight, substance, size, quality and classification such as I, II, and III, etc.

Prices prevailing for raw hides and skins during my stay in Sind are as follows :—

Average price for good quality of cow hides (sun-dried).	Rs. 16 to Rs. 18 per maund (28 lbs.).
Average price for good quality of buffalo hides (sun-dried).	Rs. 13 to Rs. 14 per maund (28 lbs.).



*Skins—*

Goat per 100 pieces ..	Rs. 150 to Rs. 200.
Sheep per 100 pieces ..	Rs. 80 to Rs. 120.

*Prices of tanning materials—*

Babul bark cleaned and cut ..	Rs. 1-12-0 to Rs. 2 per maund (82 lbs.).
Turwad bark ..	Rs. 6 to Rs. 7 per maund (82 lbs.).
Myrabolans ..	Rs. 4 to Rs. 5 per maund (82 lbs.).

6. The water used in the locality is well water which seems to be a bit brackish. I could not get any report whether this water has been ever analysed. Pipe water is also available in small quantity. As the rates for pipe water are high, nobody seems to take it in a large quantity.

7. There are no factories as such where shoes and boots and other footwears are manufactured ; but one can find a few shops that use simple machinery such as Singer Sewing Machines, Welting and Polishing Machines, etc., but the majority of the footwear makers do their work by hand. The capacity of these shops is not big at present. They produce from a quarter dozen to one dozen pairs daily.

A large number of shoes and boots of European style are sold, but the majority of the people use slippers and other footwear such as sapats, chadhavas, peculiar to this part of the Presidency, as well as sandals.

8. The Cutchi Mochis are mainly interested in turning out country footwear, while some Muhammadans from the Punjab and the United Provinces, and also some Hindu Mochis known as Jusias are interested in turning out boots and shoes together with country footwear.

The Jusias are a bit superior in workmanship to the Cutchi Mochis. There are also some Kamathi Mochis from Bombay side.

9. There is a great demand for finished upper and sole leather for footwear, as well as for leather for belting, harness and saddlery. The local production being limited, a large portion of the leather consumed here comes from various parts of India, *i.e.*, Cawnpore, Calcutta, Madras, Trichinopoly, and Bombay, etc. Sole leather in rough "crust" state comes from Cawnpore and Jullundur. In the case of light leather the chief demand is for kid, box calf and sides and lining leather.

## HYDERABAD

10. It will not be an exaggeration to say that the manufacture of leather, footwear, and other leather articles is one of the chief industries of Hyderabad.

The tanning centre is about two miles from Hyderabad called "Fuleli"—a small suburb where one could go by a tonga or motor.

There is only one big tannery where goat and sheep skins are tanned at present for export. Besides this there are a number of small tanneries. If tanning industry is to be seen as a cottage industry, I think no other place in the Presidency will present such a show as "Fuleli".

The tanners here belong to two different classes both Hindus, one being Jatias and the other Calals. The former tan only hides and occasionally a few skins, but the latter only skins.

11. **The Jatias**—There are about four thousand people of this community, but owing to adverse circumstances only about five hundred of them live by tanning; the rest do some other manual work for their living.

The tanning industry amongst them is just a cottage industry, *i.e.*, all the processes in tanning are either done in front of their cottages or in one part of their houses.

Generally speaking they are poor and cannot afford to buy hides even in small numbers for cash. They buy their requirements from Khojas (hide dealers or other commission agents, who are hide and skin merchants) on credit and have, therefore, to pay higher prices than the existing market rates. When the tanned leather is ready, they sell it to the local Mochis or any leather merchants, pay off their debts and so carry on their work.

12. They buy the raw hides in sun-dried state, which they soak in stale soaks; after completely soaking, they break them by hand and then give lime. About fifteen to twenty pounds of lime are used for ten hides. The liming takes about twelve to twenty days according to the season, hot or cold.

The unhairing is done on a beam and fleshing by a knife called "Rampi" laying the hide flat on the ground.

Then the limed pelt is put in old tan liquors for a couple of days where it is partially delimed. After this the hides are tanned by laying in fresh babul bark, which is chopped very fine, for about four to five days. The hides are then sewn in bags and are given bag tannage, where babul bark and crushed myrabolans are used. After rubbing some salt earth into the flesh side they are then dried.

About five to six hundred hides are tanned per month in this quarter.

The tannage is very crude. They do not finish the leather even to present a good look, but sell it after drying in rough crust state to local leather merchants or Mochis who make "jutas" for the working class people, who require them for hard wear. The leather is used both for uppers and soles of these jutas, somewhat similar in shape as slippers, though rough and hard, yet good for hard wear.

13. As they do the whole tanning work near their huts, they get every help from the rest of the members of their families, including women and children.

The people of this class are scattered all over the province of Sind. Practically every village has one or more Jatia families.

The main centres where there are fairly big colonies of Jantias are Shahadapur, Pano Akil, Umarkot, Jacobabad, Tando Adam, and Larkana, etc.

14. **Calals.**—There are about three hundred families of this class, out of which about hundred families do tanning. With them also tanning is a cottage industry. They do it either in front of their houses or in one central yard where each family has got a few earthen pots fixed in the ground. The diameter of these pots is about two to three feet. The whole process of tanning is very crude.

They do not use any lime as depilant for unhairing the goat skins or sulphide paint for dewooling the sheep skins. Most of the sheep skins they tan are long woolled. The wool being of great value, they pull off most of it after letting the skins putrefy to a very small extent. After this the skins are treated with a solution of "ankhadeka doodh", bajri flour and salt till the short hair and remaining wool is sufficiently loosened. The grain is then cleansed with a piece of broken earthen wear, which serves the purpose of a scudding knife. The skins are swollen in the ankhadeka doodh and hence they are drenched in a bath of bajri flour and salt for a day or two to reduce the swelling. Then they are tanned in two baths of babul bark for seven to eight days (each bath for three to four days). About twenty-five to thirty-five pounds of bark are used per kodi (20 pieces) according to the weight of the skins. Then they dry them in the sun. One peculiarity of these skins, when dry, is that they look whitish, though tanned with only babul bark. The tanned skins are not finished in any way, but are sold in the rough crust state to the local leather merchants or Mochis who further dye and finish them for their purpose.

The water used here is from wells. It seems to be suitable for tanning as these people are settled here for the last 200 years. It will be interesting to analyse this water.

It may be of interest to note that because the Jantias use lime as a depilant for hides the Calals will not use it for skins owing to certain religious scruples.

15. As the work is done in or round about their cottages all the members of the family work together. They also work as Khatiks, *i.e.*, those who slaughter sheep and goats and flay them. The biggest colony of these people is in Hyderabad, while one or more families are to be found in some important places in Sind to the south of Sukkur.

16. **Prices of raw materials—**

Cow hides (sun-dried) ..	..	Rs. 14 to Rs. 20 per maund (28 lbs.).
Buff hides (sun-dried) ..	..	Rs. 10 to Rs. 13 per maund (28 lbs.).
Goat skins per 100 pieces ..	..	Rs. 150 to Rs. 175.
Sheep skins per 100 pieces ..	..	Rs. 90 to Rs. 110.

**Prices of tanning materials—**

Babul bark annas 13 to annas 14 per maund (82 lbs.).

Myrabolans Rs. 5 to Rs. 8 per maund (82 lbs.).

17. **Leather workers.**—There are two principal classes interested in making leather goods, the Marwari and the Cutchi Mochis.

The Marwari Mochis are also called "Sochis". They are mostly from Jodhpur District and are settled here for nearly one hundred years. There are nearly four hundred families of these people in Hyderabad out of which about two hundred families are doing this work. The people of this class are scattered all over Sind. They are mainly interested in making "jutas" which are used for rough country footwear. Buffalo and cow hides tanned in Fuleli quarter are used for this purpose. For uppers, they buy tanned buffalo hides in crust state and dye them by sponge or brush with a solution of some aniline dye (yellow, green, red, etc.). Besides this, they do all kinds of saddlery for horses, camels, etc. This kind of work is very artistic. Especially what they call "nats" are just like carpets made out of leather with artistic designs, embroidered with silk or coloured thread on canvas and stitched on leather. The well-to-do people are taking to the use of motor cars instead of camels and horses and hence there is not so much demand at present for this kind of artistic work.

All the embroidery and knitting work is done by women. They use the front portion of their living houses as their work room. Some have Singer Sewing Machines, otherwise all the work is done by hand. Most of these people are in the locality known as Siroghat.

18. The shops of Cutchi Mochis are located in Chotgi Lane and Katcheri Road. They are interested in making sapats (zanana jutas), shoes, boots, etc. Fancy, patent and embroidered leather, and velvet with different artistic designs are used for sapats.

A few Marwari Sochis are found in the taluka towns. In villages only country jutas are made mostly by Meghwadis or Muhammadan Mochis.

19. Sapats, shoes and slippers are produced in large quantities. Hyderabad supplies a great deal of these articles to different places. There is an increasing use of western style shoes and boots. One could notice a number of school-going girls using high heeled shoes. Various kinds of "jutas" are also prepared here.

One could find a variety of footwear produced in Hyderabad in all grades. Shoes and boots from annas twelve up to rupees twenty are manufactured.

The stitching work is generally done on machines, otherwise all other work, such as pattern cutting, lasting, finishing, etc., is done by hand.

For cheap footwear local tanned leather is used, but for footwear of superior quality all the leather used is of outside manufacture.

Leather worth about fifty to sixty thousand rupees is consumed here per month ; chief demand is for good sole leather, box calf and side, patent, kid, fancy and lining leather.

#### THAR AND PARKAR

20. Very little tanning is done in this district. In Mirpurkhas there are about a hundred Jatia families and fifteen of Calals.

Only about eight families do tanning, others owing to lack of capital, instead of following their own trade, do some manual work in cotton ginning factories or in fields.

They use ankhadeka doodh and salt in conjunction with bajri flour in depilating process and tan with babul bark.

They get their hides, if possible, from local hide merchants, otherwise as most of the hides in the district go direct to Hyderabad, they get their supply from that place.

Supply of hides and skins in this district is very limited.

There is very little done in the way of manufacture of footwear or other leather articles except "Jutas" which are made by a few Marwari Mochis. Boots and shoes are supplied from Hyderabad and Agra, etc.

#### LARKANA

21. Only a little tanning is carried on about a mile from the Larkana railway station by Hindustani Mochis, who tan cow, and buffalo hides as well as goat and sheep skins. They also make shoes and "jutas".

With lime they use a little khar in the depilating process. After unhairing and fleshing, which is done by hand, they delime the pelts in old tan liquor by handling it in the liquor for a day or so. After this they give about ten seers of finely cut babul bark and two seers of goola (dry pomegranate flowers) for two hides for three to four days, and afterwards they complete the tanning by bag process in three or four days, when only babul bark is used.

The water used here is from small reservoirs. In Larkana there is never a shortage of water as a canal passes through the city. One can also bore wells at a little cost which will give a sufficient supply of water.

22. Nearly 1,200 cwts. hides and 2,000 cwts. skins were sent away last year from Larkana.

23. There are about twelve Kathiawari Mochi families who are interested in making shoes, boots, slippers, etc., while a few Cutchi Mochis are mainly interested in saddlery. There is also a small colony of Marwari Mochis who are interested in making "jutas".

A large number of shoes come from Agra.

About three thousand rupees worth of tanned leather is consumed here every month, half of which is country tanned and the rest being finished leather comes from outside the province.

. SUKKUR

24. Though Sukkur is one of the important centres in Sind for raw hides and skins, very little tanning is done in the district.

A little tanning is carried on in Shikarpur and in Pano Akil. One tannery in Pano Akil is producing some half tanned leather with a view to export. In this tannery they use babul bark in conjunction with turwad bark and myrabolans for hides, and only turwad bark and myrabolans for sheep and goat skins.

Otherwise, in the district where tanning is done, it is done by bag process. Hardly any leather of good quality is produced in this part of Sind.

25. Sukkur is one of the important distributing centres for raw hides and skins in Sind. There are seven big hide and skin merchants as well as a few agents of some European firms.

About 12,000 cwts. of raw hides and skins come into Sukkur annually. Hides and skins not only from the province but from the Punjab and the United Provinces, etc., come here for distribution, where they are sorted and purchased by the agents of the exporting firms. Sukkur district is well known for its buffalo hides. They are of even substance and spready. The weight is about four cwts. per twenty pieces (sun-dried). They are generally dried on poles in the shade.

26. There are about fifty shops of Marwari Mochis who are interested in producing "jutas" while there are about hundred shops of Cutchi Mochis who are interested in producing boots, shoes, slippers, etc. Harness and saddlery is also manufactured on a small scale. About 12,000 rupees worth of tanned leather is consumed here per month. Practically all this leather comes from outside the province.

27. Fairly good trade is done in raw hides and skins at Shikarpur. There are five hide and skin merchants.

✓ **Approximate prices of raw hides and skins are as follows :—**

Buffalo hides (sun-dried) ..	..	Rs. 30 per maund (82 lbs.).
Cow hides (sun-dried) ..	..	Rs. 45 per maund (82 lbs.).
Goat skins per 100 pieces ..	..	Rs. 150 to Rs. 180.
Sheep (pashmi) skins per 100 pieces ..	..	Rs. 120 to Rs. 150.
Sheep (papras) skins per 100 pieces ..	..	Rs. 80 to Rs. 100.

28. As far as tanning materials are concerned only babul bark is available in large quantities in this district.

29. There are about fifty shops of Marwari Mochis who are mainly interested in producing jutas. About two thousand rupees worth of leather is consumed here per month.

NAWABSHAH

30. As far as tanning is concerned, Tando Adam is one of the important places in this district. Here there are about two hundred

houses of Jatis, out of which only thirty families do tanning, the rest work in machine factories and railways, etc.

The liming as carried out here takes from twelve days to a month where they use about  $\frac{3}{4}$  to one maund (82 lbs.) of lime per 20 hides. The tanning is done by bag method, for which they use only babul bark. Leather weighing about 16 cwts. is produced here per month. Sufficient well water is available.

A small colony of these people is in Shahadadpur where they do tanning on similar lines.

#### UPPER SIND FRONTIER

31. Jacobabad is the only place where some tanning is carried on. There are two classes of people here, the Hindustani Mochis who tan hides, and the Khatiks who tan sheep and goat skins.

In depilating process the tanners of hides use lime and khar and they do the tanning by bag method using only babul bark. The Khatiks use ankhadeka doodh, jawari flour and salt in the depilating process and babul bark for tanning. About three hundred skins are tanned here per month.

32. There are three hide and skin merchants. About 1,500 cwts. of hides and skins are sent away from Jacobabad annually. The hides are sent in sun-dried condition. The goat skins are salted and dried. The sheep skins are allowed to sweat, the wool is pulled out, the skins are then pickled with alum and salt and are sold as "papras."

33. There are about forty shops of Hindustani Mochis who make jutas. Very little is done in shoes, boots and saddlery. About three to four thousand rupees worth of leather is consumed here per month.

#### NORTHERN DIVISION

##### AHMEDABAD

34. Though Ahmedabad is a very important manufacturing city in the Presidency and a big distributing centre of hides and skins in Gujarat, hardly any tanning is done here.

There are three tanneries off Jamalpur Gate about two miles from the city, along the bank of Sabarmati. Formerly a good deal of tanning was carried on in this place; but for the last few years no tanning is done here, barring that done by a few Chambhars who turn out leather by a very crude method. They use in depilating process ankhadeka doodh and salt, then treat the hides with jawari flour and salt and finally tan them with turwad bark. Hides and skins tanned in this way, after being dyed with a red lac solution, are used for book-binding and account book covers.

35. Owing to their ignorance of the tanning trade and the lack of capital, practically all the members of the younger generation of the tanners' class have given up their trade and are working in Cotton Mills.

The chief causes of failure of the tanning industry in Ahmedabad are the want of skilled and reliable labour and proper organization.

36. Recently a small tannery was started near Sabarmati Ashram, where tanning of hides and finishing of the tanned leather is done on an experimental scale.

Besides this there are three picker manufacturers who are manufacturing pickers for the Textile Mills on a fairly good scale.

37. In Dholka there are about seventy-five houses of Chambhars of which nearly twenty-five families do tanning. They use a shrub called 'Jawasi' (which acts just like ankhadeka doodh) with salt for loosening the hair, which process requires about a month or so. They then unhair and flesh the hides and tan the pelts with turwad and babul bark. After this two to five pounds of salt per hide are rubbed into the flesh side of these tanned hides and the hides are finally dried. Most of this leather is sent to Nadiad for the manufacture of gin washers.

On similar lines a little tanning is carried on in Dhanduka, Viramgam and Prantij. There are one or two families of Chambhars in practically every village. Here the Chambhars tan hides and make jutas to supply the local demand. Kos or mots and pakhals are also made by Chambhars from the locally tanned hides.

38. There are seven hide and skin merchants in Ahmedabad. The local slaughtered hides of good quality are turned into 'Farma' (framed hides) and these hides are mostly sent to Cawnpore. The deads which are sun-dried are mostly sent to Bombay.

About three to four thousand hides both of slaughtered and dead animals and fifteen to twenty thousand skins are available per month in this district.

39. Barks of turwad and babul are available in this district in large quantities.

40. There are about hundred Mochi shops where shoes, boots and other leather articles are made. Besides this large quantities of ready-made footwear and other articles come from outside.

Buffalo hides tanned in the Deccan have got a good market here.

Nearly twenty-five to thirty thousand rupees worth of leather is consumed in Ahmedabad per month.

#### KAIRA

41. Nadiad is the only centre where tanning is done on a fairly large scale. Once upon a time leather from Nadiad was very much in demand for gin washers. The leather for washers is sold by weight. The tanners here take undue advantage of this fact and increase its weight by using as much as seven to ten pounds of salt per hide. This has brought the Nadiad leather into disrepute, with the result that leather from Dholka and other places has taken its place.



There are about seventy families of Chambhars in Nadiad of which only twenty families do tanning. For hides they give a long liming for about a month or so, then they tan the hides in kunds. When the hides are tanned only half way, they are taken out and are dried after being rubbed on the flesh and grain sides with seven to ten pounds of salt per hide. They tan about four hundred hides per month.

There are eight gin washer manufacturers in Nadiad. About 8,000 cwts. of leather washers are sent away from Nadiad per year.

Elsewhere in the district, tanning is done here and there on a very small scale just to supply the local demand.

#### PANCH MAHALS

42. About one mile from Godhra town there are six small tanneries. The work is never constant in this quarter. Tanning is done by Khalpas or Chambhars. These tanneries are owned by Ghanchis.

They buy the hides from Dabgars and from local butchers. The hides of good quality are either sent to Bombay or Calcutta, while the rest are tanned locally.

They give twenty to twenty-five days liming to the hides and tan them with ghatbor and turwad bark, cow hides in tubs or pits and buffalo hides by bag process.

For one maund weight (dry hides) they use two maunds of ghatbor and one maund of turwad bark and finally they give a layer of myrabolans for four to five days.

Buffalo hides are used for gin washers and sole leather, while cow hides are sold to local Mochis or sent to Ahmedabad.

The water used here is from wells and it lasts them throughout the year.

43. Dabgars are the people who collect hides and skins from villages on this side. They do not do any tanning but sell the raw material to the tanners or hide and skin merchants.

44. Very little tanning is done in Dohad. There are about fifty to sixty houses of Dabgars in Dohad who collect hides and skins from the neighbouring districts and sell them to the tanners and hide merchants in Godhra.

45. In Godhra there are forty houses of Mochis who are always busy in making shoes, slippers, jutas, etc. Similarly there are about twenty to twenty-five houses of Mochis in Dohad. A large quantity of footwear is turned out in Godhra and Dohad. Nearly one thousand rupees worth of leather is consumed both in Godhra and Dohad per month.

#### BROACH

46. Broach is one of the important centres where gin washers are manufactured on a large scale. Leather for gin washers was first introduced in Broach about fifty years ago. The leather used for the

washers was bought from local Chambhars but subsequently when they began to use too much salt, the Broach leather was superseded by Nadiad leather. Even the Nadiad Chambhars began to play the same trick. So today nearly all the leather for washers of good quality comes from outside. For very cheap washers locally tanned leather is used.

Nearly three to four lakhs of rupees worth of gin washers are annually sent away from Broach.

There is a good demand for belting leather in Broach. Owing to the inferior quality of the belting leather produced in Broach, Japanese belting has taken its place.

Nearly eight to ten thousand rupees worth of leather is consumed in Broach per month. Most of the leather consumed here comes from outside.

47. What little tanning is done in Broach is of a very crude nature. The hides are not even fully tanned. After tanning them half way, salt is rubbed into them and then they are dried.

A little tanning is done in various other places such as Jambusar, Amod, Ankleshwar, etc. Most of the leather produced in these places is used for gin washers.

48. About a thousand hides and six thousand skins are available in this district per month. Practically all the hides from dead animals produced in the district are tanned locally, while the halalis are sent away in salted condition.

#### SURAT

49. There is only one large tannery in Surat near Salabatpura Gate where sheep, goat and lizard skins are tanned by vat process. Most of the tanned leather produced in this tannery is exported.

In Surat besides this tannery a little tanning is done by Khalpas both by bag and vat processes.

In the district a few Khalpas do tanning on a very small scale in Bulsar, Jalalpur, Rander, Olpad and in few other places.

50. Turward bark comes from Marwar while babul bark is in abundance in this District. Practically all the hides of good quality are sent to Bombay.

51. A large quantity of boots, shoes and other kinds of footwear is produced in Surat.

There are two classes of Mochis here (1) Kathiawari, and (2) Gujarati. Both of them do practically the same work. There are about one hundred and fifty shops of Mochis in Surat.

Nearly twenty to twenty-five thousand rupees worth of leather is consumed in Surat per month. There is a demand for good belting, patent, chrome upper and fancy leather as well as for sole leather.

## THANA

52. Tanning is done by Chambhars in this district. The Chambhars are scattered all over the district. Hardly any tanning is done in Thana town. In Kalyan there are about forty families of Chambhars out of which only seven do tanning.

They lime the hides for about twelve to fifteen days. After unhairing and fleshing they give the hides a bath of an old myrabolan liquor for four days. Then after giving two fresh layers of myrabolans (for three days each), they complete the tanning by bag process using ain bark instead of babul bark, and myrabolans. In all other places in the district practically the same procedure is followed. Some Chambhars use dhavadi leaves instead of myrabolans. The Chambhars here besides doing tanning, manufacture sandals and articles such as pakhals, water-buckets, etc., required in agriculture.

53. All the hides and skins of good quality either go to Kurla tanneries or to the hide and skin merchants in Dharavi.

In taluka towns there are a few hide and skin merchants who collect hides and skins in the neighbourhood.

About ten to twelve thousand skins are available in this district per month.

## CENTRAL DIVISION

## AHMEDNAGAR

54. Modern as well as old methods of leather manufacture are represented in Ahmednagar city, *i.e.*, at one end hides and skins are tanned and leather finished under somewhat modern lines, while at the other end of the city tanning is carried on under the old methods.

There is only one big tannery and it is situated about three miles from the city. The tannery is fairly well equipped with modern machinery. Both vegetable and chrome tanned types of leather are produced here. Chrome tanning is done on modern lines. I think, I shall not do any injustice to other tanneries in the Presidency if I say that, this is the only tannery in this Presidency at present, which produces both chrome and vegetable tanned leather of a fairly good quality. Box calf and sides, willow sides, harness and stained leather are produced in fairly good quantities.

Besides utilising all the available hides in the district, they have to get more from outside.

For liming and tanning, the proprietor of the tannery finds the tanners from Madras the best while for other processes such as staking, finishing, etc., the local Dhors and Chambhars well serve the purpose.

A workman in the productive branch costs about twenty to twenty five rupees per month.

Well water is used here. The supply is sufficient for about nine to ten months of the year, but it gets scanty during May and June.

55. At the other end of the city about two miles away, there are a few huts of Dhors who tan hides by bag process, using babul bark and myrabolans.

Elsewhere in the district tanning is carried on by Dhors. They are distributed in the taluka towns and in important villages. Tanning is done by bag process. Their chief difficulty is that they do not get a sufficient supply of hides.

56. The hides and skins in the district are sold on the market days in some of the important centres such as Valakhi, Pathardi, Rahuri, Ghodnad, etc. These are bought by tanners and the agents of the hide and skin merchants.

There are six hide and skin merchants in Ahmednagar and one or two in every taluka town.

The production of skins in the district is about ten thousand pieces per month.

100 goat skins (3 to 3½ maunds weight) wet salted cost about Rs. 150 to Rs. 180.

100 sheep skins (4 to 4½ maunds weight) wet salted cost about Rs. 90 to Rs. 120.

57. The people interested in manufacturing footwear and other articles in this district are Marwari and Pardeshi Mochis and Marathi Chambhars.

There are about hundred houses of leather goods manufacturers in Ahmednagar city, and about two hundred rûpees worth of leather is consumed every day.

The chief types of footwear produced are boots, shoes, slippers, Brahmani jodas, and sandals, and other articles such as mots and pakhals, etc.

#### EAST KHANDESH

58. Tanning is carried on in this district both by Chambhars and Dhors. There are small colonies of Chambhars in some places and of Dhors in some.

The Chambhars do tanning by vat process using ghatbor and turwad bark. In Jalgaon, Bhusaval, etc., tanning is done by Chambhars.

They give three layers of tanning materials each for eight days, using about twenty-five to thirty pounds of ghatbor and as much turwad bark per hide. They themselves use the leather which they produce, in making sandals.

In Bodwad, Chalisgaon and some other places tanning is done by Dhors. They do the tanning by bag process where they use myrabolans and babul bark.

A few years ago some attempts were made to start tanneries on a small scale by two or three persons in Bhusaval but nobody succeeded, chiefly owing to the want of skilled labour.

59. Hides and skins are sold on the market days in some of the chief centres in the district such as Mhasavad, Chalisgaon, Jalgaon, Bhusaval, Neri, etc.

The approximate quantity of monthly production of goat skins is about five to six thousand pieces and sheep skins about two thousand pieces. The goat skins from Khandesh side called the "Deccan quality" are supposed to be the best in the Presidency. They are chiefly exported to America.

The price for 100 goat skins (dry salted) is about Rs. 150 to Rs. 200. The price for 100 sheep skins (wet salted) is about Rs. 90 to Rs. 110.

The bulk of the skins goes to Madras. The production of hides in this district is about three thousand hides per month.

20 cow hides (5 maunds wet salted) cost about Rs. 130 to Rs. 160.

20 buffalo hides (10-12 maunds wet salted) cost about Rs. 150.

60. In towns Marwari Mochis, Pardeshi Mochis, and Chambhars make footwear of usual classes; while in small places there are only Chambhars and Dhors, the former make jutas and the latter mols and other agricultural requirements.

#### WEST KHANDESH

61. Tanning is carried on in this district both by Chambhars and Dhors. The principal tanning materials used being ghatbor and turwad bark by the Chambhars and babul bark and myrabolans by the Dhors.

No tanning is done on a commercial scale anywhere in the district, but it is carried on according to the requirements of local consumption.

A tannery on a moderate scale was started some years ago about two miles away from Dhulia but it had to be closed down owing to the shortage of water and want of skilled and reliable labour. In Dhulia proper no tanning is done.

62. The chief difficulty of the tanners here is to get turwad bark. This tanning material in the local forest area is farmed out to contractors, who collect the bark and send it to Bombay. Hence ghatbor is the principal tanning material which is available for the local Chambhars. The leather tanned by ghatbor alone presents light tan colour but it is spongy and tender. Many Chambhars are very ignorant about the use of babul bark and myrabolans.

63. Hides and skins are sold mostly on the market days in different centres such as Amalner, Betwada, Nandurbar, Dhulia, etc.

Most of the hides are sent to Bombay or Ahmednagar in wet salted and in sun dried condition. Sometimes the hide merchants make framed hides when there is any order for the same from Cawnpore.

About five to six hundred hides and two thousand skins are available per month, from the hides and skins merchants in Dhulia.

64. The Pardeshi, Marwari and Gujarati Mochis produce different kinds of footwear and other leather articles on a fairly large scale. The

Chambhars and Dhors are interested in making jutas, mots, pakhals, harness and saddlery.

Nearly fifteen hundred rupees worth of leather is consumed here per month, most of which comes from outside.

#### NASIK

65. In this district tanning work is done mostly by Dhors, but in some places it is done by Chambhars.

Tanning is done on a fairly good scale in Devlali and Malegaon, where there are about twelve houses of Dhors in each place. There are also a few houses of Dhors and Chambhars in taluka towns and in important villages, where they do tanning to supply leather for the local demand for country footwear, mots, pakhals, etc. Most of the leather produced in the district is tanned by bag process.

The principal tanning materials used in this district are babul and turwad bark and myrabolans and in some places ain bark.

No other tanning is done in Nasik city except that a few sheep skins are tanned for account-book binding and covers for files. The skins are tanned by turwad bark and dyed with lac dye.

66. Most of the hides and skins in the district come to the weekly bazars in places such as Devlali, Yeola, Nasik, Malegaon, etc. Here the Dhors and Chambhars in the district and agents of hides and skins merchants make purchases. About a hundred hides and a thousand skins come to these weekly bazars in some of the important centres. Nasik produces some goat skins of good quality. About 7,000 cwts. of hides and skins go outside the district per year.

67. There is a good number of Marwari and Pardeshi Mochis in some of the important towns in the district, where they consume about five to six hundred rupees worth of leather per week. Most of the leather they use comes from outside.

The Dhors besides doing tanning, supply mots and other agricultural requirements to the villagers.

#### POONA

68. There are two centres where tanning is done near Poona city. The most important centre is Wanowri nearly two miles from the Camp where there are two fairly big tanneries where mostly hides are tanned for export trade by vat process and for local consumption by bag process. There is nothing particular about these processes except that the leather produced here is of a fairly good quality as compared with the production of the village Dhors.

In one tannery some labour is imported from Madras, the rest being supplied from the local Dhors. The proprietors of this tannery find sometimes much difficulty in dealing with the labour from Madras. These people generally take advance money and then run away without any

notice, whereby the work is much hampered. This is the usual experience in many of the tanneries in this Presidency where labour is imported from Madras. In the other tannery all the work is carried on by the local Dhors under the supervision of a Dhor mistry.

Besides this, in the same locality tanning is done on a small scale by Dhors by bag process. No leather is finished here. About two thousand hides are tanned in this centre per month. Sufficient well water which is used here is available throughout the year.

Some stained leather is produced in the city for local consumption.

69. The other centre is Ambilwada near the city where bag tannage is done on a small scale. In the same centre some skins are tanned by Chambhars who use ankhadeka doodh, bajri flour and salt in the depilating process and then tan the pelts with turwad bark. After the skins have been dried they finish them by staining with a solution of lac dye. This leather is used for hats (topis) and for book-binding.

70. Bag tannage is done on a fairly good scale in Talegaon, Junnar and Baramati.

Most of the hides of good quality in this district are bought by the tanners in Poona and rest are sent to Bombay or Madras in wet salted condition.

The tanners in other centres being petty cannot afford to buy hides of good quality and hence they have to get their supply from Bombay, Bezwada, etc.

71. The hides and skins from slaughter houses are bought by big contractors, while most of the skins and a few hides from the district come to the weekly bazars in places such as Talegaon, Junnar, Manchar, Baramati, etc.

Nearly five to six hundred skins are sold daily in the skins market near Baliwalla theatre in Poona.

72. Dhond is one of the important centres where skins are collected from various centres and are cured and sent to Madras. There are four firms which carry on this business. The sub-agents of these firms collect the skins from villages and also buy on the bazar days in Poona and other neighbouring districts and send them to Dhond in wet salted condition where they are further cleaned, cured, sorted and packed and sent to their headquarters in Madras for further disposal.

About 9,000 cwts. of skins are sent away from Dhond annually.

73. There is a fairly good demand for upper, harness and belting leather in Poona city. A part of this demand is supplied by the local tanners but the rest of the supply comes from outside.

A fairly large quantity of ready-made footwear of different classes and other leather articles such as harness, saddlery, belts, etc., comes from outside.

Among the footwear produced in Poona, Brahmani jodas are well known.

Many shops in Cantonment exhibit boots and shoes, harness and saddlery of superior quality, so do also a number of shops in the city.

One can see in Poona a number of shops of Mochis and Chabmhars, which are busy in turning out a large quantity of footwear of various kinds and grades.

#### SATARA

74. The first important centre where tanning is done on a fairly large scale in this district is Satara town. There are about seventy houses of Dhors. Until recently most of them were following their trade but today only ten families are doing tanning. They tan mostly hides and occasionally a few goat and sheep skins. The local supply of hides is not sufficient for them and hence they get their supply from Bezwada, Bombay and other places.

Hides are tanned here by bag process. The principal tanning materials used are babul bark and myrabolans. To tan twenty hides costs them about ten rupees for labour.

The nearest railway station is Satara Road, which is about twelve miles away. They have to cart their goods to and fro for such a long distance.

Sufficient babul bark is available in the district, but even that has to be carried from a long distance. They have to get myrabolans from Kolhapur or Bombay.

Formerly some stained leather was produced here but its quantity is much reduced at present. The only source of water is tap water which they get in quantities just sufficient for their purpose.

75. Wai is the next important centre in this district where tanning is done on a fairly large scale. There are about ten families of Dhors and twenty houses of Chambhars who are doing tanning. The former tan hides. The latter tan a few skins just to supply their own demands for making jodas. This kind of footwear from Wai is quite well known in this part of the Presidency.

76. On a smaller scale tanning is done by Dhors in Karad, Dahiwadi, Mhaswad, etc. There are also one or two families of Dhors in other places who produce leather to supply the local demand.

77. Some years ago a Co-operative Credit Society was started in Satara amongst the Dhors, but as some of its members did not understand their responsibility and spent the money for their private use, the Society had to be wound up. Ultimately the money had to be recovered with great difficulty.

78. A few hides and most of the skins in the district are sold on the bazar days in some of the important places like Patan, Karad, Satara, Wai, etc. The skins are purchased by the agents of skins merchants. They are sent either to Bombay, Madras or Dhond.



About ten thousand goat and sheep skins are available in this district per month.

79. There are a few shops of Mochis and Chambhars in Satara and other important taluka towns, where boots, jodas, chappals and other leather articles such as mots, and pakhals are made. For jodas the Chambhars themselves dye the tanned skins with red aniline dyes.

#### SHOLAPUR

80. The largest colony of Dhors in the Presidency is in Sholapur. They have tried and are trying to produce various kinds of leather in demand in this Presidency. During the War when there was a restricted supply of imported leather especially of some special classes like belting and roller skins, etc., the Dhors from Sholapur tackled the problem very well. Besides producing ordinary kind of leather they made belting, roller leather and picker bands in fairly large quantities and supplied a part of the demand of the textile mills.

Now that the conditions are once again normal owing to their insufficient knowledge of leather manufacture, lack of scientific guidance, and of up-to-date special machinery, they are not able to compete with the quality of roller and belting leather and picker bands which are coming in large quantities to this country from abroad.

81. At present there is only one tannery equipped with a few modern machines in Sholapur, at a distance of about a mile from the railway station. All the work there is carried on by Dhors under a Dhor místry. Here cow hides and sheep and goat skins are tanned by vat process and buffalo hides by bag method. The leather tanned is further dyed or stained and is used as upper leather and for bags and portmanteaus, etc. Buffalo hides are finished for belting leather and harness leather. Some chrome leather is also produced here for belting and soles. Besides this, leather laces and roller skins are produced in a moderate quantity. Nearly twenty per cent. of the production is sold locally and the remainder is sent to Bombay for further disposal. Many improvements are necessary before the quality of the leather produced here comes to a high level.

Besides this tannery, some Dhors in the Cantonment area produce leather on a moderate scale. Their chief production consists of belting leather, leather laces, roller leather, picker bands and a small quantity of chrome belting.

Mostly well water is used by the tanners; they get it in sufficient quantity for their purpose, except in summer when the supply gets sometimes scanty.

About five to six thousand rupees worth of leather is manufactured in Sholapur per month. The excess of production over local consumption is sent to centres like Kolhapur, Barsi and Bombay, etc.

82. The Dhors here are quite intelligent, are good imitators and I think if they get proper push and scientific guidance, they will play an important part in the development of tanning industry in this Presidency.

83. Elsewhere in the district, tanning on a small scale is done in Barsi and Pandharpur; while in other places there are one or more families of Dhors who produce just sufficient leather to supply the local demand. In all these places tanning is done mostly by bag process.

84. Hides from Sholapur being of a good quality fetch high prices and find their way in large quantities to Bombay and Madras in wet salted condition. A large portion of the deads is consumed in the district and the tanners who want cheaper hides get them from Bombay and Bezwada, etc.

The prices of hides and skins when I was at Sholapur were as under :—

Cow hides (camela wet) were sold at annas 6 per lb.

Buffalo hides (camela wet) were sold at annas 3½ to annas 4 per lb.

100 goat skins (wet salted) cost about Rs. 170 to Rs. 190.

100 Sheep skins (wet salted) cost about Rs. 90 to Rs. 110.

The hides and skins from the district are sold in the weekly markets in the important centres such as Sholapur, Karmala, Barsi, Pandharpur, etc.

Eight to ten thousand skins are produced per month in Sholapur alone. About twenty to twenty-five thousand skins are produced in the whole district per month.

There are five local skin merchants and five agents of Madras firms and about 5,000 cwts. (wet salted weight) hides and 12,000 cwts. (wet salted weight) skins are sent away annually from Sholapur to Madras and Bombay.

85. Turwad and babul barks are produced in large quantities in this district.

86. There is a small colony of Dhors in Shukrawar Peth in Sholapur who manufacture leather trunks, portmanteaus, brief and hand bags and various other leather articles of good quality.

Dhors in Bhavani Peth and Camp are specially interested in manufacturing leather belting and leather laces.

Besides this there are many Mochis and Chambhars who produce a large quantity of boots, shoes, slippers, sandals, etc. In other important towns in the district there are a few shops of Mochis and Chambhars who produce sufficient footwear to supply the local demand.

## SOUTHERN DIVISION

### BELGAUM

87. There is only one factory in Belgaum. It is situated in Thalakwadi at about a mile's distance from the railway station. Here cow hides are tanned by vat method for export trade and buffalo hides by bag process

which are sold locally or sent to Bombay. The tanning work is done by the local Dhors under the guidance of a Madrasi Mistry. The output is fairly good. Besides the local hides, a good number of hides come from the neighbouring districts and Goa. The principal tanning materials used are turwad, bawa, babul bark and myrabolans. The well water which is used is available in sufficient quantities throughout the year.

There is one more tannery near Belgaum which is situated in Kurundwad State, in Peeranwadi and the nearest railway station from this tannery is about five miles away. The trade transactions of this tannery are conducted in Belgaum. In this tannery sheep and goat skins are tanned by vat process for export trade. Most of the labour is from Madras; there are also a few local Dhors. As usual Madrasi tanners take an advance, but in order to see that these tanners do not run away, they are given quarters near the tannery and the provisions are stored in the tannery in order to avoid their going even in the city as far as possible. Hardly any finished leather is produced in Belgaum.

The principal tanning materials used are turwad bark and myrabolans which are bought from the local contractors, as well as from the neighbouring districts. The well water which is used is available in sufficient quantities and seems to be suitable for tanning.

88. There are also a few huts of Dhors outside the fort where some of them tan a few hides. They use babul bark and myrabolans and also some dividivi pods which are collected locally. The tanning processes used here are very crude. Cow hides which are tanned whole, are used for mots, pakhals, ropes, etc. Some hides are tanned in sides, which are used for jutas. A few skins are tanned and finished by staining in Shahapur and they are used for making hand bags and attache cases, etc. The cost of local labour is moderate.

89. Besides Belgaum, fairly large colonies of Dhors are found in Nipani and Vadgaon, etc., and small groups in some of the larger villages. In all these places hides are mostly tanned by bag method. The tanned leather is either used locally or sent to Bombay.

90. There are six skin merchants in Belgaum. Some of the best hides and a large number of skins in wet salted condition are sent to Madras and Bangalore.

About two thousand hides and four thousand skins are available in Belgaum per month.

Wet salted cow hides are sold at the rate of three to four pounds per rupee and wet salted buffalo hides at five to six pounds per rupee.

100 goat skins cost about Rs. 140 to Rs. 170. 100 sheep skins cost about Rs. 90 to Rs. 110.

