

**LAND USE IN WESTERN ZONE OF INDIA
PROBLEMS AND PERSPECTIVE**

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(DEEMED TO BE A UNIVERSITY)**

PUNE 411 004

1994

ACKNOWLEDGEMENTS

The present research project was initiated by the Ministry of Agriculture, Government of India, on a zonal basis. We are grateful to the Ministry of Agriculture for providing the research grant to undertake this study. We acknowledge with thanks the cooperation extended by all the officers of the Departments of Agriculture, Irrigation, Animal Husbandry, Dairy, and Forestry of the States of Rajasthan, Gujarat, Maharashtra and Goa. We also acknowledge the cooperation extended by CAZRI, Jodhpur, Gujarat Land Development Corporation and Groundwater Resource Development Corporation of Gujarat.

Special mention must be made of Shri Makarand Phatak, Deputy Director Special Schemes, Department of Rural Development and Shri Mathur, Chief Statistician, Department of Agricultural Statistics for their unflinching help in getting information for Rajasthan. Our special thanks are also due to Shri J.D. Kale, Joint Commissioner Industries and Shri T.J. Kachhia of Bureau of Economics and Statistics, Gujarat. For Maharashtra, we gratefully acknowledge the friendly cooperation and guidance given by Dr. M.A. Ghare of AFARM, Pune, Dr. Deore of BAIF, Pune, Dr. B.A. Upadhye of Department of Animal Husbandry, Shri N.B. Patil, Director of Agriculture, Dr. Dhokarikar, Director GSDA; Shri D.L. Garud, Secretary to the Government of Maharashtra, Department of Irrigation, Shri Bakhale, Chief Statistician, Department of Agriculture, Shri Joshi and Shri Thete, Department of Fisheries, and Dr. P.V. Kagwade of Bombay Research Centre of Central Marine Fisheries Research Institute.

We are thankful to Shri K.R. Datye, Dr. R.K. Patil

(ii)

and Shri Suhas Paranjape of CASAD, Bombay, the Research Faculty of Centre for Development Studies, Jaipur, Centre for Science and Environment, New Delhi and Society for Promotion of Waste Land Development, New Delhi for sparing time for extensive discussions, and providing material on field experimentation and studies.

We thank our colleagues at the Gokhale Institute of Politics and Economics for fruitful interaction on several issues relating to land use problems. Special thanks are due to Prof. P. Venkatramaiah and Dr. Latika Argade for their valuable contribution in preparing the Linear Programming Model for Maharashtra and to the officers of the National Informatics Centre, Pune and New Delhi for computer programming. We are thankful to Dr. Sanjeevane Mulay for her help in elucidating population dynamics for livestock population. Mention must be made of Smt. Anuja Chandrachud for unstinted assistance in preparing statistical tables and of Shri V.N. Inamdar and Shri S.S. Ambardekar for neat typing of the Report.

June 21, 1994

Sulabha Brahme

Gokhale Institute of
Politics and Economics,
Pune-411 004.

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INTRODUCTION

The research project "Perspective Plan for Conservation, Management and Development of Land Resources in the Country", was initiated by the Ministry of Agriculture, Government of India, on a zonal basis in 1987. At that time the Planning Commission was seriously considering land resource planning by Agro-climatic zones of India in view of the acute problems of increase in waterlogged and saline areas, wastelands and desert tracts. The Government was looking for a new approach to agricultural development as the gains of Green Revolution have begun to taper off. The work of preparation of perspective plan for Western Zone was taken up by the Gokhale Institute of Politics and Economics, Pune.

Review of the development efforts during the last three decades and a critical appraisal of the present status in relation to land use called for collection of extensive data on agricultural development, irrigation, animal husbandry, forestry, fishery, mining, urban growth, etc.. Despite repeated visits and persistent efforts it was not possible to get information on such vital matters such as the number and the condition of the oustees of the completed surface irrigation projects. Neither the irrigation department nor the planning department could provide information on the families displaced due to submergence. Other major changes in land use that have taken place during the last three decades are the loss of village pastures, deterioration of village woodlots, denudation of hill tops and hill slopes, massive destruction of forest cover and dwindling of forest wealth. Attempt was made to collect information on these aspects from the concerned departments. However systematic records on these aspects are not maintained. Records of

forest department are particularly inadequate and information scanty. In relation to Narmada project, a project that is planned to bring about major changes in land use in Gujarat and involves displacement of tribals from Maharashtra and Madhya Pradesh, repeated attempts were made to discuss many of the issues that are not satisfactorily treated in the report entitled, "Planning for Prosperity: Sardar Sarovar Development Plan" brought out by Sardar Sarovar Narmada Nigam Ltd. The officials of the Nigam however stated that that is last word in the matter and no discussion can be had. The veil of secrecy around major projects like Sardar Sarovar Project in Gujarat or the ENRON Power Project in Maharashtra and the inadequate data base maintained by the Government departments proved to be one of the major handicaps in the conduct of the present study.

A few field studies were taken up to get some idea of the qualitative aspects of some of the major problems, but quantitative estimation was difficult. Field investigations were carried on in Maharashtra State to study the problems arising due to deforestation and denudation of the Western Ghats, the ecological and economic impact of changes in land use through irrigation projects such as the Jayakwadi project and Purna project in Marathwada and the Khadakwasla project in Pune district, the problems of drinking water supply in Pune district and Aurangabad district, economics of horticulture in Sangli district, impact of watershed planning in selected villages (e.g. Adgaon, Aurangabad district, Ralegan Shindi, Ahmednagar district) and condition of pastoralists and pastoralism under changing land utilization in Western Maharashtra. A special study of changes in the land use, crop pattern and problems of waterlogging was carried out in 25 selected villages of Ganganagar District of Rajasthan.

Preparation of perspective plan involved comparative

assessment of alternative models of development. In evaluating these alternatives, standard indicators like Benefit-Cost Ratio or Internal Rate of Return have not been used. These indicators are deceptively simple and appear precise, but in fact are often misleading. This is because the costs and benefits do not fall on the same segments of the population. The oustees of an irrigation project have to bear immense costs, while the benefits are reaped by the land owners in the command area. Also, not all costs can be measured in money terms. The costs of socio-economic uprooting and environmental shocks cannot be calculated in money terms. It is difficult to estimate the long-term environmental costs arising out of clear felling of forests, rapid siltation of lakes, salination of lands, overgrazing of pastures, etc.

Moreover the BC ratio requires us to foresee the benefits and costs in a distant future. Limited as the human vision is, it is distorted by vested interests. Further, projects that are not even economically viable are made to appear so by depressing social costs and heavily discounting their future effects while exaggerating their immediate benefits. What is therefore attempted is to juxtapose the alternative scenarios considering the long term qualitative dimensions and then to arrive at a reasoned judgement within a development frame that puts people at the centre of developmental efforts and emphasizes sustainability in development.