The right of collection of myrabolans and turwad bark is farmed out to contractors. Both these materials are available in large quantities.

91. Belgaum seems to be a suitable centre for developing this industry, as it is a central place for getting raw hides and skins from Dharwar, Goa, and Konkan, etc. Sufficient Labour is available, though not well trained at present. There is a sufficient supply of water as well as of tanning materials.

92. There are about seventy-five shops of Chambhars where shoes, sandals, jodas and other leather articles for local use are made, while a few Dhors are interested in manufacturing bags, bed straps and other fancy articles.

#### BIJAPUR

93. Bijapur is the only place in this district where tanning is done on a fairly large scale. There are two tanning centres about a mile apart just outside the town, one near Shahapur Darawaja and the other near Jorepur. The hides and skins tanned here are of a very inferior quality; hides are tanned by bag method and skins by vat process.

There are about thirty houses of Dhors and they work just in front of their houses. The principal tanning materials used are babul bark and myrabolans and sometimes a little turwad bark. Turwad bark is dearer than babul bark, and as they only tan skins of poor quality, it does not pay them to use the former.

The tanning done here is of a poor standard. A good number of deer skins are tawed with alum, salt and buttermilk. There is a great scarcity of water in this place and what little water the tanners get hardly suffices them for their work. Elsewhere in the district there is very little of interest to report except that there are small groups of Dhors in the taluka towns and some larger villages, who produce leather only to supply the local demand. In Bijapur there is a Co-operative Credit Society of Chambhars and Dhors, but reports are not favourable about its progress.

94. There are four hides and skins merchants in Bijapur and sub-agents in the important places in the district. About five hundred hides and ten to twelve thousand skins are available per month. They are bought on the bazar days and brought down to Bijapur. The hides and skins of good quality are sent to Madras or Bombay in wet salted condition.

95. There are about hundred shops of Chambhars in Bijapur which make shoes, jodas and sandals, etc. They get their supply of leather from the local Dhors and from Bombay, Sholapur, and other places. About two thousand rupees worth of leather is consumed here per month. Amongst the footwear produced, jodas are the speciality of Bijapur.

#### DHARWAR

96. There are fairly large settlements of Dhors in Hubli, Dharwar and Gadag, while small groups are found in some other places.

There are about twelve families of Dhors in Dharwar, who are carrying on their work along a reservoir of water just outside the city in an open

place. The water they use is very muddy. Mostly they tan buffalo and heavy cow hides by bag process. The principal tanning materials used are babul bark, myrabolans and also a small quantity of divi divi.

There are about forty families of Dhors in Hubli and twelve in Gadag who are doing tanning on similar lines as their brother tanners in Dharwar. The chief difficulty of the Hubli tanners is the want of sufficient supply of water.

About one hundred hides are tanned in Hubli per month and thirty in Dharwar. The leather from Hubli is a little superior to that produced in Dharwar, but on the whole the quality of leather is very ordinary.

A few Dhors in Dharwar, Hubli and Gadag are trying to make chrome sole leather, but nobody seems to have succeeded so far owing to lack of scientific knowledge of chrome tanning. A little alum curing is also done in these places. A moderate quantity of belting leather is produced in Hubli.

97. Besides the petty local merchants, there are agents of the important hides and skins merchants of Madras in Dharwar, Hubli and Gadag, etc. Hubli hides are supposed to be the best in the district. About one thousand hides and ten thousand skins are available in the district per month. Light cow hides, calf, goat and sheep skins in wet salted condition are sent to Madras, Bangalore and Bellary.

98. The principal tanning materials available in this district are turwad-babul bark and myrabolans.

99. There are fairly big colonies of Chambhars and a few Mochis in the big centres in the district, who produce different kinds of footwear for local consumption. Some Dhors make mots, pakhals and laces, etc.

During the cotton season, many of these people suspend their trade and work in cotton gins.

About four thousand rupees worth of leather is consumed per month in Dharwar, Hubli and Gadag.

100. In Dharwar there is a Co-operative Credit Society of Chambhars and Dhors which has been working for the last eleven years. This is the only fairly well conducted Society of its kind in this part of the Presidency. It is mainly managed by Chambhars. After some sad experience they have stopped advancing any money to the members.

At present they are interested in storing all kinds of requirements of Chambhars and Dhors. They sell these articles to the people in the trade with a small margin of profit.

#### KANARA

101. In Kanara a Chambhar is a tanner as well as a shoe-maker. There may be a few houses of Dhors of the up-ghat side.

Fairly big colonies of Chambhars are to be found in Karwar, Ankola, Yellapur, Sirsi, Kumta, Honavar, etc.

They tan mostly hides by bag process. Very little tanning of skins is done. The principal tanning materials used are matti and jambul bark and myrabolans.

After liming, unhairing and fleshing, they tan the washed pelts in liquors made of crushed myrabolans in conjunction with matti bark for about eight to ten days and then complete the tanning by bag process.

Practically all the leather tanned here is used by themselves in making sandals, jutas or vahanas and a few other leather articles. In the above-mentioned towns a good deal of sandals are manufactured. After supplying the local demand of sandals the surplus is sent to up-ghat towns and Bombay.

102. The production of hides and skins is very moderate. Most of the hides from this district are of poor quality, and of light weight. The hides of good quality and goat and sheep skins are collected by the sub-agents of Madras merchants and are sent to Madras and Bangalore.

Matti bark and myrabolans are the principal tanning materials available in the district.

#### RATNAGIRI

103. There is very little to report about the tanning industry in this district.

Tanning of hides and working of leather is done by Chambhars in this district.

Small groups of eight to ten families of Chambhars are to be found in the taluka towns and important villages; while one or two families are to be seen practically in all the villages in this district.

Nearly all the hides produced in this district are from dead animals and they are of poor quality. Hardly any hides produced in this district are sent outside the district. Almost all of them are consumed locally.

In some places it costs from annas eight to a rupee per hide; while in other places the local Chambhars get all the hides produced in that locality by paying a fixed sum to the Mahars annually. The tanning on the whole is crude and not even complete. The principal tanning materials used are ain and jambul bark and myrabolans. In some places they use leaves of aonla tree and kandal bark (mangrove).

104. Sandals from Ratnagiri district are always in demand in Bombay and certain up-ghat towns. Sandals from Lanja, Rajapur, Malvan and some other places are well known on this side of the Presidency. When there is a good demand for sandals, the Chambhars do not tan the hides properly but just colour them with tan liquors. Some artistic and thick jutas are produced which are very much liked by the farmers.

105. Goat and sheep skins produced in this district are collected by the agents of some firms in Belgaum and Kolhapur and are sent to these places in salted condition.

## KOLABA

106. Chambhars here just as in Kanara and Ratnagiri districts are both tanners and shoe-makers.

Fairly large colonies of these people are to be found in Panvel and Mahad; and most of the other places in the district have one or more families of them.

First they treat the limed pelt with myrabolan liquors for about a week and then complete the tannage by bag process where they use ain or jambul bark. The principal tanning materials used are jambul and ain bark, myrabolans and dhavadi leaves.

The tanning done here is very crude and hence many Chambhars instead of tanning the hides themselves, prefer to buy tanned leather from Dhors from the ghat districts for making jutas.

107. The hides of inferior quality of dead animals are tanned locally, while the rest are either taken away by Dhors or collected by hide merchants and sent to Bombay. Skins are collected by skin merchants and sent to Bombay.

108. Sandals are manufactured here in large numbers and are sent mostly to Bombay and Poona. There are a few Ghati Chambhars in taluka towns, who make shoes, jodas and other leather articles.

## BOMBAY AND SUBURBAN DISTRICT

109. Bombay is the largest centre in this Presidency where "half tanned" leather for export, chrome leather, vegetable tanned and finished leather and leather articles for Indian use are manufactured.

The tanning centre is situated in Dharavi. There are twenty licensees controlling 33 tanneries, out of which one manufactures chrome leather for uppers, soles, gin washers and so on, on a fairly large scale; leather laces and gin washer rollers are also manufactured in this tannery. It is equipped with most of the machines used in chrome leather manufacture and is run on somewhat modern scientific lines.

110. In most of the other tanneries cow and buffalo hides and calf, goat and sheep skins are tanned for export on an extensive scale. In a few tanneries vegetable tanned leather is produced, dyed and finished on a moderate scale. It is sold locally. The leather which is dyed and finished here is used for boot and shoe uppers, sandals, portmanteaus, bags, trunks and so on.

Most of the workmen in export tanneries are Madrasis while in others Dhors, Chambhars and tanners from upper India are employed.

Leather trunks, bags, attache cases, and other leather articles are made in this centre on a fairly large scale.

111. There are also a few hide and skin exporters' godowns in Dharavi where hides and skins are cured, sorted, pressed and baled for export. Goat skins are exported on a large scale from here.

112. Khadak and Dhabbu Streets near Null Bazar are the important centres where most of the leather trade in Bombay is concentrated.

There are various shops all over the city where boots, shoes and other kinds of footwear as well as harness, saddlery, belting and various other goods of leather are produced on a large scale.

113. In the Bombay Suburban District, Kurla is the only place where tanning is done on a fairly large scale. There are five tanneries where bark tanned leather is produced. Some of the turwad bark tanned leather is exported ; the rest is sold locally.

A good many buffalo hides are also tanned by bag process. Some of the tanned cow hides are dyed and finished.

All the work in these tanneries is done by hand. Most of the labour in these tanneries consists of Madrasi tanners, Dhors and Chambhars.

## CHAPTER IX

### GENERAL OBSERVATIONS AND RECOMMENDATIONS

#### I. Raw materials, labour and capital

1. **Tanning materials.**—It has been already pointed out that this Presidency is particularly well provided with various tanning materials which, in many cases, are not being used to the best advantage of tanners, and often the most suitable materials are not being used for the class of leather required.

In the tanneries of this Presidency the principal tan stuff used are :—Turwad and babul barks and myrabolans. Relatively small quantities of ghatbor and ain bark may also be mentioned as being used in certain places. Besides these, there are certain tanning materials, such as dhavadī leaves, divi divi, aonla bark and others which deserve more attention than they have received so far. Except turwad bark and myrabolans, only a small portion of the available quantities of the rest of the above mentioned tan stuffs is used.

2. Turwad bark is the chief tanning material which is used for “ half-tanned ” leather for export. It is very costly as compared with the other tanning materials. It has certain peculiar properties and hence leather tanned by turwad bark is highly favoured by the buyers abroad. But if “ half tanned ” leather similar in quality to the turwad “ half-tanned ” leather is produced from other tanstuffs which are cheaper and available in large quantities, it is difficult to understand why it should not be equally favoured by the buyers.

Some experiments were made in this direction in Esociet Tannin Research Factory, Maihar (Central Provinces), a few years ago, where valuable results were obtained. It was unfortunate that those experiments were not continued whereby tanners in the various parts of India would have been able to



benefit themselves. The results obtained in Esociet Tannin Research Factory show that if experiments are carried out in that direction, leather not only similar in quality to the turwad "half-tanned" leather but cheaper in cost can be produced.

3. In making these experiments the following points should be observed :—

- (1) The actual tannin percentage is not the only criterion which enhances the value of a tan-stuff, but certain qualities which are produced by the non-tans are also to be considered. Tanning materials preferred by tanners vary according to the peculiar type of leather which it is desired to produce.
- (2) The quality of individual tan-stuffs collected in different seasons from different localities under varying conditions and their different mixtures, should be studied. This study would help the collectors of tanning materials in grading and collecting the tan-stuffs under the most favourable conditions.
- (3) Tan-stuffs which are most easily got and which yield the cheapest unit of tans or other constituents are to be preferred.
- (4) New processes for tanning on a small but practical scale should be studied. Difficulties that are likely to present themselves on a large and commercial scale may be discovered by repeated tests.
- (5) Experiments in tanning with dhavadi bark and leaves, divi divi, ghatbor, babul bark, myrabolans, aonla and ain bark would be interesting and valuable.
- (6) To-day the cost per unit of tannin per maund of some of the tanning materials is as follows :—

Name	Price per maund	Tannin per cent.	Cost per unit per maund
	Rs. a. p.		
Turwad bark .. .. .	6 8 0	18	5·8 annas
Babul bark .. .. .	2 0 0	12	2·4 "
Myrabolans .. .. .	4 0 0	28	2·3 "
Ghatbor .. .. .	1 8 0	16	1·5 "

- (7) Most of the tannin contents in the various tanning materials should be utilised.

4. Leather tanned with turwad bark was till recently used in very large quantities, in Europe for book binding purposes, but this branch of the trade has been lost since, as stated in the report published by the Society of Arts (London), on "leather for book-binding", leathers tanned by turwad bark were especially condemned as unsuitable for this purpose, due to the red rot taking place after a few years.

If experiments are carried on by using other tanning materials to produce such leather as will be free from the above mentioned defect, the lost trade might be recaptured.

5. **Raw hides and skins**—References have already been made as to the outstanding defects in our hides and skins and how to minimise the same.

Raw hides and skins may be considered as a bye-product of agriculture and hence their supply to the market is little affected one way or the other by the demand, as it would not be profitable to raise animals for their hides and skins alone ; and as the demand for the raw materials is steadily increasing, the prices are going higher. This Presidency is not very rich in its supply of hides but the supply of skins is fairly large. The quality is not high, but by minimising the various defects mentioned in chapter I we may be able to get a better price for our hides than hitherto. In many other parts of the world good results in this connection have been achieved by co-operation between the Government concerned and the people interested in different branches of hide and skin trade and leather industries.

6. More than ninety per cent. of our hides are obtained from dead animals and unless a village Mahar realises that he would get a good price for the hide which is flayed and preserved properly, nothing can be done to improve the quality of our hides.

The Mahars or Dheds who are the actual flayers of dead animals have very little idea of the importance of proper flaying and of the way in which hides should be preserved, so as to give the best possible results. These people get hides free and have little notion as to what would be their real value, if proper care is taken in flaying and preserving and thus presenting them in the market in the best possible condition.

In some cases these people are advanced a few rupees by the hide collectors, and contracts are made with them, to supply these collectors with all the hides produced at a fixed price without any distinction being made whether the hide is well or badly flayed. Hence these Mahars hardly use any skill and take little trouble to produce hides in the best possible condition.

On the other hand in certain parts of the Presidency where the Mahars come directly in contact with tanners, they realise the value of good flaying and proper preserving as they get good value for their labour.

7. There are about five to six intermediaries between the purchaser and the Mahar with the result that most of the profit is swallowed by these middlemen. So possibly the best way would be to get a syndicate of intelligent buyers to co-operate with a view to bringing about the establishment of local markets, where buyers could come and purchase classified lots by auction or through brokers, and Government may provide an expert to help in the organisation. Here the hides should be inspected

and sorted in different classifications and a certain charge should be taken for each hide inspected and for so many skins from the owner of hides and skins and an equal charge should be taken from the purchaser. The defects should be studied carefully and then certain measures should be taken to instruct the flayers as to how they should minimise the defects. Defects like branding could be minimised through the efforts of the Agricultural Department, as various officers in that Department are constantly moving about in the districts to give demonstrations to the agriculturists, and on such occasions, they should make a special reference to the heavy loss the Presidency has to suffer owing to the branding of animals.

8. It is held that establishment of spinning mills in some of the important cotton growing centres such as Broach, Ahmedabad, Cawnpore, etc., has encouraged the production of long staple cotton in this country. Similarly if tanneries are opened in important centres all over the Presidency and not concentrated in large centres only, great improvements may be effected in the flaying and curing of hides at first in the areas immediately surrounding the tanning centres and then by degrees throughout the Presidency.

9. **Labour.**—Leather tanning is largely a hereditary profession of people of certain classes in this Presidency.

Today owing to the tottering condition of this industry, the causes of which have been already mentioned in the previous chapters, only a portion of the large number of tanners is doing actual tanning, while the rest are finding outlets for their labour in agriculture, mills, factories, and so on.

Many of them are anxious to follow their trade, but owing to their ignorance of the principles and processes in modern tanning and owing to the fact that tanning by primitive methods is not paying, they have been forced to give it up.

10. During my tour many tanners were anxious to know if I could give them some idea of the processes in modern tanning and formulas, but I did not think it advisable to tell them much about these things, as it would not have been possible for them to grasp and follow such things to any practical advantage. In order to follow processes in modern tanning, they would require some special guidance in the beginning during the practical work; otherwise, if I had told them of certain processes and formulas, in trying to put them into practice without any scientific guidance they would have suffered loss, which would have disheartened them and made them disinclined to take any notice of modern methods of tanning. I should say that as these people have got hereditary instinct and liking for their industry they would be able to follow the methods of modern tanning, if they were trained properly for some time under suitable guidance.

11. Even though we have so much labour available in the Presidency, the labour in almost all the export tanneries is from Madras. As these

people come a long way from their homes, they demand more money and are never steady. In most cases, they take advances and run away whenever they like, with the result that many a tanner has lost much money and owing to the unsteadiness of these people and the resulting heavy losses some have been compelled to close down their tanneries. The local tanners do not know turwad tanning; they are very anxious to learn the processes but the Madras tanners will not teach them. In some places where the owners of tanneries have arranged with great difficulty for the local tanners to work with the Madrasis, it is interesting to note that they have been able to follow these methods fairly well and have been able to produce equally good practical results.

To remove the difficulty of getting skilled reliable and cheap labour, it will be necessary to train some of the intelligent young men from the vast army of village Chambhars and Dhors.

**12. Capital.**—During my tour I was asked in several places by enthusiastic people with means and interested in industries, as to how far there was a scope for the tanning industry.

As mentioned before there is ample scope for those who will organise this industry on modern scientific lines.

There is a good internal demand for certain kinds of leather and a satisfactory demand from abroad for half-tanned leather. So far as the raw materials are concerned we have plenty of them, but the principal drawbacks which hamper the development of this industry are (a) lack of trained, skilled and reliable labour, and (b) want of proper investigations into the modern methods of tanning so as to suit our climatic conditions.

Now if these matters are attended to, and steps are taken to ensure the development of this industry on modern lines, the public will gain confidence and invest the necessary money in it.

**13. Location of the Industry.**—I am of opinion that this industry should not be concentrated only in large centres. The highly developed industrial countries have sad experience in this respect. We should take advantage of this experience. As we have yet to develop our tanning industry, due precautions should be taken to establish tanneries in towns of moderate size all over the Presidency. In selecting centres proper consideration must, of course, be given to such points as availability of raw materials, labour and other necessary requirements. Under this arrangement the industry is likely to get steady labour as the labourers would then be able to live in close touch with their old village homes.

## II. Some suggestions for the Tanning Industry

**14. Waste in the existing methods of Tanning.**—Owing to the faulty methods of soaking and liming many hides are spoiled which means a heavy loss to the tanner.

Owing to the crude and primitive methods of tanning, the tanning materials are not fully utilised and the spent tan materials are thrown away

which contain as much as six to seven per cent. of tannins. When taken collectively for the whole Presidency this means a heavy loss.

If the quality of tanned leather for export could be standardised, then many of the processes, such as softening and slicking out processes, could be avoided here as the leather is wetted back on its arrival in England.

**15. Utilisation of bye-products.**—One of the chief factors on which the success of any industry depends is the utilisation of bye-products in the main industry. The reclamation and exploitation of waste products for a variety of industrial uses constitute one of the most fascinating and increasingly important developments in modern industry.

The products, which are of no direct value to the tanner and which are wasted by the tanners in this Presidency, are many. The most important of them, which are obtained in fairly large quantities, could be utilised as follows :—

- (1) Hair should be washed and cleaned properly and could be utilised by plasterers and for stuffing furniture.
- (2) Fat could be obtained by boiling the fleshings and shavings ; after the fat is removed, glue could be prepared from the rest of the stuff.
- (3) Some of the organic waste from tanneries could be used for manufacturing manures.
- (4) The spent tan-stuffs could be pressed in moulds and sold as fuel.

**16. Finished leather.**—Of the leather tanned in this Presidency only a portion is further dressed and finished, but even that is lacking in certain qualities compared with similar kinds of imported leather.

A reference has already been made to this in paragraph 16 of Chapter IV. To develop this branch of the leather industry it is necessary to study the causes of those defects with a view to improving the quality of leather of the various kinds mentioned in that Chapter.

**17. Chrome tanning.**—As far as chrome leather is concerned, this Presidency is backward as compared with other Provinces in this country. A few years ago it was generally believed that the climate of India was not suitable for producing chrome leather of superior quality. Perhaps the same belief prevailed years ago in European countries, when the making of chrome leather was first started there, but today after several experiments and efforts, when chrome leather of superior quality in large quantities is produced there, it has been found that that belief is not correct. India produces some raw materials, especially goat skins, suitable for chrome tanning, practically all of which are exported. Today chrome leather of quite good quality is manufactured in some Provinces which proves the possibilities of successful chrome tanning in this country. The chrome leather industry is now firmly established in those Provinces. The climatic conditions in this Presidency are in no way different from those of other Provinces and hence I think I will not be wrong if I say that

immediate development of chrome leather tanning industry is necessary and possible.

18. The chief materials for chrome tanning are chrome salts. Although chromite occurs in India, commercial attempts to produce chrome compounds from this ore have not yet succeeded, but no doubt chrome salts are likely to be produced in the country in the future. Till then chrome salts necessary for chrome tanning could be imported from abroad.

### III. Assistance to the Tanning Industry

19. **Export duty on hides and skins.**—This question is already receiving the attention of the Central Government ; but as far as my report is concerned, I would like to make a reference to it. In my opinion the retention of the present export duty will be decidedly advantageous to the tanning industry in India.

20. The importance of this industry cannot be gainsaid and since the war it has been the policy of Government to foster it, with a view to enable it to develop within the shortest possible time. Now if the income from the export duty on hides and skins, which is not required by Government any more for revenue purposes, could be utilised to solve the difficulties of tanners by starting a tanning department for research, it would help to achieve the policy of Government.

21. **Railway freight.**—During my tour, I received a number of complaints to the effect that the freight rates for materials to be carried from the interior to port towns for a particular distance are much lower than those for the same materials to be carried from one centre to another for the same distance in the interior. This would obviously work against the local industry. If these complaints are correct, steps should be taken for their redress.

22. **Municipalities.**—During my tour I received many complaints from tanners that they are not given proper facilities by Government and Municipalities.

Not only is new tanning work not allowed to be started anywhere near the city, town or village, as the case may be, but tanners are sometimes forced to remove their old established tanning works to remote places, which in some cases are two to four miles away from the towns, for it is urged that the tanning trade is noxious and therefore detrimental to public health. Some of these places are far from the railway stations and there are often no roads to cart the materials.

I may say that the tanning industry is noxious because it is made noxious. There are tanneries in some of the big cities in Europe, which are in no way noxious or detrimental to public health. The most important thing is that they are kept clean ; every kind of rubbish which is liable to putrefy and cause a nuisance is collected and removed at the end of the day's work ; so also the waste liquors from the tanneries which give a very bad smell

and are detrimental to health are properly purified, before they reach the public streams or water-courses.

Here in many tanneries no attention is paid to this point by the tanners ; all the rubbish is thrown anywhere near their works, and gets putrefied and gives a bad smell which is offensive and noxious. Under these circumstances, I think, the local bodies are justified in compelling the tanners to remove their works to a remote place.

A tannery which is kept clean and waste liquors of which are properly purified by some method, *e.g.*, precipitation followed by filtration or sedimentation, land-treatment or bacterial purification, need have nothing noxious or detrimental to public health, except some peculiar smell of the tan liquors and hides and skins which though it may be objectionable is not at all injurious. In a tannery many chemicals such as arsenic, lime, sulphides, chrome salts, and others are used which act in a way as disinfectants and prevent the spread of any epidemics in the neighbourhood. I was told by several tanners and Municipal authorities in various centres that during different epidemics tannery neighbourhoods were remarkably free from sickness.

23. When a license is issued by a Municipality for a tannery it lays down certain rules to be observed by the tanners. I have seen the rules in the license form of the Bombay Municipality and the rules of other Municipalities are more or less similar ; but in many cases I have noticed that neither the Municipality nor the tanners see that the rules are observed. Now if the tanners would realise the importance of these rules and keep their works clean with the help of the Municipality, there would be nothing offensive except the particular smell which, I have mentioned above. In such cases I am sure that the Government authorities as well as the Municipalities in order to help the growth of the tanning industry and the leather trade would allow the tanneries within town limits to remain where they are situated at present.

As regards new tanneries to be established, it is, of course, advisable that they should be as far as possible on the outskirts of the towns, where there will be sufficient space for further expansion and where the labour employed in the works could be properly accommodated.

24. I have been told in some places that the Municipalities, taking advantage of certain rules in the Municipal Act regarding the levy of license duties on noxious industries, have levied high duties without taking into consideration the approximate amount of leather produced per year in those places. Even a small tanner who tans two or three hides a month requires several kunds. Some Municipalities have levied a tax of Rs. 5 per year per kund. Now if the tanner has about 10 kunds he has to pay Rs. 50 per year, while his total production of tanned hides may not exceed 5 to 10 per year. Naturally he is not able to pay such heavy dues. This has forced many tanners in the present tottering condition of the tanning industry to give up their trade.

Will not such Municipalities take notice of what harm they are doing to the poor tanners and their local industry in general?

**25. Co-operative Credit Societies.**—During my tour I found that Co-operative Credit Societies for people in the leather industries had been started in some places. Only the Society in Dharwar seems to work on right lines and it is doing good work. In some places they were failures and have ceased to exist while in other places, though they continue to exist, they are likely to disappear before long.

The principal reasons for these failures are (1) they are not properly organised; (2) the members do not understand their responsibilities when they borrow money; (3) the tanners owing to their faulty and crude methods of tanning suffer heavy losses, and hence are unable to pay back the money they borrow. In order to recover the dues, in some cases the properties of the tanners had to be sold, and ultimately these tanners have given up their trade. So instead of doing any good, these Societies have ultimately done harm to the tanners.

Before starting such Societies tanners must be guided in order that they should (1) improve their methods of tanning, and (2) find out suitable markets for their production. Work under both these heads could be done only through the tanning department working under the Director of Industries. Then they must also be made to realise their responsibility, and the working of the Societies should be checked from time to time. Unless all this is done, co-operation among tanners will not be successful.

**26. Conducting research and making trained men available.**—As has been shown in the previous chapters we are self-contained as regards raw materials both for vegetable and chrome tanning, yet tanning—especially modern type—has not made much progress in this Presidency. There are various reasons which account for the slow progress, the most outstanding being the lack of adequate technical knowledge and skilled men to conduct the industry.

**27.** As mentioned before, modern tanning is no longer an empirical craft. Through the efforts of scientists and practical and progressive tanners of the Western countries, the manufacture of leather has become a branch of chemical technology. The successful methods in tanning in those countries are based on scientific principles and have been worked out under the climatic conditions existing there. A mere blind imitation of the Western methods would lead to failure, owing to the totally different climatic conditions prevailing here. Before putting these methods into practice successfully they must be modified to suit the local conditions. This means systematic research in the methods of tanning, so as to make them suit our local conditions.

These researches can be conducted only by men well versed in the scientific principles that underlie the practice of modern tanning. Mere researches to investigate and develop methods of tanning with Indian



materials will be of no use : young Indian workmen and foremen must also be trained to apply the methods. As mentioned before, our tanning industry is more or less in the hands of illiterate Chambhars and Dhors, some of them may be good practical men but they are totally unfit to conduct and control modern methods. For this, men having knowledge of chemistry and physics are best suited and tanners will have to be trained from men having previous knowledge of these sciences.

28. Research and training are thus the principal needs for the development of our tanning industry.

This two-fold work cannot be undertaken by any private enterprise. The work lacks the prospects of an immediate profit which after all is the motive force of all private enterprises. It is here that Government can step in and render effective service by providing facilities for research and training.

29. The Indian Industrial Commission 1916-18 realising the great possibilities of the tanning industry in India and also the economic necessity of developing it in this country have fully discussed the subject in appendix D of the Commission's Report. (Pages 354-65.)

The Commission laid great stress on the need for research and training and recommended that facilities for such research and training should be afforded by Government. A few passages from the Report bearing on this point may be quoted :

" It may almost be accepted as axiomatic that the development of the Indian leather trade can only be accomplished by bringing to its assistance technically trained men, qualified to deal with local problems and capable of modifying European and American methods to suit local conditions. It is obvious that India cannot afford to neglect any of the advantages enjoyed by the tanning trade in other countries, and it may be regarded as essential that adequate provision should be made, as early as possible, for the investigation of tanning methods in India." (Page 360.)

Discussing the provision to be made for training Indian tanners the Commission observes : " That if India is to gain its position in the leather world to which she is entitled by reason of the abundance of raw materials at her command, the tanning and leather industries must pass under the control of expert technologists and scientific methods must replace empirical and rule-of-thumb working. Tanning is a chemical industry in certain stages of which bacteria play an important part, and those who, in the future, would control the industry must be capable of understanding the scientific principles underlying its technique. This means that the students before admission to the tanning trade school should have received a scientific education and should possess a fair knowledge of Physics and Chemistry. We may take it that the expert tanner of the future should be a graduate in science, and it will be best that his

technical studies should begin after he has completed a university course in pure science. The training in technology must be followed by work in a factory to gain practical experience." (Pages 360-61.)

"The general lines on which Government can best promote industrial progress are explained in our Report and they can be applied to tanning and leather dressing. Only here it must be pointed out that the need for immediate action to take full advantage of the situation is urgent, and that private enterprise is keenly interested and requires only intelligent guidance. (Page 364.)

**30. Establishment of a tanning Section.**—I, therefore, recommend that the Government should start a tanning department which should work under the guidance of the Director of Industries.

There should be one technical tanning expert who has sufficient practical experience in tanning industry both in India and Europe. He should also possess sufficient scientific knowledge of the subject.

**31. Experimental tannery for research and training.**—Most of the tanners have suffered heavy losses owing to their ignorance of certain principles, underlying the various processes in the tanning industry a proper understanding of which would have enabled them to give proper treatment to raw hides and skins according to certain qualities required in the tanned leather. They would have been able to save much of the tanning materials and labour by such knowledge.

Some of the practical tanners have, undoubtedly from their failures from time to time, got certain experience as to the right treatment of raw materials in different conditions and have also established certain formulas which give good results.

Their experiments have been carried out on unscientific lines and as they believe in keeping their results as commercial secrets, no record of the results has been made public.

Although the tanning industry is one of the important industries in this Presidency, there has never been any co-operation among the tanners to promote objects in which they are jointly interested and a narrow-minded trade rivalry prevents one tanner from helping another and all from working for the common good.

Commercial secrets and connections may be safely guarded, but it does not seem advisable to keep the technical methods also secret.

Under the circumstances there is a need of a model experimental tannery in the Presidency, where experiments could be made on scientific lines and the results published for the benefit of the tanning industry and where the tanners' difficulties could be solved.

Bombay is the most suitable centre for this because there is not much difference of temperature in different seasons. It would be an ideal place for research. Besides, as it is the greatest industrial and commercial centre in India, it would provide every kind of facility for the work of the model tannery.

This tannery should be in charge of the abovementioned tanning expert. To assist him there should be one research chemist with similar qualifications, one tannery foreman, three to four workmen, one machine mistry, one fitter for engine, one clerk and one chaprasi.

32. The principal objects of this model tannery should be :

- (1) Research on tanning methods with a view to adapting modern Western processes to local conditions.
- (2) Investigations on local tan-stuffs, to find out and to utilise new and commercially beneficial products from different forests in India.
- (3) A survey of hides and skins of various districts of the province and of different parts of India to determine the qualities of leather they produce.
- (4) Helping the trade with machine work, technical advice and schemes, etc.
- (5) Training apprentices to provide existing tanneries with expert tanners and to create a body of technically trained, educated men who may take up tanning as a profession and expand and improve the Presidency's leather industry by starting new tanneries on modern lines.
- (6) To prepare two or three peripatetic tanning demonstration parties to introduce improved methods of tanning among the leather working classes in the mofussil ; and to create a taste for leather and leather goods of superior quality among mofussil people and to inspire a desire to learn tanning and to take up the leather industry as a profession among students.
- (7) To arrange demonstrations in the indigenous tanning centres and also at the annual Industrial and Agricultural Exhibitions held at the headquarters stations of the different districts in this Presidency with the above object in view ; also to arrange demonstrations at the request of District and Local Board authorities and such public bodies as desire the introduction of the improved methods of tanning among the local Chambhars and Dhors.
- (8) To help small tanneries in the province which have no machinery and thus experience much difficulty in finishing their products ; such tanneries may be helped by the machine work being done for them at the tannery and by technical advice.
- (9) Analysis for the trade could be carried out at reasonable charges.

## CHAPTER X

### ESTAMATE OF THE PROPOSED MODEL TANNERY

1. The total cost of the proposed Model Tannery and Laboratory referred to in paragraphs 31-32 of Chapter IX will be about Rs. 1,75,000

as shown below. It may, however, be stated here that the figures given below are more or less approximate and may vary at the time of the actual construction of the factory. A revenue of about Rs. 5,000 is expected from the sale proceeds of the finished goods produced in the Tannery.

2. I regret I could not give a detailed estimate of the scheme as the time at my disposal was very short. However, if Government desire to pursue the project as suggested by me, I shall be glad to submit a detailed scheme with the necessary estimates.

*A. Non-recurring—*

<i>Land</i> —about 4,000 square yards at Re. 1 per square yard .. .. .	Rs.	a.	p.
	4,000	0	0
<i>Buildings</i> —Factory, Lecture Hall, Laboratory, etc.—			
Total area about 9,000 square feet at Rs. 10 per square foot .. .. .	90,000	0	0
Machinery .. .. .	25,000	0	0
Engine, Boiler, etc. .. .. .	5,000	0	0
Pulleys, shafting, etc., and Erection charges .. .. .	4,000	0	0
Laboratory fittings and Chemical Apparatus, etc. .. .. .	10,000	0	0

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1,38,000 0 0

*B. Recurring charges for 12 months—*

<i>Raw Materials</i> such as skins, hides, tanning materials, dyes, etc. .. .. .	10,000	0	0
<i>Staff</i> —1 Superintendent	}	..	22,000 0 0
1 Assistant Superintendent			
1 Machine Mistry			
1 Fitter			
1 Clerk			
1 Peon			
Unforeseen and Miscellaneous expenses .. .. .	2,000	0	0
Renewals, repairs, chemicals, etc. .. .. .	3,000	0	0

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37,000 0 0

A ..	1,38,000	0	0
B ..	37,000	0	0

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Total .. 1,75,000 0 0

## APPENDICES

## STATEMENT No. I

## Tanning Materials exported from the Bombay Presidency

—		1922-23	1923-24	1924-25	1925-26	1926-27
Tanning Bark	{ Cwts. ..	13	3	36	5	261
	{ Rs. ..	707	33	1,495	120	5,226
Myrabolans	{ Cwts. ..	653,384	636,611	877,340	564,625	744,885
	{ Rs. ..	31,69,258	32,92,029	47,54,651	35,39,322	39,52,138
Cutch and Gambier	{ Cwts. ..	91	86	66	132	15
	{ Rs. ..	5,665	3,837	3,760	4,195	880
Myrabolans Extract	{ Cwts. ..	..	..	..	5	..
	{ Rs. ..	..	..	..	100	..

## STATEMENT No. II

## Raw Hides and Skins exported from the Bombay Presidency

—		1922-23	1923-24	1924-25	1925-26	1926-27
<b>BOMBAY</b>						
Hides	{ No. ..	57,885	92,126	13,608	102,931	81,113
	{ Tons ..	232	586	55	417	398
	{ Rs. ..	4,22,364	8,46,172	1,13,801	7,10,283	5,72,811
Skins	{ No. ..	4,386,739	3,472,470	2,682,969	2,945,236	3,461,574
	{ Tons ..	7,509	5,952	3,400	3,979	4,574
	{ Rs. ..	96,60,594	78,30,449	46,84,489	55,84,932	66,45,640
<b>SIND</b>						
Hides	{ No. ..	328,022	291,708	482,551	359,257	625,946
	{ Tons ..	1,547	1,414	1,975	2,185	2,929
	{ Rs. ..	13,83,595	15,34,821	25,36,849	24,66,830	28,78,710
Skins	{ No. ..	3,443,721	3,222,554	4,209,395	5,632,548	5,409,219
	{ Tons ..	3,536	3,122	3,973	5,305	5,185
	{ Rs. ..	42,35,003	43,66,607	55,46,671	73,65,932	72,52,679

## STATEMENT No. III

## Tanned Hides and Skins exported from the Bombay Presidency.

—		1922-23	1923-24	1924-25	1925-26	1926-27
<b>BOMBAY</b>						
Tanned Hides	No.	352,585	483,293	545,134	366,571	349,096
	Tons	1,090	1,186	1,412	948	937
	Rs.	42,06,502	47,47,962	56,96,614	38,90,645	33,58,301
Tanned Skins	No.	999,829	1,183,041	1,683,964	1,355,307	1,877,643
	Tons	386	441	781	623	778
	Rs.	19,88,905	24,61,112	39,11,748	33,70,847	43,57,466
<b>SIND</b>						
Tanned Hides	No.	9,469	24,140	16,755	12,038	10,343
	Tons	37	74	47	34	25
	Rs.	96,649	1,85,855	1,48,020	81,719	80,515
Tanned Skins	No.	652,121	548,096	782,269	556,756	527,847
	Tons	238	188	289	197	186
	Rs.	14,23,798	7,01,225	12,02,750	8,81,236	8,45,595

## STATEMENT No. IV

## Foreign Raw Hides and Skins imported into the Bombay Presidency

—		1922-23	1923-24	1924-25	1925-26	1926-27
<b>BOMBAY</b>						
Hides	No.	73,577	63,645	65,876	27,176	55,880
	Tons	312	289	192	75	147
	Rs.	2,01,968	1,88,453	2,41,961	93,851	1,59,761
Skins	No.	467,928	646,499	456,272	653,298	868,262
	Tons	305	339	272	473	698
	Rs.	2,30,935	3,53,646	3,09,130	6,51,132	8,93,521
<b>SIND</b>						
Hides	No.	880	23	302	898	338
	Tons	4	..	1	9	1
	Rs.	2,960	60	400	3,150	1,946
Skins	No.	22,834	6,605	5,598	56,153	22,126
	Tons	42	3	2	10	10
	Rs.	22,841	7,493	5,558	59,986	24,334

## STATEMENT No. V

## Leather and Leather Goods imported into the Bombay Presidency

		1922-23	1923-24	1924-25	1925-26	1926-27
<b>BOMBAY</b>						
Hides (tanned or dressed).	No. ..	3,754	4,948	3,537	5,100	2,613
	Tons ..	17	21	17	18	13
	Rs. ..	1,46,343	1,74,437	1,05,379	70,317	73,537
Skins (tanned or dressed).	No. ..	52,496	42,452	47,718	41,657	36,494
	Tons ..	14	12	19	28	18
	Rs. ..	2,23,351	2,18,235	2,64,288	2,80,247	2,51,170
Leather, unwrought	Cwts. ..	79	94	132	359	1,388
	Rs. ..	25,811	30,710	70,692	1,43,709	2,73,235
	Pairs ..	51,585	82,101	99,923	129,991	155,579
Boots and Shoes	Rs. ..	4,69,216	6,45,196	7,11,718	8,32,216	9,69,308
	Cwts. ..	50	55	78	163	188
Bags and Trunks	Rs. ..	25,300	21,162	22,876	45,446	52,179
	Cwts. ..	226	123	103	280	260
Saddlery and Harness	Rs. ..	97,626	66,707	42,121	69,826	67,513
	Cwts. ..	1,861	2,367	2,344	2,720	2,318
Pickers	Rs. ..	5,19,866	5,46,245	4,77,906	5,23,057	7,06,054
	Cwts. ..	1,391	1,485	2,215	1,581	2,004
Picking bands and straps	Rs. ..	4,47,827	4,16,581	5,86,124	4,03,894	5,95,122
	Cwts. ..	419	690	663	607	612
Roller Skins	Rs. ..	8,05,772	9,78,300	8,43,334	7,07,295	6,29,494
	Cwts. ..	1,804	1,431	1,342	1,461	2,704
Other Sorts	Rs. ..	4,99,987	3,56,274	2,81,322	2,54,132	3,32,769
Total .. Rs. ..		32,61,099	34,53,847	34,05,760	33,30,139	39,50,381
<b>SIND</b>						
Hides (tanned or dressed).	No. ..	..	..	..	2,245	199
	Tons ..	..	..	..	3,666	4,249
Skins (tanned or dressed).	No. ..	2,666	7,053	28,609	23,101	3,768
	Tons ..	10,469	17,588	53,036	29,688	13,085
Leather, unwrought	Cwts. ..	4	26	59	20	25
	Rs. ..	10,048	20,340	28,043	9,115	16,571
Boots and Shoes	Pairs ..	16,371	18,101	40,603	60,040	67,346
	Rs. ..	1,14,152	1,37,988	2,81,373	4,11,391	3,73,838
Bags and Trunks	Cwts. ..	13	15	37	75	54
	Rs. ..	4,627	6,244	13,209	20,096	19,131
Saddlery and Harness	Cwts. ..	18	8	28	31	14
	Rs. ..	16,935	5,699	15,669	12,969	12,482
Other sorts	Cwts. ..	107	60	108	167	93
	Rs. ..	44,217	24,939	39,127	50,039	30,530
Total .. Rs. ..		2,00,448	2,12,798	4,30,457	5,36,964	4,69,886
Total for the Presidency. Rs. ..		34,61,547	36,66,645	38,36,217	38,67,103	44,20,267

## STATEMENT No. VI

## Leather and Leather Goods re-exported from the Bombay Presidency

	1922-23	1923-24	1924-25	1925-26	1926-27
<b>BOMBAY</b>					
Hides (tanned or dressed)—					
No. ..	..	..	78	..	10
Tons ..	..	..	..	..	..
Rs. ..	..	..	2,486	..	450
Skins (tanned or dressed)—					
No. ..	99,074	24,409	13,995	426	145
Tons ..	36	9	7	1	..
Rs. ..	9,30,800	1,78,037	1,91,045	5,245	2,129
Leather, unwrought—					
Cwts. ..	20	38	176	128	33
Rs. ..	9,596	8,744	28,034	29,398	9,376
Boots and Shoes—					
Pairs ..	10,479	10,408	6,749	7,159	4,946
Rs. ..	78,980	62,226	31,633	42,393	20,102
Manufactures—					
Rs. ..	1,51,893	2,25,223	1,28,712	93,842	83,272
<b>SIND</b>					
Hides (tanned or dressed)	..	..	..	..	..
Skins (tanned or dressed)—					
No. ..	127,989	302,155	220,351	127,097	24,166
Tons ..	55	103	58	44	8
Rs. ..	13,48,679	26,27,042	16,89,942	10,45,412	1,41,283
Leather, unwrought—					
Cwts. ..	..	..	..	..	..
Rs. ..	..	..	231	..	6
Boots and Shoes—					
Pairs ..	2,790	2,204	1,579	1,344	463
Rs. ..	32,992	15,383	8,821	6,142	2,413
Manufactures—					
Rs. ..	6,851	7,977	1,670	3,713	6,035



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**STATEMENT No. VII**

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## STATEMENT

Statement showing the number of animals slaughtered at the slaughter-

District	Place where slaughter-house is situated	Buffaloes	Bullocks
1. Karachi	Karachi City and Cantonment ..	174	2,253
	Other places in the District ..	27	92
2. Hyderabad (Sind) ..	Hyderabad City and Cantonment ..	18	387
	Other places in the District ..	45	100
3. Sukkur	Sukkur .. ..	....	....
	Shikarpur .. ..	250	181
	Other places in the District ..	43	86
4. Larkana	Larkana .. ..	365	....
	Other places in the District ..	64	4
5. Nawabshah	Nawabshah .. ..	....	....
	Shahadadpur .. ..	12	30
	Naushahro .. ..	....	....
	Moro .. ..	....	....
6. Upper Sind Frontier	Kandiara .. ..	134	327
	Jacobabad .. ..	57	500
	Other places in the District ..	....	135
7. Thar Parkar	Mirpurkhas .. ..	....	....
	Other places in the District ..	....	....
8. Ahmedabad	Dholka .. ..	370	350
	Prantij .. ..	45	....
	Virangaon .. ..	730	243
	Ahmedabad .. ..	4,298	5,770
	Other places in the District ..	29	30
	Carried over ..	6,661	10,488

- (a) No separate account of goats  
(b) No separate account of bullocks  
(c) No separate account of cow and

## No. VII

## houses in various towns in the Bombay Presidency during the year 1926

Cows	Calves		Goats	Sheep	Animals unclassified
	Buffaloes	Cows			
2,714	868	....	104,848	58,648	....
64	481	32	14,218	4,775	12
285	....	....	78,567	13,731	....
126	185	11	27,372	1,046	....
146	....	116(c)	35,609	8,441	31
306	141	114	34,202	4,094	115
63	20	20	12,970	745	....
28(b)	....	....	22,357	1,087	....
109	....	123(c)	14,779	1,631	....
111(b)	....	....	14,001(a)	....	....
....	....	....	8,000	1,500	....
25	5	35	17,575	483	....
....	....	....	8,805	1,000	....
....	....	....	3,930	....	....
514	246	47	9,770	1,706	....
120	18	35	11,220	4,380	....
235	....	50	11,060	350	....
....	....	....	8,337	....	....
10	....	....	20,169	149	....
35	....	....	380	350	....
132	....	....	180	90	....
....	....	....	3,595	1,103	....
4,067	....	298(c)	47,552	44,024	....
25	106	....	630	250	200
9,115	2,070	881	510,126	149,583	358

and sheep kept ; total of both.  
and cows kept ; total of both.  
buffalo calves kept ; total of both.

## STATEMENT

District	Place where slaughter-house is situated	Buffaloes	Bullocks
	Brought forward ..	6,661	10,488
9. Kaira ..	Borsad .. .. .	497	118
	Kapadwanj .. .. .	700	200
	Nadiad .. .. .	1,568	12
	Other places in the District ..	469	78
10. Panch Mahals ..	Godhra .. .. .	1,262	1,365
	Dohad .. .. .	51	80
11. Broach ..	Broach .. .. .	1,100	699
	Ankleshwar .. .. .	314	274
	Other places in the District ..	....	....
12. Surat ..	Surat City .. .. .	1,334	....
	Rander .. .. .	....	....
	Bulsar .. .. .	3	....
13. Thana ..	Other places in the District ..	....	....
	Thana .. .. .	....	....
	Kalyan .. .. .	400	75
	Bhiwandi .. .. .	688	23
14. Ahmednagar ..	Other places in the District ..	....	....
	Ahmednagar City .. .. .	287	453
	Ahmednagar Cantonment ..	....	918
15. East Khandesh ..	Jalgaon .. .. .	1	993
	Edlabad Peta .. .. .	100	175
	Bhusaval .. .. .	70	1,612
	Erandol .. .. .	187	1,465
	Chopda .. .. .	195	1,547
	Pachora .. .. .	89	958
	Other places in the District ..	113	1,383
	Carried over ..	16,089	22,916

(a) No separate account of goats

No. VII—contd.

Cows	Calves		Goats	Sheep	Animals unclassified
	Buffaloes	Cows			
9,115	2,070	881	510,126	149,583	358
8	283	5	1,169	46	....
230	150	....	3,600	120	....
4	....	....	3,710	329	....
10	232	2	1,326	243	....
1,487	....	....	5,310(a)	....	1,539
113	459	3,141	9,158	988	....
400	....	....	15,318	5,107	....
76	5	4	2,103	176	....
....	....	....	2,934	1,000	....
586	84	24	52,224	35,157	1,217
215	15	48	15,754	....	26
20	....	37	7,000	2,025	....
....	....	2,197	437	17	....
54	....	....	10,691	5,345	....
50	....	....	8,000	10,000	....
7	40	26	....	....	....
....	....	....	40,932 7,200(a)	47,865	324
513	....	....	13,155	1,032	....
685	....	268	1,945	1,397	....
455	....	....	7,073	1,059	....
160	50	50	1,313	4,843	15
1,660	10	50	12,696	9,150	....
500	62	29	7,003	85	1
408	....	19	5,086	34	....
439	55	141	6,800	1,075	25
335	36	77	10,742	2,994	1,506
17,530	3,551	6,999	762,805	279,670	5,011

and sheep kept; total of both.

## STATEMENT

District	Place where slaughter-house is situated	Buffaloes	Bullocks
	Brought forward ..	16,089	22,916
16. West Khandesh ..	Whole District .. ..	991	5,482
	{ Nasik City Municipality .. ..	146	183
	{ Deolali Cantonment .. ..	....	260
	{ Malegaon Municipality .. ..	1,823	1,434
17. Nasik ..	{ Yeola Municipality .. ..	142	937
	{ Igatpuri Municipality .. ..	....	417
	{ Manmad Notified Area .. ..	....	195
	{ Other places in the District .. ..	2	115
	{ Poona City .. ..	....	....
	{ Poona Cantonment .. ..	....	2,684
18. Poona ..	{ West Kirkee .. ..	....	....
	{ Lonavla and Mulsi .. ..	730	225
	{ Baramati .. ..	716	660
	{ Other places in the District .. ..	7	226
19. Satara ..	{ Satara .. ..	41	75
	{ Other places in the District .. ..	145	649
20. Sholapur ..	{ Sholapur City .. ..	2,021	1,798
	{ Other places in the District .. ..	336	565
21. Belgaum ..	{ Belgaum .. ..	....	....
	{ Other places in the District .. ..	....	....
22. Bijapur ..	{ Bijapur City .. ..	173	93
	{ Bagalkot .. ..	26	220
	{ Other places in the District .. ..	6	105
	Carried over ..	23,394	39,239

(a) No separate account of goats  
(b) No separate account of bullocks  
(c) No separate account of cow and

No. VII—contd.

Cows	Calves		Goats	Sheep	Animals unclassified
	Buffaloes	Cows			
17,530	3,551	6,999	762,805	279,670	5,011
1,307	....	....	15,576	26,285	541
116	....	....	12,495(a)	....	....
173	....	....	581	4,762	....
1,407(b)	....	....	581	4,762	....
613	....	59	6,629	172	....
609(b)	....	....	6,629	172	....
176	....	102	7,240	....	....
374	....	....	3,778	3,077	....
32	....	....	4,524	1,508	....
75	4	....	1,574	189	....
....	....	....	39,840	13,280	....
3,628	....	8,445	31,987	18,321	....
1,681(b)	....	....	7,514(a)	....	....
345	195	351	1,803	9,030	4,747
418	....	....	....	....	....
525	5	395	6,605	2,204	5,670
626	....	....	4,046	5,970	....
115	....	....	5,087	4,646	....
2,350	....	1,690(c)	86,757	6,873	....
180	36	24	787	15,101	....
....	....	....	712(a)	....	....
....	....	....	....	....	....
107	....	....	17,683	23,738	....
235	....	....	4,811	1,604	....
143	....	....	6,171	11,273	....
32,765	3,791	18,065	1,032,749	427,703	15,969

and sheep kept ; total of both.  
 and cows kept ; total of both.  
 buffalo calves kept ; total of both.

## STATEMENT

District	Place where slaughter-house is situated	Buffaloes	Bullocks
	Brought forward ..	23,394	39,239
23. Dharwar	Dharwar Taluka ..	136	347
	Hubli ..	10	2,510
	Bankapur ..	95	550
	Ranebennur ..	5	417
	Other places in the District ..	12	423
24. Kanara	Bhatkal ..	140	....
	Other places in the District ..	....	75
25. Ratnagiri	Ratnagiri ..	....	....
	Other places in the District ..	....	....
26. Kolaba	Pen ..	....	....
	Other places in the District ..	....	77
27. Bombay	Bandra ..	11,312	9,231
	Kurla ..	4,159	....
	Bombay City proper ..	....	....
	Grand Total ..	39,263	52,869

(a) No separate account of goats



No. VII—concl.

Cows	Calves		Goats	Sheep	Animals unclassified
	Buffaloes	Cows			
32,765	3,791	18,065	1,032,749	427,703	15,969
182	90	54	5,800	4,942	1,140
121	....	....	9,470	15,000	....
690	5	....	1,904	1,754	....
285	69	43	2,053	3,626	....
366	36	....	12,078	8,712	....
43	....	....	....	373	....
18	....	15	1,500	2,698	....
....	....	....	1,506	1,023	....
....	....	....	3,190	1,325	....
....	....	....	3,100	400	....
75	....	....	5,503	8,816	....
26,044	....	....	780,043(a)	....	....
....	....	....	....	....	....
....	....	....	....	....	1,528
60,589	3,991	18,177	1,858,896	476,372	18,637

and sheep kept ; total of both.

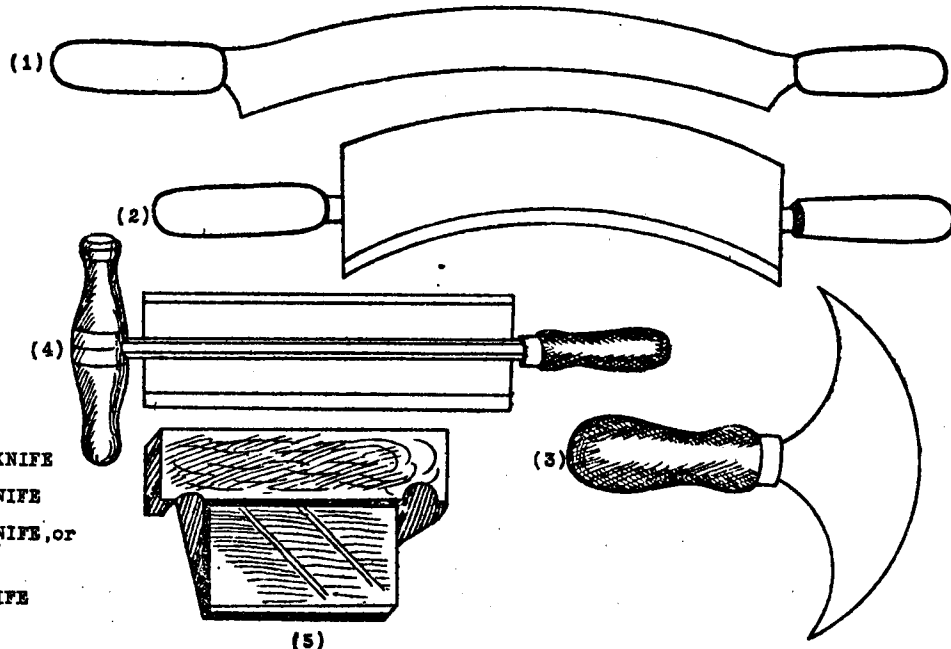
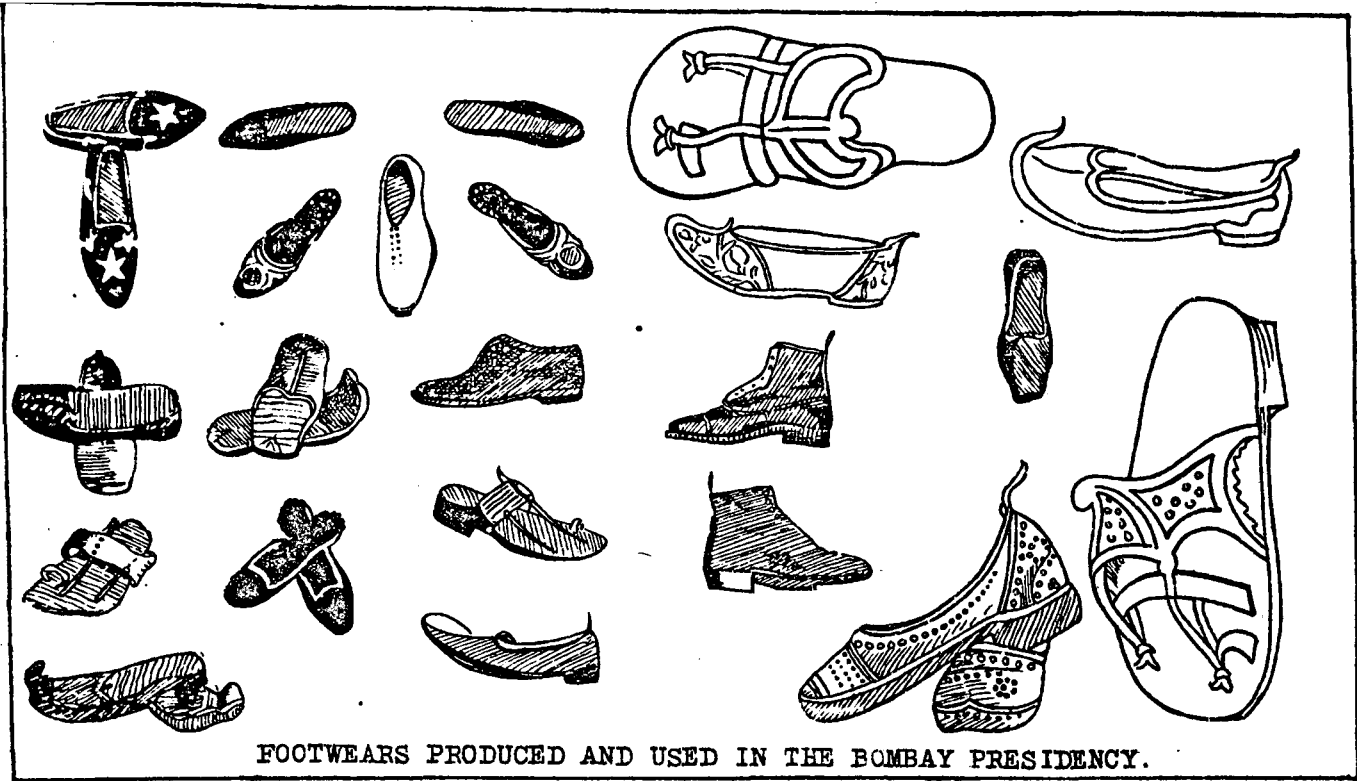


Fig 41

- (1) UNHAIRING KNIFE
- (2) FLESHING KNIFE
- (3) FLESHING KNIFE, or  
RAMPI
- (4) SHAVING KNIFE
- (5) SLICKER.



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BOMBAY PRESIDENCY

# INDIAN CASEIN

PART I

PREPARATION OF "SULPHURIC" CASEIN

BY

DATTATRAYA MANJUNATH GANGOLLI

and

ANDREW NORMAN MELDRUM

BULLETIN No. 1

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## PREFACE.

The present bulletin on Indian Casein is the first of a series which it is proposed to publish in order to make the public acquainted with the activities of the Department of Industries, and to place information in a convenient form at the disposal of those who can make practical use of it.

The investigation by Mr. D. M. Gangolli and Dr. A. N. Meldrum of the production and utilisation of Casein in India is a good example of the kind of chemical research which must be widely undertaken in India in order to make full industrial use in the country of its natural resources.

BOMBAY,  
17th February 1920.

R. D. BELL,  
Director of Industries.

# INDIAN CASEIN

## PART I—THE PREPARATION OF "SULPHURIC" CASEIN.

### INTRODUCTION.

MUCH of the casein that is produced in India is of inferior quality and when exported to Europe it sells at a price which, at the most, is half that given for the best French casein. In correspondence received from the United Kingdom by the Director of Industries, Bombay, Indian casein is described in disparaging terms. One comb-making concern refers to it as "lactic" casein in such a way as to imply that lactic casein is essentially casein of the worst description. There are, however, different varieties of casein which are named according to the method of production as "rennet," "sulphuric," "lactic," "electrolytic," etc., and each of these varieties has its special qualities. Lactic casein of good quality can be made. The real objections to Indian casein are, not the fact that it is lactic, but the presence in it of dust and dirt, the high content of fat, inorganic matter (this is not always an objection) and acid, its bad odour and its bad colour. Obviously, if and when good casein is made in India and exported to Europe it will not at once fetch its proper price. Only in course of time can a good name and a good price be acquired for it.

2. The production of casein is a matter of importance in the Bombay Presidency, particularly in Gujarat where the abundance of the milk supply has given rise to a large number of creameries at which butter and ghee are made. Part of the separated milk is used as a source of casein, either at the creameries or at adjoining places.

The casein is made chiefly by the lactic process as follows :—The separated milk, which contains milk sugar and casein, is allowed to ferment, the milk sugar yields lactic acid and this acid precipitates the casein.

3. Attention was drawn to the subject when a demand arose in India for casein good enough to be used in making the glue and cement that are required in aeroplane factories. The Director of Industries, Bombay, asked one of us (A. N. Meldrum, D.Sc.) to carry out work with a view to the improvement of Gujarati casein and to the production of casein for making the best glue and cement. With the sanction of the Government of Bombay the work was undertaken and it has been carried on conjointly with Mr. D. M. Gangolli, B.A., B.Sc.

#### OBJECTS OF THE WORK.

4. In the work that is going on, three objects are being kept in view :—

(1) to find a simple method of producing casein of high quality ;

(2) to lay down rules for the production of lactic casein, simple enough to be readily adopted in villages ;

(3) to ascertain the ways in which casein can be utilised in India.

5. The second object, namely, the improvement of village casein, although of great importance, had to be set aside at first. We had ourselves to learn about casein and then we could not do anything on village casein during the monsoon season when it is not made. This paper describes the working out of a method for the preparation of "sulphuric" casein.

6. As a preliminary to the preparation of casein on an economical basis it was necessary for us to learn to prepare good casein without regard to economy except in so far as we worked on a small



scale. We set to work to prepare casein and endeavoured to avoid certain objections to Indian casein—the high proportion of fat, inorganic matter, and acid—thinking that at the same time the other objections might disappear of themselves. Our general method of procedure has been to pay attention to the petty details of making casein, to vary the details and to determine by analysis the effect of each variation.

#### THE PROPORTION OF FAT.

7. Sometimes a solvent, *e.g.*, ether, is used for extracting fat from casein. It is likely that a solvent is most often used in preparing casein on a small scale for the purpose of scientific research without regard to expense. But there was no need to consider the use of alcohol or ether for carrying out our object of producing good instead of inferior casein.

8. The obvious course, in order to keep down the proportion of fat in casein, is to start with separated milk as free from fat as possible. The separator, having been worked so as to produce cream for making butter, must then be worked so as to remove traces of cream, the value of which, as cream, is negligible.

9. In experiments that were made for us, separated milk was returned to the separator and put through again and again, a sample being taken each time. When the samples were submitted to Gerber's test, we saw that the amount of fat, small at first, had become less and less. Finally, Gerber's test could hardly indicate that fat was present. Obviously the separator had been worked so as greatly to improve ordinary separated milk for the purpose of making casein.

10. We are indebted to Mr. R. Osborn and Mr. C. H. Dūdha, of the Government Military Dairy, Ahmedabad, for the above experiments and also for the supplies, which we used in our work, of milk that had been thoroughly treated for the removal of cream.

## SMALL SCALE EXPERIMENTS.

*I.—Removal of Inorganic matter.*

11. A litre of milk was treated with a mixture of hydrochloric and acetic acids, a mixture that is strongly recommended (Van Slyke and Baker, *J. Biol. Chem.*, 1918, **35**, 127); the whey was removed and the precipitate was washed many times with distilled water. The casein, when dried and analysed, was found to contain inorganic matter in high, and acid in low proportion.

Ash	..	3.9 per cent.
*Acid, in terms of HCl	..	0.32 per cent.
Acid, in terms of 0.1 N alkali	..	0.88 cc. per g.

12. In consequence of this result we made it our immediate object to reduce the amount of inorganic matter. Milk was precipitated as above, and the whey having been removed, the curd was washed once with water and a sample of it was taken for analysis. The bulk of the curd was then washed three times with dilute hydrochloric acid, and a sample was withdrawn each time. When the samples were analysed, the results proved that washing with hydrochloric acid has the effect of reducing the amount of inorganic matter.

(1) Washed once with water	..	Ash 4.8 per cent.
(2) Washed once with water and once with acid	..	.. 2.1 ..
(3) Washed once with water and twice with acid	..	.. 1.6 ..
(4) Washed once with water and thrice with acid	..	.. 0.8 ..

13. We found in the literature that many different acids are used for precipitating casein, namely, lactic, sulphuric, acetic, nitric,

\*Apparently, acidity is expressed in Britain in terms of HCl per cent., in the United States of America in terms of 0.1 N alkali per gram. We therefore give acidity on each basis, using the relation:—  
HCl per cent. = 0.365 x cc. 0.1 N alkali per gram.

carbonic, hydrochloric and a mixture of acetic and hydrochloric. Riegel recommends the use of ethyl-sulphuric acid (Scherer, *Casein*, 1911, page 24). Casein, as it exists in milk is a calcium compound. Sulphuric being the cheapest acid, the others, presumably, are used with the intention of preventing the presence, in the precipitated casein, of insoluble calcium sulphate.

14. Our experiments indicated that the proportion of inorganic matter in casein depends above all on the washing of the casein after precipitation. The mixture of acetic and hydrochloric acids, recommended by Van Slyke and Baker, led to a high proportion of inorganic matter, in spite of great care taken in the precipitation. Washing the casein many times with distilled water reduced the proportion slightly ; washing three times with hydrochloric acid reduced the proportion considerably.

15. Further, Riegel's ethyl-sulphuric acid presumably gave tolerable results although, owing to the method by which it was prepared, it must have contained some sulphuric acid. We therefore decided to try precipitation by sulphuric acid. In parallel experiments casein was precipitated and washed, in one experiment by hydrochloric acid, in the other by sulphuric. On analysis the results showed that sulphuric acid can advantageously be used in making casein provided that the washing subsequent to precipitation is carefully done.

(1) Hydrochloric acid treatment	..	Ash 0.3 per cent.
(2) Sulphuric acid treatment	..	.. 0.4 ..

16. From the commencement of our experiments we had been using distilled water for the final washing of the casein. It was therefore necessary to ascertain the effect of replacing the distilled by hard water. Casein that had been very carefully washed with acid was washed once with hard water, dried and analysed. We used (1) the Ahmedabad Municipal water which is hard and (2) the Chemistry Department water which is harder. The result shows

that hard water can be used for washing casein without much increasing the proportion of inorganic matter.

- (1) Washed once with Ahmedabad Municipal water .. Ash 0·16 per cent.
- (2) Washed once with Chemistry Department water .. „ 0·22 „

#### SMALL SCALE EXPERIMENTS.

##### *II.—Removal of Acid.*

17. Attention was then given to the presence of acid in casein : an attempt was made to remove it by treatment with alkali. Casein having been precipitated and washed with acid was divided into three parts :—

- (1) was washed with water.
- (2) was washed with NaOH solution and then with water.
- (3) was washed with  $\text{NH}_4\text{OH}$  solution and then with water.

##### Acid in terms of—

Ash.	(a) HCl.	(b) 0·1 N alkali.
(1) 0·38	1·39 per cent.	3·80 cc. per gram.
(2) 0·20	0·28 „	0·78 „
(3) 0·34	0·34 „	0·92 „

Thus sodium hydroxide, when used in washing casein, lowers the proportion of acid and does not lead to an increase in the amount of inorganic matter.

#### LARGER SCALE EXPERIMENTS.

18. Making use of the experience we had accumulated in working on a small scale, we carried out experiments with 6 litres of milk at a time. The casein was precipitated with N  $\text{H}_2\text{SO}_4$  and washed once with 0·1 N  $\text{H}_2\text{SO}_4$ . Enough sodium hydroxide

was added to neutralise half the acid and then the casein was washed with tap water. Throughout the precipitation and subsequent treatment the liquid was vigorously stirred by means of a rotating stirrer worked by an electro-motor. The acid and alkaline solutions were added slowly. The casein was filtered, dried and analysed.

Fat	..	0.24 per cent.
Ash	..	0.32 "
Acid in terms of HCl	..	0.10 "
Acid in terms of 0.1 N alkali	..	0.28 cc. per gram.

#### THE ISOELECTRIC POINT OF CASEIN.

19. Work on amphoteric electrolytes, to which class casein belongs, shows the existence of a characteristic condition which is called the isoelectric point. A substance in this condition attains the maximum freedom from foreign matter, acid and basic, and the minimum of solubility. (See Jacques Loeb on gelatin, *J. Gen. Physiol.* 1918, 1, 237—254.) With casein the isoelectric point is reached at a hydrogen ion concentration of 0.000025 (Michaelis and Pechstein, *Biochem. Zeitsch.* 1912, 47, 260). This concentration is indicated approximately by cochineal and by methyl red (Prideaux, *The Theory of Indicators*). In the absence of methyl red we used cochineal. We find that it serves the purpose though it does not give a sharp indication. We precipitated and washed casein by means of sulphuric acid as usual and then, without removing the acid liquid, we brought the casein by addition of sodium hydroxide solution to the isoelectric condition with a tendency to the alkaline side. In practice, we found that this required enough alkali to neutralise the acid we had used. The casein was washed with water and dried. It was the best in colour we had ever obtained: the yield of ash was 0.34 per cent.; acid 0.08 HCl per cent.

#### DETAILS OF THE PROCESS.

20. We give the full details of another experiment which we made on the lines just laid down. Separated milk, contained in an

enamelled pail, was stirred by means of a rotating stirrer that was worked by an electro-motor, and  $N H_2SO_4$  was added by means of a tap-funnel. Coagulation commenced when 135 cc. had been added and the addition of acid was continued till the casein became granular. The stirrer was stopped and the casein settled to the bottom in five minutes. The liquid having been syphoned off, the precipitate was filtered through cotton cloth and squeezed to remove water.

## Data.

-Volume of $N H_2SO_4$ added	..	180 cc.
Time of addition	..	19 min.
Temperature of the milk before addition.		27.5° C.
Temperature of the milk after addition..		28°C.

21. The casein was transferred back to the pail and 0.1  $N H_2SO_4$  (1,800 cc.) having been added, the stirrer was worked for 15 minutes. The precipitate settled in less than 5 minutes. 0.2  $N NaOH$  was then added with constant stirring: 450 cc. were added during 11 minutes and 450 cc. more during 20 minutes. Sufficient alkali had thus been added to neutralise all the sulphuric acid. Then an additional 20 cc. alkali were added with stirring. The casein was allowed to settle, the liquid was syphoned off, and, tap-water\* (2 litres) having been added, the mixture was stirred for five minutes. The casein, which settled rapidly, was filtered, pressed and dried in the air-oven (temperature 50°—60°C). As was to be expected from the use of alkali in slight excess, the casein contained more inorganic matter and less acid than in the previous experiment. Ash 0.47 per cent.; acid 0.05  $HCl$  per cent.

## CONCLUSION.

22. In the course of our reading we had found serious gaps in the literature on casein. Very little information was available on two important questions; it is necessary to know with respect to a

---

\* This water was found to contain 0.278 per cent. of soluble matter.

given method of making casein, (1) what composition the product can be expected to have; (2) for what purpose the product is best suited: it is obviously desirable to know whether "rennet", "lactic" or "sulphuric" casein is best for making glue, or to know that it does not matter how the casein is made provided only it is well made. The first gap has been filled up by the publication of a valuable paper by F. L. Browne (*J. Ind. Eng. Chem.* 1919, **11**, 1019—1024), which gives Browne's conclusions regarding the various factors that determine the composition of commercial casein and also gives the composition of numerous caseins made in various ways. The paper reached us just as we were writing up our own work for publication. Browne's conclusion is in complete agreement with ours, that the proportion of fat in casein depends on the proportion of fat in the milk from which the casein is made. When the separator has been worked efficiently, the proportion of fat in casein is always under 0.5 per cent. and the average appears to be 0.25. We can see no reason why casein, made from milk that has been treated in an efficient separator, under the control of Gerber's test, should ever contain more than 0.35 per cent. of fat.

23. Browne's conclusions as to the factors governing the proportion of inorganic matter and acid are different from ours. "The ash content is governed primarily by the acidity of the milk from which the curd is precipitated, and secondarily by the thoroughness with which the curd is washed. . . . . with the natural sour method, washing the curd after precipitation lowers the ash content, while it has little influence in the sulphuric acid method." "As is to be expected, there is a fairly close relation between the acidity and the ash content of the casein—the higher the ash the lower the acidity, but this value is influenced also by other factors, such as the presence of some of the acid used for the precipitation. The acidity, therefore, is influenced by the same factors as govern the ash content, namely, the acidity of the milk, and second by the thoroughness of washing the curd." There is no need for us to discuss these conclusions at length. In Browne's paper "washing" means

washing with water only. We have shown how to control the amount of inorganic matter and of acid in casein by washing with acid and then with alkali. When casein has been properly precipitated, that is, when the formation of large clots of casein has been avoided by thorough stirring of the milk during slow addition of acid, the removal of inorganic matter is brought about rapidly by washing the casein with dilute acid and the removal of acid by addition of alkali to the proper amount.

24. Browne's paper gives the composition of caseins, "bought from dealers in casein", "bought from makers of casein, classified according to the method of manufacture", "prepared in a commercial creamery by commercial methods, but under the supervision of an expert in dairy practice of the Dairy Division, Bureau of Animal Industry" (U. S. A.) and "five samples of pure casein made by the Hammarsten and Van Slyke methods." In all 304 samples were analysed. The following table has been drawn up, making use of Browne's data and of our own. It gives the composition of:—

- (1) Argentine casein, average of 8 samples : (F. L. B.)
- (2) Indian casein, average of 8 samples : (F. L. B.)
- (3) Indian village-casein : (D. M. G. and A. N. M.)
- (4) U. S. A. casein, made under special supervision, average of 34 samples : (F. L. B.)
- (5) Casein, made with reference to the isoelectric point, (D. M. G. and A. N. M. p. 7, § 19.)
- (6) Casein, made with reference to the isoelectric point, (D. M. G. and A. N. M. p. 8, § 21.)
- (7) "Pure caseins, made by the Hammarsten and Van Slyke methods", average of 5 samples : (F. L. B.)



Throughout the table, fat and ash are expressed on the water-free basis, nitrogen and acid on the water, fat and ash-free basis.

	Water.	Fat.	Ash.	Nitrogen.	Acid in terms of	
					HCl.	0.1 N alkali.
1 ..	8.20	1.10	3.87	14.66	4.20	11.5 cc.
2 ..	8.13	1.93	4.43	14.17	4.56	12.5 cc.
3 ..	5.76	1.69	4.24	15.48	1.91	5.2 cc.
4 ..	7.81	0.35	4.05	14.46	2.77	7.6 cc.
5 ..	6.76	0.33	0.34	15.53	0.08	0.22 cc.
6 ..	6.04	0.28	0.47	15.33	0.05	0.15 cc.
7 ..	8.38	0.13*	0.94	15.32	2.84	7.8 cc.
			per cent.			per gram.

25. Consideration of the figures in this table shows the possibility of making great improvements in the casein of commerce. The five "pure caseins made by the Hammarsten and Van Slyke methods" are not on the whole superior to our preparations of casein, which were made by a comparatively rapid process. Our caseins were made on a small scale, nevertheless the difference between commercial caseins and ours is so great, in respect of fat, ash and acid, as to leave no doubt that the method we propose could give excellent results on a much larger scale. It should be possible to prepare casein commercially, of a quality suitable to be used direct for most purposes, without the trouble having to be taken of purifying it by re-resolution and re-precipitation.

26. Work for the Director of Industries, Bombay, is in progress on lactic and electrolytic casein and on the applications of casein to industrial purposes in India.

AHMEDABAD,  
February 1920.

\* Average of only 4 samples.

Department of Industries

BOMBAY PRESIDENCY

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# UTILISATION OF BITTERNS

BY

A. J. TURNER, B.Sc. (Lon.), F.I.C.,

Head of the Department of Technical and Applied Chemistry, Victoria  
Jubilee Technical Institute, Bombay.

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## PREFACE.

THE second bulletin of the Department of Industries is a record of scientific work done in securing a sound foundation for a new Indian industry. The production of magnesium chloride is now established, but further developments await, not only the result of technical investigations but an examination of the commercial possibilities in each case.

The obstacles to the success of a new industry on the business side are illustrated by the fact that the majority of cotton weaving mills in Bombay still use imported magnesium chloride in preference to the Indian article, although the latter has a considerable advantage in price.

BOMBAY,  
*26th February 1920.*

R. D. BELL,  
Director of Industries.

## UTILISATION OF BITTERNS.

ON the outbreak of war with Germany in August 1914, the stocks of magnesium chloride in India soon became dangerously depleted and material costing Rs. 3-8-0 in July 1914 soon commanded Rs. 45 to 55 per cwt. Apart from these excessive prices there was a risk that supplies would soon be unobtainable.

Magnesium chloride is an article of great importance to the textile industry in which it is used as a deliquescent agent in sizing. The warp yarn has to be strengthened before it will stand the strain, wear and tear of the healds and reeds in weaving. The process of sizing consists in coating the warp yarn with a preparation intended to strengthen it, and in many cases to add weight to the finished cloth. If the cloth is to be bleached it is only necessary to add sufficient size to give the yarn the required strength, but if grey cloth is to be manufactured, or if coloured yarn is used in the weaving, it is not uncommon to find 100 parts of size applied to 100 parts of yarn. Even for the purpose of giving the necessary strength about 25 per cent. of size is required.

Sizing mixtures contain as a rule five classes of substances :— (1) adhesive materials such as starch or flour ; (2) weighting materials such as china clay, barytes (or barium sulphate), french chalk, etc. ; (3) softening agents such as tallow, glycerine, soap ; (4) deliquescent agents which are added to keep the yarn moist, soft and pliable ; (5) antiseptics such as zinc chloride, salicylic acid, thymol and phenol.

Chief among the deliquescent agents is magnesium chloride of which a regular supply is, therefore, a matter of vital importance to the textile industry. Under the conditions prevailing in Bombay after the outbreak of war, it was suggested by the author that calcium chloride should be used as a substitute for magnesium chloride. The Morarjee Goculdas Mill made a sizing mixture in which the magnesium chloride was largely replaced by calcium chloride.

and tried this as well as a size mixing of the usual composition on the same yarn. The weaving master reported that he experienced no unusual difficulties in working the yarn sized with the new mixture, and the trade was about equally divided as to which cloth was the better. Quantitative tests made by Mr. Pomfret, a weaving expert in Bombay, showed the new cloth better, if anything, than the usual cloth. The only difference noticed by merchants was the "feel". Calcium chloride at this time was selling at Rs. 5 per cwt., and Government granted the concession of import duty free under the same conditions as similar mill stores are admitted free of customs duty. In spite of the low price and this concession, calcium chloride made no headway as a substitute for magnesium chloride. The result was to stimulate the manufacture of magnesium chloride in India.

At Stassfurt, in Germany, there is a mineral deposit known as carnallite; this is a double chloride of potassium and magnesium and contains also traces of bromides and iodides.

The potassium, bromine, and iodine are all valuable. Potassium salts are in great demand in agriculture, and potassium compounds, bromides, and iodides are used for medicinal and photographic purposes, and for making certain dyes. As magnesium chloride, which constitutes by far the greater portion of carnallite, has to be removed before the bromides and iodides can be recovered, it was found possible to sell magnesium chloride at a price so low that it was impossible to manufacture it from other sources in competition.

When the German supply of magnesium chloride was cut off, serious consideration was at once given to its manufacture in India. As a temporary expedient its manufacture by the action of hydrochloric acid on magnesite was suggested, but attention was soon directed to a better method of manufacture by the recovery of the salt from bitterns. Sea water contains a small proportion of magnesium chloride which is capable of recovery, therefore, from the residual liquor of salt pans in which sea water is utilised for the manufacture

of salt. A still better source of supply was found at the Pritchard Salt Works at Kharaghoda in Kathiawar. These are the largest salt works in the Presidency, and are worked directly by Government. The salt is manufactured, not from sea water, but from brine obtained from wells, some of which have a remarkable composition. According to Mackenzie Wallis, the average composition of brines at Kharaghoda and Dhrangadra is as follows. The figures for sea water are given for comparison :—

	Kharaghoda.	Dhrangadra.	Sea Water.
	Per cent.	Per cent.	Per cent.
Sodium Chloride (NaCl) ..	16·00	17·47	2·71
Magnesium Chloride (MgCl <sub>2</sub> ) ..	4·60	4·27	0·37
Calcium Chloride (CaCl <sub>2</sub> ) ..	0·25	0·20	0·07
Sodium Sulphate (Na <sub>2</sub> SO <sub>4</sub> ) ..	0·50	0·40	0·14
Magnesium Sulphate (Mg SO <sub>4</sub> ) ..	0·82	0·79	..
Calcium Carbonate (CaCO <sub>3</sub> ) ..	0·02	0·28	0·23
Calcium Sulphate (CaSO <sub>4</sub> ) ..	0·67	0·679	..