The development efforts during the last four decades have been basically sectoral and departmental. Integration between various development programmes and schemes is lacking. The adverse side effects of developmental strategies are being overlooked. Consequently the rural population of India is facing a variety of problems e.g. lack of employment, low wages, inadequate income, shortage of firewood, shortage of

fodder, shortage of drinking water, waterlogging and salination of lands, crop failure due to erratic rains, flash floods due to denudation of hills, etc.

We begin the study with the evaluation of the present development strategy in relation to agriculture and animal husbandry and examine its consequences through a few case studies. The status of land resources and problems of developments in agriculture and animal husbandry, in the three States, viz. Maharashtra, Rajasthan and Gujarat, are reviewed in Chapter II. In Chapter III, we outline the alternative development approach in relation to land and water use, in the light of the experience generated so far in India and discuss the new strategy for sustainable development. Projected demand for agricultural products by 2001 A.D. and assessment of land requirement for major uses are presented in the last section of Chapter III. For arriving at the optimum crop pattern to maximize the total net return/total employment linear programming model was constructed for Maharashtra and the results of the same are given in Chapter IV. Chapters V, VI and VIII present the proposals regarding land use policies and programmes for Rajasthan, Gujarat and Goa respectively. Chapter VIII deals with the special problems relating to development of animal husbandry and fishery. Organizational imperatives and policy implications in relation to institutional framework to implement the alternative land and water use plan are discussed in Chapter IX. Chapter X discusses the implications emerging out of the present study for National Plan of conservation development and management of land resources.

At the end, we regret to state that the whole exercise relating to alternative planning strategy and the organizational restructuring that should receive immediate and serious attention of the planners, scientists, technicians, and

producers so that the land and water resources of the country would be better conserved, managed and developed on a sustainable basis to ensure prosperity and well-being of the Indian masses, has now turned futile. The Report will only gather dust till the 'new economic policy' continues.

In July 1991, the Government of India announced a new economic policy, which meant decontrol and deregulation. The Non-Resident Indians and even the non-Indians are permitted to buy land and acquire real estate in India. The Government of Maharashtra has proposed relaxation of Agricultural Land Ceiling Act to promote the entry of multinationals. The restrictions on industrial location are removed. As it is the Government had only a limited instruments to guide land use. But it was hoped that during the Eighth Plan efforts to regulate land use would be made in view of the critical problems in relation to land use and primary resource development that the country is facing. But that was not to be.

Indian masses are now facing the problem of getting displaced from agricultural lands, losing fishing rights, tribal rights because of the "free for all" regime. The rupee is overdevalued; while its purchasing power parity value is estimated to be around Rs. 9 per US dollar, its market value is pegged at Rs. 31.5 to promote exports. The NRIs and foreign nationals earning about fifty to hundred times as much income as the Indian nationals are at a great advantage to buy lands in India wherever they please and the Indians are likely to be trapped in this money game and lose their lands. The land use will be decided by the multinationals and the market forces and will not be regulated by the Government of India in the long term interest of conservation

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of land, water, forest and marine resources. Multinationals are now free to mine the natural wealth of India. Under such circumstances an exercise in land use planning has become a mockery.

June 21, 1994

Sulabha Brahme

CHAPTER I

CRISIS OF AGRICULTURAL DEVELOPMENT STRATEGY

India today is facing a critical situation. Even though the agricultural production has increased the prospects for 2000 A.D. are bleak. A shortage of 12 million tonnes in rice production, of 8 million tonnes or 35 per cent of the requirement in the case of pulses and 5 million tonnes of oilseeds (Table 1.1) in the basic food items of the Indian population is expected assuming the continuation of the present trend of development. In the case of firewood, the estimated annual consumption was about 155 million tonnes in 1981. This level of utilization is resulting in depletion of the existing stocks, as the rate of replacement of forest and tree resources is extremely inadequate. As a result, the anticipated shortage by 2000 A.D. is of 100 million tonnes if annual regrowth is only to be used. Even when crores of rupees have been spent on drinking water supply, shortage of drinking water supply persists in numerous villages; it is difficult even to estimate this number, as the situation keeps on changing from year to year depending upon the rainfall quantum and pattern.

As a consequence of development programmes, such as building of dams, factories, roads and for production of paper and supply of timber, etc., forest cover to the extent of about nine million hectares has been reduced between 1972-75 and 1980-82 (SIE, 1985, p. 80). At this rate India will be left with little exploitable forests by 2010 A.D. This would mean acute shortage of raw material for the industries based on forest products, loss of fuel source to millions of rural households and other serious consequences due to ecological imbalance e.g. fast soil erosion, rapid siltation of dams reducing surface irrigation and hydro-power, shortage of groundwater, with adverse effects on agricultural productivity.

The rate of loss of soil at present is very high and is growing due to the ongoing process of continued destruction of forests; this means that the area of marginal soils with low productivity is on the increase. The unscientific management of irrigated agriculture is accentuating the problems of waterlogging and salinity. Ten to 15 per cent of the irrigated area is affected reducing its productive potential.

I. Backlash of Growth Oriented Strategy

The present strategy for increasing agricultural production is dependent mainly on application of irrigation, chemical fertilizers and pesticides. However irrigated agriculture is facing problems due to waterlogging/salinity, and depletion of groundwater resources in many parts of the country. Fertilizer supply is dependent on petro-chemicals. The known oil resources of the country are expected to last till about 2010 A.D. India's foreign trade situation is already adverse, so that stepping up of imports of oils is nearly impossible. Hence the question; how long can we reap the productivity gains from the green revolution technology?

The gravity of the situation today and the prospects by 2000 A.D. demand a critical assessment of the strategy of development followed in India during the last four decades. What has been attempted and achieved through the process of development planning?

To accelerate agricultural growth, new resources like hybrid seed, chemical fertilizers have been introduced and introduction of one kind of input creates a chain of need for other new inputs. For example if hybrid seed is introduced to achieve high yields, the varieties being more sensitive to pests, pesticides in large quantities are needed. Use of such chemical inputs have adverse effects on soil and water. Thus

for short-term gains long term ecological disturbances are created. The supply of these chemical inputs depends on the stock of non-renewable minerals and oils which puts a constraint on their use in the long run. Again chemical fertilizers can be profitably used in conjunction with controlled water application otherwise if the rains fail the expenditure on fertilizer gets wasted. Fertilizers can be used with definite advantage mainly by the water-resource rich regions and resource-rich farmers. Further the new strategy makes for a near-total dependency of the cultivator on 'delivered inputs' and 'information package' and the advantages of use of knowledge accumulated over generations and local innovations are lost. Particularly in the case of biological processes which are microclimate and soil specific standardized 'Ready Packages' are of little use. In addition delays in the delivery of canal water, supply of hybrid seed, fertilizers, shortage of pesticide, etc., which are inevitable when one has to reach millions of fields lead to wastages and losses. However once the process of 'marketisation' starts everyone is caught up in the net. Those who have the cushion to bear the risks and uncertainty of market stand to profit while the weak - the small land owners and tenants bear the brunt. The green revolution or white revolution technology is not and cannot be neutral to scale due to these factors. Moreover, while developing surface irrigation facilities, the burden is mainly borne by the weaker sections - the tribals and the peasant farmers whose lands got submerged for the construction of reservoirs.

Development is a social process which makes the growth of the material base of the economy ever widening, expressing itself in the cumulative growth of net national product. This is made possible largely through the process of economic

evaluation of the resources the society possesses thus providing commodities using country's resources. This requires systematic knowledge of the resources and of converting resources into commodities. The evaluation is through the market which requires each individual participant to maximize his profit. The development planners aim at accelerating this process. In a country like India where there is still a substantial non-market sector such a development process has a backwash effect on this sector. With the penetration of market forces many of the resources which are not 'priced' get overexploited leading to resource depletion. In the process the traditional users of these 'free' resources are deprived of these resources. For example, the felling of bamboos for pulping means that the tribals and artisans face shortages. The gap between supply and requirement widens, as there is no market mechanism for renewal of these resources, as these are considered 'free'. The dwindling of such priceless natural resources like forests, pastures, soil, groundwater, etc., not only means immediate shortage of that particular resource but a permanent long term loss due to triggering of ecological imbalance for short term use.

As a consequence of the current development strategy the inequalities between the developed regions and backward regions are getting aggravated mainly through the channels of market. The inter-regional trade between these unequal partners is based on the prevailing comparative advantages which means specialization in manufacturing in the developed region and production of foodgrains and industrial raw materials in the backward regions. The trade based on interregional specialization causes in the backward regions a rise in prices of fixed assets (e.g. agricultural land) and a fall in prices of factors specific to manufactures (decline in income of workers

engaged in traditional manufacture). A fall in demand for and consequently prices of factors specific to village industries results in additional pressure on agriculture. Disguised and open unemployment grows in the backward regions.

The shift of productive resources from lower productivity lower income-elasticity of demand sector of production to higher productivity higher income-elasticity of demand sector of production is in the form of migration of productive resources to developed regions particularly to metropolitan areas. As a result 'back-wash effect' superseded 'trickle down effect' of economic growth. Within the national economy it is not possible to adopt protective measures, and the backward regions get impoverished as more and more resources get siphoned off.

The concentration of investment in agglomerations gives rise to external diseconomies, depresses the overall efficiency of capital and increases the factor cost for the society. On the other hand investment in backward regions, in say permanent improvement of land or conservation and augmentation of water resources, will prove to be far more productive in the long run than an equivalent investment in marginally improving the facilities in the overgrown regions. Considering an adequately long period, both the economic and social costs of economic development of the national space as a whole will be less, less the disparities in development between regions. However in the economy operating under market mechanism it is the private productivity estimates that determine the resource allocation and social costs are not given due consideration.

The growth oriented development strategy operating through market has thus created multifarious problems which we will examine through a few examples relating to land use

and water resources use in Maharashtra. The examples would provide indications of the pitfalls and major lacunae in the present development strategy. Land use perspective for the future can be elaborated on this background.

II. Beginnings of Commercial Exploitation

Till the establishment of British rule in India and the subsequent industrial-urban revolution commercial demand for timber was limited. The forest resources like timber, bamboo, fuelwood, grass, leaves, fruits, nuts, etc., were mainly used to satisfy a variety of local needs. The forest resources were very rich, particularly in the high rainfall regions e.g. the Western Ghats. Commercial demand for timber for laying sleepers and for fuelwood suddenly mounted up with the beginning of the construction of railways in India. In addition, the demand for timber for ship building, building and construction, etc., also increased. In Maharashtra, the forests in Ratnagiri district connected by sea route to Bombay were literally massacred in a period of about 40-50 years. In 1829, the Collector of the district lifted all the customary bans on tree felling and by 1880 the rich forests along the Western Ghats in Ratnagiri district were totally destroyed. In 1830 the district did not have even two per cent of the area under forests (GBP, X, 1880, pp. 32-33). This destruction of tree cover had disastrous consequences. The Western Ghats receive 400 cm of annual rainfall concentrated in about a three months period. The torrential rains washed the soil on bared slopes with the result that the ports were silted, fertile agricultural lands were washed and the district which was surplus in rice production, turned into an importer of rice. The indiscriminate commercial exploitation of the forest resulted in ruining agriculture, and

shortage of water soon after the rainy season, shortage of fuel-wood, grass and timber, etc. People were forced to migrate due to impoverishment. This migration provided a ready source of supply of labour to work in the docks, on railways and in the factories in Bombay. The felling of forests thus served the dual purpose for the British, of supply of timber at no cost for railways and ship building, and supply of cheap labour to work in docks, factories, etc.

The process of loss of balance between different land uses was thus set in motion by the British to meet their commercial demand for raw materials like cotton, indigo and timber supplied at a low price. In the pre-British India the non-cultivated tracts of the country played a role supportive to agriculture. They provided fuel, small timber and fodder and organic manure (directly as leaf matter and indirectly by supporting cattle grazing). The organic manure was vital for the maintenance of soil fertility. Large tracts, particularly the hilly regions, were under forests that regulated the hydrological cycle so vital for agriculture. Apart from sustaining agriculture, the non-cultivated tracts provided diverse materials that formed a basis for production of a number of articles of everyday use e.g. mats, brooms, baskets, carts, implements, house construction, gum, herbal medicines, etc. Various castes and communities traditionally specialized in using different resources for specific purposes. This dependence of each group on a particular resource for survival made for a prudent use of the natural resources.

Among tribals the material cycle was largely confined to the tribal territories. This meant that the tribals had a stake in sustaining their resource base and a number of cultural traditions to ensure its sustenance evolved. These

included long fallows in the cycle of rotation of shifting cultivation, selective retention of valuable trees like mango and mahua while clearing land for cultivation, preservation of certain areas of terrestrial as well as aquatic eco-systems as sacred groves and sacred ponds, prohibition on hunting or fishing during the mating/spawning season, prohibition of certain foods in specific season for preserving it for future use, etc.

The British put the tribal territory of forests under Government ownership and under the garb of scientific management exploited it to serve their commercial interests. By denying the tribals a free access to forest resources the British impoverished the tribals and turned them into cheap labourers. For example in Dhule district, by provisions of the Forest Act of 1878 the forest area was put under reserve forests and protected forests. With the starting of Surat-Bhusaval line and Dhule-Chalisgaon line completed in 1899-1900 there was a spurt in felling forests (Brahme, Upadhyaya, 1979, pp. 375-376). The forest that belonged to the tribals and was the very basis of their survival was thus lost and many were forced to migrate to the plains to take up either tenancy or saaldari. The shortage of labour was thus wiped off. In 1898 the proportion of tenants and of labourers was 2.8 per cent and 12.6 per cent respectively in Shahade taluka of Dhule district, by 1917 the corresponding figures were 35.2 per cent and 39.7 per cent respectively (Brahme, Upadhyaya, 1975, p. 35).