The following analyses made by Dr. Mann show, however, that the brine differs very considerably in character in different wells :—

	No. 1.	No. 2.
Calcium Carbonate (CaCO <sub>3</sub> ) ..	Nil.	0·05
Calcium Sulphate (CaSO <sub>4</sub> ) ..	0·71	1·12
Magnesium Sulphate (MgSO <sub>4</sub> ) ..	0·08	1·21
Magnesium Chloride (MgCl <sub>2</sub> ) ..	2·51	2·32
Sodium Chloride (NaCl) ..	27·75	62·17
Total Solids .	39·46	73·00

These tables give ratios of magnesium chloride to sodium chloride of roughly 1—11 and 1—26, respectively. If the whole of the bitterns is not required, it is obviously very desirable to make a careful investigation of the bitterns from the various wells before collecting material for the manufacture of magnesium chloride.

Mackenzie Wallis suggested that the large proportion of magnesium chloride in Kharaghoda brines may be due to the fact that the pans have been in use for many years, and that the waste liquor, rich in magnesium chloride, after absorption by the soil, has eventually found its way into the brine wells again. This is a question, which it is unnecessary to discuss here. The important practical fact is that there is a large quantity of magnesium chloride available.

According to Mackenzie Wallis an important and remarkable feature of the brines is the entire absence of potassium and iodine. The absence of potassium salts makes the recovery of magnesium chloride a simpler matter than at Stassfurt.

The method of manufacturing salt at Kharaghoda is as follows. Manufacture begins as soon as practicable after the close of the monsoon. Brine from wells is let into the pans and, owing to the extreme dryness of the atmosphere, solar evaporation takes place with great rapidity so that, in a short time, crystals of salt separate out. After a time the other salts present in the brine concentrate to such an extent that they also tend to crystallise out along with the common salt. As their presence renders the common salt impure, and imparts to it a bitter flavour, the mother liquor or bitterns is run off before the magnesium chloride and other salts crystallise out. The pans are then refilled with a fresh charge of brine from the wells.

It is the mother liquor or bitterns which is the source of the magnesium chloride. On standing in the drains, it still further concentrates, and eventually the magnesium chloride crystallises out. Samples of these crystals were taken in October 1914, and examined by the author; other samples were sent to Dr. Harold H. Mann and Lieutenant-Colonel W. H. Dickinson, I.M.S., Chemical Analyser to Government. The results agreed closely and showed the crystals had a purity of 82—98 per cent. The liquor from which these crystals were formed gradually dried up, and masses of crystals could be taken from the trenches. By the end of December the liquor is completely evaporated, and the remaining mass of salts becomes covered by a layer of mud which can be easily detached.



Having shown that there was an ample supply of magnesium chloride to keep the mills running, it was decided to call a meeting of those likely to forward the development of the industry. This meeting was held early in January 1915, when a representative of the salt department, the Managing Agents of the Eastern Chemical Company, Limited, and their Works Manager, a lessee of some of the salt pans at Matunga and the author were present under the Chairmanship of the Collector of Bombay, Mr. A. H. A. Simcox, I. C. S. It was decided to carry out experiments at Matunga, in order to determine whether the salt pans there could be utilised, and so save the higher manufacturing charges incurred in a place like Kharaghoda where there was no fuel or any other convenience. It was also arranged that the Eastern Chemical Company should be asked to take up the manufacture of magnesium chloride from the Kharaghoda bitters. A large amount of the bitters was sent from Kharaghoda to the Company's Works at Matunga, but after some time the Company decided not to proceed in the matter, and it did not put any magnesium chloride on the market.

At this stage, tenders for the right of collecting the bitters were invited, and Mr. P. V. Mehd of Ahmedabad secured the concession. He erected a factory at Ahmedabad and commenced manufacture. As there was no security as to the length of time the concession would last, he was naturally chary of putting any large amount of capital into the project. He produced with very primitive plant a fairly good article, but it was not as good as the German product, and consequently there were complaints. Experience also indicated that Kharaghoda was a more convenient location for the factory, and operations were subsequently transferred there.

The factory at Kharaghoda was also of a primitive type, and proved very uneconomical. The method of manufacture was as follows. Bitters from the salt pans were collected and further evaporated by solar heat. The bitters on removal from the salt pans still contained a certain amount of common salt, and this crystallised on further concentration. At the same time other salts

were also thrown out. The liquor, rich in magnesium chloride, was then heated in copper pans and concentrated to such an extent that the boiling point was  $135^{\circ}\text{C}$ . By this means the magnesium sulphate, which had up till now existed as epsom salts ( $\text{MgSO}_4, 7\text{H}_2\text{O}$ ), lost water of crystallisation and was converted into another sulphate known as kieserite ( $\text{MgSO}_4, \text{H}_2\text{O}$ ). This kieserite is practically insoluble in a saturated solution of magnesium chloride, and so is thrown out of solution. The liquor was then pumped from the evaporating pans into a settling tank. Here the kieserite fell to the bottom and the supernatant liquor was ladled into drums. Owing to the fact that, on cooling, the liquor soon solidifies, it is not practicable to allow the liquor to stand long enough for settlement to be complete, and a certain amount of the solid kieserite is ladled out along with the liquid. This is especially the case when nearing the bottom of the settling vat. Experiment has shown that the kieserite falls to the bottom of the drum, as there is always a small percentage of magnesium sulphate in samples taken from the bottom of the drum, while samples taken from the top are free from it. Both Dr. Mann and the author have examined samples taken from the drum and found this to be true.

After a short time Mr. Mehd combined with Sardar Khan Bahadur Rustomjee Jehangir Vakil and Mr. B. S. Lalkaka of Ahmedabad to develop the industry under the name of the Pioneer Magnesia Works. The new company soon found that it was necessary to improve the process of manufacture, with the double object of reducing the consumption of fuel, and of bringing the quality of the product up to the standard of the German article. The fuel consumption was excessive, as the evaporating pans had been placed on brickwork and were heated from below by coal and wood, without any provision for draft, with the result that a great amount of heat was thrown out in front of the pans and lost. This was remedied early in 1919. At the suggestion of Mr. T. S. Dawson, Principal of the Victoria Jubilee Technical Institute, the pans were set in wheel flues which were all connected to a chimney. By this change a very

great economy of fuel has been effected, and the time required for concentration has been enormously reduced. Care in manufacture has resulted in improvement in quality. Further purification can be obtained by allowing the liquid magnesium chloride, concentrated as at present, to stand in settling tanks maintained at  $120^{\circ}\text{C}$ ., at which temperature the magnesium chloride will remain molten indefinitely.

Another method of manufacture was suggested by Mr. Mackenzie Wallis which would allow of magnesium sulphate also being recovered in a fairly pure state. The solubility of common salt is practically the same at all temperatures and so, on evaporation, it is thrown out of solution independent of the temperature: the other salts are more soluble in hot than in cold water. From this it follows that the common salt will crystallise during the day, while the others will tend to separate during the cold night. If the crystals formed during the day are skimmed off at the close of the day and those formed during the night are taken away early in the morning, there will be a partial separation of the various salts present. An extended series of tests is necessary to determine to what extent separation might be commercially effected by this method.

#### BYE-PRODUCTS OBTAINABLE FROM BITTERNS.

The industry was started for the specific purpose of supplying the cotton mills with magnesium chloride after the German supply ceased and no endeavour was made to work up bye-products. The further utilisation of the bitterns is now under investigation by the author, assisted by Mr. M. M. Koppikar, on behalf of the Department of Industries.

#### BROMINE.

Bromine occurs in sea water and sea-weed, and a very large proportion of the world's supply came from the carnallite mines at Stassfurt. It was natural, therefore, for the first investigator to look for bromine in the brine wells at Kharaghoda, and Mackenzie

Wallis found it in varying amounts in different wells. He states that it varies from 0—0·025 per cent. as magnesium bromide in the fresh brine, and from 0·25—0·5 per cent. in the bitterns. He also found that the bromine content gradually decreased on storing, in circumstances which indicated that this was due to the absorption of bromides by the soil. New arrangements for the investigation, therefore, include the provision of water tight stoneware tanks for the storage of bitterns.

This percentage of bromine appears small, but the amount of bitterns available is so large, that bromine can probably be recovered in commercial quantities. As the cost of the plant is considerable, it is very desirable that the figures should be fully confirmed by actual measurement of the bromine recovered, rather than by calculating the theoretical amount recoverable. With this object a new experimental plant, designed by Dawson from the suggestions made by Mackenzie, Wallis, has recently been erected in Khara-goda. The plant consists of the following parts:—

- (1) Film evaporator,
- (2) Steam heated teak tub,
- (3) Steam heated teak tub,
- (4) Flat crystallising tray.

The evaporator (No. 1) consists of a number of horizontal iron pipes through which steam passes, and over which a film of the bitterns is allowed to trickle. By this means a certain amount of concentration is effected.

The liquor collecting under this evaporator is then pumped into the tub (No. 2) which is fitted with a large steam coil sufficient to evaporate water from the liquor and bring its temperature up to 134°C. When this temperature is reached the liquor is allowed to run into the next tub (No. 3) which is fitted with a smaller coil, as the only object is to keep the liquor at about 120°C. and so allow the kieserite to settle. When this has occurred, the clear liquor is run into the flat tray (No. 4), so that it may cool and allow

the magnesium chloride to crystallise and leave the bromide in solution.

The following experiment was made with this plant. 186 gallons of bitterns were run over the film evaporator and pumped into the first steam heated tub (No. 2 above) where evaporation was continued till the boiling point reached  $134^{\circ}\text{C}$ . The liquor was then run into the settling tub (No. 3) and allowed to stand for some time. As the settling was a very slow matter, the partially settled liquor was run into the flat crystallising tray. The remainder of the kieserite settled to the bottom leaving a clear supernatant liquid which, on cooling, gave very fine crystals of magnesium chloride. These crystals were removed and, after draining, were heated in direct fired copper pans till a small sample, on cooling, was found to solidify. The molten chloride was then run into a drum. This mass was almost entirely free from magnesium sulphate. The mother liquor left in the crystallising tray measured 64 gallons, and was found to contain 1.18 per cent. of bromine. This is equivalent to 0.4 per cent. of bromine or 0.46 per cent. magnesium bromide in the bitterns themselves.

The experimental plant itself cannot be considered a success. First, at the high temperature reached in the evaporating tub ( $134^{\circ}\text{C}$ .) the magnesium chloride absorbed water from the timber, and after a short time the tub began to leak considerably. As the inside shrunk under this action without the outside being to any extent affected, it was impossible to stop the leak by driving down the hoops. Secondly, wrought iron is somewhat affected by magnesium chloride, and the steam coils would in course of time be eaten away.

It is more economical to evaporate by direct heat than by steam, and the latter should never be employed unless absolutely necessary. In this test it has been shown that steam heating offers no advantage, and nothing has been done by it which could not be done more economically by direct heating. The following modified procedure is, therefore, suggested.

The bitters are run into direct fired copper pans, and heated till a temperature of 134°C. is obtained. As soon as the liquor reaches this temperature, it is run into a flat wooden tray fitted with a false bottom. Owing to the bad conducting power of the wood, the large mass of the liquor will take a long time to cool and give ample time for the kieserite to settle below the false bottom, while the magnesium chloride crystals, to a very large extent, form above it. The crystals of magnesium chloride can be separated from the mother liquor by lifting the false bottom, which has been built in sections to facilitate the work.

The mother liquor can be drained from the crystals formed in the tank leaving a layer of kieserite on the bottom. This kieserite can be removed and washed in a hydro-extractor, and finally worked for epsom salt.

The clear liquor may be further concentrated, when a further supply of magnesium chloride will be obtained, or it may be worked at once for bromine.

Three methods of obtaining the bromine are available—

(1) The liquor can be treated with manganese dioxide and sulphuric acid in accordance with the following equation:—



(2) The liquor can be treated with chlorine, when bromine is set free and removed from the solution by the aid of a current of steam:



(3) The liquor may be electrolysed by using a current at 4.5 volts.

#### CHOICE OF SITE FOR BROMINE RECOVERY.

There are two choices—either to carry the magnesium bromide to a place where sulphuric acid, manganese dioxide or materials for making chlorine are conveniently obtained, or to work the bromides at Kharaghoda itself. Railway freights for acids and

bromine are high, and it would appear more advantageous to carry the bromide to Bombay where sulphuric acid is being made, or perhaps later, to a site where cheap hydro-electric power is available from the Koyna Valley.

Another point for consideration is the best way of transporting the bromine. The rate for bromine itself, both by rail and steamer, is very high, and it is, therefore, probable that it would be better to convert the bromine into a bromide, such as iron bromide, which would be carried at a lower rate. This problem is one of minor importance as it is, if anything, easier to recover the bromine as bromide, than to recover the element bromine itself. The manufacture of bromine from iron bromide offers no difficulty.

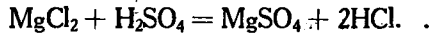
It may be mentioned here that experiments are being carried out to determine the amount of bromine in the bitterns available at Aden, and also to ascertain whether they contain an appreciable amount of iodine and potassium, neither of which according to Mackenzie Wallis occurs in the Kharaghoda bitterns. If the small scale laboratory estimations are promising, it will be desirable to carry out experiments on a fairly big scale in the same manner as proposed for Kharaghoda. Mere laboratory experiments would be unreliable, as the bitterns vary in composition especially as regards the bromine content.

#### EPSOM SALTS.

Another matter for consideration is the treatment of the sludge in the settling tank after the removal of the magnesium chloride. This sludge consists of a mixture of kieserite ( $MgSO_4 \cdot H_2O$ ) and magnesium chloride.

Experiments have already been made on a laboratory scale for the separation of these two salts. It has been found that while the kieserite is practically insoluble in a saturated solution of magnesium chloride, it is fairly soluble in a weak solution, and so the method of fractional crystallisation is not suitable.

It has been found, however, that on treatment with sulphuric acid, quantitative decomposition takes place, the whole of the chloride being converted into sulphate with the evolution of hydrochloric acid. The sulphate can be removed from the still, and practically pure magnesium sulphate or epsom salts can be obtained on crystallisation. The reaction may be expressed :



The practical difficulty in this case is to get an acid resisting still.

#### ZINC CHLORIDE.

It is suggested that the hydrochloric acid should be run into water in which has been placed some scrap zinc. In this way the waste hydrochloric acid will be recovered as zinc chloride. This salt finds considerable application in the textile industry.

#### SODIUM SULPHATE.

The salts crystallising from the bitters, before they are finally run into the evaporating pans for the manufacture of magnesium chloride, are chiefly sodium chloride, sodium sulphate and magnesium sulphate.

Investigation is necessary before deciding on the best method of separating the sodium sulphate from the other crystals, but, as already stated, the sodium chloride will separate during evaporation in the day time, whereas the others will deposit during the night, so that it mainly becomes a question as to the best manner of separating sodium and magnesium sulphates.

#### HYDROCHLORIC ACID AND CHLORINE.

These have been obtained from magnesium chloride without the use of sulphuric acid at Stassfurt, and it may be worth while investigating whether manufacture would be profitable on these lines at Kharaghoda. The chlorine could be converted into bleach-



ing powder or magnesium chlorate. The former could, however, only be made during the cold season, as the high temperature existing during the hot weather would tend to the formation of a chlorate. For this reason magnesium chlorate could be made at any time.

The magnesium chlorate could be transported as such, and converted into other chlorates, such as potassium chlorate, in a suitable place where water is available.

The magnesia recovered as a bye-product might be used for the manufacture of magnesia cement which is a mixture of magnesium chloride and magnesium oxide.

#### POSSIBILITY OF FURTHER DEMAND FOR MAGNESIUM SALTS.

In addition to the existing uses in the textile and paper industries there will probably be an opening for magnesium salts for cements. Drs. Sudborough and Watson have been experimenting for some time with a magnesia cement, and it appears that such a cement has very useful properties and is likely to be considerably used in the near future.

There is no doubt about Kharaghoda being able to supply the whole of the magnesium chloride to meet Indian needs, and leave a large amount over for export.

Mackenzie Wallis has estimated that there are 1,800 tons of bromine available annually.

#### LABOUR, TRANSPORT, ETC.

Labour is a great difficulty at Kharaghoda, but recently a motor tank has been ordered, and should soon be delivered to the Pioneer Magnesia Works. The bitters will then be pumped direct to the tank from the water tight stone reservoirs which have been built among the pans, and into which salt pans drain. The tank with the bitters will then be run direct to the factory where it will be emptied into storage tanks. This method will obviate loss in handling, and save time and labour.

The motor will run on the railway lines, and thus be able to reach any part of the workings.

Owing to the extreme dryness of the air in Kharaghoda, the richness of the bitters in magnesium salts, and the improved manner of working, Kharaghoda should be soon the centre of a flourishing industry, supplying not only India's needs, but that of other countries as well.

BOMBAY,  
*February 1920.*

A. J. TURNER.

Department of Industries  
BOMBAY PRESIDENCY

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THE VEGETABLE OIL INDUSTRY IN THE  
BOMBAY PRESIDENCY

BY  
A. F. YULL

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## PREFACE.

While he was Assistant Controller, Oils and Paints, under the Indian Munitions Board, Lieutenant A. F. Yuill kindly gave the Department of Industries much valuable assistance and advice in dealing with a large number of enquiries regarding the vegetable oil industry. It was then suggested to him that he might collect and compile the available information regarding oil seeds, oils, machinery, and other subjects bearing on the possibilities of the vegetable oil industry in the Bombay Presidency. Lieutenant Yuill very kindly consented to undertake this task for which he was exceptionally qualified by reason of his scientific training, his practical experience of the vegetable oil industry in America and India and the opportunities for investigation which his appointment under the Indian Munition Board afforded him. Unfortunately several causes have delayed the publication of the bulletin. The result is that, in some details, statistical information is not up to date. This does not impair, however, the practical value of the bulletin, which is published in its original form except for some slight alterations which could be made without further delaying publication.

The subject is treated in a practical manner based on current practice and the bulletin should be of great value to all who are interested in the industry. The author shows clearly that the expansion of the vegetable oil industry depends, not merely on the provision of more plant, but on the existence of favourable economic factors, efficient technical supervision and sound and enterprising business management.

An interesting proposal is made for a system of standardisation. The views expressed on this and other matters are those of the author and while the Department of Industries cannot now officially pronounce upon these views, it will welcome the interest and discussion which the expression of them will promote.

The Department of Industries is under a deep obligation to the author for his generosity in placing his experience and knowledge freely at the disposal of the department and in sacrificing much spare time in the work of compiling this bulletin.

*Bombay, 10th May 1921.*

R. D. BELL,  
Director of Industries.

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# THE VEGETABLE OIL INDUSTRY IN THE BOMBAY PRESIDENCY.

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## CHAPTER I.

### INTRODUCTION.

In recent years it has been frequently asked why the vegetable oil industry in India is not more widely established and more prosperous than it is and whether more active interest and assistance by Government would not stimulate its development. To assist his department to answer these questions and to deal with the practical problems of the industry, the Director of Industries, early in 1920, invited the writer to make a comprehensive survey of the conditions in the Bombay Presidency. In submitting this report, for which no terms of reference were laid down, the writer hopes that it will not only be useful for departmental purposes, but that, if its publication is considered to be desirable, the practical information which it contains may be of assistance to those who are engaged in the industry or who are considering its commercial possibilities.

In order to arrive at a correct estimate of the situation, a careful survey of existing oil-pressing equipment has been carried out, and the size, importance, and efficiency of the vegetable oil industry of this Presidency has been carefully compared with those of the same industry in more highly developed countries such as France, the United Kingdom and America. The results will be found tabulated in Chapter II.

Secondly, a careful survey of all existing and easily available supplies of raw materials has been made. Each of the prominent oil seeds, available in commercial quantities within the Presidency, has been carefully studied and the prospects of its development from an oil-pressing point of view have been considered; the possibilities of finding profitable outlets in India and elsewhere for the products of an expanded industry have been investigated; attention has been drawn to favourable and unfavourable factors in

the situation, while the question of the best location and equipment for factories, which may in future be erected to deal with each of the different kinds of oil seeds, has not been neglected. The results of these and other investigations are detailed in Chapter III.

In Chapter IV various types of machinery, used in oil-milling in India and elsewhere, are described in detail, and comparisons of their suitability for Indian conditions, their efficiency, outturn, capital costs, and working expenses are given so that prospective purchasers may not have to rely entirely on advertising literature or on the advice of interested salesmen.

In Chapter V the results of a careful survey of the efficiency of existing methods of oil expression are tabulated, explained and commented on.

Chapter VI is devoted to the subject of oil refining, or the further treatment of crude oils in order to render them less liable to become rancid, and to make them more suitable for use in India or for export to those countries which at present import India's oil seeds. Existing methods or want of methods are also examined, and compared with the methods in vogue in other countries.

The problem of finding new uses in India for the products of an expanded industry is discussed at some length in Chapter VII.

As the success of an oil industry in the Bombay Presidency is mainly contingent on the establishment of an export trade in such of the products as cannot be utilised in India, an attempt is made in Chapter VIII to point out the necessity for improvements in marketing methods, in the type of containers in which oil for export should be packed, and for the establishment, either by Government or by private agency, of standards of quality for each of the oils, the export of which it is intended to encourage. Particulars of a standardisation scheme which is considered to be worthy of the attention of provincial departments of industries are detailed in the same chapter.

Appendices include :—

- (1) A list showing the average oil content of each of the important oil seeds available within the Presidency.

- (2) A list of the principal manufacturers of oil mill machinery in Europe and America with, where known, the names of their local agents.
- (3) A bibliography of the best books available on the subject of vegetable oil manufacture and refining.
- (4) Extract from a Memorandum submitted to the Committee on Edible and Oil Producing Nuts and Seeds (1916) by Prof. Crowther of the University of Leeds, showing the average oil content of some oil cakes available in England.
- (5) Extract from "Feeds and Feeding" by Henry & Morrison (1907) showing average oil content of some oil cakes available in the United States of America.
- (6) Extraction of oils by solvents (from the Oil and Colour Trades Journal of March 19, 1921).

## CHAPTER II.

## POSITION OF THE VEGETABLE OIL INDUSTRY IN THE BOMBAY PRESIDENCY AND A COMPARISON WITH THAT OF OTHER COUNTRIES.

In normal years more than two-thirds of India's oil seed export passes through Bombay and Karachi, while of her very much smaller export of oils, less than two per cent. passes through the same ports. The exports of oil from Presidency ports are therefore very small compared with exports of oil seeds. This will be seen from the figures for 1913-14, i.e., a normal pre-war year.

TABLE I.

*Particulars of exports from Bombay to all countries during twelve months ending 31st March 1914.*

	Tons.	Weight per cent.	Value Rs.	Value per cent.
Oil seeds (non-essential) total ..	842,000	= 100	12,42,00,000	= 100
Oils (non-essential) .. ..	700	= '08	3,61,000	= '3

TABLE II.

*Particulars of exports from Karachi to all countries during the same period.*

	Tons.	Weight per cent.	Value Rs.	Value per cent.
Oil seeds (non-essential) total..	224,000	= 100	3,83,00,000	= 100
Oils (non-essential) .. ..	100	= '04	49,000	= '3

The corresponding figures for the nine months ending 31st December 1919 are given below :—

TABLE III.

*Particulars of exports from Bombay to all countries during nine months ending 31st December 1919.*

	Tons.	Weight per cent.	Value Rs.	Value per cent.
Oil seeds (non-essential) total ..	274,000	= 100	8,63,00,000	= 100
Oils (non-essential) .. ..	3,500	= 1'29	28,90,000	= 3'33

NOTE.—Nearly 3,000 tons of coconut oil, previously imported from other provinces into Bombay, were in this period re-exported to Europe. After deducting this exceptional item, the weight of oil is only 2 per cent. of the weight of oil seeds exported in the same period.

TABLE IV.

*Particulars of exports from Karachi to all countries during the nine months ending 31st December 1919.*

	Tons.	Weight per cent.	Value Rs.	Value per cent.
Oil seeds (non-essential) total ..	188,000	= 100	4,73,00,000	= 100
Oils (non-essential) .. ..	70	= '04	68,000	= '15

The following statements show the approximate quantity of oil contained in the manufactured articles imported into Bombay and Karachi during the same periods, as well as the total weight of oil seed which would be required to furnish the same.

TABLE V.

*Imports into Bombay during twelve months ending 31st March 1914.*

Articles.	Total weight.	Approximate oil content weight.	Representing finished products of exported oilseeds.	Per cent. of total seeds exported.
	Tons.	Tons.	Tons.	
1. Candles ..	200	100	} (say) 15,000	1·78
2. Oil, vegetable ..	1,400	1,400		
3. Oil cloth ..	200	20		
4. Paints and colours ..	5,318	265		
5. Soap ..	7,000	3,500		
6. Sundries ..	100	50		
	14,218	5,435	15,000	1·78

In other words, the manufactured articles imported into Bombay represented only the oil extracted from 1·78 per cent. of the seed exported from Bombay during the same period.

TABLE VI.

*Imports into Karachi during 12 months ending 31st March 1914.*

Article.	Total weight.	Approximate oil content weight.	Representing finished products of exported oilseeds.	Per cent. of total seed exported.
	Tons.	Tons.	Tons.	
1. Candles .. ..	Nil.	0	} (say) 2,700	1·2
2. Oils, vegetable .. ..	170	170		
3. Oil cloth .. ..	Nil.	0		
4. Paints & colours .. ..	855	43		
5. Soap .. ..	1,349	674		
6. Sundries .. ..	50	25		
	2,424	912	2,700	1·2

TABLE VII.

*Imports into Bombay during nine months ending 31st December 1919.*

Article.	Total weight.	Approximate oil content weight.	Representing finished products of exported oilseeds.	Per cent. of total seed exported.
	Tons.	Tons.	Tons.	
1. Candles .. ..	19	10	} say 9,500	3·5
2. Oils vegetable .. ..	294	294		
3. Oil cloth .. ..	44	4		
4. Paints & colours .. ..	3,954	200		
5. Soap .. ..	5,455	2,700		
6. Sundries .. ..	100	50		
Total .. ..	9,866	3,258	9,500	3·5



TABLE VIII.

*Imports into Karachi during nine months ending 31st December 1919.*

Articles.	Total weight.	Approximate oil content weight.	Representing finished products of exported oilseeds.	Per cent. of total seeds exported.
	Tons.	Tons.	Tons.	
1. Candles ..	Nil.	0	} (say) 1,500	·8
2. Oil, vegetable ..	48	48		
3. Oil cloth ..	7	1		
4. Paints & colours ..	488	24		
5. Soap ..	726	363		
6. Sundries ..	50	25		
Total ..	1,319	461	1,500	·8

The disturbing effect of the war appears to have done little to improve the situation, and, failing a rise in the standard of living, the increased demand for oil which might be expected to result from the stoppage of all imports of such materials and their manufacture in India, would not be more than sufficient to warrant the erection of one oil mill of moderate size, or to increase by 15 per cent. the outturn of the existing machinery.

#### *Oil Imports into Bombay.*

On the other hand there is a very considerable import of oil into Bombay Presidency from other provinces, e.g., cocoanut oil from the west coast of Madras, groundnut oil from Eastern Madras, rape and mustard oils from the United Provinces, and linseed oil from the Central Provinces. Against this, exports of oils from the Bombay Presidency to other Provinces are inconsiderable, and the total excess of imports from other provinces over exports thereto may be reckoned at not less than 8,000 tons per annum, representing the oil yield of approximately 20,000 tons of oil seeds and nuts. The greater portion of this oil is imported into Bombay

city for consumption there, or for despatch to the mofussil, and much of it is so superior to the oil expressed locally that it realises a higher price, e.g., Cochin cocoanut oil imported by sea is superior to and realises a higher price than oil expressed locally from copra similarly imported. In the case of certain other oils, such as groundnut and castor from the Madras Presidency, the market rates of the imported oils are lower than those of locally manufactured oils of similar quality. In none of the districts from which these oils are imported is the oil pressing machinery superior to that available in Bombay, practically the whole of it being the output of country ghanis and rotary mills. In spite also of the obviously greater expense of transporting the oil over the cost of transporting the oil bearing materials, these oils are able more than to hold their own against oil of local manufacture.

*Present position as regards Equipment.*

At the present time there are scattered throughout the Bombay Presidency a number of oil mills equipped with fairly modern hydraulic machinery, with daily outputs varying from two to fifty tons of seeds per day. These crush castor seed, linseed, cotton seed, groundnuts, etc. The potential daily output of these mills may be taken to be about 150 tons of seeds. There are also expellers with a potential output of 25 tons per day, rotary ghanis worked by oil engines with a potential output of say 200 tons per day of 24 hours, and ordinary bullock ghanis capable of crushing about 125 tons per day of 12 hours. This gives a total existing crushing capacity of approximately 500 tons per day or say 150,000 tons per annum. It is doubtful, however, whether the actual weight of seeds crushed in the Presidency is much in excess of 100,000 tons per annum. This is about 9 per cent. of the total available, so that for every ton of seed crushed locally 11 tons are sent overseas as raw materials.

It is evident, however, that there is already in the Presidency sufficient oil pressing machinery not only to supply all existing oil requirements, even if there were no imports from other provinces,

but also, if need be, to produce all the oil required for the manufacture of those imported products mentioned in Tables V, VI, VII and VIII.

#### POSITION OF THE INDUSTRY IN OTHER COUNTRIES.

Before attempting to account for the existing state of affairs it will be interesting and instructive to consider the position of the oil crushing industry in other countries, *e.g.*, in the United Kingdom, France and the United States.

Taking first the United Kingdom in a pre-war, a war and a post-war year, the total imports of raw materials, and consequently the weight of seed crushed were as under :—

TABLE IX.

#### *United Kingdom.*

	1910. Tons.	1914. Tons.	1919. Tons.
Total imports of oil seeds, nuts and kernels into the United Kingdom.	1,549,400	1,482,600	1,689,500

The average, excluding war years, would appear to be over one and a half million tons, of which not less than one million tons were less oily seeds such as cotton seed and linseed. The import and expression of richer oil bearing material has however increased considerably during and since the war, and arrangements are at present being made for considerably enlarging existing plants, and for building additional factories in different parts of the United Kingdom to meet the increased demand for oils and fats for margarine manufacture. When these are complete, the annual requirements of the oil mills of the United Kingdom will be not less than two million tons.

TABLE X.

#### *France.*

	1908.	1913.	1919.
Total imports of oil seeds and kernels (approximately).	700,000	628,450	454,500
		(Marseilles only.)	

The nominal requirements of French oil mills would appear to be not far short of 1,000,000 tons per annum, most of which, consisting mainly of richer oil bearing material, such as copra and groundnuts, are crushed at Marseilles.

TABLE XI.

*United States of America.*

	1918. Tons.
Total weight of seeds, etc., used in oil pressing industries in 12 months.	4,845,000 (approximately)

The above total includes approximately 4,000,000 tons of cotton seeds, which is about the average quantity of that seed crushed annually in the U. S. A. during recent years. Excluding linseed, which accounts for more than half of the balance, the industry concerned with the crushing of the remaining oil seeds and kernels, though expanding, is relatively unimportant.

*Comparison with Bombay Presidency.*

It is apparent, therefore, that, while a fairly large proportion of the oil seeds treated in other countries is grown within the limits of the Bombay Presidency or is shipped from Presidency ports, the vegetable oil industry of the province compares, in mere size, unfavourably with that of other countries.

## CHAPTER III.

DETAILED CONSIDERATION OF THE OIL SEEDS AVAILABLE IN  
THE BOMBAY PRESIDENCY.

The principal oil seeds exported from Bombay and Karachi in normal years in order of their importance are :—

Linseed, cotton seed, rape seed, sesamum, castor seeds and groundnuts.

In 1913-14 the exports of these seeds from this Presidency were :—

			Tons.
Linseed	..	..	214,000
Cotton seed	..	..	279,000
Rape seed	..	..	241,000
Sesamum	..	..	107,000
Castor seeds	..	..	100,000
Groundnuts	..	..	54,000

During the years 1919-20 and 1920-21 exports from the same ports were :—

			1919-20.	1920 21.
			Tons.	Tons.
Linseed	..	..	114,000	83,000
Cotton seed	..	..	241,000	99,000
Rape seed	..	..	120,000	180,000
Sesamum	..	..	45,000	11,000
Castor seeds	..	..	7,000	14,000
Groundnuts	..	..	36,000	13,000

*Linseed* (Botanical name *Linum Usitatissimum*).

Linseed is not extensively crushed in the Bombay Presidency. At the outside, the total weight crushed annually does not exceed 9,000 tons, the yield of oil from which probably amounts to a little over 3,000 tons. The cakes are mostly exported as there is little demand for them in this or any part of India. The oil is used in certain parts for edible purposes, but chiefly either raw or boiled for mixing with paints. The requirements of the Presidency for this oil, either as oil or in manufactured articles, probably do not

exceed 5,000 tons per annum, hence any considerable expansion of the industry would necessitate the export of both the products. During recent years, and particularly during the war, there has been an increasing export of linseed oil from India, chiefly from Calcutta, to Australia, New Zealand, South Africa and the East Indies. So far Bombay has lagged far behind Calcutta, but there appears to be no particular reason why this Presidency should not be able to compete on equal terms with Bengal and to obtain a share of the export business which, during 1918-19, amounted to over 6,500 tons. The machinery in use in Bengal is similar to that in use throughout this Presidency, and practically the whole of the cakes produced there have also to be exported. In view of the fact that the oil cakes produced will have to be exported, and that English importers require a cake not too poor in oil, the Anglo-American type of machinery appears to be most suitable, while the best location for oil mills appears to be in the vicinity of the chief ports. The chief difficulty which new manufacturers will have to face is the absence of any recognised standard of quality for oils marketed in Bombay. Failing the establishment of a suitable system of grading and inspection, the manufacture and export of linseed oils, whether raw or boiled, could only be *undertaken by large concerns* who would themselves be in a position to organise a rigid system of standardization, so that importers in other countries might be able to depend on the quality of oils purchased from them. As regards Bengal, this has already been done by concerns like the Gourepore Company, Howrah Oil Mills, etc., and possibly other less deserving concerns reap the benefit, but in Bombay no such standard exists and, while the product of at least one concern is of sufficiently high grade to meet every possible requirement of such a standard, much of the remainder is of very inferior quality. This applies to both raw and boiled oils, but more particularly to the latter.

Owing to the uncertain quality of the oils offered in the Bombay market, ordinary commercial firms are chary of dealing in them, and in consequence much valuable business is lost to this side of India.

Linseed cake being so greatly in demand in the United Kingdom and other European countries for feeding purposes, no difficulty need be anticipated in disposing of the cakes even if the whole of the seeds now exported should eventually be crushed in Bombay. Any advantage obtainable from the establishment of the crushing industry in this Presidency will be industrial rather than agricultural, and its success as an industry will depend entirely on the ability of Indian concerns to do the work cheaper or better than it can be done in Europe. Crushing costs per ton of seed in Europe are remarkably low. Previous to the war, in the large oil mills of England, which cost less than £1 per ton of annual crushing capacity to build and equip, linseed was crushed and the resulting oil filtered and packed, all at a cost of less than £1 per ton of seed, and English crushers were then quite satisfied with a profit of five shillings per ton of seed. Possibly the cost has now more than doubled. The present cost of crushing linseed in India varies from Rs. 15 per ton in rotary ghanis to Rs. 25 or over in factories equipped with Anglo-American machinery. In heavily protected countries like France, Germany and Italy, which, previous to the war, imported considerable quantities of linseed, the products of Indian mills would have to face further handicaps in the form of protective duties equivalent to an additional crushing expense of £1 per ton of seed. All foreign manufacturers, moreover, have this great advantage over the oil producer in India, that the overseas freight for seed, which is easily packed and transportable, is lower than that for oil and oil cakes. It may seem, at first sight, that the disadvantage in freight rates and the foreign protective duties on oils, might be counterbalanced by the imposition of export duties on raw Indian linseed, but the fact that India, though a large exporter, has not a monopoly of linseed production, renders an export duty ineffective for this special purpose.

*Cotton seed (Botanical name Gossypium Herbaceum).*

Much has been written regarding the desirability and possibility of establishing a cotton seed crushing industry in India, and much more has been written with the object of explaining away

the want of success which has so far attended the various attempts to establish it, particularly in Bombay. The success of the American industry has been contrasted with the failure of the Indian, and its failure has been variously attributed to inferior organization, faulty selection of machinery, bad business or technical management, and last but not least, the failure of the Indian cultivator to know what is good for him and for his cattle. One of the most noticeable facts in connection with the recent history of the Indian cotton seed trade is the increasing popularity of cotton seed as a food-stuff for cattle, particularly for milch cattle. Trade returns show that during the five years preceding the war, the total exports of cotton seeds from Bombay exceeded one million tons, practically all of which went to England; while during the five years ending 1918-19 the total export did not exceed 300,000 tons. There was no falling off in production, and in spite of the fact that the export of approximately 700,000 tons of seeds had been lost during the period of the war, stocks in India at the time of the armistice were lower than at the same date in 1913, and the market rate of the seed was between 60 per cent. and 70 per cent. higher than the pre-war average. During the five years in question, practically the whole production of Indian cotton seed had been utilized in India, partly as seed but chiefly for cattle-feeding.

The editor of an influential English trade paper commented on the trade returns for June 1919 as follows :—

“ One slightly reassuring feature appears in the June returns and that is the arrival of 3,218 tons of cotton seed from India. This is the first arrival of Indian cotton seed which has occurred since 1917, during which year we received 8,436 tons from that country. Does it mean that at last the trade is to be allowed to make some use of the large quantities of cotton seed produced by our great dependency ? ”

These remarks were apparently made under the impression that the English oil industry was being prevented from obtaining available supplies, and that, as the same writer stated a month previously, the stocks of cotton seed were *piling up* in India. The fact of the matter is that, in addition to being an oil-seed, cotton seed is a very useful cattle food which will be utilised as such, unless crushers,



whether English or Indian, are prepared to pay for it at a higher rate than the Indian cultivator is prepared to pay for it as food for his cattle. The Indian cultivator is not willing to accept cotton seed cake as a substitute for the whole seed, and it has yet to be proved that he is wrong in so doing. It is just probable that the oil, which is present in Indian seed to the extent of 16 per cent. to 17 per cent. of the total weight of the seed, is not wasted but acts as a slight laxative and enables larger rations of the seed to be fed without any untoward effect, such as would result from attempts to feed similarly large rations, particularly of decorticated cotton seed cake. At any rate, it is a question for the Agricultural Department to investigate and to prove, by careful and extended feeding trials, the correctness or otherwise of this cherished belief of the Indian cultivator, whose faith in the efficacy of cotton seed is only equalled by his disbelief in the virtue of cotton seed cake. Should the result of careful investigation prove that the Indian cultivator has been misguided, figures should be published showing the parity at which it will pay the cultivator to exchange his cotton seed for cake, or to substitute the one for the other in his feeding rations. It is only fair to state that Indian cotton seed, with its scantier covering of lint, thinner and more digestible shell and better balanced food value, is a better food-stuff than American cotton seed with its firmly adhering lint, tough hull and greater oil content, and that it has much better keeping properties than cotton seed cakes, whether these are decorticated or undecorticated. Being an article capable of utilization either as a food-stuff or as an oil seed, it follows that its market rate will fluctuate in sympathy with both these markets and, while in the case of other oil seeds there is a direct relation between the cost of the raw materials and the rates realised for the oil and *vice versa*, in the case of cotton seed there is no such relation.

During the period of the war, when it was impossible either to export cotton seed cake to Europe or to dispose of it profitably in India, the cost of manufacturing one ton of oil from cotton seed was far higher than the cost of manufacturing the same weight of oil from groundnut, and to establish itself as an article of Indian commerce, cotton seed oil should sell at about the same rate as the

best quality of groundnut oil. Both oils are used for the same purposes, and neither have any specific virtues such as are possessed by the oils obtained from castor and linseed. Roughly speaking, to enable cotton seed and groundnut oils to approximate in cost, the market rate for cotton seed should not be more than two-sevenths of the market rate for the same weight of groundnuts, *i.e.*, 7 cwts. of cotton seed should not cost more than 2 cwts. of groundnuts. So long as this relation is maintained, the crushing of cotton seed will be profitable and capable of expansion. Variation will result either in abnormal profits or in abnormal losses to those engaged in the business. It will be apparent, therefore, that as far as India is concerned the business is likely to prove highly speculative, and to require the provision of larger capital than would be required for engaging to the same extent in the business of crushing other varieties of oil seeds. A more highly qualified, and, therefore, more expensive technical staff is required for the successful working of a cotton seed oil mill than is necessary in the case of a mill equipped for crushing other kinds of oil seeds.