Apart from the direct losses due to reservation of forests that was the backbone of agriculture and animal husbandry, the loss of sanction to customary community control of non-cultivated or common lands due to the imposition of

alien rule had disastrous consequences. Firstly, the shrinkage of area available to meet the requirements of agriculture and animal husbandry meant that the pressure on the remaining non-cultivated area grew leading to degradation of these areas. Secondly, the non-cultivated lands now became open access common property resource without community control and management. There was no more any interest in their sustainable use; the resources were exploited for as much immediate benefit as possible leading to their indiscriminate use.

A British chemist Dr. Voelcker appointed by the Government in 1897 to report on the conditions of Indian agriculture (Voelcker, 1893) pleaded for proper development of fodder, fuel reserves and manure supply for greater agricultural productivity for realizing higher taxes but to no avail.

It is most unfortunate that the policy pursued by the British in their commercial interest that exhausted the forest resources and thereby led to deterioration of agriculture is being followed by the Indian Government under the name of "development planning".

III. Intensification of Commercial Exploitation

Since 1950, paper industry has expanded rapidly depleting the bamboo stocks, rayon industry fed on soft wood and sugar industry burning wood in boilers are taking heavy toll of the forest resources. With expanding building construction activity and furniture industry teak prices are sky rocketing. The limited forest resources of Maharashtra, Gujarat and Rajasthan are getting exhausted for industrial use or getting submerged under reservoirs or cleared for building factories, townships, roads or for teak plantation. Decrease in forest areas leads to increase in the pressure on village grazing lands. Increase in the demand for fodder

due to the growth of dairy industry puts further pressure on the over-used pasture resources. A variety of problems due to the serious imbalance in land use are thus surfacing. A few case studies were taken up in Maharashtra to analyse these various dimensions of the problems of 'development planning'. The results of these case studies are briefly examined in the following.

1. The Gavli Dhangars or Pastoralists of Pune District

The Gavli Dhangars inhabit the hill top and the slopes of the Western Ghats. The annual rainfall in this region exceeds 250 cm and it is around 100 cm to the east of crestline of the Ghats. In pre-1947 period, much of the region inhabited by the Dhangars was inaccessible and the natural resource-base provided sustenance to the Dhangars and their milch cattle. Their diet was mainly based on home-produced livestock products like buttermilk, some poultry, honey, fruits, nuts together with the millets they cultivated.

Milk collection network to supply milk to the urban centres reached this region during the sixties. Over 80 per cent of the milk is now delivered to the Cooperative. However the organization of production remains unchanged. The milch cattle is of local breed, and it subsists mainly on grazing. There is a serious shortage of drinking water for the cattle during summer months. Proper shelter for the cattle is lacking. The much-needed veterinary service is not accessible. Even the local breeds succumb due to such adverse conditions. Under such circumstances, it is impossible to shift to improved breeds and develop dairy business. The natural resource base is getting depleted due to commercial exploitation of forests for timber, coal-making, etc.; the Dhangars are unable to maintain adequate number of cattle due to the

impoverishment of natural resources. They are not only forced to reduce their herd size but also to shift from buffaloes to cattle as buffaloes require relatively richer grazing grounds, more water and more shade. In a poor and degraded habitat the Dhangars are even taking to goat-keeping (Gadgil, Malhotra, 1979, p. 82). However, no effort is being made to conserve and improve the natural resource-base that sustains the cattle population; on the contrary the natural resources are being frittered away to maintain the urban milk supply. This has also led to a deterioration in the diet; Dhangars no more consume any buttermilk as milk is now sold directly (and not ghee as was the practice earlier). There are diverse demands on the cash income they earn from the sale of milk; part of it is used to buy the essential food items, but a part is spent for clothing, liquor, trinkets, etc. (Brahme, 1980, p. 48). It was noted that in 70 per cent of the families surveyed the income was not adequate to meet the bare subsistence needs of a family. Thus the inroads of market forces have led to deterioration of the forest/pasture resources, acceleration of soil erosion and further degradation of the natural resource base. Consequently the people like Gavli Dhangars who primarily depend on these resources for their livelihood have to experience down-grading in their quality of life.

2. Displaced Families Due to Construction of Large Reservoirs

A number of dams have been constructed across the east-flowing rivers, rising in the Western Ghats. In Pune District, Panshet dam on Ambi river (1974), Pavana dam on river Pavana (1974), Warasgaon dam on river Moshi (1986) have displaced respectively 1302, 1238 and 1935 families living in the valley region. These villages shifted to

the upper hilly area have been cutoff from the plains due to the construction of reservoirs. As the families have lost their rich paddy lands, they are forced to resort to shifting cultivation on the hill slopes where they grow nachani, vari, sawa; the productivity is low (3 to 6 quintals per hectare) and the land available for cultivation, each year is very limited. The produce of land can meet upto 70 per cent of the cereal consumption requirements of the family. A small income is obtained through the sale of milk. The families are forced to resort to sale of firewood or of trees for bare survival. The large dam project has thus pushed the displaced families below the subsistence level. Furthermore, the way the resources - pasture, tree cover, etc., are being used, the very resource-base is getting depleted; however in the given situation the displaced families have no other alternative but to use up their forest resources. This means increasing soil erosion and siltation of the reservoir, and growing impoverishment of the people.

Similar sets of problems were recorded in a study of Pavana dam. It was estimated that if the real costs were taken into account (adequate monetary compensation to the displaced people, proper reforestation of the hill slopes, etc.) the benefit/cost-ratio would work to 0.46:1; in addition if the fact that a weak-underprivileged group gets displaced for the construction of large water reservoirs and the hardship imposed due to displacement are taken into consideration the B/C ratio will be further lowered. This brings forth the need to reconsider the approach of constructing large reservoirs, destroying vast stretches of forest area and displacing the villagers.

Another project - Inchampalli irrigation project on river Godavari on the border of Maharashtra and Andhra Pradesh

involves submergence of valuable reserved forest extending over 11300 hectares and displacement of 6000 tribals (from Sironcha taluka, Gadchiroli district). This would be a deathblow to the tribals. The cash compensation gets exhausted in a short period and soon they are turned into paisaless refugees. Lacking education, skill, and contacts they can hardly eke out even a bare subsistence. Before launching development projects involving construction of large dams, industrial complexes and townships, roads, etc., it must be made conditional that the full ecological and social and economic costs thrust on the people - particularly the weaker sections are adequately considered.

3. Gonds of Gadchiroli District

Gadchiroli district of Maharashtra State has about 250,000 tribals (about 35 per cent of the district population), mainly Gonds. Nearly 75 per cent of the area in the district is under forest and the tribals depend for their livelihood partly on the wage-work in the forest, collection of forest produce and cultivation; the land productivity is quite low as there is no irrigation and the lands are not properly developed. In a Survey carried out in 1978-79 among the tribals it was noted that 75 per cent of the families were living below the poverty line (Brahme, Prakash, 1983, pp. 248-250). They are undernourished, their diet is very poor - rice or millet gruel with some vegetables or beans.