Owing to the difficulty which is experienced in disposing of cotton seed cake in India, and the fact that cotton seed hulls, which comprise 50 per cent. of the weight of the undecorticated cakes are readily saleable locally, it will be advisable at the outset to equip Indian cotton seed oil mills with decorticating, pressing and even refining machinery such as is in use in the United States, rather than with the type common in England. Such mills, however, on account of their very limited press room equipment are not suitable for economically crushing other oil seeds such as linseed and groundnut.

In England most of the cotton seed is crushed without decortication or removal of the hulls, and the machinery required for this method of treatment is equally suitable for crushing linseed. Later on, when the Indian demand for cotton seed cake is sufficiently large to obviate the necessity for export, it may pay better to instal machinery capable either of making undecorticated cotton seed cakes or of crushing linseed. It will be seen from the foregoing that, for the present at least, cotton seed crushing in India is

*not likely to prove a success as a small scale industry*, and, as the bulk of the cake will for some time require to be exported, mills should be built as near as possible to a port. As the local demand for the products improves, the establishment of mills in the interior may become advisable and further advantages may result from the introduction of the American system whereby the mills produce only crude oil which is shipped in tank cars to a central refinery, suitably equipped for the proper treatment of the oil and the recovery of all the by-products. It is doubtful, however, whether the American system whereby the crushing mills are independent concerns, selling their crude oil to the refining companies, would be practicable in India.

As, for the present at any rate, the cake produced would have to be exported, and the oil to be sold in competition with oils like groundnut either in Europe or India, it follows that success in this industry will depend to a large extent on the ability of the Indian crushers to crush the seed economically; to obtain the best results as regards oil yields, utilization of by-products, etc.; and to manufacture products equal, if not superior, to those prepared in Europe and America.

NOTE.—A comparison of the relative market rates for cottonseed and groundnuts shows that, at the time of writing, cottonseed crushing is or should be a highly profitable business.

#### *Rapeseed (Botanical name Brassica Campestris).*

Comparatively little rapeseed is either grown or crushed in Bombay Presidency. Most of the exports, therefore, which before the war averaged over 200,000 tons a year, were brought by rail from the Punjab and the United Provinces to Karachi and Bombay for export to Europe. In 1913-14 the countries to which exports were made were, in order of their importance, Belgium, Germany, France, Great Britain, Italy, Austria-Hungary and Holland. Rapeseed is grown and extensively crushed in most European countries where the oil is used for edible purposes, for tempering steel, for the preparation of compound lubricants, and for lighting purposes. The total quantity crushed in Europe is, however, considerably less than that crushed in India. In India approximately one million tons of rapeseed are crushed annually, chiefly in Bengal and the United Provinces.

The total import into Bombay of rapeseed oil being barely 100 tons per annum, there is little prospect of a local expansion of the industry unless new uses can be found for the products, or an export market can be developed. In other parts of India, rapeseed oil is used for edible and toilet purposes. In this Presidency, however, its place for edible purposes is taken by sweet oils such as sesame, groundnut, kardi, etc., and the use of oil for toilet purposes is not general. Even if deodorized, it is doubtful if rape oil would find favour, or partially displace any of the oils just mentioned. The only probable opening for the extended use of rape oil in this Presidency would be in the manufacture of compound lubricants, and it is doubtful whether the quantity which could be utilized in this way is at all considerable.

Rapeseed is the one oil seed of which India has practically a monopoly and the questions arise whether, under a protective or preferential fiscal system, the imposition of an export duty on the seed would not stimulate an export trade in oil in replacement of the export trade in seed, and whether the Bombay Presidency should not be able to share in the consequent expansion of the rape oil industry. The main question involves a careful study of foreign markets and other conditions some of which are outside the scope of this report. An export tax alone would not create a local rape oil industry which, even under a protective scheme, would require very careful organisation.

For the establishment of the industry locally the installation of additional machinery would be necessary. For a small scale installation it is probable that rotary ghanis or expellers would prove most economical. For large concerns the cage type of press, specially adapted for pressing small seeds, would be more suitable, especially for the production of cold drawn oils. Such oil would be eminently suitable for the preparation of deodorized rape oil, now largely used in Europe for edible purposes. They would also, when required, be suitable for crushing other oil seeds. Anglo-American presses might be used for the second pressure. The advantages of a benzine or other solvent extraction process for removing the oil left by the first or cold pressure are worth investigation, but as there is little

data available regarding the working of solvent extraction plants in hot countries like India, the installation of such a plant, without further trial, cannot be definitely recommended. Whether the crude oil is obtained by cold or hot pressure, in hydraulic presses, by rotary ghanis or by extraction, it is necessary that it should be carefully freed from impurities and refined to the standard required in Europe. For edible purposes, refining with solutions of caustic or carbonate of soda and salt, followed by washing, drying and treatment in deodorizers would be necessary. For other technical purposes, purification might be effected by the sulphuric acid process which, however, would not be admissible if the oil were required for the manufacture of lubricants. The industry of oil refining might well be carried on in places like Bombay and Karachi, even if the oil were manufactured in the seed producing districts.

For the shipment of the oil to European markets strong steel containers would be necessary, and although these would entail extra expense they would probably pay in the long run. Very careful standardization of oil for export is essential and if the industry is unable to establish its own system of standardization, it should be considered whether Government can arrange for the grading and certification of all rape oils offered for export. The necessity for such standardization is shown by the fact that large American oil concerns, who use rape oil for preparing compound lubricants and import their requirements from Europe, are at present unable to make use of the inferior oils now manufactured in India. The cost of crushing in this country is quite as high as it is in Europe and the cost of shipping oils, including the cost of containers, is higher than the cost of shipping seeds. In most European countries, except England, the oil produced in India would also be handicapped by having to pay import duties varying from £0-2-3 in the case of Norway to about £0-6-0 in the case of France and Germany. The cake also is one for which there is not much demand except from Germany, and the excess resulting from any expansion of the industry, would have to be sold very cheaply in order to find a ready local market.

*Sesamum or Tilseed (Botanical name Sesamum Indicum).*

In normal years nearly 75 per cent. of India's total production of this seed is utilized in this country for the manufacture of sweet or edible oil, and only about 25 per cent. of the crop is exported. In the Bombay Presidency, approximately 50 per cent. is utilized, and the remainder, *viz.*, about 20,000 tons, is exported from Bombay, along with about 80,000 tons received by rail from Rajputana, Central India, United Provinces, Central Provinces and Hyderabad. The exports in pre-war years went chiefly to Belgium, France, Germany, Austria, and Italy, *i.e.*, those European countries, the laws of which demand that, for identification purposes, margarine should contain a certain fixed proportion of sesamum oil.

In the Bombay Presidency the seed is crushed chiefly in country ghanis, and the oil obtained is consumed locally with the exception of about 500-600 tons which are annually exported from Bombay to oriental markets, *e.g.*, Persian Gulf, Aden, Ceylon, Natal, Mauritius. Owing to its firm hold on popular favour, sesame oil is in great demand and fetches a higher price than any other sweet oil. Groundnut, kardi and cottonseed oils are, however, replacing sesame to a certain extent, and the former at least is considerably cheaper. In view of the fact that, for the purposes for which it is used in India, groundnut and cotton seed oils serve equally well, it is doubtful whether it is worthwhile trying to increase the local demand for the oil. Nor would it be advisable to attempt to extend the crushing industry in this country by imposing export duties on the seed. India has no actual or virtual monopoly of the seed supply, and such a course would merely result in lowering the returns of the ryot by the amount which the European importers have to pay in export duties. Most of the European countries which import sesamum are protectionist countries. While admitting the seed free, they impose duties of approximately £0-5-0 per cwt. on the imports of oil. In the face of such a handicap, combined with the higher cost of transporting the oil compared with that of transporting seed, the establishment of a successful crushing industry in Bombay and an export trade in oil will not be a very easy matter.

On the other hand, there is no reason why a well equipped Indian industry should not be able to obtain a market for sesame oil in some of the countries, which do not penalise the import of oil. Belgium, which in 1913-14 took nearly one-third of the sesamum exported from India, Holland, which imports considerable quantities, and the United Kingdom, which took over 20,000 tons in 1916-17, all admit oil free or practically free of duty.

The Indian method of production, *viz.*, expression in country or rotary ghanis, yields to none either in point of quality or of cost, and it is doubtful whether it will pay to instal expensive hydraulic machinery for pressing this seed. Except in the case of cold drawn oil obtained by first pressing either in cage or Marseilles presses, the oil produced in hydraulic presses is darker, more bitter and otherwise inferior to the oil produced in ghanis. It is after and not during expression that the bulk of the Indian oil is spoiled. Failure to effect a prompt separation of the oil and mucilage results in excessive development of acidity, and the absence of facilities for drying and filtering the oil are responsible for the cloudy and dirty appearance of much that is offered in the bazaar. Provision of these facilities for treating the oil obtained by pressing in ghanis, and careful attention to the question of both seed and oil storage, would result in a decided improvement in the quality of all oils produced in India. If sesame oil, treated as above, could be collected at central refineries, and treated for the purpose of reducing excess acidity, it is probable that an export trade in sesame oil might be established without the necessity of erecting any extra crushing mills.

On the other hand, if there is any doubt about the possibility of obtaining supplies of oil of absolute purity, it would become necessary for firms seeking to establish an export trade to arrange for their own pressing facilities. On a small scale rotary ghanis would probably provide the best oil and at the lowest rate per ton of seed, but on the large scale preliminary cold pressing in cold presses, and second pressing in rotary ghanis would be more suitable. Refining equipment for reducing the acidity, for washing, drying, filtering and deodorizing would be essential, and all the oils should be carefully tested and standardized before export.

Owing to the fact that sesame oil is by law required to be used in all margarine made in most of those countries which are at present importing sesamum, and that in the highest grades of margarine the use of liquid oil such as sesame oil is not desirable, it is probable that margarine makers would favour the introduction of hydrogenated sesame oil, which would enable them to use larger quantities of this excellent oil without injuriously affecting the melting points of their products. Hydrogenation does not interfere with the reaction by means of which sesame can be detected in mixtures of other oils and fats. This appears to be one of the instances in which hydrogenation might be profitably employed in connection with the Indian oil industry and, if all the sesame oil exported were sufficiently hydrogenated to give a product solid at ordinary temperatures, one of the chief difficulties of transport would be successfully overcome.

*Castor seed (Botanical name Ricinus Communis).*

Practically the whole of the castor seed produced in the Bombay Presidency is now crushed locally. The castor seed exported from Bombay is chiefly Hyderabad seed which has been brought in by rail. A considerable quantity of castor seed is crushed throughout the Presidency in country ghanis, but Ahmedabad is by far the most important pressing centre as far as castor oil is concerned, just as Guzarat is the most important castor seed growing division. Most of the mills in Ahmedabad are equipped with complete hydraulic plants chiefly of the Anglo-American type, although one or two have also cage presses of the Premier type. Hot drawn oil is produced and double pressing is the rule. A good yield of the oil is obtained although it is doubtful whether the slightly increased yield obtained by this method compared with that obtained by using rotary ghanis compensates for the increased crushing cost. Rotary ghanis give only slightly inferior results as regards oil yields and, as far as ordinary hot drawn oil is concerned, equally good results as regards quality. They are low in first cost, and when driven by crude oil engines can be operated at a cost between Rs. 15 and Rs. 16 per ton of seeds. Owing to their low output, the cost of



crushing castor seed in country ghanis is probably much higher and there are no compensations either in the way of increased yield or superior quality.

Expellers are unsuitable for the expression of oil from castor seed. The hard shells of the seed quickly wear away the central worm and other parts of the machine, and the cost of renewals is excessive.

For the production of large quantities of cold drawn oil, suitable for pharmaceutical purposes or for aeroplane engine lubrication, cage presses are essential. The resulting cakes can afterwards be broken up, tempered and repressed or extracted with solvents. The latter method has not yet been tried on a commercial scale in India, but it is used in England and other continental countries. Provided the technical difficulties due to climatic condition can be overcome, there seems to be no reason why the method should not prove satisfactory in India. An interesting point in connection with this process is the fact that the extracted powder is said to have lost its poisonous properties, and to be capable of being used as a cattle food.

Only about 25 per cent. of the oil produced in the Bombay Presidency is of really good quality. The remainder is usually excessively acid and is imperfectly purified before leaving the mills. As the quality of the oils obtained after the monsoon is usually inferior to that obtained between harvest time and the beginning of the monsoon, it is feared that the use of badly stored seed is in part at least the cause of the increased acidity. Other causes are want of cleanliness in and around the mills leading to contamination of the oil, and want of facilities for effecting the separation of the oil and the mucilage. Much might be done to improve the quality of the castor oil by improving the clarifying equipment of existing mills.

Failing an increased castor seed crop within the province, which is unlikely, expansion of the industry would necessitate the importation of raw material from outside. At present Hyderabad (Deccan) supplies the bulk of the castor seed which passes through Bombay to Europe, and instead of establishing new mills in Bombay, it might be more economical to establish oil mills for crushing castor

seed in Hyderabad State itself, and to rail the partly clarified oil to Bombay for further treatment prior to its export to Europe. The cake produced ought to find a market in the state itself, or in other parts of the Deccan. There is little or no demand for the cake in Bombay, and if mills were erected in Bombay the resulting cake would probably have to be railed back again to the Deccan. The preparation however of better qualities of cold pressed oil, such as are required for pharmaceutical purposes, for lubricating aeroplane engines or for making compound lubricants requires greater care in manufacture, more elaborate plant and more efficient supervision than would be obtainable in the Deccan rural districts. Mills for the preparation of such oils as well as refineries for treating the partly clarified oils prepared elsewhere might be erected in Bombay.

An export trade in high grade castor oil could also be more conveniently established by Bombay firms. Uniformity of quality, and an efficient system of grading are necessary if an export trade in castor oil is to be established and maintained.

Before the war the exports of castor seeds were chiefly to the United Kingdom which took about half the total quantity exported, to the United States, which took nearly one quarter, and to France, Belgium, Italy and Germany. During the war exports to the last three countries fell off considerably or stopped altogether. Since the conclusion of peace, exports to the United Kingdom also have greatly diminished but as soon as the Home Government's surplus stock of castor oil has been worked off, there should again be a good demand from that country, either for seed or for oil, and an excellent opportunity for establishing an export trade in oil instead of in seeds will present itself.

#### *Groundnuts (Botanical name Arachis Hypogaea).*

Compared with Madras which accounts for 75 per cent. of the Indian groundnut crop, Bombay's production of this oilseed is relatively unimportant. Still it amounts to between 50,000 and 100,000 tons per annum, about 20,000 tons of which are utilized for edible purposes within the province, or are exported to northern India for the same purpose. The balance, of approximately 50,000

tons, per annum is available for crushing or for export. In normal years about 20,000 to 30,000 tons are crushed within the Presidency limits, and the balance together with about 20,000 tons imported from other provinces is exported to Europe.

Before the war the exports went chiefly to France, Belgium, Germany and Austria. Recently the exports to the United Kingdom have increased very considerably, while exports to other countries have fallen off.

Groundnuts are crushed locally by means of hydraulic presses, expellers, rotary ghanis and country ghanis. Owing to the absence of hydraulic plants suitable for preparing cold drawn oil, the best quality of oil is not prepared in such mills. The cost of crushing groundnuts in hydraulic mills is not less, and probably more, than Rs. 25 per ton, and with double pressing the average yield from the shelled nuts is nearly 40 per cent. Expellers alone, or in combination with rotary ghanis, produce a good quality of oil, but are too expensive both in first cost and maintenance. Double pressing is necessary to obtain a normal oil yield. Ghanis, rotary and country, though slightly less efficient as regards oil yield, are cheapest in first cost, are capable of producing the best oil with the least amount of skilled attention and, particularly in the case of rotary ghanis, are by far the cheapest to maintain and run. They however leave more oil in the cake than is economically advisable. Failure to clarify properly oils obtained by the last two methods is probably responsible for the inferior quality of much of the groundnut oil obtainable in the bazaars. This is to be regretted as the clarification of groundnut oil is easily effected, and the plant required is neither complicated nor expensive.

In addition to the oil produced within Presidency limits, about 4,000 tons of this oil are yearly imported from other provinces. Very little groundnut oil is exported from Bombay. Although Bombay's production and export of groundnuts is small compared with that of Madras, the groundnut crushing industry is capable of considerable expansion. To supply the oil imported from other provinces would utilise 10,000 tons of the quantity available for export,

and would occupy 150 rotary ghanis throughout the year. The demand for groundnut oil from other oriental countries is increasing and probably offers a better chance of expansion than trade with Europe. Trade with Europe depends on the ability of the Indian industry to produce economically oils of equal or even better quality than those presently prepared from Indian nuts in Europe. The development of an export trade in groundnut oil to protectionist countries will be almost impossible. In the case of free trading countries like England, however, the prospects are better. During recent years the United Kingdom has been importing about 130,000 to 140,000 tons of groundnuts annually of which less than one fifth was imported from India. There is also a fairly considerable import into England of groundnut oil chiefly from France, China, Burmah, etc. One or two mills equipped for pressing 20,000 tons of groundnuts per annum ought to find no difficulty either in obtaining supplies of nuts or in disposing of the products, which, it is probable, would for a time have to be exported to England. Profitable working, as in the case of crushing linseed, would depend on the care exercised in maintaining the quality of the products, on a satisfactory oil yield, and on the exercise of the strictest economy in regard to working expenses.

#### MINOR OIL SEEDS.

##### *Poppy seed* (*Papaver Somniferum*).

In normal years considerable quantities of poppy seed are imported into Bombay from the United Provinces and Rajputana and are thence exported chiefly to France for the manufacture of high class salad oils, etc. In 1913-14 about 17,000 tons were so exported, while during 1920-21 the export was only 4,000 tons. It is doubtful whether any considerable success is likely to result from attempts to utilise the seed in this country. France is the chief consuming country, and oils produced in India and exported thereto would have to pay an import duty of about £0-6-0 per cwt. which is equivalent to an additional expenditure of Rs. 15 on every ton of seed crushed in this country.

*Niger seed (Guizotia Abyssinica).*

Prior to 1914-15 there was an annual export of this seed of about 4,000/5,000 tons chiefly to France and the United Kingdom. Recently the exports have dwindled considerably, and during the past year they did not exceed 400 tons. It is evident therefore that this seed, the total outturn of which may exceed 20,000 tons per annum, is already being utilized within the province. Most of the seed is produced in the Deccan, and is crushed in country ghanis, the oil being utilized for edible purposes. The only improved variation from present practice that can be suggested, is that rotary ghanis driven by oil engines should be substituted for the country ghanis driven by bullocks. This would effect a considerable economy in crushing costs, and set free both men and bullocks, the labour of which is badly required in other industries.

*Safflower (Carthamus Indicus).*

About 15,000 to 20,000 tons of this oil seed are produced annually, chiefly in the Deccan districts. As there are no records of any exports it would appear that the whole of the crop is at present utilized within the province, and the remarks made regarding the limited scope for introducing improvements in manufacture in regard to niger seed, apply equally in regard to this oil seed.

*Cocoanut or Copra (Cocos Nucifera).*

Although the cocoanut palm is fairly extensively grown along the western coast of the Presidency, very few of the nuts are used for the preparation of cocoanut oil. About 5,000 tons of this oil are produced annually within the province from copra imported chiefly from the Malabar coast and Ceylon. The oil produced is consumed locally with about 4,000 tons of oil imported chiefly from Cochin. Apart, therefore, from the inferiority of the available supplies of copra as compared with the quality of the copra which in Cochin is used for preparing the well known Cochin cocoanut oil, there would appear to be little reason why the whole of the cocoanut oil required in the Presidency should not be prepared in the Province. In view of the recent development in the method of

refining cocoanut oil it ought to be possible to produce, even from available supplies of copra, oils equal in quality to those imported from Cochin. The copra crushed in Bombay is treated chiefly in rotary ghanis, and by this method of manufacture the oil left behind in the cake is greater than appears to be necessary, so much so, that the cake offered for sale by some crushers contains nearly as much oil as Indian cotton seed, and might probably pay for further treatment in hydraulic presses or for extraction by means of solvents. The oils obtained would, however, only be useful for soapmaking.

#### FOREST PRODUCTS.

##### *Mowrah seed (Bassia Latifolia).*

In the year 1913-14 nearly 30,000 tons of this seed were exported from Bombay chiefly to Germany and Belgium. Last year the exports totalled only about 1,000 tons. The actual crop varies somewhat from year to year but not to this extent. It is evident, therefore, that like most other forest products mowrah seeds are collected only when there is a demand for them. The season also for collection is very short, viz., from the middle of May till the break of the monsoon, and unless previous arrangements are made a large proportion of the crop becomes spoiled and is lost to commerce. Of the portion which is actually collected a considerable proportion produces rancid oil, owing to having been stored through the monsoon without having been properly dried previously. There is considerable room, therefore, for improvement of the arrangements for the collection and disposal of this valuable forest product. In view of the known shortage of higher melting point oils suitable for the manufacture of soap and candles, and the high prices which are being paid for such oils in Europe, if the difficulties regarding collection, treatment and storage of the seed could be overcome, it should be possible to establish a profitable export business in mowrah oil to other than protectionist countries.

At present a small quantity of this seed is crushed for local use in hydraulic presses, rotary and country ghanis. By the use of hydraulic presses about 33 per cent. of oil is obtained. In view of the valueless nature of the mowrah cake this result cannot be

considered to be entirely satisfactory. It is possible that better results might be obtained by extracting the ground seeds with benzine or other solvent and utilizing the extracted meal for fuel purposes. Any extraction or other plant, the produce of which it is intended to export, should be erected as conveniently as possible to the port from which the product is likely to be shipped.

Other forest products, not at present utilized to any extent, but which are worth attention are :—

- (1) The seed of *Vateria Indica* (yielding Malabar tallow).
- (2) *Garcinia Indica* (yielding kokam butter).
- (3) *Calophyllum Inophyllum* (yielding domba oil).
- (4) *Mauritia Vinefera* (yielding Maruti fat).
- (5) *Melia Azirdarakhta* (yielding nim oil).
- (6) *Pongamia Glabra* (yielding karanj oil).
- (7) *Salvadora Olerides* (yielding kakan fat).

## CHAPTER IV.

DESCRIPTION AND COMPARISON OF VARIOUS TYPES OF OIL  
MILL MACHINERY AND EQUIPMENT.

The means employed in the production of vegetable oil are chiefly mechanical. Chemical methods, such as extraction with solvents, are also being used to some extent, but the weight of material so treated at present is small compared with the weight treated by mechanical methods. Of mechanical methods, expression in hydraulic presses is by far the most important, particularly in the West. In oriental countries, however, a considerable quantity of oil is still produced by mechanical means in other than hydraulic equipments. Many of these mechanical devices are crude and wasteful, while others are surprisingly effective. Even in the West, the supremacy of the hydraulic press has from time to time been challenged by the introduction of oil milling machinery employing mechanical methods of pressure transmission and application. Machines of this type, e.g., the expellers, though often offering considerable advantages, such as continuous operation and reduced working expenses, have, however, never been able to stand up, for a prolonged period, to the excessively hard work involved in oil milling. The chemical or solvent system of oil extraction, which offers several distinct and substantial advantages over mechanical systems, is likely to become, and remain a much more formidable rival.

*Hydraulic Systems.*

Machinery utilising hydraulic methods of pressure application may be roughly subdivided as under :—

(1) American types such as are used for the treatment of cotton seed.

(2) Anglo-American types such as are used in England and on the continent of Europe.

(3) American types such as are used for the treatment of linseed and other small seeds.

(4) Cage or clodding types, used chiefly on the continent of Europe.



*American Cotton-seed Oil Mill Machinery.*

It is probable that this type of American machinery heads the list of hydraulic equipments, as regards numbers of press units, if not of actual outturn. Over two and a half million tons of cotton seed kernels, equivalent to nearly five million tons of cotton seed are treated annually in such presses and, as crushing operations in America only last about five or six months in a year, the total annual capacity of this type of machinery must be not less than five million tons.

The preparatory machinery employed is adapted for removing dirt, foreign substances, and excess lint; for bringing about an effective separation of the kernels and husks; for rolling the former to break down the oil cells; for bringing the oil bearing material to the correct condition as regards heat and moisture and for effecting its transfer to the presses. Except that more ample cooking capacity is provided, the machinery up to this stage is similar in principle, if not in detail, to all preparatory oil mill machinery. The presses however are peculiar. They are fitted with plates, which resemble boxes, the two ends of which have been removed. The spreading of the cooked kernels is prevented by the resistance of the sides, and spreading from the ends is prevented by the fold of the press cloth. For dealing with decorticated cotton seed, such types of presses are very satisfactory, but, should it be found necessary to change over and work other types of oil seeds their disadvantages soon become apparent. Owing to the great thickness (about 2 inches) of each of the built up box plates, a press of this type will only deal with about three-fifths of the quantity of oil bearing material per operation which could be dealt with by a flat plate press of similar size. This means that a plant listed to treat say 40 tons of cotton seed per day, only 20 tons of which are actually dealt with in the presses, would treat about 20 tons of other oil bearing materials, such as linseed, as compared with not less than 30 tons which could be treated under the same conditions in an Anglo-American mill of similar size. This loss in production raises the operating costs and may in some cases, renders the whole operation unprofitable. This fact must be taken

into consideration when comparing the costs of different types of machinery. Each full size American press holds about  $1\frac{3}{4}$  cwts. of cooked cotton seed kernels which in turn represents nearly 3 cwts. of Indian cotton seed. Three pressings per hour is as much as can be satisfactorily accomplished, so that each press represents a productive capacity of 9 cwts. of cotton seed per hour or about 10 tons per day. Its capacity for dealing with linseed or other material requiring to be once pressed would only be about 5 cwts per hour or  $5\frac{1}{2}$  tons per press per day of 22 hours. Excluding expenditure on erection, housing and power plant, the cost of machinery for a mill of this type, at present rates of exchange, would be approximately Rs. 50,000 per 10 tons daily capacity when treating cotton seed or per  $5\frac{1}{2}$  tons capacity when treating linseed, that is, about Rs. 1,10,000 per ton hour capacity for pressing cotton seed and Rs. 2,00,000 per ton hour, for single pressing linseed or other small seeds.

Equipments of this type are working satisfactorily in this Presidency. The average percentage of oil left in Indian decorticated cotton seed cakes, after expression in such presses, is between 9 and 10. There are, however, American records of cakes from similar presses showing less than 6 per cent. of oil, but such results are the exception rather than the rule. The working expenses of crushing cotton seed in a mill of this type should not exceed Rs. 20 per ton. For crushing other oilseeds such as linseed, the cost per ton is about 50 per cent. higher. Such mills, without the addition of extra machinery, are quite unsuitable for the treatment of seeds or nuts like castor, groundnuts, etc., which, for best results, require to be pressed, first cold and afterwards hot.

#### *Anglo-American Oil Mill Machinery.*

As far as actual outturn is concerned, this type of machinery is probably ahead of the American type. Most of the English oil mills are equipped with such machinery, as also are a considerable number of oil mills on the continent of Europe and elsewhere. The name Anglo-American is however somewhat of a misnomer, the only part of the equipment which resembles closely its American counterpart being the rolls. The plant usually consists of cleaning

and preparatory machinery suited to the material which is to be treated; a stack of heavy chilled rolls; cooking kettles; steam or hydraulic cake forming machinery; hydraulic presses of the corrugated plate type; belt driven hydraulic pumps connected to accumulators which in turn operate the presses; cake paring machines and edge runners for grinding up the parings and press sludge, for finely grinding material such as undecorticated cotton seed or for re-grinding once pressed material to prepare it for repressing.

These edge runners have long been the most distinctive part of the Anglo-American equipment and they are perhaps the most useful machines which can be installed in any oil mill. It would appear however that there has lately been a tendency on the part of manufacturers of oil mill machinery to discard these most useful machines and to substitute for them cake breaking and disintegrating machines.

Anglo-American machinery will treat in a fairly satisfactory manner almost every known oil bearing material from comparatively dry seeds like cotton seed or soya beans to very oily materials such as castor-seed and groundnuts. It is suitable for single pressing materials such as undecorticated cotton-seed or linseed, or for the double pressing of groundnuts, castor-seed, etc. It will be apparent, therefore, that this type of plant is particularly suitable for use in countries which have to import their raw materials and for manufacturers who have a choice of many different kinds of oil-seeds, all of which they wish to treat in the same plant. Anglo-American plants are built in various sizes. The smallest will crush about 10 tons of seed per day, while mills of this type to crush over 1,000 tons of seed per day have been erected.

Except in the case of undecorticated cotton-seed cakes the oil content of which is usually under 5 per cent. or of the cake from double pressed materials such as castor-seed, groundnuts, etc., cakes from Anglo-American plants usually contain between 9 per cent. and 10 per cent. of oil. This is due to the fact that only limited pressure, *e. g.*, 18 cwts. to 20 cwts. per square inch can be applied to materials

which are not properly confined. The actual ram pressures employed in equipments of this type vary, however, from 35 to 40 cwts. per square inch, but as the area of the plates is twice the area of the ram, the actual pressures per square inch on the cakes are as stated above. In certain cases where trade customs demand a minimum oil content in the cake as, for example, in the case of linseed, Anglo-American machinery will be found quite suitable, while on the other hand, if oil yield is the only consideration, better results can be obtained by using specialised machinery of the cage type. Anglo-American plants are, however, unsuitable for the manufacture of cold drawn oil the demand for which for edible purposes is increasing. Certain oil-seeds such as tilseed cannot be satisfactorily treated in Anglo-American plants owing to the fact that the steam employed therein liberates colouring matter from the seed and the resulting oil is dark and inferior. Exclusive of housing, erection charges and expenditure on power plant, an Anglo-American plant of four presses with preparatory and finishing machinery will at present rates of exchange cost from Rs. 60,000 to Rs. 80,000. Such a plant being capable of treating per day of 24 hours about 22 tons of material requiring only once pressing, or about 12 tons of material requiring to be pressed twice, the cost per ton hour capacity will be about Rs. 75,000 for single pressing and Rs. 1,40,000 for double pressing.

In England, prior to the war the cost of treating linseed in mills of this type did not exceed £1 per ton of seed. Owing however to the rise in wages, increases in the price of coal, press cloths and other stores, it is probable that the present crushing cost is not far short of £2 per ton of seed. In India, on account of the small size of plants hitherto employed, neglect of the machinery and the consequent increase in the expenditure on press-cloth, the cost of once pressing seeds like linseed in mills of this type is not less than Rs. 25 per ton, while for double pressing seeds like castor, the cost per ton is not less and probably more than Rs. 30. In purchasing presses of the Anglo-American type, preference should be given to those, the plates of which are supported by means of lugs or screws resting on fixed side racks, rather than to those, the plates of which are supported from the press heads and each other by means of links. Equipments

provided with edge runners and double or continuous rather than single heating kettles are also preferable. Generally, single kettles only are provided, but with these the best results cannot always be obtained.

#### *American Linseed Oil Mill Machinery.*

This type of machinery is largely used in America for crushing linseed and other small seeds. It differs materially from the Anglo-American type only in the fact that edge running grinders are not provided. It is therefore unsuitable for the treatment of an oil bearing material which requires to be double pressed, or for the manufacture of cold pressed oil. The capital cost of an equipment of this type suitable for the treatment of less oily seeds such as linseed, will be practically the same as that of a cotton-seed oil mill containing the same number of standard sized presses. The capital cost per ton hour of crushing capacity will therefore be about Rs. 1,20,000. The cost of working will be similar to that of an Anglo-American oil mill. One advantage, however, possessed by this type of plant is in regard to the provision of sufficient cooking kettles for bringing the ground material into the best possible condition as regards temperature and moisture. American cooking kettles, particularly those operating on a continuous basis, are on the whole superior to the kettles usually provided by English makers. The lower percentage of oil left in American linseed cake as compared with that left in linseed cakes prepared in England, is probably the result not only of longer pressing, and higher pressures employed but also of better cooking, which in turn is due to the more generous cooking capacity provided by American plants. As, however, the English market demand is for a linseed cake containing nearly 10 per cent. of oil, no material advantage is to be gained by reducing the oil content far below that figure.

#### *American Oil Mill Machinery, General.*

Intending purchasers of American machinery should take the greatest care to ensure that the individual machines are sufficiently strong to stand up for a prolonged period to the continuously hard work and rough usage which they are likely to meet with

in this country. The American idea, that it pays to scrap even good machinery and buy improved models every five years, is probably responsible for the tendency of all but the very best American manufacturers to build machinery, the vital parts of which are far too light. In America, also, the majority of oil mills work only about five months of each year. There is therefore ample time for repair work, realignment of bearings and other adjustments. For India, however, machinery must be capable of working continuously and satisfactorily all through the year. Preference should also be given to those equipments which are provided with belt driven pumps and accumulators, rather than to those provided with direct steam driven hydraulic pumps, such as are generally supplied with small or medium sized mills.

#### *Cage or Clodding Types of Press Equipments.*

In all equipments of this type the material under pressure is effectively confined in cages or baskets either of perforated sheet iron or of iron bars correctly spaced and reinforced by circular hoops. Increased pressures up to about 3 tons per square inch can be utilised and heavy expenditure on press cloth is avoided. The cake residue is retained in the cage and the expressed oil is allowed to flow freely away. Very oily material can be treated either cold or hot in equipments of this type. If superior cold drawn oil is required, the material can first be treated cold and the residue, after regrinding, can be retreated hot. In this way the maximum quantity of best quality oil as well as the maximum yield from any material can be obtained. Preparatory machines of the usual type are provided as well as special machinery for pulverising the cake residue and preparing it for retreatment. Any kind of oil bearing material can be treated but, for the most satisfactory results, manufacturers should be told what oil-seeds are to be treated. They will then be able to arrange for the most satisfactory spacing of the bars of the cage, or size of outlets in the case of cages with perforated sheet metal sides. This type of equipment is not very largely used or manufactured in America where the bulk of the oil-seeds treated are of the less oily varieties. It is, however, largely used and manufactured on the

continent of Europe and to an increasing extent in the United Kingdom. Cage presses, manufactured by the leading English oil mill engineers are equal if not superior to any manufactured elsewhere, and there appears to be little to choose between the equipments manufactured by the different English firms whose names are shewn in Appendix No. 2.

The cage type of press equipment comprises :—

(1) Presses, the cage or barrels of which are not removeable from the press.

(2) Presses, the cages of which are made to revolve so that the material may be brought alternately over high and low pressure rams.

(3) Press equipments, the cages of which can be removed from the preparatory press on mechanical propelled trollies and placed in separate high pressure presses to complete oil drainage.

#### *Fixed Cage Presses.*

Presses of the first type, of which the Premier press manufactured by Messrs. Rose, Downs & Thomson, Ltd., and the Leeds press, manufactured by Messrs. Greenwood & Batley, Ltd., are examples, are generally placed beneath the heating or distributing kettle and the cages are never removed from over the ram. The removal of a false press head allows the material to be charged directly into the press. Iron plates are used for separating the cakes which, before pressure, are about 6 inches thick. The largest sized presses of this type have press rams 18 inches in diameter and are 9 feet deep. As each charge weighs about 5 cwt. a press equipment comprising two full size presses will have a crushing capacity of from 20 cwts. to 25 cwts. of material per hour if only one pressing is required, and twelve to fifteen cwts. if the material has to be twice pressed. This type of press, besides being the simplest, is also the most efficient. It is well known that material from which pressure has once been released re-absorbs oil, and cannot again, even under increased pressure, be made to yield its full oil content. As the pressure on material under treatment in cage presses of this type

is never released until the material is exhausted or ready for removal, better results should be obtainable with this than with any other type. The cost of an equipment of this type comprising the usual preparatory and re-treating machinery and two cage presses capable of double pressing an average of about 12-15 cwts. of material per hour, will, at present rates of exchange, be from Rs. 80,000 to Rs. 1,00,000, *i. e.*, about Rs. 1,40,000 per ton hourly crushing capacity. On account of the saving effected by dispensing with press cloth and in labour charges, the cost of double pressing castor seed or other oily material in equipments of this type should not be greatly in excess of Rs. 20 per ton of seed.

#### *Revolving and other Cage Presses.*

Presses of the second type, of which Lambert & Butler's press manufactured by Messrs. Robert Middleton & Co., Ltd., and Craig's patent revolving copra press are examples, are manufactured by some, but not all, of the leading English makers and are working in Europe and elsewhere with apparently satisfactory results. The same may be said of the third or battery type of press of which the Albion type manufactured by Messrs. Manlove Alliot & Co. is an example. Unlike the other types of hydraulic presses previously mentioned, which have been largely standardised, cage presses of the last two types are manufactured in a variety of styles, and it is probable that the production of one manufacturer may be superior in certain respects to the product of others. For India, however, without further practical experience of their working under Indian conditions, their purchase cannot be recommended. With unskilled labour such as is obtainable in India there is a considerable risk in operating any kind of complicated machinery, but the risk is greatly increased when, as in the case of these types of presses, heavily loaded cages containing oil bearing material have to be transported from place to place before being subjected to enormous pressure in other parts of the equipment.

#### *Combinations of Cage and Anglo-American Press Equipments.*

Equipments utilising a combination of the fixed type of cage presses and Anglo-American presses are largely adopted for dealing



with very oily seeds such as castor, copra, groundnuts, etc. The material is first treated cold, or nearly cold, in the cage presses where it yields about 75 per cent. of its oil content. The half pressed cakes are then broken up in disintegrators or ground in edge runners, and the ground material is transferred to the cooking heaters of the Anglo-American plant where, after being sufficiently heated and moistened, it is submitted to a second pressure in the Anglo-American presses. Such equipments are working satisfactorily in India, chiefly on castor seed, but they are also suitable for the treatment of copra, groundnuts and indeed of any material, the cold drawn oil from which is more valuable than hot drawn oil or in cases where market requirements demand a cake with a minimum oil content of nearly 10 per cent. The cost of an equipment of this type will at present rates of exchange be about Rs. 1,50,000 and as the hourly crushing capacity of the equipment will be about 25 cwts., the capital cost per ton-hour crushing capacity will be about Rs. 1,33,000.

*Other Oil milling Equipments making use of Mechanical rather than Hydraulic Methods.*

Equipments of these types are made in great variety and include amongst others

(1) Oil Expellers of which those manufactured by Messrs. V. D. Anderson Co., Frans Smulders and others are examples.

(2) The improved iron rotary ghani, largely used in India.

(3) The indigenous type of ghani, which in India is driven by bullock, ass, or camel.