The fact that the conditions of tribals are deteriorating due to the inroads made by the outsiders leading to (a) ecological disequilibrium and consequent shortage of food, deficiencies in diet, a variety of health problems, (b) exploitation by trader-moneylender, (c) social disorganization, (d) spread of new diseases and the like, is long acknowledged.

It is also recognized that when a weak group gets incorporated into the market economy, the stronger group benefits at the cost of the weaker group. Attempts are therefore being made to protect the tribals from trader-moneylender and other exploiters from outside the region. However, the machinery to protect the tribals is provided in the form of bureaucratic apparatus which has several limitations, e.g. (a) the bureaucratic rules and procedures are highly formalized and do not permit consideration of grass-root level problems (b) the approach is segmentary. For example there are schemes to encourage production of milk, vegetables, etc., for sale to earn some cash income. There is a scheme to provide supplementary nutrition to the school children. These schemes entail high costs for transportation and service personnel as the tribal settlements are small in size, scattered in location and many of the settlements are remote and inaccessible. Instead, if the resource-base of the tribal is strengthened he can improve the diet on the basis of his own farm and forest resources.

Forest serves as the main resource-base for the tribals. However, the forest exploitation policy of the State aims at maximization of the revenue of the Forest Department and incorporation of larger and larger forest resources in the market economy to promote commercial/industrial profits. With this aim, the State Government constituted Forest Development Corporation and 25 per cent of the reserved forest in Gadchiroli district is earmarked for clear-felling and teak plantation - a luxury timber with a long growth-period. As a result the tribal inhabitants near the clear-felled areas are being deprived of their important source of food, fuel, fodder, timber for shelter, liquor i.e. all the essentials of tribal life. It is necessary to take steps

to totally prohibit clear-felling of reserved forests, auction of forest resources to industrial/commercial interests at throw away prices and consider tribals as the custodians of the forest wealth. If a plan for conservation and restoration of forest wealth is worked out in partnership with the tribals, enrichment of natural resources and improvement in the level of living of the tribals will be possible.

4. Jayakwadi : A Failed Irrigation Project

Jayakwadi is one of the major irrigation projects on Godavari river taken up in the Marathwada region during the Third Plan period. The proposal proved controversial from the time of inception. The command area falls mainly under assured rainfall zone and medium and deep black cotton soils predominate in the command area. The slope in 86 per cent of the command area is less than 2 per cent. Due to the location of the dam in the middle reaches, submergence was considerable. About 35000 hectares of fertile lands were submerged displacing 34952 persons to irrigate 184000 hectares of land. According to irrigability classification 34 per cent of the land under irrigable command is not suitable for sustained irrigation. Eighteen per cent is suited with moderate limitations. Nineteen per cent is suited with severe limitations and 29 per cent land is marginal for sustained use under irrigation. Thus about 63 per cent of the land was not suitable for sustained irrigation. Despite these adverse factors the project was hailed as "Bhakra" of Marathwada.

As anticipated, utilization of irrigation is very poor. Of the potential of 156642 hectares available in 1985-86 only 34236 hectares (or less than the area submerged) was utilized. Area under L.S. cotton was 3882 hectares only (as against 40000 hectares planned). The irrigated area is

not increasing despite the additions in the potential. Response in kharif season is quite poor and the area under irrigated wheat is declining. The actual irrigated crop pattern is considerably different than the planned one. The kharif crops that need irrigation water in small quantities occupy much less than the designed proportion while voracious water consuming crops like sugarcane are occupying significantly larger proportions particularly in the unauthorized component. Sugarcane occupied 13.6 per cent of the irrigated area in 1985-86. However the area under sugarcane was considerably reduced in the following two seasons because of shortage of water supply. The total irrigated area was only about 14000 hectares in 1986-87 and 1987-88.

A survey of 15 villages was carried out in January 1989 in the Jayakwadi command area. It was noted that the area under sugarcane declined by 80 per cent between 1985-86 and 1986-87. The severity of the problem of waterlogging got less due to the drastic reduction in the irrigated area for two consecutive years. However, in 1988-89, the year of normal rainfall again the problems surfaced. It was noted in the survey that the water level in 30 per cent of the wells was within 3 metres. About 25 per cent of the irrigated area has reportedly got affected by waterlogging.

Problem of waterlogging and salinity is faced in a number of villages due to the absence of proper drainage system, poor maintenance of canals and distributories and consequent profuse growth of weeds (like pankanis), irrigation by flooding of fields, etc. Structures like cross regulators are reportedly stolen, water measuring devices are destroyed or silted, control gates are out of repair or stolen. Field channels are overgrown with weeds. The need for providing drainage facilities in Jayakwadi command area

was realized at the time of project planning and initially an estimate of Rs. 223 million was prepared. However only Rs.31 million were provided for a limited section. To rectify the problem of waterlogging open trench drains have been provided in the affected areas but they are difficult to maintain. Pipe drainage is being attempted on experimental basis but the costs are prohibitive. Apart from costs, provision of drainage is fraught with many problems and unless designed and executed very systematically and maintained properly the drainage system cannot be effective. As a result once fertile lands yielding bumper crop in a season of timely rainfall have been turned to waste-lands particularly in lowlying regions as these lands are getting waterlogged due to seepage from canal or from flooded fields in the upper sections. Schemes prepared by the government for reclaiming waterlogged lands are not proving effective due to red-tape, haphazard implementation, etc.

The original estimated cost of the project was Rs.36.58 crore which increased to Rs. 149.03 crore. If the costs are related to the area actually under irrigation, it works to Rs.46,000 per hectare. In view of all this, a comprehensive study of Jayakwadi irrigation project is necessary to bring out the costs and risks of assuming that an irrigation project is inherently good and beneficial.

5. Modernization of Subsistence Agriculture

The integration of village economies without provision of mechanism for resource conservation is leading to a number of complex problems. Survey of selected villages in Satara district over a period of last fifty years carried out by the Gokhale Institute brings to the fore a variety of problems.

(i) There is some growth in the cultivation of commercial crops and spread of chemical inputs. But the

farms are still operated to basically satisfy the family needs and not for profit maximization. There is no crop specialization but the crop pattern has changed to a certain extent, replacing traditional crops like sweet potato and pulses, by sugarcane and hybrid jowar. This has disturbed the traditional soil preservation mechanisms; cultivation of pulses helped nitrogen fixation and deep rooted sweet potato was useful for soil turning. The spread of new inputs not only means great dependence on non-renewable fossil resources but it also means soil pollution. Use of irrigation without drainage and of fertilizers without proper supplement of organic manure is resulting in deterioration of soil quality.

(ii) The loss of social cohesion and pressure of market pulls mean that the forest and pasture resources traditionally regulated by custom and managed by the village community are no more under any regulation. Consequently trees are disappearing and pastures are being overused. This is resulting in shortage of fodder and fuelwood, increase in soil erosion and decline in productivity.

(iii) The flooding of the village market with a number of commodities, some even of dubious value like country liquor, cosmetics has meant that the increased cash income is being used not necessarily for improvement in the quality of life. Replacement of gur by sugar, of milk, butter-milk by tea, or purchase of new alluring trappings means diversion of money income from nutritious food. It also means diversion of energies from acquiring critical outlook, co-operative ethos to passive existence of silent consumer fed by T.V. This is leading to perpetuation on the one hand of traditional stereotypes like role of male, family, leader, etc., and on the other hand to boosting up of new 'needs' and values that breed envy, greed and waste.

The truncated incorporation of the village economies into the market economy is thus resulting in exhaustion of the natural resource base, and impoverishment of the sections that do not command any assets/skills, because of the loss of erstwhile 'free' resources and deterioration of the 'common' resources.

The challenge today is not only to arrest this down-gradation of the resource base but also to create a basis for, and move towards sustainable and equitable development.

Table 1.1 : Production of Food Crops in India

(Figures in million tonnes)

Crop	Production (triennium ending 1985-86)	Projected production 2000 A.D.	Projected requirement 2000 A.D.
Rice	60.86	78.56	90.00
Wheat	45.48	101.44	74.00
Coarse Cereals	30.31	35.55	36.00
Total Cereals	136.65	215.55	200.00
Pulses	12.61	13.39	21.00
Oilseeds	12.26	17.10	22.00

Source : Report of the Working Group on Rainfed/Dryland
Agricultural Production Programmes for the
Formulation of Eighth Five Year Plan, August 1989,
p. 51.

CHAPTER II

STATUS OF LAND RESOURCES AND CRITICAL PROBLEMS IN WESTERN ZONE OF INDIA

Western zone of India - the region under study- comprises three large States viz., Maharashtra, Rajasthan and Gujarat, the State of Goa and the Union Territories of Diu, Daman and Dadra and Nagar Haveli. The geographical area of this region is 850 thousand sq.km. and the population according to 1991 Census was 1652 lakh. There are some similarities between these States; the three large States have extensive semi-arid areas, face problem of water shortage in many parts as irrigation potential is limited and rains uncertain. Despite adverse agro-climatic conditions, agriculture in Gujarat is highly commercialized with over half the value of agricultural produce being contributed by cotton and oilseeds. In Maharashtra State, on the other hand, it is mainly in the belt of sugarcane cultivation around the nucleus of cooperative sugar factory that rural development is concentrated. The returns to agriculture are low in major parts of the State. In Rajasthan, agriculture is largely subsistence oriented with cereals and pulses accounting for 60 per cent of the total value of agricultural produce. In Goa, only about a third of the total area is cultivable and rice is virtually the only agricultural crop grown. Mining, forestry and fishery are the major natural resource based activities in Goa. Animal husbandry is an important supplement to agriculture in Rajasthan and parts of Gujarat.

Reorganization of States and changes in the boundaries during the period 1947-1960 made it difficult to collect comparable statistics relating to land use, production, etc., over a long period. For the analysis of trend in land use, crop pattern, production, productivities, etc., time series

data could be obtained from 1960-61 on a uniform basis. The assessment of changes is therefore made on the basis of trends over the last three decades.

I. MAHARASHTRA

Physiography

The chief element in the lithological complex of the State is the basaltic plateau which has been configurated by diastrophic movement in the past and later on by sub-aerial processes resulting in several microforms in the present terrain. The general elevation ranges from 300 to 1200 m above MSL. The western margin of the plateau, the relic of original surface subjected to erosional cycle is known as the Sahyadri range which forms the northern part of the Western Ghats. Sahyadri is a narrow crest zone of the divide with a width of 15 km. to 25 km.

The western part of Sahyadri drops abruptly giving rise to steep escarpments followed by low hillocks and subdued ridges with intervening valleys merging into the Arabian Sea giving rise to a strip of rocky and rugged coast line in the west. Eastward, from Sahyadri crest zone, the landscape is characterized by inter-digitating elongated interfluvial ridges running eastward enclosing deep valley bottoms in between. The plateau surfaces running south-east are flanked by number of mesas and buttes overlooking deep valleys with precipitous rectilinear escarpments. Further, the eastern part is characterized by flat, block like interfluves gradually narrowing down and finally disappearing giving rise to broad alluvial plains covered with black soils. However, in such a terrain occasional distant buttes interrupt the monotony of the vast stretch of the flood-plains. This terrain of broad valley lies between Ajanta and Mahadeva plateau with eroded pediment followed by depositional pediment merging to flood plains of

the Godavari, Bhima and Krishna rivers. Tapti basin is an asymmetrical valley bounded by Satpudas and Ajanta ranges in the north and south respectively.

The eastern part of the State is again marked by mesas, buttes and isolated plateau furrowed by the rivers Wardha, Wainganga and Kanhan. This region marks the transition between the trappean and precambrian landmass. The extreme eastern part of the State is covered by deep alluvium interrupted by isolated hillocks projecting over the valley floor. The dissected rolling topography covering the eastern part of Bhandara and Chandrapur districts is formed of subdued hillocks and ridges with intervening valleys.

Rivers

The entire State is drained by three major systems viz., Godavari, Krishna, and Tapi. The Godavari basin comprises the Godavari basin proper and Wainganga sub-basin. Its main tributaries are Purna, Pravara, Sindphana and Majra. The Krishna basin is divided into Krishna basin proper and Bhima sub-basin. A small portion in north-western corner is drained by the Narmada and north-eastern corner by the Mahanadi river systems. More than the half of the State is covered by the Godavari basin, one-fifth by the Tapi and remaining by the Krishna. With exception of the Narmada and Tapi rivers draining into the Arabian Sea, rest of the rivers join the Bay of Bengal. In the Sahyadrian region the drainage network is fairly close having sub-parallel sub-dendritic type. On the tabular mesas, the drainage pattern, is mostly radial whereas along the escarpment it is mostly fine textured sub-parallel type. However in the eastern plain or flood plain fine textured dendritic pattern is clearly visible.

A major part of the State consists of plateau basalts (Deccan Trap) of more or less uniform composition. The alluvial deposits in the flood plain are not older than the early pleistocene. The extensive basaltic sheet is of varied

thickness which gradually decreases and ultimately disappears towards east, north-east, whereas maximum thickness of more than 2000 m is observed in western margin of the Sahyadri crest zone. Laterization of this rock is noticed in Ratnagiri district and western part of Kolhapur, Satara and Pune districts. In the eastern part of the State Wardha-Wainganga basin comes under rocks of older formations comprising granites, gneises, etc., flanked by metamorphosed precambrian sedimentaries, Dharwarian schists with sporadic exposures of rocks of Gondwana system Cuddappaha and Vindhya.

Climate and Rainfall

The entire State broadly falls under tropical monsoonic climate having three distinct seasons, viz., rainy season from June to October, winter from November to February and Summer from March to May. The rainfall varies from 50 to 500 cm., with the State average of about 100 cm distributed over 60 to 70 days. The rainy season is confined mostly to south-west monsoon from June to October receiving about 80 per cent of the total annual precipitation. Normally, there occurs heavy rainfall immediately following the onset of monsoon with an interlude of dry spell and again it is followed by a second maximum in the month of September. In western part of Vidarbha region the rains are largely confined to a six week period which includes about 10 days in June and the whole of July. July in fact is the rainiest month in the whole of Maharashtra. Around Solapur, rainfall occurs in late September, and early October resulting from the retreating south-west monsoon.