*Oil Expellers.*

The sale of this type of oil press has been pushed very energetically in this country for some years. The results, however, either from the point of view of the manufacturer or of users cannot be considered to be entirely satisfactory. When sold at a reasonable price, expellers certainly have their uses, but that they also have equal limitations does not seem to be clearly recognised by those who

recommend their use. In the machine itself, which requires to be provided with the usual preparatory machinery, direct mechanical pressure or torsion of the material against the perforated or ribbed barrel and the resistance cone in front, is substituted for hydraulic pressure. When a certain pressure, usually about 3 tons per square inch, is exceeded, the exhausted material is forced out in thin sheets from the smaller end. The machine was originally introduced for the treatment of cotton seed, linseed and rapeseed. A number of cotton seed oil mills in Texas installed expellers about 15 years ago, but after a short time discarded them. They have, however, been found quite useful even if not economical on a small scale for the preparation of cold drawn varnish-making linseed oil. Owing, however, to the danger of prussic acid generation the cake produced in this way cannot be safely fed to animals without first being boiled. With all very oily seeds, such as rapeseed, groundnuts, copra, etc., double treatment is necessary. The first pressing may be carried out with cold or nearly cold material, yielding cold drawn oil, and the partially exhausted material can afterwards be ground up, heated, moistened and repressed yielding ordinary hot drawn oil. The oil yield by this method will be about equal to that yielded by the hydraulic press system. The outturn per machine, however, will be reduced to about 3 tons of oil bearing material per day of 24 hours, as compared with 5 tons per day for single treatment. Expellers are suitable and recommended for the first cold pressure of copra, and other soft materials, or for the re-treatment of materials partially treated in rotary mills, but they are unsuitable for treating undecorticated cotton seed and castor seed, the ground material of which contains hard particles. Excessive corrosion, due to the combined effect of the abrasive nature of such material wears away the worms and other vital parts of the machine and necessitates frequent and costly renewals. The present cost of a complete Anderson expeller equipment is about Rs. 24,000 per expeller without power or housing. (The cost of Anderson's expellers alone is about Rs. 14,000). The annual bill for renewals may run from Rs. 1,000 to Rs. 3,000 according to the seed treated. The outturn per day of 24 hours will be from 5 tons for material which will require one treatment, to 3 tons for material requiring double treatment. The

capital cost per ton hourly pressing capacity for single treatment will be Rs. 1,30,000, and for double treatment it will be Rs. 1,92,000. Working cost per ton of seed will vary from Rs. 12 to Rs. 20 per ton of seed, according to whether single or double treatment is required. It will be seen, therefore, that within certain limits expellers are useful machines, but from the limited success so far attained it does not appear likely that they will ever seriously threaten the supremacy of the hydraulic press system of oil extraction, or even replace the rotary ghani in the small oil mills of India. A Dutch firm, Messrs. Frans Smulders of Utrecht, manufacture an equally good expeller equipment. This is obtainable (1920) in Bombay at a price nearly 40 per cent. lower than that quoted above.

### Improved Rotary Ghanis.

For small equipments in countries like India, no type of oil milling machinery offers so many advantages as that generally known as the "Improved Rotary Ghani". Its simplicity enables it to be manufactured very cheaply in any foundry, and in dealing with most oil seeds it is surprisingly efficient. Mounted on a substantial framework foundation in batteries of ten, and driven by a crude oil engine, an equipment of this sort is low in first cost, can be run with the minimum of supervision and, gives results which compare quite favourably with those obtained by the use of expensive hydraulic machinery. The rotary ghani resembles to some extent a chemist's pestle and mortar, is under driven, and has an outlet for oil at the bottom of the mortar. Both pestle and mortar revolve, and the former is held tightly against the inside of the mortar by means of a chain and screw tightener. As the bowl of the machine revolves, the material under treatment is pressed between it and the pestle until the oil flows freely away. After being sufficiently pressed, the exhausted material rises to the top of the bowl, and can be removed by the attendant, who adds fresh material to replace that removed. Both the bowl and the pestle are scored in various ways to increase their effectiveness. If the working of the machine be carefully observed, it will be seen that the operations performed in one simple

machine correspond to the work ordinarily carried out on the large scale in the following preparatory and other machinery :—

- (1) The disintegrators which break down the material to make it suitable for treatment in the rolls, where it is further reduced.
- (2) Cooking heaters,
- (3) Cake forming machinery,
- (4) Presses hydraulic or otherwise,
- (5) Regrinding machinery,
- (6) Re-heating machinery,
- (7) Re-pressing machinery.

The only preparatory machinery required is that dealing with the removal of foreign substances and, in the case of castor seed, for scalding the beans prior to treatment in the ghani. In small equipments, such as are commonly met with, such preparatory work is invariably done by hand. Rotary ghanis will treat satisfactorily, first cold and afterwards hot (as a result of the addition of some hot water), such oil bearing material as tilseed, rapeseed, groundnuts, copra and, in fact, most seeds which yield a liquid oil. It will also treat (after scalding with hot water) castor seed and the fat bearing nuts. A battery of 10 Ghanis will in 22 hours extract the oil from 5 tons of oil bearing material, and the actual cost of such an equipment, without power, will be about Rs. 5,000. The capital cost per ton hourly crushing capacity is therefore only Rs. 20,000. Even considering that both pestles and bowls require to be replaced every two or three years, the cost of crushing a ton of material in this type of oil mill does not exceed Rs. 16 per ton. It will therefore be seen that, compared with other types of oil mill machinery, such an equipment is very low, both in capital cost per ton hours of crushing capacity and in working expenses. Any one desiring to establish a small oil mill to treat up to 10 tons of castor seed per day of 24 hours would be well advised to consider the various advantages of this type of equipment before ordering expensive machinery from overseas.

The only disadvantages of this type of machinery are firstly, the fact that too much discretion is allowed to the operator and with careless workmen partially exhausted material containing an excess of oil may be removed from the machines at too early a stage of the operation, and secondly, the fact that it is impossible to obtain cold drawn castor oil from the treatment of castor seed in this type of equipment.

#### *Country Ghanis.*

The rotary ghani is, after all, only an improvement on the country ghani which is still very largely used through the country. Except that the mortar portion does not revolve, the working of the country ghani is similar to that already described but, owing to its low outturn, and higher working costs it is somewhat less economical as an oil producer. In certain cases, however, owing to the absence of iron in its construction, the oil produced is superior to that obtained from the same seed when pressed in rotary mills. Compared with the rotary mill its daily outturn is very low, viz., only about 1 cwt. of oil bearing material per day of 24 hours. Owing to its low outturn the working costs per ton of seed are at least 50 per cent. higher than the working costs of a rotary mill. The advantages in increased output, efficiency, and reduced working expenses which would result from the substitution of rotary for country ghanis, might be brought to the notice of the local telis, and if necessary loans on easy terms might be granted to them to enable them to establish small rotary mills driven by oil engines in place of their present equipments.

#### *Chemical Methods of Oil Extraction.*

In view of the fact that few factories using this type of equipment for treating oilseeds have as yet been established in India on a commercial scale, and that in consequence, no working results are available to enable a comparison with other methods to be made, the immediate establishment in India of large factories for the extraction of oils from such materials by chemical means cannot be definitely recommended. Such factories have, however, been working

satisfactorily in Europe for a considerable time, and improvements are constantly being effected both in regard to the efficiency of operations and to the quality of the products. At first, only products suitable for technical purposes were turned out, but extracted oils are now being utilised for food purposes. As far as the writer is aware, the only factory working in India on a commercial scale for the extraction of oil from any oil bearing material is the Calcutta factory of the Indian Oil Products Ltd. which has for some years been extracting oil from bazaar oil cake, and disposing of the extracted meal to the tea gardens. The oil produced is mainly sold to soap-makers. Despite the fact that the plant is old and comparatively inefficient, the results from a financial point of view have always been very satisfactory.

The solvent used by the Calcutta factory is benzine, which being the cheapest solvent available, is also largely used in Europe. Benzine or low boiling petroleum, however, is not a suitable solvent for the treatment of castor seed or castor cake. Benzol, which is a low boiling point coal tar spirit or light oil, is more expensive, but is on the whole a better solvent than benzine. Benzol and alcohol can both be used for the extraction of castor seed and castor cake, the oil from which is miscible with them in all proportions. Carbon bisulphide which was formerly the principal solvent is not now largely used. The non-inflamable chlorine derivatives, carbon tetrachloride and trichlor-ethylene, despite the risk which their employment involves, are finding extended use in England for the preparation of food oils.

Roughly speaking, the process of extraction consists in percolating the solvent through the ground material in order to dissolve out the oil content. The solvent mixture is afterwards subjected to distillation, the solvent being condensed, and used over again, while the oil is recovered and treated in various ways to eliminate all trace of the solvent. In recent plants the above process has been considerably modified, and various economies in heat transmission have been effected, but the principle of the operation remains the same.

The percolation may take place in single tanks or in a battery system; the latter system enables the solvent to be passed in succession through the different tanks, until it becomes fully saturated with oil. A considerable economy in distillation is thereby effected. The very best design and construction is necessary in equipments of this type, and such are supplied by British firms. Messrs. Geo. Scott & Son, Ltd., London, and other British manufacturers prepare solvent extraction plants which are far superior to the cheap German made plants, whose inefficiency, high working charges, and inferior products retarded for many years the development of this useful method of oil production.

The extraction method is, on the whole, unsuitable for the original treatment of oil bearing material, both, or even one product of which is to be used as a food, either for man or animals. When, therefore, as in the case of oilseeds like linseed, cotton seed, copra, groundnuts, etc., there is a large and unsatisfied demand for the resulting oil cakes, it is obviously unwise to turn a useful food product into a manure. On the other hand, in the case of rapeseed the cake from which is only in moderate demand, of castor seed the cake from which can only be utilised as manure, or of forest products, such as mowrah seed, the residue from which is useful only as a fuel, extraction may prove to be the most satisfactory method of dealing with such materials.

Care must, however, be taken to see that the process is without injurious effects on the oil produced. Extracted rape oil is said to be equal, if not superior, to that obtained from the treatment in hydraulic presses, while, on the other hand, castor oil is said to be injuriously affected by some solvents. There is little doubt, however, that, provided the technical difficulties can be successfully overcome, the extraction of oil cake intended for manurial purposes, as well as the combination of hydraulic and extraction apparatus for dealing with seeds the residue from which is only useful as manure, are well worth consideration.

The cost of an extraction equipment may be roughly estimated as being 50 per cent. higher than that of a hydraulic equipment of

the same daily or hourly capacity, while the working charges will probably be in about the same proportion. Any advantage possessed by the extraction system over the hydraulic system is due to the greater yield of oil, *e.g.*, the residue resulting from extraction contains only about 2 or 3 per cent. of oil as compared with an average of 10 per cent. in the case of hydraulic press cakes. Against this advantage has to be placed the inferiority of the oil product except for soap-making, and of the residue except for manurial purposes. The greater risk from fire and of injury to workmen may also retard the development in India of this system of oil production.

#### *Selection of Machinery.*

The figures of capital cost per ton-hourly crushing capacity which are given above, represent the approximate cost of oil mill machinery of the type in question sufficient to enable one ton of oil bearing material to be crushed every hour the mill works. In some cases the figures given are for material which requires to be pressed once only, and in some cases for material which requires to be twice pressed. Roughly speaking, except in the case of a rotary ghani outfit, the total cost of which, including housing power, etc., is about three times the cost of the actual machinery as given above, the total cost of any equipment will be about double the price quoted for the actual machinery. By utilising the figures given above, comparing the efficiencies of the various types as shewn by the oil content of the resulting cakes given in Chapter V as well as the working charges per ton of material, and ascertaining by reference to Chapter III the suitability or otherwise of the particular type for the treatment of the oil seed or oil seeds in question, intending purchasers should be able, without further outside assistance, to decide which type of plant is most likely to meet their requirements. While efficiency as measured by oil yield should be the first consideration, it need not necessarily be the only one, and care should be taken to see that the cost, both capital and recurring, of such extra efficiency is not higher than the value of the excess products which such extra efficiency might be expected to yield.



## CHAPTER V.

## SURVEY OF EFFICIENCY OF MACHINERY.

In order to enable definite conclusions to be arrived at regarding the efficiency or otherwise of the various types of oil pressing machinery now employed within the Presidency limits, district officers and others were invited to supply samples of the various kinds of oil cakes produced in their districts, as well as information concerning the type of machinery employed in the production of such samples. No attempt was made to obtain samples produced under any particular set of conditions or calculated to give results conforming to any particular theory. The samples may, therefore, be considered to be fairly representative, and the results of their analyses may be confidently accepted as indicative of the results obtained under ordinary working conditions within the Presidency.

The samples examined comprised :—

(1) Hydraulic Press Cakes	.. 13 samples.
(2) Expeller Cakes	.. 9 „
(3) Rotary Ghani Cakes	.. 8 „
(4) Country Ghani Cakes	.. 30 „

Classified as above the average oil contents were as under :—

	Average oil content.
(1) Hydraulic Press Cakes	.. 10'54 per cent.
(2) Expeller Cakes	.. 11'33 „
(3) Rotary Ghani Cakes	.. 12'30 „
(4) Country Ghani Cakes	.. 11'40 „

The average oil content of all the 60 samples will be found to be 11'35 per cent. As compared with the figures quoted in Appendices IV and V this indicates a loss of approximately a ton of oil for every 100 tons of oil seeds treated within Presidency limits. The results, though shewing that the oil-cakes produced in the Bombay Presidency contain oil in excess of what is considered to be desirable, are less unsatisfactory than had been supposed. The best results by each of the above methods are more or less satisfactory and are equal

to European and American practice. Thus the lowest oil content for hydraulic press cake (castor) *viz.*, 5·9 per cent. ; for expeller cake (rape seed) 9 per cent. ; for rotary ghanis (castor) 9·8 per cent. and for country ghanis (safflower) 6·85 per cent. are all quite up to European standards. On the other hand the worst results for each method, *viz.*, 18 per cent. for hydraulic press cake (mowrah) ; 15·7 per cent. for expeller cake (linseed) ; 15·80 per cent. for rotary ghani cake (tilseed) ; and 19·51 per cent. for country ghani cake (cocoanut) are all more or less indicative of carelessness in working or of attempts to overtax the machinery, rather than of fundamental defects in the types of machinery employed. Machinery, whether indigenous or otherwise, capable of giving results such as the best recorded above, is worthy of attention, and instead of blaming indigenous machinery and methods for India's want of success in this line, and recommending owners of such plants to scrap them and to purchase complicated and expensive machinery of foreign manufacture, which according to the figures quoted above is capable under unfavourable conditions of yielding results almost if not quite as bad as the worst obtained by indigenous methods, it would be well if the engineering staff of the Industries Department and other Government agencies would carefully study the working of the rotary and country ghanis and find out just what conditions are necessary to enable the operators of such machines to obtain results equal to the best reported above, and what are the causes which at times lead to the production of unsatisfactory results such as are also recorded. Such an investigation should present little difficulty to intelligent engineers who might even be able to suggest improvements in construction which would enable even the best recorded results to be exceeded. Provided the Industries Department engineers are able to shew how improvements can be effected at little or no additional cost, they will find the indigenous oil industry only too willing to accept advice and follow their instructions, and if the oil yield by indigenous methods can be increased by even 1 per cent., the total gain to the Presidency will be nearly four lakhs of rupees per annum.

Small capitalists who are desirous of starting oil mills, and who have less than Rs. 50,000 to invest, or who do not wish to crush more

than 10 tons of seed daily, would be well advised to purchase indigenous rather than foreign machinery. By purchasing such machinery a manufacturer would be able to treat nearly six times as much material in the same time for the same capital cost as he would if he purchased foreign machinery. For large capitalists who wish to go into the business on a more extensive scale, the selection of the most suitable type of machinery is a more complicated matter. Suffice it to say that the results tabulated above go to show that *hydraulic equipments* give satisfactory results with castor seeds (double pressing), linseed, cotton-seed and, apart from the question of the inferior quality of the resulting hot pressed oil, with groundnuts also. They ought to be equally suitable for the treatment of mowrah seed, but neither of the samples of mowrah cake were found to be satisfactory. *Expeller equipments* appear to give satisfactory results in the case of copra, rapeseed, groundnut and safflower seed. For linseed they would appear to be less satisfactory. *Rotary ghanis* give good results with castor-seeds, tilseed and groundnuts and comparatively good results with copra; they ought to treat satisfactorily all material which can be successfully treated in country ghanis. *Country ghanis* give excellent results with safflower, mustard, and jamba seeds, and good results with niger-seed, copra, and tilseed. They do not appear to be equally efficient in dealing with groundnuts, rapeseed and black mustard seed. The reason for this is not apparent, and it is suggested that this and other points which have not been cleared up by the present enquiry should be investigated further.

TABLE XII.

*Oil content (Percentage) of samples of oil-cakes obtained under ordinary working conditions in the Bombay Presidency in 1920.*

No.	District from which sample was obtained	Variety of oil-cake.	Botanical name of seed	Method of expression.	Analysed by		Oil content per cent.	Remarks.
					Designation or name.	Address.		
1	Bombay City ..	Linseed ..	( <i>Linum Usitatissimum.</i> )	Hydraulic Press.	The Chemical Analyser to Government, Bombay.	J. J. Hospital Byculla, Bombay.	10 per cent. ..	(Single Pressing.)
2	" ..	Groundnut ..	( <i>Arachis Hypogaea</i> ) ..	" ..	" ..	" ..	9.80 per cent.	(Double Pressing.)
3	" ..	Cocoonut ..	( <i>Gossypium Herbaceum.</i> )	Rotary ..	" ..	" ..	14.1 per cent.	
4	" ..	Groundnut ..	( <i>Arachis Hypogaea</i> ) ..	" ..	A. J. Turner, Esq., Professor of Chemistry.	V. J. Technical Institute, Bombay.	13.00 per cent.	
5	" ..	Linseed ..	( <i>Linum Usitatissimum.</i> )	Small Hydraulic Press.	" ..	" ..	8.32 per cent.	(Single Pressing.)
6	" ..	Tilcake ..	( <i>Sesamum Indicum</i> ) ..	Country ghani..	" ..	" ..	12.86 per cent.	
7	" ..	Castor ..	( <i>Ricinus Communis</i> )..	Rotary ..	Assistant Controller (Oils & Paints).	Old Custom House, Bombay.	9.08 per cent.	
8	" ..	" ..	Do. ..	Country ghani.	" ..	" ..	8.58 per cent.	Previously partially treated in rotary ghani.
9	" ..	Groundnut ..	( <i>Arachis Hypogaea</i> ) ..	Expeller ..	A. J. Turner, Esq. ..	V. J. Technical Institute.	9.96 per cent.	
10	" ..	Sarsoe ..	( <i>Brassica Campestris</i> )..	Country ghani.	" ..	" ..	12.60 per cent.	
11	" ..	Tilcake ..	( <i>Sesamum Indicum</i> ) ..	" ..	" ..	" ..	12.40 per cent.	
12	" ..	Groundnut ..	( <i>Arachis Hypogaea</i> ) ..	Rotary ..	Agricultural Chemist to the Government of Bombay.	Poona	10.25 per cent.	
13	" ..	Cocoonut ..	( <i>Cocos Nucifera</i> ) ..	" ..	" ..	" ..	12.75 per cent.	
14	" ..	Tilcake ..	( <i>Sesamum Indicum</i> )..	" ..	" ..	" ..	15.80 per cent.	

15	Surat	Decorticated cotton seed.	(Gossypium Herba- ceum.)	Hydraulic Press.	Dr. A. N. Meldrum, R. M. Science Institute.	Ahmedabad	12'20 per cent.	(Single Pressing.)
16	Sholapur	Kardi	(Carthamus Indicus)..	Country ghani.	"	"	10'70 per cent.	
17	"	Groundnut	(Arachis Hypogaea) ..	"	"	"	12'40 per cent.	
18	Ahmedabad	Castor	(Ricinus Communis)..	Hydraulic Press.	Asst. Controller (Oils & Paints).	Bombay	9'2 per cent.	(Double pressing.)
19	Bijapur	Groundnut	(Arachis Hypogaea) ..	Expeller	Dr. A. N. Meldrum..	Ahmedabad	10'6 per cent.	Once pressed only, i.e., rolled and then pressed.
20	"	Linseed	(Linum Usitatissi- mum.)	"	"	"	15'7 per cent.	
21	"	Groundnut	(Arachis Hypogaea) ..	Rotary ghani ..	"	"	14'00 per cent.	
22	Bombay	Groundnut	Do	Hydraulic Press.	Chemical Analyser to Government.	Bombay	10'5 per cent.	(Single Pressing.)
23	"	Castor	(Ricinus Communis)..	"	Asst. Controller (Oils & Paints).	"	11'7 per cent.	(Single Pressing.)
24	Godhra	Mowra	(Bassia Latifolia) ..	"	Chemical Analyser to Government.	"	18'00 per cent.	(Single pressing.)
25	Bijapur	Groundnut	(Arachis Hypogaea) ..	Expeller	A. J. Turner, Esq. ..	V. J. Technical In- stitute, Bombay.	9'10 per cent.	
26	"	Kardi (decorti- cated).	(Carthamus Indicus)..	"	"	"	10'29 per cent.	
27	"	Linseed	(Linum Usitatissi- mum.)	"	"	"	14'95 per cent.	
28	"	Groundnut	(Arachis Hypogaea) ..	Country ghani ..	"	"	12'30 per cent.	
29	"	Kardi	(Carthamus Indicus) ..	"	"	"	12'98 per cent.	
30	Belgaum	Niger cake	(Guizotia Abyssinica) ..	"	"	"	10'41 per cent.	
31	"	Groundnut	(Arachis Hypogaea) ..	"	Chemical Analyser	Bombay	12'80 per cent.	
32	"	Safflower	(Carthamus Indicus) ..	"	"	"	9'50 per cent.	
33	Karachi City	Jamba cake	(Eruca Sativa) ..	"	"	"	7'50 per cent.	
34	"	Cocoanut	(Cocos Nutifera) ..	Expeller	"	"	11'4 per cent.	
35	"	Tilcake	(Sesamum Indicum) ..	Country ghani ..	"	"	10'7 per cent.	
36	"	Groundnut	(Arachis Hypogaea) ..	"	"	"	13'1 per cent.	

No.	District from which sample was obtained.	Variety of oil-cake.	Botanical name of seed.	Method of expression.	Analysed by		Oil content per cent.	Remarks.
					Designation or name.	Address.		
37	Karachi City	Castor	(Ricinus Communis)	Country ghani..	Agricultural Chemist to Govt. of Bombay.	Poona	7.65 per cent.	
38	"	Cocoanut	(Cocos Nucifera)	"	"	"	10.70 per cent.	
39	"	Sarreh (Black)	(Sinapis Nigra)	"	"	"	11.55 per cent.	
40	"	Mustard	(Sinapis Alba)	"	"	"	7.30 per cent.	
41	Belgaum	Safflower	(Carthamus Indicus)	"	"	"	8.00 per cent.	
42	"	"	Do.	"	"	"	6.85 per cent.	
43	"	"	Do.	"	"	"	6.85 per cent.	
44	Satara	Groundnut (uncorticated).	(Arachis Hypogaea)	"	Dr. A. N. Meldrum..	Ahmedabad	15.8 per cent.	
45	"	"	Do.	"	"	"	12.1 per cent.	
46	"	"	Do.	"	"	"	12.1 per cent.	
47	"	"	Do.	"	"	"	14.3 per cent.	
48	Ratnagiri	Tilcake	(Sesamum Indicum)	"	A. J. Turner, Esq. ..	V. J. Technical Institute, Bombay.	10.77 per cent.	
49	"	Groundnut	(Arachis Hypogaea)	"	"	"	13.11 per cent.	
50	"	Cocoanut	(Cocos Nucifera)	"	"	"	19.51 per cent.	
51	Ahmedabad	Mowra	(Bassia Latifolia)	Hydraulic Press..	Chemical Analyser to Government.	Bombay	13.8 per cent.	(Single Pressing.)
52	"	Rapeseed	(Brassica Campestris)	Expeller	"	"	9.0 per cent.	
53	"	Linseed	(Linum Usitatissimum)	"	"	"	11.0 per cent.	
54	"	Castor	(Ricinus Communis)	Country ghani..	"	"	11.8 per cent.	
55	"	Castor (uncorticated).	Do.	Hydraulic Press..	"	"	5.9 per cent.	(Double Pressing.)
56	"	Castor (decorticated).	Do.	"	"	"	6.9 per cent.	(Double Pressing.)
57	"	Linseed	(Linum Usitatissimum)	"	Agricultural Chemist to Govt. of Bombay.	Poona	10.35 per cent.	
58	"	Tilseed	(Sesamum Indicum)	Rotary	"	"	9.40 per cent.	
59	"	"	Do.	Country ghani ..	"	"	15.80 per cent.	
60	Ratnagiri	Groundnut	(Arachis Hypogaea)	Hydraulic Press..	"	"	10.35 per cent.	(Single Pressing.)

## CHAPTER VI.

## THE REFINING OF VEGETABLE OILS.

The art of oil refining has long been looked upon as a mysterious business, requiring for its successful practice the possession of secret knowledge and exceptional skill. More recently, however, owing to the great developments of chemical science, the changes involved in oil refining have come to be better and more generally understood. Great improvements also, both in regard to methods and equipment, have been effected within recent years. In spite, however, of all that has been written on the subject, oil refining is still looked upon as being a complicated business which had better be left to experts. The want of an adequate supply of such experts is considered by some to be responsible for the slow development of the Indian oil pressing industry, and for the inferiority of much of the oil met with in the bazaars. While a knowledge of chemical science is of great value in dealing on a large scale with some of the more complicated problems of oil refining, it is by no means essential, especially for dealing on a small scale with the oil refining problems of India. In many cases, the early application of commonsense methods would effect an enormous improvement in existing conditions and obviate entirely the necessity for more drastic chemical treatment. Especially is the application of commonsense methods necessary in regard to the treatment of oil bearing material previous to and during the actual pressing operations so that the resulting oil product may require only the minimum of treatment to fit it for use or for storage. Neglect of the raw material especially during the monsoon is responsible for much of the excessive acidity of oils produced thereafter, while the improvement in the oil product which might be brought about by careful attention to the previous removal of all dirt, broken seeds, shells, etc., from the raw materials is not generally appreciated. Again the necessity for strict cleanliness in all oil milling operations does not appear to be understood by most of those engaged in the industry. Piles of half treated materials are allowed to lie fermenting for days on the floors of oil mills before being finally disposed of. The utilization of

press<sup>m</sup> sludge, too, is often delayed until it begins to smell strongly, which means that hydrolysis has set in, and that the oil obtained from it, will be of inferior quality. Strict cleanliness and attention to details such as those mentioned above will, especially in the case of oils obtained by cold or nearly cold pressure, go far to obviate the necessity for drastic chemical or other treatment. All oils whether obtained by mechanical or chemical means are, however, more or less impure, and require some sort of treatment to fit them for use or for storage. Even when produced by cold pressure from fresh material and under the best conditions they contain moisture and mucilaginous material which, if not removed, will lead to hydrolysis, and decomposition of neutral glycerides. Most oils also contain more or less free fatty acids. These if not excessive will probably do no great harm, but if present in excess they may render the oil less useful for certain purposes. Every effort should be made to keep the percentage of acidity as low as possible. Oils obtained by hot pressure or from inferior raw material will usually be found to require much more drastic treatment, than oils obtained by cold pressure from fresh materials, while oil such as that obtained from cotton seed requires even more drastic treatment than other hot pressed oils before it can be made use of in any way.

It is proposed therefore to indicate shortly a few methods of treatment which have been found useful and are considered to be applicable to Indian conditions. They may be conveniently divided into three classes, (1) methods of treatment which can be carried out by ordinary workmen, (2) methods of treatment involving the use of simple and safe chemicals but calling for the exercise of more than average intelligence, (3) more drastic methods of treatment involving the use of chemicals and the employment of experts. Needless to say the methods included in class (3) should never be employed if those included in class (2) will suffice to give a satisfactory product, nor should those included in class (2) be employed if satisfactory results can be obtained by the purely physical methods included in class (1).



*Simple Methods of Treatment.*

Such methods are generally commercial adaptations of simple household practices. Every cookery book contains recipes for improving the flavour or keeping properties of fats and oils while every Indian is familiar with the method whereby butter, which will only keep a short time, is converted into ghee, which has been known to keep fresh for hundreds of years. In the methods under discussion, just as in the examples given above, the change is brought about by the judicious application of heat, followed by removal of the precipitated impurities. In the case of cold drawn oil prepared from fresh material in the proper way, no other treatment should be necessary, while even inferior oils would be improved by the treatment. Care however must be exercised in carrying out the details. If the quantity to be dealt with is small and the oil is to be boiled by direct heat, the operation should be carried out in a boiling pan built into a flue in such a way that the hottest gases strike the sides rather than the bottom of the boiling pan. The vegetable matter, on precipitation, will sink to the bottom, and if the hottest gases strike the bottom of the boiling pan, the vegetable matter may become charred and thus injuriously affect the flavour and colour of the oil. Again, the heating should be gradual and just a little more than sufficient to drive off all moisture. If considered necessary fresh addition of water may be made from time to time during the boiling operation. When free from moisture the oil should be allowed to cool and settle. Provided time is no object, the best results will be obtained by allowing the impurities to slowly settle out. If time does not allow, the oil, when cool, may be strained through a dry clean cloth.

On the larger scale, the operation can be carried out in steam jacketed tanks having a jacket all round the sides, but not on the bottom. The bottom should be conical or dish shaped. Some simple stirring arrangement should be provided as well as an open steam coil. Closed steam coils are however unnecessary, and only lead to carbonization of vegetable matter and consequent injury to the oil. The steam jacket should have two steam outlets, one a syphon pipe for retaining steam up to atmospheric pressure and

another connected to a steam trap for higher pressures. Except for the final heat, only steam at atmospheric pressure should be used. As on the large scale slow settlement of the precipitate is not practicable a filter press is necessary. Except that the filtering area is vastly increased and oil is forced through the cloths under pressure instead of flowing by gravity, the operation of filtering oil by means of a filter press is similar to that of straining it through a cloth, as is done on the small scale. Filter presses should be installed in every mill producing over 1 ton of oil every day. They can be prepared in any iron works at a much cheaper rate than they can be imported. A filter press, complete with pump, capable of filtering up to 5 tons per day, can be manufactured for less than Rs. 1,000. When using a filter press, great care should be taken to see that the cloths are kept clean: otherwise the oil may be injured rather than improved by being passed through them. The purely physical method detailed above is suitable for the treatment of tilseed, groundnut, kardi, rape, niger and in fact most cold drawn edible oils, also for linseed oil, rape oil and castor oil, whether hot or cold drawn. It is not, however, suitable for cold drawn cocoanut oil which would be injuriously affected by the treatment. The mucilaginous matter must, in this case, be removed before the moisture is dried off. This is accomplished by mixing with the oil some filtering powder such as fuller's earth, and passing the mixture through a filter. The oil is afterwards slowly dried as detailed above. On the large scale, this treatment is carried out in a vacuum still at a temperature considerably lower than the boiling point of water. On the smaller scale excess moisture may be removed by stirring finely ground dry salt into the oil after filtration and allowing the whole to settle for about 24 hours. This will in some cases obviate the necessity of applying any heat whatever. The simple methods of treatment detailed above would, if applied in the small oil mills of this Presidency, effect a very considerable improvement in the quality and appearance of the oils offered in the local bazaars.

#### *Less Simple Methods of Treatment.*

This class of treatment includes :—

(a) Treatment of oils the acidity of which is higher than is considered desirable.

(b) Treatment of oils the colour of which is higher than is considered desirable.

(c) Treatment of oils required for burning purposes.

Oil, the acidity of which is higher than is considered desirable, for example hot drawn oil prepared from material the cold drawn oil of which was considered satisfactory, or oil obtained from slightly inferior material, may be improved by treatment with sodium carbonate or washing soda and salt, prior to the usual heat and filtration treatment. The acidity of oil may be reduced by about 1 to 2 per cent. by stirring into the warm (but not hot) oil about 10 per cent. of a 10 per cent. solution of sodium carbonate and keeping the oil and solution in intimate contact for one or two hours, after which about 5 to 10 per cent. of a salt solution containing about 2 per cent. of salt is added, and the whole is boiled up until steam begins to escape. The solutions are then allowed to settle out and are afterwards run off. The oil is then given one or two washings with clean water to remove all trace of salt or soda, and is thereafter dried and filtered in the usual way. If air pumps are available drying operations may be carried out at a temperature of about  $150^{\circ}$  F. This method of drying is not admissible in the case of castor oil which is likely to be more or less oxidized in the process.

In the case of oils the colour of which is at fault, treatment consists in the careful removal of moisture, after which about 5 per cent. of fuller's earth is thoroughly stirred for about twenty minutes into the heated oil which is thereafter filtered as quickly as possible to prevent it acquiring an unpleasant odour and flavour. Other chemical methods of bleaching are not admissible in the case of edible oils and it is doubtful whether there is any necessity for bleaching oils for technical purposes in India.

Oils, such as castor and rape, which are required for burning purposes, must be completely freed from all vegetable matter which would be likely to char the wicks of the lamps in which they are used. They are therefore given a preliminary treatment with about 1 per cent. of a mixture of equal parts sulphuric acid and water in a wooden vessel. After the vegetable matter has become charred, the treated

oil is thoroughly washed with hot water, and afterwards dried, and filtered in the usual way. The above treatment cannot be applied to oils which are intended, or are likely to be used, as lubricants. Only oils of reasonably good quality can be successfully treated by the methods included in the first two classes, viz., those which can be carried out by ordinary workmen or with intelligent supervision. In the case of more acid oils and of oils like crude cotton seed oil, more drastic treatment is required, and such treatment can only be successfully given under expert supervision. In such cases the oil, after a laboratory experiment to determine the exact percentage of acid present and the quantity and strength of solution required for its neutralization, is treated in a proper refining tank, with a solution of caustic soda of the required strength and in the correct proportion. Such solution contains about 25 per cent. more caustic soda than is theoretically required to neutralize the acid present. The oil is stirred and slowly heated up to a maximum of about 120° F. when the soda soap formed should be ready to sink to the bottom, carrying with it the impurities and excess colouring matter. After settling and running off from the crude soap stock which can be converted into a useful soap, the clear oil is washed, dried and filtered in the usual way. The actual percentage of refining loss should not exceed twice the percentage of free fatty acid originally present in the crude oil.

#### *Bleaching.*

In the case of oils such as groundnut and tilseed the colour of oil after treatment as above should be sufficiently light, but in the case of cotton seed oil, especially from old seed, the colour of the oil will be considerably darker than the refined oil obtained from American seed. To obtain a paler oil, bleaching with fuller's earth may be resorted to. After the oil has been freed from moisture about 5 to 6 per cent. of fuller's earth is stirred in and mixed vigorously with the oil for about twenty minutes, after which the mixture is pumped through a filter press to remove the fuller's earth. Considerable variations from the above or standard practices may be and are often introduced into the operations of refining. Particulars of such variations may be found in various textbooks. Bleaching with ozone

may prove effective with certain oils but not with Indian cotton seed oil.

#### *Deodorizing.*

Where the retention of the characteristic flavour of an oil is not desired, as for example, when the oils are intended to be used for the manufacture of butter substitutes or for cooking fats or, as in the case of cotton seed oil, where it is desired to eliminate the unpleasant odour which makes itself felt when the oil is first heated to a temperature higher than the boiling point of water, oil treated as above is further treated in what is called a deodorizer. Oils intended to be treated in this way should be as nearly neutral as possible, as oils showing excess acidity cannot be satisfactorily treated. Deodorizers may be either of the atmospheric or vacuum type. In the former type the oil is subjected to the heat of both closed and open steam coils. The former should be sufficient to raise the temperature of the oil to the temperature of the steam, while the latter should be sufficient to maintain the oil in an exceedingly vigorous state of ebullition, thus enabling all unpleasant odours to escape into the atmosphere. Some oils can stand higher temperatures than others. Cotton seed oil, for example, requires to be treated 5 to 6 hours at over 300° F. Groundnut and tilseed oils can be deodorized in about 4 hours at about 270° F. to 280° F. Coconut oil should not be heated over 250° F. and it can be deodorized in two hours.

In the vacuum type of deodorizers, the oil is similarly treated, but at reduced temperatures and pressures, and, in consequence, there is less likelihood of damage to the oil. The extra cost of deodorizing oils amounts in some cases to about Rs. 80 per ton of oil.

#### *Hydrogenation.*

This is one of the most recent improvements in oil treatment. By treating a liquid oil with hydrogen gas in the presence of a catalyst and at a certain definite temperature and pressure, liquid oils such as groundnut or cotton seed can be converted into solid fats like ghee or tallow. The equipment required is, however, very complicated and rather expensive. In view of the fact that supplies of material

capable of yielding solid vegetable fats are available in this Presidency and are not yet utilized, it is questionable whether there is any immediate necessity for the establishment of such plants in this Presidency at least for the production of soap and candle material. The demand, however, for a cheap and wholesome ghee substitute may yet lead to their establishment. It has been suggested also that, in the case of sesame oil, it might be possible to create an export trade in hydrogenated sesame oil, instead of exporting the more liquid oil.

#### *Stearine Manufacture.*

In America, before the advent of the hydrogenation process, considerable quantities of cotton seed stearine were prepared by refrigerating cotton seed oil and keeping it at temperatures of between 30° F. and 40° F. until the stearine settled out from the olein which was run off and sold as winter cotton seed oil. The stearine was afterwards pressed in hydraulic presses to free it from the remaining oil and to raise its melting point. Even in America the manufacture of cotton seed stearine is declining, and there is little prospect of its manufacture on a large scale in India. The percentage of stearine which would remain solid at summer temperature, obtainable from Indian cotton seed oil, is very small and the colour of the product is higher than is desirable in a ghee substitute.

Cocoonut oil, however, when similarly treated yields a harder and white stearine in a larger proportion and at a cheaper rate. As very low temperatures are not required to be employed, working expenses are much lower. Cocoonut stearine can be prepared either in large or small quantities and the plant required is simple and comparatively inexpensive. In this it differs greatly from the hydrogenation process of solid fat production which can only be successfully worked on a large scale. It is probable that the demand for a wholesome vegetable ghee substitute may in time lead to the establishment of this industry at least on a small scale,

## CHAPTER VII.

POSSIBLE LOCAL OUTLETS FOR THE PRODUCTS OF AN EXPANDED  
OIL INDUSTRY.

It has already been shewn that any considerable expansion of the industry will necessitate the establishment of an export trade in one or both of the main products. At the same time the possibilities also of the local markets should be investigated, as it is always much easier to build up a successful export trade on the foundation of a flourishing home business than to establish an export trade alone.

The products for which markets have to be found are :—

- (a) Oils ( edible and technical )
- (b) Oil cakes ( cattlefood and manure )
- (c) By-products ( minor ).

*Demand for Oil as Oil.*

The demand for oil as oil in India is undoubtedly increasing. This particularly applies to edible oils which are being more largely used in place of ghee, the price of which has recently increased to such an extent as to place it entirely beyond the reach of the poor. The partial substitution of oil for ghee in the army ration is symptomatic of the change which is taking place all over India and more particularly in Southern India, and the total increased demand for oil must consequently be considerable. This demand will undoubtedly go on increasing. The expansion in the demand for technical oils has, however, been inconsiderable, with the exceptions of linseed oil, which has almost completely replaced the imported article, and of castor oil, the demand for which for lubricating purposes appears also to have increased considerably.

*Other Outlets for Oil.*

In addition to the increasing demand for oil as oil, increased utilization of oil in the undernoted industries is necessary to secure an internal market for the oil products of an expanded oil industry.

Industries utilizing oils include :—

- (1) Manufacture of soap.
- (2) Manufacture of ghee and butter substitutes.
- (3) Manufacture of paints and varnishes.
- (4) Manufacture of candles.
- (5) Manufacture of compound lubricants.

#### *Manufacture of Soap.*

Cheap soap is already largely manufactured in India. It is estimated that the quantity manufactured in the Bombay Presidency alone amounts to not less than 6,000 tons per annum, while the annual import of soap of all kinds amounts to over 8,000 tons. The soap manufactured locally is mostly inferior soap made down to a price rather than up to a standard. Most of it is cold process soap prepared from cocoonut oil, heavily filled with soda ash and salt, and containing an excessive amount of water. The total fatty acid content of this type of soap is under rather than over 30 per cent. It sells, however, readily at a price considerably lower than that of imported soap. Unless the price of imported soap rises still higher, it is doubtful whether any considerable expansion of the manufacture of such soap can be expected. A good soap containing between 60 and 70 per cent. of fatty acids would, if offered at a price lower than the price of imported soap, find a ready market. It is doubtful whether such a soap could be profitably manufactured in India from marketable oils and fats, but there is no reason why it should not be possible to produce a high grade soap from the refining residues which are likely to result from the activities of an expanded oil industry. Cotton seed refining residue, for example if purified by repeated washing with caustic soda, and stiffened by the addition of a small proportion of mowrah oil makes an excellent brown carbolic or other soap at a very reasonable price.

#### *Imported Household Soaps.*

The imported soap business, particularly that of household soap, is largely in the hands of one or two big English manufacturers,



Their bar soaps are not of particularly high grade as far as European standards are concerned. They correspond roughly to what are called fifty per cent fatty acid soaps, and consequently contain more water, and are more wasteful in use, than would be considered advisable in Europe. They are, however, regular in quality and are certainly more satisfactory in use than locally made soaps. As they apparently satisfy the present demand, the advisability of manufacturing a similar article in India would appear to be worth considering. The capture of any considerable portion of the imported soap business would require, however, strong financial backing.

#### *Locally Made Toilet Soaps.*

The toilet soap manufactured in the Bombay Presidency is mostly of inferior quality. It contains too much free alkali and unsaponified fat ; it keeps badly and is wasteful in use.

#### *Imported Toilet Soaps.*

Imported soaps of good quality, sell at very high prices. As the toilet soap business, unlike that of household soap, is not a monopoly of one or two firms there appears to be no reason why a well made and attractively scented and packed local product should not find a ready market at profitable rates.

#### *Glycerine.*

Prospective Indian manufacturers are repeatedly warned that only by extracting all the glycerine, which is set free in the process of soap manufacture, can they hope to compete with European manufacturers. Looking, however, to the present market rates for glycerine, it does not appear that this article more than pays the cost of its recovery even in England, while in India, with hydrochloric acid at its present price, the cost of recovery would be prohibitive. Unless, therefore, the market rate of glycerine advances, or that of hydrochloric acid declines, glycerine recovery in India will not pay.

#### *Butter and Ghee Substitutes.*

The import of ghee into the Bombay Presidency exceeds the export therefrom by about 8,000 tons per annum. The production

of ghee in the Bombay Presidency is also considerable, and if the consumption per head in the mofussil is only half as much as the consumption per head in Bombay City, the total consumption of the Presidency cannot be far short of 50,000 tons per annum. It has been pointed out, however, that a gradual substitution of oil for ghee has been going on for some time on account of the advancing price of ghee. Sweet oils such as groundnut, cotton seed, til seed, kardi, etc., are being used to a greater extent for culinary purposes, and except in wealthy households the more expensive ghee is mainly reserved for special occasions, eating with cooked dishes or for use in the preparation of confectionery. It is doubtful whether consumers will knowingly pay for a ghee substitute, intended for general cooking purposes only, a price much in excess of the price they have to pay for sweet oils, and judging by the grade of oil which satisfies this demand, questions of quality count for little. To have any chance of successful introduction as ghee substitutes, such preparations must behave exactly like ghee when heated and recooled, and as far as possible should resemble ghee in colour, odour, and flavour so that they can be used for eating with cooked dishes, etc. No merely hardened oil product would have any chance of permanent success, though it might be purchased by fraudulent dealers for adulterating ghee. Even granted success in producing an article closely resembling ghee, a great deal of propagandist work would be necessary before it could be successfully marketed as a ghee substitute in the Bombay Presidency. The best way to test the correctness or otherwise of these conclusions is for prospective manufacturers to import from Europe a few shipments of different hardened oils, and to attempt their sale as ghee substitutes in the markets of the Presidency.

It is doubtful also if there is any possibility of creating a demand in the Bombay Presidency for an article resembling margarine such as is so largely manufactured and consumed in Europe. Butter is only used by a very small minority of the population, and that minority is more or less able and willing to pay the present or even a higher price for genuine butter of good quality,

*Paints and Varnish Manufacture.*

The only Indian oil, the demand for which is likely to expand for industrial purposes, is linseed oil which is used either raw or boiled for mixing with paints, or as the chief vehicle in varnishes. Before the war, and before oil of local manufacture came upon the market in any considerable quantities, the annual import of linseed oil into Bombay and Karachi amounted to about 1,600 tons, while the quantity contained in the mixed paints imported probably amounted to between 300 and 400 tons per annum. The Presidency's total requirements of linseed oil for mixing with paints was therefore under rather than over 2,000 tons a year. As has been pointed out in another chapter, locally prepared oil has to a large extent replaced the imported oil. There is, however, considerable room for improvement in the quality of many of the locally produced "boiled oils." Many of them are insufficiently boiled, dry most unsatisfactorily and when thinly spread on glass yield an irregular and patchy film. Only one firm in the Bombay Presidency appears to have succeeded in making a boiled oil which complies with all the requirements of the Government specification for that article. Unless, therefore, improvements in its manufacture are effected, purchasers of boiled oil may possibly revert to the use of imported oils, rather than run the risk of having inferior locally prepared oils foisted on them.

The establishment of paint factories to supply the needs of the Presidency would only increase the demand for linseed oil by about 300 tons per annum. As however such factories, if run on proper lines, would be almost certain to develop business with other provinces there is every possibility that they may require very much larger supplies of oil. At the present moment scarcely any of the small paint factories in the Bombay Presidency prepare satisfactory paint. Their equipment is very crude, and incapable of thoroughly grinding the stiff paste. In consequence of this the paints produced are gritty and their opacity and spreading capacity are seriously affected. Better paint grinding machinery must be imported and installed in Bombay factories before they will be able to compete with the paint works of Bengal, let alone with European factories,

Factories, also, should be on a large enough scale to warrant the employment of a practical paint maker, preferably one trained in Europe. Theoretical knowledge is very useful in its way, but even more important is the practical knowledge which comes from long experience in a well equipped paint works.

#### *Varnish Making.*

Varnish, and that of rather poor quality, has hitherto been made only in small quantities on this side of India. Every technical chemist thinks he can make varnish and many of them set out to manufacture it on a commercial scale, but they soon find that here, also, practical experience is of equal if not greater importance than chemical lore. Again, difficulty is experienced in regard to the ageing of the varnish. Financial restrictions prevent the storage of good varnish in large quantities for a sufficiently long time, so that small factories generally end by manufacturing only the cheapest substitute for copal varnishes, or take up some new line altogether. For the manufacture of satisfactory varnishes the investment of a considerable amount of capital is necessary. Manufacturers must also be prepared to provide free trial samples and to spend money fairly lavishly in convincing likely purchasers of the merits of their products. Having secured a market, they must unceasingly watch the details of manufacture and see that the quality once introduced is rigorously maintained. Varnish making is not an industry which can be successfully developed by inexperienced and impecunious technical graduates or by versatile amateurs.

#### *Oil Cloth.*

The manufacture of oil cloth appears to offer some scope for the utilization of at least a small portion of the linseed oil supplies, which would become available in the event of any considerable expansion of the oil industry. The annual imports of this article into Bombay before the war amounted to over 800,000 square yards valued at over Rs. 5,25,000. As far as the writer is aware, there are no oil cloth factories in India, and such a factory, if established on a proper basis with up-to-date equipment, and with proper technical assistance, would appear to be capable of yielding satisfactory profits and afford good prospects of further development.

### *Manufacture of Candles.*

The imports of candles into the Bombay Presidency in pre-war years amounted to approximately 1,100 tons per annum. The greater part came, as might be expected, from Burmah. Assuming that the 900 tons of Burmese origin contained an average of about 15 per cent. of stearic acid, the total quantity of an oil such as mowrah required to supply the stearic acid portion would be not less than 400 tons per annum, while to supply the stearic acid contained in candles imported from England in pre-war years would further necessitate the hydrolysis of about 300 tons of a similar oil. The local manufacture of candles probably does not exceed 200 tons per annum, and as these contain a very high proportion of stearic acid, they should, if properly made and marketed, realise a higher price than the mineral candle imported from Burmah. As a matter of fact, however, it is difficult to sell the almost pure stearine candles, even at the same rate as is obtained for the almost pure mineral wax candles. Owing to the fact that the demand for glycerine has seriously declined, and that mowrah oil yields only about 30 to 35 per cent. of stearic acid suitable for candle making, the balance, *viz.*, oleic acid having to be utilised for the manufacture of soap, it is doubtful whether there is any immediate opening for further expansion in this line.

At the same time there appears to be no reason why the business of preparing stearic acid for candle manufacture should not prove profitable in this Presidency. In pre-war years Burmah imported, chiefly from Belgium, nearly 1,000 tons of stearic acid per annum. Doubtless this and other markets could be exploited, and in time a profitable addition to the Presidency's export trade might be effected. The matter is, at any rate, well worth the consideration of persons interested in the development of the forest products of the Presidency.

### *Compound Lubricants.*

For lubricating certain kinds of machinery, notably marine engines, and high class motor car engines, compound lubricants

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### *Compound Lubricants.*

For lubricating certain kinds of machinery, notably marine engines, and high class motor car engines, compound lubricants

are preferred to lubricants prepared exclusively from either vegetable or mineral oils. Castor and rape oils, the latter after being air blown to increase its viscosity and lessen its tendency to gum, are compounded with varying proportions of mineral oil of a suitable grade, and used for lubricating purposes. As one large American lubricating oil concern utilises in its compound lubricant manufacture about 4,000 tons of rape oil every year, the total quantity of this oil utilised in Europe and elsewhere must be very large. Again, for high class aeroplane engines, the most popular lubricant at present is a compound consisting chiefly of castor oil.

Quite recently it has been discovered that the addition of 2 per cent. of free fatty acids to a mineral oil increases its lubricating properties to the same extent as would be effected by the addition of 80 per cent. of a neutral vegetable oil such as rape. Not only should the results of this discovery effect a very considerable economy in the use of vegetable oils, but owing to the small extra cost of such an addition, it is possible that in the near future the business of manufacturing this class of lubricant will greatly expand. The whole question of the manufacture of compound lubricants is well worth the attention of prospective industrialists and the establishment of such an industry in India would provide an outlet for a fairly large quantity of oil.

#### *Oil Cakes.*

Only about 10 per cent. of the oil cake produced in India is exported. The same is the case as regards the Bombay Presidency. The balance in this Presidency is utilised chiefly for cattle feeding and for manurial purposes. A small proportion is utilized as fuel. The local demand appears to be more than satisfied and failing a radical change in the agricultural methods of the Presidency there seems to be little hope of creating an increased demand sufficient to take up any considerable proportion of the increased output which will result from an expansion of the oil pressing industry. Nor is this because of the high prices asked by manufacturers for their product. During the war, when freight to Europe was unobtainable, best mill pressed linseed cake for which English farmers are now willing to pay nearly £25 per ton, failed to find



buyers, even at Rs. 30 per ton, and had to be disposed of in Bombay for fuel purposes in some of the local mills.

Assuming that the total weight of oil cake utilised within the Presidency limits is approximately 75,000 tons per annum, of which approximately half is used for cattle feeding and half as manure, the quantity utilised locally appears remarkably small when it is compared with the British demand of approximately 1,300,000 tons per year.

*Use of Oil Cake for Cattle Feeding.*

As far as the use of oil cakes for cattle feeding is concerned, one of the chief reasons for the small consumption of oil cakes is the fact that in India there is no shortage of concentrated foodstuffs such as is experienced in Europe. Pulses, such as gram and guvar are largely grown and utilised within Presidency limits, while refractions from edible pulses, such as chuni are available in considerable quantities. But the greatest competitor of the oil cakes is cotton seed, and a comparison of the local consumption of this seed during the years 1913-14 and 1916-17, *i.e.*, two years of normal rainfall, goes to shew that its use is increasing. The figures are as under :—

TABLE XIII.

*Apparent local consumption of cotton seed in the Bombay Presidency limits in the fiscal years 1913-14 and 1916-17.*

	1913-14.		1916-17.	
	Total tons.	Total tons.	Total tons.	Total tons.
Yield of local crop ..		300,000 approx.		300,000
Inland imports into Presidency.	342,000		71,000	
Inland exports from Presidency.	165,000		49,000	
Total excess of imports over exports.		177,000		22,000
Total available for use and seaborne export.		477,000		322,000
Actual seaborne export ..		270,000		37,000
Apparent local consumption for planting and cattle feeding.		207,000		285,000

Later figures are not available, but it does not appear likely that any reaction against the use of cotton seed for feeding purposes has yet set in. Assuming that approximately 27,000 tons are required for planting purposes, the quantity utilised as cattle food within the Presidency in 1916-17 was not far short of 260,000 tons. Almost the only hope of increasing the local demand for edible oil cakes in the Bombay Presidency lies in the possibility of convincing the cultivating community of the desirability of substituting such cakes for the whole cotton seed which they now feed to their cattle. A considerable amount of propagandist work in this line has already been undertaken principally by interested parties, and the results as deduced from the figures given above, have been decidedly disappointing. If the cultivators are to be convinced of the wastefulness of their present practice, this can only be accomplished by the wide publication of the results of successful experiments carried out by the Agricultural Department. Such tests should be carried out under different conditions, and for fairly long periods. They should be carried out with a view, not only to ascertain the effects of different foods on the milk or work output of animals undergoing the trials, but also to find out the effect of the different foodstuffs on the animals themselves. The effects of supplying foodstuffs containing greater and smaller percentage of fat should be carefully investigated, and the digestibility of the more oily rations should be ascertained by careful analysis of the excrement of the animals undergoing the tests. So many unproved statements have been made regarding the indigestibility of the oil content of cattle rations containing an excess of this constituent, that it is necessary once and for all to prove whether or not the excrement of cattle fed on cotton seed and locally prepared oil cakes, really does shew an excess of oil. Should the results of the trials go to shew that oil cakes and cotton seed are interchangeable in cattle rations, tables should be prepared shewing the parity at which it would pay the cultivators in any part of the Presidency to substitute any of the oil cakes for the cotton seed, which they are now using. It is doubtful whether any good will result from attempts to persuade cultivators to use a greater amount of oil cakes for feeding their

cattle rather than to use them as manure for their crops. Owing to the widespread use of cowdung as fuel only a very small proportion of the manurial elements of the foodstuffs given to cattle find their way to the cultivated areas. Until some substitute fuel becomes available the use of cattle dung for this purpose will continue, and the comparison of the values of such foodstuffs must be confined to their immediate effect on the animals themselves either in regard to milk and work, or to physical condition. The absence in India of any substitute for the great animal fattening industries of the West no doubt partly accounts for India's low consumption of concentrates including oil cakes, and it is doubtful whether it is even desirable that such industries should be introduced into a country like India.

#### *Use of Oil Cakes as Manure.*

It is doubtful whether there is much scope within this Presidency for the extended use of oil cakes as manure. At present all the castor cake produced within the Presidency is so utilised, while in the Deccan considerable quantities of safflower and niger cakes are also used for manuring sugarcane. Other edible oil cakes are not used to any considerable extent, chiefly because of the fact that their presence in the soil attracts the attention of pigs and other wild animals, and leads to the destruction of the young cane sets. It seems possible that this difficulty could be overcome by adding to such ground oil cakes a proportion of the powder of poor but inedible cakes such as mowrah and karanj. Except in regard to sugarcane, the cultivation of which offers scope for expansion, and garden crops which require the addition of a quick acting nitrogenous manure, there does not seem to be much room for the extended use of oil cakes as manure. As a matter of fact, with the aforementioned exceptions few of the large Indian crops appear to benefit greatly from the lavish use of nitrogenous fertilizers such as oil cakes.

#### *Minor By-products of the Oil Industry.*

The only minor by-products of any considerable importance are those connected with the cotton seed industry and with the refining residues from other oils. The latter can be conveniently

worked up into soaps while of the former, the short cotton or lint, provided its recovery is found to be profitable, can be used for the manufacture of bedding, in upholstery, and possibly in paper making. The refining residue, after repeated treatment with caustic soda and stiffening with an oil of higher melting point, can be used for the preparation of cheap and effective household soaps. It is doubtful whether in India it will be worth while carrying the treatment further, but in America the residue is acidified to effect the separation of the fatty acids which are afterwards distilled leaving behind a pitch residue which is used for the manufacture of paints, roofing felts, etc. The distilled fatty acids are used directly or after removal of stearic acid for making higher grade soaps. For the husks removed in the process of preparing decorticated cotton seed cake there is, within the Presidency, an almost insatiable demand for feeding to milking stock. They are nutritious, stimulate the secretion of milk, and give necessary bulk to the milking time ration which is such a noticeable feature of Indian dairy practice.

#### *Human Food Products from Oil-cakes.*

The possibility of obtaining from the comparatively inexpensive oil-cakes, food products of high grade suitable for the preparation of bread, cakes, etc., for human consumption has for long occupied the attention of chemists, dietists and economists. The results obtained have on the whole been rather disappointing. In America, considerable progress has been made in the preparation of an edible flour from cotton seed cake which, when mixed with wheat flour in certain proportions, can be used for the preparation of nourishing bread and toothsome cakes. In this Presidency the efforts of the Industries Department to encourage the preparation and use of a similar flour from groundnut cakes has so far yielded no practical results. Both in America and India, the chief difficulty has been to prepare a flour with reasonable keeping properties. When freshly prepared, cotton seed flour is pleasant in appearance, of good odour and most palatable. After being stored for some time, even in America, it goes off in colour, odour and taste and can only be used as cattle food or manure. In India, owing to the higher temperatures and in some parts and seasons, excessive humidity, cotton seed flour is much less

stable than it is in America, and it soon goes mouldy. Biscuits and other preparations in which cotton seed flour has been used have also inferior keeping properties as compared with similar products prepared from wheat flour. As cotton seed, the cake from which will be suitable for the preparation of cotton seed flour, is only obtainable for two or three months after harvest, extensive experiments are necessary to find out some method, either of treatment or packing, which will eliminate this excessive "tenderness" and enable the flour to remain fresh even after several months' storage. At the same time the cost of such treatment or container must be low enough to enable the resulting product to compete with the flour of pulses such as chana dal. Another difficulty experienced even with freshly prepared flour is the fact that preparations in which it is used darken badly while being cooked. This appears to be due to caramelization of the sugar, etc., present. In America, this difficulty is to a certain extent overcome by cooking with steam rather than dry heat, but in India there is, except in the preparation of boiled rice, very little steam cooking. It must be clearly understood that cotton seed flour does not or should not consist merely of the siftings from ground cake. Such a product, if examined under the microscope, would be found to consist of small cubical particles, while a true flour should consist of minute flat flakes. Until the difficulties detailed above have been overcome, there is little prospect of the manufacture of cotton seed flour in India becoming an important or profitable business. It is probable that the situation as regards the manufacture of nutramine from groundnuts is similar to that detailed above, and that a considerable amount of experimental work is necessary before such a preparation can be confidently marketed.

## CHAPTER VIII.

THE DEVELOPMENT OF AN EXPORT TRADE IN THE PRODUCTS  
OF AN EXPANDED OIL INDUSTRY.

It is clear, from the conclusions arrived at in the foregoing chapters, that the development of an export trade in the products of an expanded industry is a necessity. Facilities for such must in fact be provided before any considerable expansion can take place. The only products which it will be necessary to export are oil cakes and oil.

*Oil Cakes Export.*

The oil cakes for which there is in Europe an almost insatiable demand are linseed cake, and cotton seed cake. There is a considerable demand for groundnut and cocoanut cakes, but for other kinds of oil cake the demand in normal times is poor. As all these cakes are sold on an analytical basis, and Indian exporters are not always satisfied that they are fairly treated when their cases are subjected to arbitration, it might be an advantage if representatives of the Indian Trade Commissioner were appointed at the principal ports to look after the interests of Indian exporters.

*Oil Exports.*

The establishment of a successful export trade in oils will be a much more difficult matter. Not only is the product a comparatively expensive one and one liable to losses on the voyage, but the business also is new and there is no insatiable demand for the article. There is, in fact, a decided preference for the raw material which in many European countries takes the form of the imposition of heavy import duties on the finished product.

*Necessary Conditions.*

The first essential requirement is a considerable improvement in the quality of the oil produced within the Presidency. At the present time it is doubtful if more than forty per cent. of the product is even of second grade, *i.e.*, when judged by European standards. A very much smaller percentage might pass for first quality, and the balance, equal to nearly half the production would in Europe be classed as off oil and be disposed of accordingly.

*Standardization.*

With the exception of refined cotton seed oil the acidity of which should not exceed  $\frac{1}{8}$ th per cent., most oils shewing under 2 per cent. of acidity would be classed as first grade ; oils shewing between 2 and 4 per cent. might be considered to be second grade ; and all oils shewing over this percentage should be classed as third grade or off oils. Every effort should be made to increase the proportion of first and second grade oils and to eliminate, as far as possible, oils of lower quality. How this might be accomplished has been shewn in Chapter VI. In no case should the export of oils of the third category be encouraged.

*Government Standardization.*

Careful analysis and classification of all oils intended for export will be necessary, and as proper arrangements for carrying out the necessary tests could not be provided except by large manufacturers, and as even their results would be more or less suspect, it is suggested that, for the development of the oil crushing industry of the Presidency, Government should establish test houses, through the warehouses of which, all oils for export would require to pass before obtaining the Government grade marks. Oils might be graded as shewn above and special seals marked " First Grade " or " Second Grade " as the case may be, might be attached to all packages the contents of which were found to be in accordance with the specified requirements of either of these grades. No grade mark should be affixed to packages containing oil of lower grades, nor should their export from Government warehouses be allowed. The export of oils bearing Government grade marks except from Government warehouses should be prohibited, but no restriction need be placed on the export of ungraded oil. If particulars of the system of grading adopted were widely published in England and elsewhere, it is suggested that European importers would find it to their advantage to arrange for supplies of such oils, instead of purchasing ungraded oils of uncertain quality. Bombay and Karachi commercial firms would also be safeguarded against possible claims for variations in quality, and would be willing to buy and sell graded oils on reasonable terms. For example if they have an enquiry for 100 tons Bombay

No. 2 grade linseed oil, they would contract with a bazaar or mofussil merchant to deliver that quantity to the Government Test Warehouse. Should the oil pass the necessary test the merchant would receive payment; if not, he would be forced to take back his oil. The officials in charge of such test warehouses would be kept up to the mark by the fear of different results being obtained on receipt of the oil in Europe, while their interests should be watched over by representatives of the Indian Trade Commissioner at the principal ports. A charge for inspection sufficient to defray at least a portion of the necessary expense should be imposed and be made payable in cash or stamp at the time of affixing the grade seals. It is suggested that the commercial and manufacturing communities concerned should be consulted as to the advisability of establishing such a system.

#### *Containers.*

This is a most important problem on the successful solution of which the success of an oil export trade will ultimately depend. It is largely on account of the high cost and comparative unreliability of available oil containers that the export of oil seeds has hitherto flourished and that of oils failed. The greater part of cotton seed oil exported from the United States to Europe and elsewhere is shipped in new oakwood barrels the insides of which have been coated with glue, paraffin wax, shellac, or silicate of soda, and the results appear to be fairly satisfactory. In this case, however, the oil does not leave the temperate zone or pass through countries the temperature and humidity of which shew any considerable variation so that the containers are not subjected to variations likely to lead to serious deterioration. Further, the shipments of such oil being usually of considerable magnitude, difficulty is not experienced with regard to their stowage alongside other merchandise which might be spoiled by leakage of oil. Indian exports, on the other hand, have to pass from the tropical to the temperate zone, and to withstand the adverse effects of considerable variations both of temperature and humidity. It is not clear whether leakage of oil is greater in the case of changes from lower to higher, or from higher to lower temperatures. Judging, however, by the greater leakage



which occurs in Indian oil godowns in the cold weather due to the shrinkage of the staves, it would appear to be greater in the case of the latter. In India, at any rate, the wooden barrel is not a very satisfactory package. This is due to the fact that in dry weather the natural moisture of the wood is evaporated, and as its place is not as quickly filled by the oil, greater expansion and contraction takes place than in the temperate zone. It is possible that the leakage from such causes might not be sufficient to warrant higher expenditure on other forms of containers, but for a long time to come full cargoes of oils will not be offered, and consequently fear of damage to other goods placed in the same holds, will lead to the rejection of oil shipments which shew the slightest tendency to leak. It is necessary, therefore, to look around for some form of package which will meet the requirements of carriers and reduce the possibility of loss through leakage. The familiar kerosene case containing two 4 gallon tins is not suitable as the loss from leakage in the event of rough handling is greater than in the case of wooden barrels. Large steel barrels are excellent containers but with freights at their present height the cost of returning empty barrels would be a very expensive matter and it is doubtful if any suitable return load could be arranged. At any rate, return loads could only be arranged by large concerns. The same difficulties apply more or less in the case of tank steamers, although in this case the difficulties may in future be more easily overcome. For the present the only suitable container available in almost unlimited quantities is the small 4 or 5 gallon double turned over oil drum made from 24 or 22 gauge galvanized iron sheets which can be manufactured locally and does not require very heavy or elaborate machinery. If arrangements can be made for their disposal at a reasonable price in Europe they should prove only slightly more expensive than wooden barrels and the leakage difficulty would be largely overcome.

In conjunction with the proposed scheme for testing and grading of oils, it is suggested that an attempt should be made to standardize containers so that the advantages of grading seals will not be neutralised by the damage caused to other goods by leaky oil containers. No consignments the containers of which are unsuitable for ocean transport should be accepted for test by the Government Test Warehouses.

## APPENDIX No. I.

*Oil contents of the principal Indian oil seeds available in the  
Bombay Presidency.*

Name.	Botanical name.	Oil content per cent.
Castor seed ..	Ricinus Communis ..	46·50
Copra ..	Cocos Nucifera ..	65·70
Cotton seed ..	Gossypium Herbaceum ..	16·19
Groundnuts ..	Arachis Hypogaea ..	44·50
Jamba seed ..	Eruca Sativa ..	32·35
Linseed ..	Linum Usitatissimum ..	42·44
Mustard ..	Sinapis Nigra ..	31·33
Mowrah ..	Bassia Latifolia ..	40·45
Niger seed ..	Guizotia Abyssinica ..	35·37
Poppy seed ..	Papaver Somniferum ..	45·50
Rape seed ..	Brassica Campestris ..	40·45
Safflower seed ..	Carthamus Indicus ..	30·32
Sesamum seed ..	Sesamum Indicum ..	45·55

APPENDIX No. II.

*Principal Manufacturers of Oil Mill Machinery and Plant for the treatment of Vegetable Oils.*

Names.	Addresses.	Local Agents.
UNITED KINGDOM.		
1. Messrs. A. F. Craig & Co., Ltd. ..	Paisley, Scotland.	
2. „ Greenwood & Batley, Ltd. ..	Leeds .. ..	Messrs. Duncan Stratton & Co., Bombay.
3. „ Robert Middleton & Co., Ltd.	Sheepscar, Leeds .. ..	Messrs. Macbeth Bros. & Co., Ltd., Bombay.
4. „ Manlove Elliott & Co., Ltd.	Nottingham .. ..	Messrs. J. Fleming & Co., Bastion Rd., Bombay.
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6. „ George Scott & Co., Ltd. ..	Kingsway Home, Kingsway, Lon- don W. C. (Solvent Extraction Plant).	
7. „ Scott & Sons, Ltd. ..	72, Oxford St. London, W. 1. (Sol- vent Extraction Plant).	
8. Mr. Howard Lane .. ..	Ashford, Middlesex. (Hydrogena- tion Plant).	
9. Messrs. Blair, Campbell & McLean, Ltd.	Govan, Glasgow (Hydrogenation Plant).	
10. Messrs. L. H. Johnson & Co., Ltd. ..	Carpenter Road, (Filter Presses) Stratford, London, E.	

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|---|---|--|
| 1. Messrs. The American Machine and Manufacturing Co. | Greenville S. C. (Oil Mill Machinery).                        |  |
| 2. Messrs. Barnard & Leas Mfg. Co. ..                 | Moline Ill : (Cotton seed Hull Packing Machinery).            |  |
| 3. Messrs. Baner Bros. .. ..                          | Springfield, Ohio. (Cotton seed Decorticating Machinery).     |  |
| 4. Messrs. Brecht Co. .. ..                           | St. Louis, Missouri (Oil Refining Plant).                     |  |
| 5. Messrs. Buckeye Manufg. Co. ..                     | Dayton, Ohio (Oil Mill Machinery).                            |  |
| 6. Messrs. The Buruss Engineering Co.                 | Atlanta, Georgia (Anderson Oil Expeller).                     | Y. G. Pandit, Bombay.                          |
| 7. Messrs. Cardwell Machinery Co. ..                  | Richmond Va. (Oil Mill Machinery).                            | Messrs. J. Fleming & Co., Bastion Rd., Bombay. |
| 8. Messrs. The Diamond Huller Co. ..                  | Winona, Minn. (Cotton seed Decor-ticators).                   |  |
| 9. Messrs. The French Oil Mill Machinery Co.          | Piqua, Ohio (Oil Mill Machinery).                             |  |
| 10. Messrs. The Murray Company ..                     | Atlanta, Georgia (Cotton seed Oil Mill Machinery).            |  |
| 11. Messrs. Sprout Waldron & Co. ..                   | Muncy, Pen. (Cotton seed Decorticating & Grinding Machinery). |  |

*Holland.*

- |                           |   |   |
|---------------------------|---|---|
| Messrs. Frans Smulders .. | Utrecht, Holland. (Expellers & Oil Mill Machinery). | The Holland Bombay Trading Co., Ltd., Bombay. |
|---------------------------|---|---|

APPENDIX No. III,

*List of useful Books on the Manufacture and Treatment of Vegetable Oils.*

Author.	Title.	Publisher.
1. Andes, Louis E.	"Vegetable Fats and Oils "	Scott Greenwood & Co.
2. Do.	"Drying Oils, Boiled Oil and Solid and Liquid Driers.	Do.
3. Archbutt & Deeley	"Lubrication & Lubricants "	C. Griffen & Co.
4. Brodie, N.	"The Manufacture of Paint and Varnish in India."	The Superintendent, Government Printing, Calcutta, for Indian Munitions Board.
5. Chalmers, T. W.	"Production & Treatment of Vegetable Oils."	Constable & Co.
6. Ellis, Carlton B.	"Hydrogenation of Oils "	D. Van Nostrand, New York.
7. Ennis, William D.	"Linseed oil and other seed oils "	Do.
8. Fryer & Weston	"Oils Fats and Waxes "	Cambridge University Press.
9. Holde & Mueller	"Examination of Hydrocarbon Oils."	John Urby & Son, New York.
10. Hurst, Geo H.	"Lubricating Oils, Fats & Greases "	Scott Greenwood & Co.
11. Do.	"Soaps "	Do.
12.	"Industrial Handbook 1919 "	Indian Munitions Board.
13.	"International Library of Technology Sections 36 to 44 "	I. C. Schools.
14.	"Oilseeds and Feeding Cakes "	Imperial Institute, London.
15.	"Oilseeds, Oils, Fats & Waxes "	Do.
15A.	Colonial Reports (Miscellaneous).	Do.

16.			"Quarterly Reports of Imperial Institute."	Do.
17.			"Oil content of some South Indian Oilcakes." Journal of Indian Institute of Science, Vol. 1, Part XIX.	Mysore Residency Press.
18.			"Oil Splitting by Castor Seed Lipase." Journal of Indian Institute of Science, Vol. 2, Part XV.	Do.
19.	Koppe, S. W.	..	"Glycerine"	Scott Greenwood & Co.
20.	Lamborn, L. L.	..	"Cottonseed Products"	Do.
21.	Do.	..	"Soaps"	Do.
22.	Lewkowitch, D. J.	..	"Chemical Technology & Analysis of Oils, Fats and Waxes." 3 Vols.	MacMillan & Co.
23.	Noel Paton, F.	..	"Indian Cottonseed ; Its Industrial Possibilities."	Superintendent, Government Printing, Calcutta.
24.	Pandit, Y. G.	..	"Report on Oil Pressing Industry of Bombay Presidency."	Bombay Government Central Press.
25.	Simmons, W. H. and Mitchell, C. A.	..	"Edible Fats & Oils"	Scott Greenwood & Co.
26.	Watt, Sir George	..	"The Commercial Products of India."	John Murray.
27.	Wright, C. R. Alder	..	"Animal and Vegetable Fixed Oils, Fats and Waxes."	
28.			"Minute of Evidence of the Committee on Edible Oil Producing Nuts & Seeds of West Africa."	H. M. Stationery Office, London.

## APPENDIX No. IV.

*Average oil content of some English oil-cakes as given by Professor Crowther, M.A., Ph.D., Director of the Institute for Research in Animal Nutrition in the University of Leeds, in a memorandum submitted to the Committee on Edible and Oil Producing Nuts and Seeds (1916).*

No.	Variety.	How prepared.	Average oil content.
1	Palm kernel cake ..	Hydraulic Press ..	6 per cent.
2	Coconut cake ..	Do. ..	10 ..
3	Groundnut cake ..	Do. ..	10 - ..
4	Linseed cake ..	Do. ..	10 ..
5	Decorticated cotton seed cake.	Do. ..	9 ..
6	Undecorticated cotton seed cake.	Do. ..	5.5 ..

## APPENDIX No. V.

*Average oil contents of some American oil-cakes as given by Henry and Morrison in  
" Feeds and Feeding " (1917 Edition).*

No.	Variety.	How prepared.	Average oil content.	Number of samples analysed.
1	Cotton seed cake and meal choice ..	Hydraulic Press, decorticated ..	9.1 per cent. ..	2,556
2	Do. prime ..	Do. do. ..	8.3 " ..	1,322
3	Do. good ..	Do. do. ..	8.2 " ..	482
4	Do. ..	Expeller, undecorticated ..	7.7 " ..	64
5	Linseed cake and meal ..	Hydraulic Press ..	7.5 " ..	714
6	Linseed meal ..	Extracted ..	2.9 " ..	182
7	Groundnut cake ..	Hydraulic Press, decorticated ..	8.0 " ..	2,480
8	Do. ..	Do. undecorticated ..	11.1 " ..	7
9	Coconut cake and meal ..	Hydraulic Press ..	11.3 " ..	11
10	Palmnut cake ..	Do. ..	9.5 " ..	600
11	Rape seed cake ..	Do. ..	9.6 " ..	500
12	Sesamum or tilcake ..	Do. ..	14.00 " ..	150



## APPENDIX VI.

*Extraction of Oils by Solvents.*

FROM THE OIL AND COLOUR TRADES JOURNAL OF MARCH 19, 1921.

The second lecture by Mr. R. A. Bellwood (of Rose, Downs & Thompson, Ltd.), on "The Extraction of Oils by Volatile Solvents" was delivered at the College of Technology, Manchester, on March 10. An interesting and extremely valuable feature of the lecture was the section devoted to the design and construction of oil extraction works utilising the process which was the subject of Mr. Bellwood's remarks.

The lecturer stated that, though a great deal of progress had been made in recent years, there still existed in this country a prejudice against solvent extraction plants when edible oils were required. Provided that the process were properly carried out, it had been proved, however, that oils produced by solvent extraction were quite suitable for edible purposes. Moreover, many chemists were of opinion that extracted oils were much easier to refine than ordinary expressed oil. One argument that had been used against extraction was that a solvent extracted oil contained more free fatty acids than an expressed oil, but such was not the case. The use of a solvent did not increase the fatty acid content, and if more fatty acids were found in a solvent extracted oil it was simply due to the fact that the raw material had not been of equal quality to begin with. Another objection that was sometimes met with was the great risk run in using an inflammable solvent, such as petroleum spirit. Provided, however, that a plant was properly constructed and properly worked, very little danger existed. Notwithstanding this prejudice, there had been great developments in the process. Large plants were now at work, in Hull, Liverpool, Warrington, London, Port Sunlight, and Manchester, the aggregate capacity being between 7,000 and 8,000 tons of oleaginous seeds weekly. Manufacturers were beginning to realise the fact that with the solvent process practically the whole of the oil could be extracted. At the present time, the only drawback was the high price of the solvent. That, however, was bound to be reduced, which would give the solvent

extraction plants a better opportunity of coming to the front. The seeds and oils that could be treated in a properly designed extraction plant were so numerous that there was a very wide scope indeed for the enterprising manufacturer in the future.

To those about to enter the extraction business, the first thing to consider was a suitable site for the necessary buildings. An ideal position was one where both water and railway accommodation could be made available. When choosing a site, it should be borne in mind that there should be room for expansion purposes. Where water accommodation was available, the seed could be brought up in barges and delivered to silos by elevators. In designing a new plant, special attention should be paid to the handling and transporting of the raw materials and the finished products. As regards the buildings themselves, the lecturer recommended these to be of fireproof construction throughout, the silos being preferably of concrete. The ventilation of an extraction house was a very important problem, and should be studied very carefully. Whatever solvent was used, whether inflammable or non-inflammable, ample provision should be made for taking away any vapour caused by leaky joints, or any other cause. Some solvent vapours, though non-inflammable, were detrimental to health, some which were inflammable were only slightly detrimental, while others were both inflammable and injurious. Although the vapours of most of the solvents used in extraction works were heavier than air, and tended to sink to the floor, much of the vapour was carried away if the top of the extraction house was provided with a ventilator louvre running the whole length of the building. It was necessary, however, to have a series of ventilators at the floor level, which would take away any vapours that could not get away otherwise. Extraction houses should be, and usually were, of lofty construction, with top louvres as described. In buildings so constructed it was usually difficult to trace any smell of the solvent being used.

Solvent extraction plants should be well lighted, so that defects might be easily seen and quickly remedied. All the main cables should be carried in steel tubes on the walls outside the building. Wherever possible, all lamps should be of the air-tight bulkhead type,

with water seal, these being let into the walls of the building and connected to the mains outside the building by short branch pipes. As a rule, a plentiful supply of light could be obtained by that method. Where this was not possible, similar lamps might be arranged on the ceiling, all the cables being enclosed in steel tubes. All repair work on the extraction pots should be carried out by the aid of an ordinary battery lamp of good construction.

To obtain the most economical results from an extraction plant, it was essential, said the lecturer, that the type of motor to be installed should have very careful consideration. If the solvent used was an inflammable one, the motors should be arranged outside the extraction house in a vapour-tight building. Most manufacturers preferred an ordinary steam-engine, and took part of the exhaust steam to the extraction house to be used in the solvent evaporators for vapourising the solvent from the oil. Whatever type of driving power was selected, it was necessary to have a boiler for steam production, the steam being essential for distilling off the solvent used from both the oil and the meal. In some plants steam was required for special heaters which drove off a certain percentage of moisture from the raw material before it went to the extraction plant. Steam might also be required for operating drying machines, and also for treating the oil or grease residues. It was usually the practice in designing extraction plants to provide a boiler with a steaming capacity above the actual average steam consumption of the plant. That was a wise precaution, because if anything went wrong, the proper working cycle of the plant was disarranged, with the natural consequence that an abnormal quantity of steam was required at some given period, so as to bring the working back to its proper cycle without loss of time. It might be, when first starting work on a new material, that the estimated time required for extraction might not work out according to calculation, or temporary stoppages might be caused through iron getting into some part of the grinding plant. Even with the most carefully designed plants, and with the best magnetic separators that might happen. To get the best results from a plant, a small recording meter should be fixed to each separate unit, so that it might be definitely ascertained when and where the steam was being consumed.

It was impossible to lay too much stress on a proper preliminary treatment of the material before extraction. All oleaginous seeds or nuts contained greater or lesser quantities of foreign matter, such as stones, iron, sand, and seeds other than those it was intended to treat. If the seeds were not properly cleaned, an inferior oil was obtained, and in some cases the process was retarded, and a smaller percentage of oil obtained on account of the absorbent qualities of the impurities. The theory of extraction was that if ground oleaginous seed was taken and saturated with a solvent, the oil diffused into the solvent, and penetrated into the cells, so that there was a concentrated mixture both in and out of the cells. If, therefore, the quantity of oil in the material being treated was previously known, the amount of the solvent measured, and the amount of mixture run off from the extraction vessel measured, the amount of oil remaining in the material could easily be calculated, as could also the amount of solvent required to bring the oil down to any desired percentage. Briefly explained, the extraction process consisted in : (1) the preparation of the material so that the solvent would pass easily into it, and into the oil cells ; (2) to allow cold or hot liquid solvent or hot vapour to percolate through the material which was contained in an enclosed pan ; (3) to drain off the mixture of oil and solvent from the material into a still ; (4) to drive off the solvent from the oil by heat, as a vapour, and pass through a condenser to liquify and recover the solvent for further use ; (5) to drive off the solvent from the meal by heat, as a vapour, and pass through a condenser to recover as a liquid for future use.