The isohyet map of the State shows wide variations in rainfall from humid to rain-shadow semi-arid climate. The area between 250 and 400 cm isohyets lying in the eastern part of the State indicating the high rainfall zone constitutes the windward western flank of the Sahyadri range. This zone being

close to the Arabian Sea is under the influence of maritime climate experiencing more humidity with low range of diurnal as well as annual temperature fluctuation with mean summer temperature of 24°C and the mean winter temperature of 20°C . The eastern flank of Sahyadri range forming the leeward side shows rapid decrease in the precipitation from 70 to 50 cm in the central part of Maharashtra, accounting for 40 to 50 per cent coverage of the annual potential evapotranspiration. The mean summer and mean winter temperatures of this part are 29°C and 22°C respectively.

The moderate rainfall zone with the isohyets ranging from 100 to 150 cm lies in the central and eastern parts of the State showing wide diurnal fluctuations of temperature and humidity. It experiences mild winter temperature around 20°C rising to 32°C during dry summer period causing sub-humid climate. Besides, the most extensive area is found between isohyets of 100-75 cm in north central part experiencing high temperature associated with low humidity thus making it sub-humid to semi-arid.

The total annual quantity of rainfall received in the State is 11250 mcft which works out to 3.5 feet per acre if averaged over the entire area of the State (Kulkarni, 1970, p.3). The total quantity is, however, very unevenly spread over the different regions of the State.

The high rainfall region of the State which covers about 13 per cent of the area receives more than a quarter of the total quantity of rainfall. The land in the high rainfall coastal region is highly undulating with a limited soil cover in places. The region is not, thus, suitable for irrigation on a large scale. There is also a considerable impoverishment of the soils due to severe soil erosion. The region, however, provides excellent sites for storages of water which could be used for irrigation in the low precipitation areas. In the

second zone viz., the moderately high rainfall region that covers another 13 per cent of the area about 19 per cent of the total rainfall is received. The assured rainfall region covers 40 per cent of the area and receives nearly 35 per cent of the total rainfall, with an average rainfall of 90 cm. The low rainfall area or the drought-prone region receives only about 20 per cent of the rainfall which is spread over nearly 34 per cent of the area of the State. Because of the erratic and low rainfall this tract has the least vegetation. As a result the organic matter in the soil cover is poor. The ground slopes are steeper and cause severe erosion increasing the vulnerability of the region.

About one-third area of the State is thus liable to crop failure due to the vagaries of the monsoon. Various factors viz., variations in the aggregate precipitation, the date of onset of monsoon and cessation of the rainy season, the number of rainy days, the frequency and duration of dry spells govern the crop response in a given season. The margin between the necessary rainfall needed for the normal growth of the crops and the normal rainfall is very narrow in the low rainfall area. Hence the adverse effects of a small shortfall in the total rainfall or irregularities in the rainfall are serious in the tract. The soil cover in this region being generally poor and non-retentive of moisture longer dry spells result in a failure of crop. In the areas with assured or high rainfall crop failures are less frequent as there is a larger margin between the normal rainfall and the requisite rainfall for the crops grown, though the untimely nature of the rainfall does affect the yields.

Soils of Maharashtra

The Coastal Salines and Coastal Alluvial Soils: These soils occur all along the West Coast. The alluvium is mostly derived from trap and the soils are impregnated with salts to

varying extent according to their location with respect to sea. In the immediate vicinity of the coast or creeks, they are highly saline, and in spite of the high rainfall obtaining in this zone, they are not capable of supporting any crops except perhaps the salt bush type of vegetation. The coastal salines merge into the coastal alluvium as one proceeds away from the sea. The soil depth is variable and the fertility rather poor. While salinity has masked the influence of other soil-forming factors in the case of coastal salines, topography has influenced soil development in the case of coastal alluvium.

The Laterites, Lateritic and Red Soils: On account of the forest vegetation and warm humid climate, the basalts (Deccan trap) have given rise to laterites and lateritic soils in the southern part of Raigad, most of the Ratnagiri, western part of Satara, Sangli, Kolhapur and Nashik districts. On account of the alkaline reaction of the percolating waters, the silica from the original rock is differentially leached leaving a residue of sesquioxides in the rock as well as in the soil. Intense leaching accompanying the high rainfall has removed from the soil all the bases giving it a distinctly acidic character. There is complete absence of calcium carbonate and the soils are very poor in fertility, specially in their contents of phosphate and potash. In the case of lateritic soils therefore climate and vegetation have played a more dominant role than the other soil forming factors. Red soils are developed in the eastern part of Chandrapur district from mixed parent material, the influence of warm humid climate and forest vegetation.

Coarse Soils on Hill Slopes and Clay-loams in Valleys: These soils are also derived from trap and occupy the mountainous terrain in the west. According to their topographical situation, they vary in depth from a few cm. on steep slopes

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Coarse Soils on Hill Slopes and Clay-loams in Valleys: These soils are also derived from trap and occupy the mountainous terrain in the west. According to their topographical situation, they vary in depth from a few cm. on steep slopes

to more than one metre in valleys. As the rainfall in this tract is comparatively high, the soils are low in base status and neutral to slightly acid in reaction. Those on steep slopes, locally known as "Kumaris" are terraced and put under hill-milletts once in six or seven years and then allowed to be under grass for the remaining years to enable them to regain fertility. The soils in valleys which receive washings from hill slopes are comparatively more fertile and constitute what are known as rice fields. The rice soils vary in texture from clay to clay-loam and are neutral in reaction.

Medium-black and Deep-black Soils from Trap: The medium black soils derived from Deccan Traps cover by far the largest area of the State. The singularly uniform minerological and chemical composition of the traps and the more or less arid conditions under which they decompose are the two factors which are responsible for some of the important properties of these soils. Thus the basic character of the rock and the restricted leaching accompanying the arid climate have given these soils their high lime reserve, high base status and alkaline reaction. The lime may either occur as nodules or as a band at some depth of the profile or as a substratum over which the solum rests. As a rule, these soils are fair in their contents of phosphates and potash but low in organic matter and nitrogen, which again reflects the influence of climate on soil development. While the fundamental properties of the black cotton soils such as their minerological make up, base exchange capacity, etc., remain the same all over the State, differences are observed from place to place in such texhrinsic properties as depth, texture, etc., the differentiation being brought about by variations in topography or local relief. Thus, along the cross section of a country, also known as "Catena" one comes across shallow soils of lighter shades and textures on the

ridge, medium deep and loamy soils in the intermediate positions and greyish black deep soils of heavy texture in low lying situations.