Discussing at some length the ideal solvent material, Mr. Bellwood said the conditions laid down were very exacting indeed : (1) it should neither be inflammable nor expensive ; (2) it should vapourise with the use of only a small amount of heat ; (3) it should dissolve only the oil content of the material under treatment ; (4) it should be of a very searching nature ; (5) it should be a uniform chemical body that would not disintegrate when being distilled off ; (6) it should not give off noxious vapours that would be detrimental to the health of the worker ; (7) it should not cause any chemical change in the material under treatment ; (8) it must not cause deterioration in the

apparatus ; (9) the cost must be low. Needless to say, there was no solvent known that fulfilled all these conditions. Of the many different kinds of solvent materials, only trichloroethylene and carbon tetrachloride could be regarded as safe from explosion and fire. Leaving out the question of specific gravity, carbon tetrachloride was the most favourable as regards the consumption of heat units, both its specific heat and vapourising heat being the lowest. Owing, however, to its higher cost and detrimental effect upon the worker it had been superseded by benzine. The weight of benzine used as against other solvents was as follows :—Compared with carbon tetrachloride 45·9 per cent. ; compared with trichloroethylene, 50·0 per cent. ; compared with carbon bisulphide, 57·2 per cent. ; compared with benzole, 84·0 per cent. The comparative cheapness of benzine and the fact that it was easy to obtain in large quantities should be taken into consideration. It was therefore not difficult to see why benzine was to-day the chief solvent used for extraction purposes.

Department of Industries  
BOMBAY PRESIDENCY

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# INDIAN CASEIN

## PART II THE PROPORTION OF FAT IN CASEIN

BY  
DATTATRAYA MANJUNATH GANGOLLI  
and  
ANDREW NORMAN MELDRUM

**BULLETIN No. 4**

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## PREFACE.

The first bulletin of the Department of Industries, published in February, 1920, contains an account of the earlier investigations of Mr. D. M. Gangolli and Dr. A. N. Meldrum relating to the preparation of high quality casein in India. The results of their subsequent work are contained in the present publication.

The work of these investigators has enabled the Department recently to open at Anand, under their supervision, a small demonstration factory for the manufacture of casein on a commercial scale. It is hoped that this factory will ultimately result in an extended and improved casein industry.

R. D. BELL,  
Director of Industries.

BOMBAY,  
5th January 1921.



# INDIAN CASEIN.

## PART II.—THE PROPORTION OF FAT IN CASEIN.

In Part I of this series of papers on Indian Casein—"The Preparation of 'Sulphuric' Casein"—we have considered, in detail, the factors that determine the proportion of acid and of ash-yielding matter in "sulphuric" casein. We have indicated a method, that could be used on a large scale, for making casein so that it shall contain a low proportion of these impurities. A sample of casein that we prepared in July 1919, according to an earlier, though almost a similar process (Part I, page 6, paragraph 18) was sent by the Director of Industries, Bombay, to the Imperial Institute, London. The report which reached us from the Imperial Institute stated that "the casein was regarded by experts as of good quality and it was considered that material equal to the sample would find a ready market in the United Kingdom. . . . There is no doubt that if a product of this quality could be produced on a commercial scale for export much better prices would be obtained than formerly and the reputation of Indian casein would be enhanced."

2. In casein that is intended for industrial use, the impurities, apart from dirt pure and simple, on which its value depends are, water, fat, ash-yielding matter and acid. The more water in a sample the less casein, and further, the more water the greater the liability of the casein to fermentation. In this part of India, it is easy by mere drying in air—except during the monsoon season which lasts less than four months of the year—to produce casein containing a low proportion of water. A high proportion of water and of acid together may encourage decomposition and fermentation of the casein. A high proportion of ash-yielding matter is not always a disadvantage, otherwise "rennet"

casein would be of little value. In "sulphuric" casein, since the acid and ash-yielding matter are easily reduced to small amounts, their presence in large amount encourages the suspicion that the casein has been unskillfully made. The presence of fat is probably a factor on which the value of casein largely depends. The fat in casein is proportional to the amount of fat in the separated milk from which the casein is made. In this paper we consider methods for determining and for reducing the amount of fat in casein. The following paper is therefore divided into two parts:—A. Methods of Analysis; B. Elimination of Fat.

#### A.—METHODS OF ANALYSIS.

3. During the work described in Part I of this series, we had used the customary methods for determining the amount of fat in casein. These consist in treating dry casein with ether, either in Soxhlet's apparatus, or by shaking the casein with the solvent.

4. The method of extraction, using the Soxhlet apparatus, appears to be widely used in the Agricultural Departments of the United States of America. F. L. Browne gives figures which he regards as proof that, for practical purposes, the extraction by ether, of fat, from casein placed in a Soxhlet apparatus, is complete in 8 hours. (*J. Ind. Eng. Chem.*, 1919, 11, 1019-1024.)

Time of extraction in hours.					Fat per cent.
3	..	..	..	..	10.00
6	..	..	..	..	10.45
8	..	..	..	..	10.50
(a) 16	..	..	..	..	10.54
(b) 16	..	..	..	..	10.58

Another method is recommended in Lunge and Keane's "Methods of Technical Analysis," Vol. III, page 328:—The finely powdered casein (10 grams) is shaken for one hour with ether (100 cc.), the ether extract is

filtered and 50 cc. are placed in a small weighed flask; the ether is evaporated and the residue is regarded as fat. These two methods, although they can give comparable results if always used in the same way, are defective in this respect, that the extraction of dry casein, even if the casein is finely ground, can always be regarded as incomplete: it can be objected that fat is left in the interior of the grains.

5. In our work we had used both these methods and had found that they lead to much the same result. But whilst we had found 0.24 per cent. of fat in the casein that was sent to the Imperial Institute, there, the fat was found to be 7.4 per cent. Granting that the method we used does not give absolute results we could not believe that it indicates only 1/30th of the true value, that an absolute method can give 30 times the value we had obtained. We were thus led to investigate methods for determining the amount of fat in casein.

6. Since dry granular casein, on extraction with a solvent, does not yield all its fat, the natural remedy is to dissolve the casein first and then to carry out the process of extraction. We were informed that at the Imperial Institute the method adopted consists of "preliminary digestion with hydrochloric acid followed by extraction with ether." We have followed out this suggestion and by trying various solvents, under different conditions, have been able to arrive at an absolute method for determining fat in casein and, at the same time, to account for the very high result obtained at the Imperial Institute.

7. We used the following solvents:—Hydrochloric acid (concentrated) and sulphuric acid (concentrated); solution of borax and of sodium phosphate; hydrochloric acid, sulphuric acid, sodium hydroxide, ammonium hydroxide, each of 0.5 N strength; barium hydroxide and calcium hydroxide.

8. The use of borax, of sodium phosphate and of calcium hydroxide was abandoned as soon as it was found that these solvents give

rise to a solution that forms an emulsion with ether. In the case of concentrated hydrochloric and sulphuric acids the apparent yield of fat on extraction with ether was high and uncertain. The results in the case of hydrochloric acid were particularly suspicious and the only conclusion we could come to was, that this acid hydrolyses the casein, producing substances that are soluble in ether. The sulphuric acid had a similar effect, though to a less extent. We are pursuing this subject further, and we hope to give the results in a separate paper. At present we can say that casein, when dissolved in concentrated hydrochloric or sulphuric acid, is hydrolysed, producing material that is soluble in ether. On the other hand, when a 0.5 N solution is used, hydrochloric or sulphuric, there was little sign of hydrolysis. We also used dilute solutions of sodium and barium hydroxides, and observed signs either that slight saponification of the fat had occurred or that fatty acid was already present in the casein; the alkaline solution was extracted with ether and then, when the solution was acidified, a small amount of fatty acid was liberated.

9. The casein of which a sample had been sent to the Imperial Institute was again analysed for fat with the following results:—

Solvent.	Fat per cent.
HCl sp. gr. 1.16 .. .. .	(a) 2.28
	(b) 1.94
	(c) 1.46
H <sub>2</sub> SO <sub>4</sub> sp. gr. 1.82 .. .. .	(a) 1.24
	(b) 1.02
HCl 0.5 N .. .. .	0.31
H <sub>2</sub> SO <sub>4</sub> 0.5 N .. .. .	0.29
NaOH 0.5 N .. { Fat .. 0.25 } ..	0.28
	{ Fatty acid 0.03 }
Dry casein shaken with ether .. .. .	0.24
.. in Soxhlet. with ether .. .. .	0.23

10. We submit that these results are as they should be. Strong acids give high and uncertain results because they hydrolyse the casein

and ether extracts fat and hydrolysis product as well. 0.5 N acid and alkali give nearly the same result ; moreover, this result is a little higher than that which is obtained on extracting dry casein with ether.

11. These conclusions were confirmed by further experiments. The following results were obtained on analysing four samples that were obtained in an experiment described in part B, paragraph 18, of this paper :—

Solvent.	Samples.			
	1	2	3	4
HCl sp. gr. 1.16 ..	2.89	0.64	0.26	0.26
HCl 0.5 N ..	2.15	0.49	0.17	0.12
H <sub>2</sub> SO <sub>4</sub> 0.5 N ..	1.99	0.41	0.15	0.08
NaOH 0.5 N ..	1.99	0.37	0.13	0.09
Dry casein shaken with ether ..	1.66	0.22	0.08	0.04

12. A sample of casein, that had been made by a firm in Bombay, was sent to us for analysis. This casein contained a high proportion of fat and was thus advantageous in testing various solvents. The results were as follows :—

Solvent.			Fat per cent.
H <sub>2</sub> SO <sub>4</sub> 0.5 N ..	..	..	3.26
NaOH 0.5 N ..	..	..	3.28
NH <sub>4</sub> OH 0.5 N ..	..	..	3.29
Ba(OH) <sub>2</sub> 0.5 N supersaturated solution ..	..	..	3.23
Dry casein shaken with ether ..	..	..	3.20
.. .. in Soxhlet, with ether ..	..	..	3.18

13. Further experiments were made with a view to finding which of the possible solvents dissolves casein most rapidly. The results

are summarised in the following table. The amount of casein used was 1 gram in each experiment :—

Reagent.	Strength.	Quantity.	Time during which the casein dissolves.
<i>Alkalies.</i>			
(1) NaOH	.. 0·5 N	15 cc.	2—5 minutes.
(2) NH <sub>4</sub> OH	.. 0·5 N	15 cc.	2—5 „
(3) Ba(OH) <sup>2</sup>	.. 0·5 N*	15 cc.	5—7 „
<i>Acids.</i>			
(1) HCl	.. 0·5 N	25 cc.	3—4 hours.
(2) H <sub>2</sub> SO <sub>4</sub>	.. 0·5 N	25 cc.	3—4 „

14. From the results given in paragraphs 9, 11 and 12, it is clear that 0·5 N hydrochloric acid gives slightly higher results than 0·5 N sulphuric acid. It is possible that the hydrochloric acid causes slight hydrolysis of the casein. Again, the results in paragraph 13 indicate that alkali should be used in dissolving the casein because it acts far more quickly than acid. The details of the method we recommend are as follows :—In a conical separating funnel (capacity 100 cc.) is put the solvent 0·5 N NaOH (15 cc.), and to this is gradually added the finely ground casein (60 mesh, 1 gram). The whole is then shaken vigorously until the casein is completely dissolved. Ether is then added and a rotatory movement is given to the funnel. After allowing the extract to separate, the ethereal layer is transferred through a dry filter paper to a weighed flask and subsequently evaporated to dryness and weighed as fat. In case it is thought desirable to include fatty acid along with fat, the necessity of a second extraction with ether can be avoided by dissolving the casein in alkali and then acidifying by adding sulphuric acid. This acid solution is then extracted with ether as usual.

---

\* Supersaturated;

## B.—ELIMINATION OF FAT.

15. It is easy, as we have shown, to control the proportion of ash-yielding matter and of acid in casein, and to reduce these impurities to small amounts. The proportion of fat is less easily controlled, since, in the production on a large scale, it depends almost entirely on the fat left in the separated milk from which the casein is produced. This fact we pointed out in Part I, page 3. Information is not easy to obtain as to the amount of fat left in milk by a good separator, working under the best conditions. As far as we can judge from the extensive series of analyses of casein that F. L. Browne has published, (*loc. cit.*), and from our more limited experience, the proportion of fat in casein, when the separator has been worked efficiently, is always under 0.5 per cent., and the average appears to be 0.25. Casein made in the United States of America and in India, often contains far more fat than this.

16. We have made a number of experiments with a view to reducing further the amount of fat in casein. In the first place, we tried a method that has been recommended, namely, to heat the separated milk at 60°—70° C until a scum is formed. The scum is supposed to contain albumen and fat, and is removed. The milk is then cooled to be converted into casein. An experiment indicated that very little is gained by this process.

	(a) original milk	(b) milk heated to 60°—70° C.
Fat in casein	0.36 per cent.	0.34 per cent.
		Scum 3.401 gr.
		Fat in scum 0.018 gr.

This process, though we gained nothing by it, may be advantageous when the milk contains a large proportion of fat.

17. Knowing the amount of fat in casein it is interesting to calculate back to the amount of fat in the milk, from which the casein was

made. On the supposition that milk contains 3·3 per cent. of casein, the fat in the milk is one-thirtieth of the fat in the casein. This, however, assumes that casein contains all and the whey, none of the fat in the milk. We made an experiment in which we determined the amount of fat (a) in the casein and the whey obtained from a litre of milk and (b) in a litre of the same milk.

Fat in casein	0·84 gr.	
"    whey	0·08 "	
(a) Total fat	0·92 "	(b) Fat in milk 0·93 gr.

Of course, ether was used to extract the fat. The usual assumption made is that ether-soluble matter is fat. Strictly speaking, the experiment proves only that ether-soluble matter in small amount passes into the whey.

18. We have endeavoured to prepare fat-free casein by removing fat from the milk through the agency of petrol. The milk was shaken with petrol in a bottle and the mixture was passed through a separator. This gave petrol and an emulsion on the one hand, and milk on the other. The milk was again treated with petrol and passed again through a separator. In all, four samples of milk were treated so as to get casein, the original milk, and milk that was treated once, twice and thrice with petrol. The amounts of fat in the four samples were determined. The results have been shown in Part A, paragraph 11. We need only repeat that three treatments with petrol led to casein containing 0·09 per cent. of fat.

19. As the process just described was too protracted the petrol was used in another way. Casein was precipitated as usual from separated milk, a sample was taken, dried and analysed; the remainder of the casein was filtered and then, to remove water, was shaken with rectified spirit, filtered, shaken with absolute alcohol and filtered again. The casein was then placed in a bottle and petrol was added and the two were shaken together, using a shaking machine. The casein was filtered, dried and analysed.



				Fat per cent.
Casein untreated	..	..	..	0.44
.. treated with petrol..	..	..	..	0.09

In another experiment casein was precipitated as above and washed with rectified spirit and absolute alcohol. It was then treated three times with petrol. Thus four samples of casein were obtained that had been treated 0, 1, 2 and 3 times respectively. These were dried and analysed.

	0	1	2	3	
Fat	.. 0.21	0.08	0.05	0.04	per cent.

20. We are of opinion that the colour of casein depends greatly on the presence of fat in it. The samples, that we obtained, containing a low proportion of fat, had a very pale green colour, and when the casein was finely ground the colour was almost white. Further, in preparing pure casein for research purposes, we recommend the use of petrol instead of ether in order to remove the fat. Ether is expensive and is liable to contain peroxide which may lead to contamination of the casein. Petrol is cheap, is easily purified and easily passes away from the casein at the end.

AHMEDABAD,  
October 1920.

Department of Industries

BOMBAY PRESIDENCY

# CHINA CLAY DEPOSITS

OF

TALUKA KHANAPUR, BELGAUM DISTRICT

BY

**K. A. KNIGHT HALLOWES,**

M.A. (Cantab.), F.G.S., A.R.S.M. (London), A.Inst.M.M., F.R.M.S., Mem.R.S.L., F.Inst.P.

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# THE CHINA CLAY DEPOSITS OF TALUKA KHANAPUR, BELGAUM DISTRICT.

## I.—INTRODUCTION.

Mr. E. R. Fern, Superintendent of the Pottery Department of the School of Art, Bombay, having observed kaolin near Karalgi and Kapoli, Taluka Khanapur, Belgaum District, South India, I was deputed, in November 1920, to investigate these occurrences, in order that their economic value might be ascertained and made known to the Government of Bombay before concessions were given to private individuals.

The quantity of china clay available at Karalgi and Kapoli was determined by sinking a number of prospecting shafts at each locality with the aid of some forty-seven men from one of the settlement colonies in the District, and my thanks are due to Mr. P. R. Cadell, I.C.S., Commissioner, and to Mr. G. Laird MacGregor, I.C.S., Collector of Belgaum, for arranging for this labour to open up the deposits.

I am indebted to Mr. E. R. Fern for making, in his laboratory, a number of chemical and physical tests on the samples of kaolin from Karalgi and Kapoli submitted to him by me from the field; those for Karalgi will be found tabulated on page 12.

My thanks are specially due to Mr. R. D. Bell, C.I.E., I.C.S., Director of Industries, Bombay, for arranging to have the above tests carried out, and for all the help he so courteously gave me during the progress of the research.

There has been no previous literature on the kaolin of Karalgi and Kapoli, and the only reference to the area is by Bruce Foote, who remarks on page 43 of his *Geology of South Mahratta Country, Mem. G. S. I.*, Vol. XII, Pt. 1, that "a kind of granitoid gneiss runs through the town of Khanapur".

## II.—THE DEPOSITS.

### (a) KARALGI.

The kaolin of Karalgi, as will be seen from the sketch plan (Figure 1), occurs in a natural hollow on the side of a bank, the lateritic soil having been washed away by floods of rain during the monsoons, revealing a bed of white china clay which passes gradually through kaolinized gneiss into

the latter in its unaltered state. This hollow has a long oval shape, the main axis of which strikes N.E.-S.W. At the actual junction between the overlying lateritic soil and the underlying kaolinized gneiss, the white clay is very impure and iron stained, being of an ochre-yellow colour ; it becomes, however, purer and whiter at lower and lower horizons until,

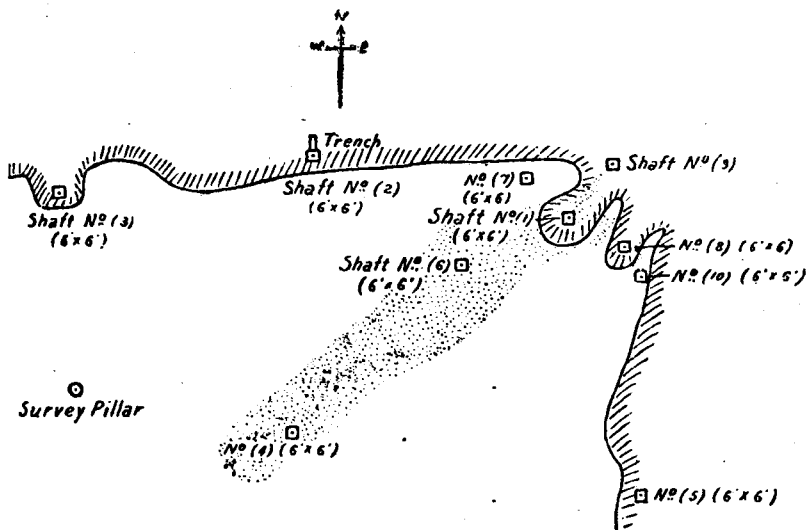


Fig 1. Diagrammatic Sketch Plan of the First Upper River Terrace near Karalgi, and of the Prospecting Shafts Sunk through it to test the kaolin Deposits.

finally, in the trial shaft No. (1) which was sunk here, it passes into pure white china clay of excellent quality. The kaolin bearing ground of this locality (which is included in Revenue Survey Sheet No. 76) is held by Vithal Yeshvant, Patel of Karalgi, and is situated some three miles from the railway station at Khanapur.

Fresh completely unaltered gneiss was not observed in any of the trial shafts, but exposures of it were seen (a) in a field adjoining shaft No. (1) and (b) at a point in the Malpraba river near by. In the latter locality situated a short distance north-west of shaft No. (1), are beds of schistose gneiss forming a bar across the river ; these are traversed by a series of joint planes with an inclination of  $50^{\circ}$  to S.  $70^{\circ}$  W. North-east of shaft

No. (1), on the east bank of the same river, just beyond the bend which it makes to flow northwards after pursuing an easterly direction, and not far from the point where it is joined by a small tributary, is an exposure of slightly kaolinized gneiss, the felspars of which can be seen with the unaided eye to have been partly altered into kaolin. Except for these exposures of the underlying gneiss, the country, in the vicinity of the kaolin at Karalgi, is covered by alluvium. In the midst of the china clay itself, moreover, are fragments of still undecomposed gneiss, the outer skin of which only has been altered into kaolin; these indicate that the china clay of this locality has been formed by the kaolinization of the gneiss. That the kaolin in shaft No. (1) Karalgi has been formed by the decomposition of the upper surface of the muscovite gneiss underlying the lateritic capping is also shown by the china clay containing here and there flakes of white muscovite which escaped decomposition when all the felspars of the original gneiss were decomposed.

In all probability the kaolins of Karalgi and Kapoli have been formed by percolating carbonated surface waters, which have kaolinized the gneiss into which these deposits merge by gradual transition.

#### (b) KAPOLI.

The china clay of Kapoli occurs in (1) land included by Sheet No. 111 of the Land Records Survey, and (2) in Government reserved forest land shown by Sheet No. 93 Land Records Survey. The occurrence is situated four and a half miles from Londa railway station.

The rocks of Kapoli, from which the low grade china clay deposits of that area have been derived, consist of slightly felspathic quartz-muscovite schists with some subordinate grey gneiss, and one of the reasons why there is so little kaolin available there is that the former series of rocks contain comparatively little felspar to become kaolinized.

### III.—QUANTITY.

The quantity of china clay available at Karalgi and also at Kapoli was determined by sinking ten trial shafts at the former and seven at the latter locality to investigate the thickness of each of the beds of kaolin and

their horizontal extent, and to ascertain to what degree the gneiss and felspathic quartz-muscovite-schist forming the country rock had become kaolinized. Those sunk at Karalgi indicate that the quantity of kaolin available there is fairly good; in No. (1) the bed of kaolin is 11' 7" thick, and extends under the ground in a south-south-easterly direction to shaft No. (8), where it increases to a thickness of 17 ft.

A tabulated statement of the trial shafts sunk at Karalgi is given on page 8. These show that the china clay of Karalgi is not in the form of a bed of pure kaolin of uniform thickness and quality extending over a considerable area, but is of the nature of a lenticular somewhat irregular bed of kaolin, whose thickness and quality varies from point to point, consisting at one place of pure kaolin, and at another of slightly kaolinized or almost unaltered gneiss. The bed of kaolin which, as already mentioned, is 11' 7" thick in shaft No. (1), and 17' 0" in No. (8), extends underground for a distance of 240' in a direction S. 49° W. to No. (4), where it diminishes to a thickness of 10' 8". It appears, therefore, that there is a very fair quantity of kaolin available at Karalgi. The shafts, moreover, indicate that when the lenticular bed of kaolin 11' 7" thick in shaft No. (1) is traced for a distance of (a) 47' in a north-westerly direction, it thins out completely before shaft No. (7) is reached; of (b) 56' in a north-easterly direction, it thins out into a few worthless stringers of gritty kaolin in No. (9); of (c) 69' in a direction S. 65° W., it is found to have a thickness of rather more than 6' 3" in No. (6); and of (d) 35' in a direction S. 15° E., it increases in thickness to 17' in No. (8), but thins out entirely in No. (10), after a distance of another 90'. The bed of china clay in No. (1), moreover, thins out completely before shafts Nos. (9), (7), (2), (3), (10) and (5) are reached.

Taking the horizontal area over which the ten prospecting shafts have shown the bed of kaolin to extend underground, which I find to be 8,417.5 sq. ft., and taking the average thickness of the bed to be 10 ft., the total quantity of china clay available at Karalgi, including the lower grade and more gritty varieties, is  $8,417.5 \times 10 = 84,175$  cubic ft., or about 3,750 tons. Owing, however, to the lenticular nature and the somewhat erratic distribution of the kaolin in the gneiss of this locality, it is quite impossible to arrive at an exact figure, and there may, consequently, be

rather more or less than this quantity actually present. I do not think, however, that the quantity available is much less than the figure given above, although it may very well be higher than this, since the lenticular bed of kaolin in the locality tested is probably continued underground in a direction S. 45° W. of shaft No. (4) into the adjoining country.

The quantity of china clay available at Kapoli is indicated by the table of the seven prospecting shafts given on page 10. These indicate that there is no actual bed of kaolin at Kapoli, such as was found at Karalgi, but only slightly kaolinized felspathic muscovite schists and gneiss, which merely contain occasional worthless stringers of gritty kaolin; the kaolin of Kapoli is, therefore, of no economic value.

#### IV.—QUALITY.

The bed of kaolin 11' 7" thick in trial shaft No. (1) Karalgi was sampled by means of a vertical groove 7" wide and 3" deep cut from the top to the bottom of the bed, the china clay so obtained being coned and quartered in the usual way.

As will be seen from the "Table of the Analyses and Physical properties of the china clays of Karalgi," given below on page 12, the kaolin of the locality is of excellent quality, and is of use for the manufacture of porcelain and china ware.

This table shows that since the china clays of shafts Nos. (1), (4), (6) and (8) have silica and alumina percentages which approximate to kaolinite,  $\text{Al}_2\text{O}_3$ ,  $2\text{SiO}_2$ ,  $2\text{H}_2\text{O}$ , ( $\text{SiO}_2$  40·8 per cent.;  $\text{Al}_2\text{O}_3$  39·8 per cent.), they consist of high grade kaolins. The 1·5 per cent. of  $\text{Fe}_2\text{O}_3$  in the kaolins of shafts Nos. (1) and (8) causes the clay to burn a pale yellowish white, while the 2·1 per cent. of  $\text{Fe}_2\text{O}_3$  in the kaolin of shaft No. (6) gives a buff product after firing in the kiln; the action of the lime present in the latter is, however, to diminish the depth of colour by destroying a part of it.

Moreover the table also shows that the quality of the kaolin, so good in shafts (1) and (8), falls off in No. (6), but actually becomes better in No. (4) than it was in No. (1). The analyses also indicate that the quality of the lenticular bed of kaolin, 11' 7" thick in No. (1), is maintained in a S.S.E. direction into No. (8), where it becomes 17' 0" thick.



There is no china clay at Kapoli at all comparable in quality with the pure white kaolin of Karalgi. None of the trial shafts sunk at Kapoli indicate a bed of good pure china clay like that in Nos. (1) and (8) Karalgi, but merely reveal slightly kaolinized ferruginous felspathic muscovite schists and gneisses. The kaolin is tinged a very pale greyish blue, and is iron stained and gritty, all of which very greatly diminish its value for the manufacture of china. Such kaolin would require an excessive amount of levigation to produce a very small quantity of pure clay; this would be an expensive matter, and would, moreover, not completely wash out all the iron-oxide with which the clay is stained.

Very white kaolin is frequently used as a filler of cotton fabrics, as it serves to stiffen them and to give them a surface. In order to see if the Karalgi kaolin was of any value for sizing, an average bulk sample of  $2\frac{1}{2}$  tons of crude kaolin was obtained and sent to Mr. E. R. Fern, who washed out of it the impurities of sand and mica in the specially large levigating trough attached to his laboratories; he produced from it 700 lbs of refined kaolin, which was sent to Messrs. C. N. Wadia & Co., Century Mills, Bombay, who were good enough to make with it a "full sizing test." Mr. J. G. Anderson, General Manager, reporting on the adaptability of the Karalgi china clay for sizing yarn, says that it is somewhat inferior, in its sizing properties, to the china clay which they import from home for the purpose, since the latter is a little whiter in colour and is less brittle and adhesive. He points out, however, that the whiteness of the kaolin could be improved by sun bleaching, and by treatment with a trace of blue colouring matter, and that its brittleness could be remedied by adding to the size a little glycerine or tallow, although this treatment would, of course, somewhat increase its cost. He concludes from his tests that the kaolin is more suitable for finishing cloth than for sizing yarn, since, in the former process, other ingredients are added to whiten the cloth, which, to some extent, would neutralize the objectionable tint of this clay. With all its disabilities, however, the Karalgi kaolin has the following distinct merit in its favour—it has better adhesive qualities than the clay imported from England. On the other hand it sets harder, which may cause the yarn to be harsher and

brittle in shred. Taking everything into consideration there is little doubt that with careful treatment and enterprising business management a market might be obtained for the levigated kaolin of Karalgi as a sizing material for cotton cloth. The kaolin of Kapoli is not pure white like that of Karalgi, but either has a very pale greyish-blue tinge or is of a pale yellowish colour from the contained iron oxide ; it is not, therefore, of any value for the above purpose.

#### V.—TRANSPORT.

The transport facilities of Karalgi are very fairly good since (a) the Malprabha river, flowing eastwards, runs close by (see map), whose channel passes under the railway near Khanapur at a point some  $3\frac{1}{2}$  miles to the west ; at certain times of the year, therefore, when there is sufficient water in the river, small country boats might bear loads of refined kaolin from the china clay occurrence at Karalgi to the railway at Khanapur ; and since (b) the railway at Khanapur is only  $3\frac{1}{2}$  miles due west, in a straight line, from the kaolin at Karalgi. To it should be laid a light tramway, but failing this some two and a half miles of metalled road should be constructed running in a W.S.W. direction from the kaolin occurrence at Karalgi, through, or close to, the village of Jalga, to meet the main road from Khanapur to Nandgad at milestone 18. Along this road motor-lorries might then be used to transport the washed kaolin in casks or gunny-bags to the railway station at Khanapur.

Table of the Prospecting Shafts sunk at

Prospecting shaft (see fig. 1 for the position of each shaft).	Dimensions.	Total depth from surface.	Depth of the upper limit of the bed of Kaolin from the surface.	Depth of the lower limit of the bed of Kaolin from the surface.	Thickness of the bed of Kaolin.
No. (1)	6' x 6'	20' 3"	8' 8"	20' 3"	11' 7"
No. (2)	Pit 6' x 6'; attached trench is 32' x 1' 10".	Pit 6' 4'; attached trench 6' 6"	....	..	Merely a few mi- nute stringers of partly kaolinized gneiss.
No. (3)	6' x 6'	10' 6".	..	....	Do.
No. (4)	Do.	25' 10'	14' 0"	24' 8"	10' 8"
No. (5)	Do.	8' 0"	....	....	Merely a few mi- nute stringers of partly kaolinized gneiss.
No. (6)	Do.	24' 3"	18' 0"	..	More than 6' 3'; total thickness un- known, since the shaft was not sunk deep enough to reach its lower limit.
No. (7)	Do.	19' 7"	....	....	Merely a few mi- nute stringers of partly kaolinized gneiss.
No. (8)	Do.	22' 4"	4' 4"	21' 4"	17' 0"
No. (9)	Do.	6' 9"	....	....	Merely a few stringers of white kaolin.
No. (10)	Do.	7' 0"	...	....	Merely a few mi- nute stringers of pale, sea-green kaolin.

*Karalgi, Khanapur, and their beds of Kaolin.*

Nature and thickness of the "Overburden"	Nature and thickness of the Rock Formation between the lower limit of the "Overburden" and the upper limit of the Kaolin.	Nature of the Rock Formation between the lower limit of the Kaolin and the bottom of the pit.	Remarks.
Granular Laterite: 4' 10".	Yellowish brown clay (highly decomposed gneiss): 3' 10".	Dark yellowish brown ferruginous clay, (highly decomposed gneiss), containing occasional minute stringers of kaolin and partly kaolinized gneiss.	A lenticular bed of excellent kaolin suitable for the manufacture of china ware. The kaolin is very free from grains of quartz and felspar, except near the lower limit of the bed where it passes gradually into partly kaolinized gneiss. At the bottom of this prospecting shaft the lower surface of the lenticular bed of kaolin dips towards No. (8); it was subsequently found to have increased in thickness to 17' 0" in the latter shaft.
Soil and decomposed gneiss.	Partly decomposed gneiss	Partly decomposed gneiss	The prospecting trench attached to the shaft strikes N. 70° E; it merely shows decomposed gneiss with occasional minute stringers of white partly kaolinized gneiss.
Do.	Do.	Do.	The bed of china clay, which is 11' 7" thick in shaft No. (1), has thinned out, entirely before reaching shaft No. (3).
Granular Laterite: 2' 8".	Dark brick-red coloured clay (highly decomposed gneiss): 11' 4".	Pink gneiss showing very slight kaolinization of the felspars.	The shaft is sunk on the wedge-shaped end of the lenticular bed of china clay. At its lower end, against the west wall, is kaolin of very good quality similar to that in Pit No. (1). This lenticular bed of kaolin is seen in the shaft to pass down by gradual transition into partly kaolinized gneiss which grades, at a lower horizon, into almost unaltered pink gneiss.
Soil and decomposed gneiss.	Partly decomposed gneiss	Partly decomposed gneiss	The bed of kaolin 11' 7" thick in shaft No. (1), has thinned out entirely before reaching Pit No. 5.
Granular Laterite: 6' 0".	Yellowish brown clay (decomposed gneiss): 12' 0".	....	The upper boundary of the bed of china clay in this shaft slopes slightly to the west; the bed contains fragments of quartzite, and is not of such good quality as that in prospecting shaft No. (1).
Granular Laterite: 4' 2".	Partly decomposed gneiss	Partly decomposed gneiss	Between the surface and a depth of 10' the gneiss is decomposed into a dark yellowish brown clay, while between the horizons of 10' and 19' 6" the gneiss is less decomposed and contains stringers of kaolinized gneiss.
Soil and decomposed gneiss: 2' 10".	Partly decomposed gneiss: 1' 6".	Brown clayey ferruginous decomposed gneiss, (practically the same as that below the kaolin bed of shaft No. (1)).	This shaft is sunk in the middle of a natural hollow in the ground formed by the heavy rains during the monsoons. The china clay is very pale sea-greenish-white in colour.
Do.	Do.	Partly decomposed gneiss	The bed of kaolin, 11' 7" thick in shaft No. (1), when traced for 56' in a north-easterly direction, thins out into a few worthless stringers of gritty kaolin in prospecting shaft No. (9).
Do.	Do.	Do.	The bed of kaolin, 17' 0" thick in shaft No. (8), thins out almost entirely in pit No. (10).

Table of the Prospecting Shafts

Prospecting shaft (see fig. 1 for the position of each shaft).	Dimensions.	Total depth from surface.	Depth of the upper limit of the Kaolin from the surface.	Depth of the lower limit of the Kaolin from the surface.	Nature and thickness of the Kaolin.
No. (1)	8' x 6'	13' 6"	....	..	Partly kaolinized pale sea greenish white felspathic muscovite schists, containing occa- sional stringers of impure gritty kao- lin; no actual bed of kaolin is present.
No. (2)	8' x 7'	19' 0"	..	....	Partly kaolinized somewhat iron- stained felspathic quartz muscovite schists, containing minute stringers of gritty kaolin; no actual bed of china clay is present.
No. (3)	8' x 6'	13' 3"	..	..	Small lenticles of pale bluish white- kaolin; no actual bed of china clay is present.
No. (4)	Do.	10' 6"	....	....	....
No. (5)	8' x 6' 6"	14' 4"	3' 4"	5' 7"	A somewhat irregu- lar layer, 2' 3" thick, of impure gritty kaolin oc- curring immedi- ately under a cap- ping of laterite.
No. (6)	8' x 6'	25' 0"	11' 6"	23' 0"	A bed of pale green- ish-white impure gritty kaolin, which is somewhat stain- ed with iron oxide, and has a thick- ness of 11' 6".
No. (7)	6' x 6'	21' 0"	8' 0"	12' 0"	Soft decomposed, slightly kaolin- ized, and some- what iron stained gneiss and fels- pathic muscovite schist containing minute stringers of gritty kaolin which form a bed of im- pure china clay 4' 0" thick.

*sunk at Kapoli, Khanapur.*

Nature and thickness of the "Overburden".	Nature and thickness of the Rock Formation between the lower limit of the "Overburden" and the upper limit of the Kaolin.	Nature of the Rock Formation between the lower limit of the Kaolin and the bottom of the pit.	Remarks.
Soil and decomposed gneiss.	Partly kaolinized felspathic-muscovite schists.	Partly kaolinized felspathic muscovite schist and ochre-yellow iron-stained decomposed gneiss	The kaolinized felspathic muscovite schists, besides having small stringers of impure gritty kaolin, which become more numerous in depth, contain stains of brown oxide of iron, and areas of brown ferruginous completely unkaolinized felspathic muscovite schist.
oil 1' 6"	Do.	Partly kaolinized felspathic muscovite and chlorite schists.	At 10' from the surface is a zone 1' 8" deep of reddish-brown, highly iron stained and gritty very slightly kaolinized felspathic quartz-muscovite-schist. Immediately below this, and between the 11' 8" level and the bottom of the shaft is a zone of contorted, unkaolinized, slightly felspathic quartz muscovite schist, which passes into pale emerald green chloritized quartz muscovite schist, containing "eyes" of felspar and no kaolin, near the bottom of the shaft.
A 3' 5" layer of laterite capped by 4" of soil.	Slightly kaolinized gneiss	Soft decomposed deeply iron-stained kaolinized gneiss.	One of the largest lenticles of kaolin measures 2' 6" x 4' 8". These are more or less iron stained in places with patches of yellowish-brown iron oxide, and are also very impure and gritty containing many fragments of still unkaolinized felspar and grains of quartz. The junction between the cap of laterite and the underlying slightly kaolinized gneiss appears to be the channel along which the circulating carbonated surface-waters gained entrance to the latter to bring about kaolinization. The iron staining increases below the 8' 9" horizon. The quantity of kaolin present in the altered gneiss becomes less and less at lower and lower horizons.
Capping of laterite: 4' 6".	.....	.....	No kaolin was met with in this shaft, but only pale emerald-green plastic clay derived from epidiorite.
Soil and laterite: 3' 4" thick.	No intervening rock	Slightly kaolinized and partly iron-stained gneiss passing down into unaltered gneiss with porphyritic crystals of pink orthoclase.	The china clay is not worth sampling, since it consists of a bed of impure gritty kaolin.
A 2' 0" layer of laterite capped by 9" of soil.	Partly kaolinized and iron stained felspathic quartz muscovite schists.	Ochre-yellow soft decomposed clayey gneiss.	The percentage of kaolin, in the partly kaolinized felspathic quartz muscovite schists, gradually increases at lower and lower horizons as far as the 11' 6" level.
Laterite: 5' 0" thick	Decomposed, slightly kaolinized, and somewhat iron stained gneiss and felspathic muscovite schists, which form an ochre-yellow clay.	Decomposed, slightly kaolinized, and somewhat iron-stained gneiss and felspathic muscovite schists, which form a dark reddish-ochre clay.	No pure white kaolin is present here, for it is either of a light bluish-grey colour or iron stained.

*Table of the Analyses and Physical Properties*

Locality.	SiO <sub>2</sub> .	Al <sub>2</sub> O <sub>3</sub> .	F <sub>2</sub> O <sub>3</sub> .	CaO.	Loss on ignition.	Fine clay produced after Levigation.	Residue after Levigation.
Kaolin of prospecting Shaft No. 1, Karalgi.	44.9	39.1	1.5	2.5	11.7	Per cent. 35.8	Mostly mica with some fine quartz sand.
Do. No. 4 ..	44.0	41.3	0.5	1.5	11.9	19.15	Nearly all mica ..
Do. No. 6 ..	45.5	38.4	2.1	2.3	11.1	17.95	Mostly mica ..
Do. No. 8 ..	44.2	41.5	1.5	1.0	11.9	16.75	Do. ..
Kaolin from near prospecting Shaft No. 1, Karalgi.	45.0	39.0	1.5	3.0 (Traces of MgO present).	11.0	..	Mica and quartz sand.

*of the China Clays of Karalgi, Khanapur.*

Colour of levigated sample.	Quality of levigated sample.	Plasticity.	Effect on Drying.	Effect on Firing to 1050°C.	Refractoriness at 1300°C.	Colour on Firing to 1050°C.	Porosity.	Hardness.	Remarks
White (slightly creamy).	Good quality.	Non-plastic.	Does not crack.	Does not crack.	Soft and porous with no signs of fusion.	Very pale cream almost white.	Porous.	Fairly hard.	May be employed for the manufacture of common china and earthenware, and as sizing material for cloth. Of no use for modelling, as it is not plastic.
White ..	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	May be used for the manufacture of good china and porcelain, and as sizing material of good quality for cloth and paper making.
Dark cream, nearly yellow.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Not of much use for pottery or porcelain except for the very lowest and cheapest grades. Of no value as a sizing material.
Light cream ..	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Will serve the same purpose as the kaolin of prospecting Shaft No. (1), Karalgi.
White ...	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.	Do.



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