Along the banks of rivers and natural water courses crossing the trap area are distributed the deep black soils also derived from basalt. They are of alluvial nature, very deep and more fertile than their medium black associates. Vast stretches of such soils are met with in the important river valleys of the State like the Bhima valley, the Krishna valley, the Godavary valley and the Tapi valley. On account of their high fertility, the deep black soils grow some of the best garden crops. Whenever late rains are favourable, they yield excellent crops of wheat and rabi jowar. In their physio-chemical make-up they are not very much different from the medium black soils.

Coarse Gravelly Soils: In the western parts of Chandrapur district, where the topography is very hilly, the soils are very coarse and are derived from mixed parent material. They are locally known as baradi, retadi, etc., according to their coarseness. On account of their poor fertility and coarse texture they are put under hill-milletts.

Shallow Clay-loam Soils: Nearly seventy per cent of the area in Bhandara district is under shallow clay loams derived from mixed parent material. They exhibit more or less similar characters as the medium deep soils of trap origin. On account of assured rainfall these soils are put under paddy, some of the deeper phases being put under wheat in the rabi season.

Land Use

Of the total geographical area of 307580 sq.km. for which land utilization statistics is available, 18019 thousand hectares or 60 per cent area was under cultivation. Permanent pasture and grazing lands formed less than 5 per cent of the total area (Table 2.1).

About 17 per cent of the total area of the State is shown under forests. Despite high rainfall and suitable edaphic conditions, many parts of the State do not support forest due to unfavourable soil conditions, rugged terrain, etc. However, the far-eastern part of the State supports good forest cover due to good supply of moisture and it accounts for more than 60 per cent of the total forest area of the State.

According to ecological conditions the forest types of the State may be classified as follows:

i) Tropical wet evergreen forests in heavy rainfall areas (400 cm) on the western margin of the Sahyadri crest zone.

ii) Tropical wet evergreen grading to tropical semi-evergreen eastward from Sahyadri crest zone to Maval.

iii) Further eastward grading to Tropical moist deciduous which covers areas receiving 125 cm including eastern slopes of Sahyadri, Chandrapur, etc.

iv) Tropical moist deciduous grading to tropical dry deciduous forests with generally teak-bearing forests that are found in Ajanta-Aurangabad area.

v) Tropical dry deciduous forest grading to biotic forests of tropical thorny and dry Sevanah forest in drier central and south Central Parts.

The forests in Maharashtra are degraded and sparse. It is only in Chandrapur and Bhandara districts that the forests are extensive. The rich forests of Western Ghats and Konkan have been ruined through indiscriminate commercial exploitation.

The gross cropped area in 1988-89 was 19619 thousand hectares, the intensity of cropping being as low as 109. Only about 12 per cent of the gross cropped area received irrigation. Consequently for major portion of the land under cultivation only single crop can be taken during a year.

Very few changes in the land use pattern have been

effected during the last three decades. The net cultivated area remained at around 180 lakh hectares. Some reduction in the barren and uncultivated land and increase in the land put to non-agricultural uses is recorded. There is a continuous extension of urban areas, particularly in the case of metropolitan cities. The urban population increased from about 220 lakh in 1961 to 305 lakh in 1991. There is ribbon development along Bombay-Pune highway and land speculation is rife in the areas on the fringe of cities. There is no effective control on the process of conversion of lands to non-agricultural uses. The incentives given by the Government to industries located in backward talukas is leading to establishment of industrial units in rural areas near the metropolitan cities. Consequently agricultural lands in the vicinity of these industries are threatened.

Crop Pattern

The crop pattern varies considerably between different areas of the State according to the agro-climatic factors. In the heavy rainfall region of Konkan paddy and nachni are the main crops (Table 2.2). Paddy is the major crop in Bhandara and Chandrapur. In Kolhapur district paddy and sugarcane are the important crops. In Dhule, Jalgaon and Nashik districts among the cereal crops grown jowar, bajra and wheat are important. Cotton is the major commercial crop in Jalgaon and groundnut in Dhule district. Cultivation of sugarcane, grapes and onion in Nashik district and of bananas in Jalgaon district is noteworthy. In the scarcity zone, sugarcane is the important irrigated crop. The major area in this zone is put to the cultivation of cereals like jowar, bajra, pulses and some oilseeds. In the assured rainfall region jowar and cotton are the major crops grown and these are grown under dry conditions.

Development of Irrigation

The major technical problem in the development of agriculture in Maharashtra is the uncertainty and wide variability in the rainfall over a large tract of the State. The drought-prone area forms 30 per cent of the geographical area of the State. In view of the recurring menace of drought the State Government appointed a Committee in 1958 for suggesting (a) preventive measures against famine and scarcity, (b) policy in regard to taking up irrigation and other productive works in these areas. The Committee emphasized the need of considering the problem of development of irrigation in scarcity-prone areas as an integral part of the development plans. It was recommended that the major irrigation schemes be combined with well and lift irrigation schemes to spread the water over as large an area as possible. The Committee suggested that well irrigation may be resorted to under conditions where irrigation by flood cannot be provided, because of the fact that well irrigation is a relatively costly mode of irrigation and because of the considerable risk and uncertainty involved in respect to the viability of a well (MSSA, I, 1960, pp. 19-21).

In Maharashtra State the harnessing of underground water resources is fraught with a high element of uncertainty. Unlike the regions of alluvial plains, where once the depth of the water table is known, it can be assumed that bores made approximately to that depth will strike water, in the Deccan, the depth at which an aquiferous bed will be found, its size and the yield vary with the structure of rock formation. Hence the costs of providing a given quantity of water vary from well to well. In the absence of hydro-geological knowledge the likelihood of striking water remains highly uncertain. Hence there is a considerable risk of failure and waste of investment in the case of well digging programme.

The probability of a viable well can, at best, be put around 30 per cent (Kadam, 1968, p. 123; Lal, 1972, p. 110). Thus even though huge investments have gone into the well digging programmes and a large number of new wells are being added, their contribution to agricultural development remains limited.

The area irrigated from surface sources was 2.1 per cent in 1950. A number of projects were completed under the plans and a potential 2663 thousand hectares was created by 1991. However only 987 thousand hectares or 37 per cent of the potential created was utilized by 1991-92. The ultimate irrigation potential in 60 lakh hectares by surface sources. The progress in development as well as utilization of the irrigation potential has been very slow.

Dug wells is the ubiquitous source of irrigation. The number of wells increased from 5.57 lakh in 1961 to about 10 lakh in 1989-90. The area irrigated under well is only about 1.5 hectares. The well irrigated area increased from about 595 thousand hectares in 1960-61 to 1177 thousand hectares in 1991-92, the net irrigated area in 1991-92 being 2165 thousand hectares and the gross irrigated area 2814 thousand hectares forming only about 14 per cent of the total cultivated area. About 47 per cent of the irrigated area is under cereals and 19 per cent under sugarcane/ (Table 2.3). The water requirements of different crops are highly divergent varying from about 12 acre-inches for rabi jowar to 176 acre-inches in the case of sugarcane (MSIC, 1962, pp. 348-349). In fifties about 45 per cent of irrigation water was used for sugarcane cultivation. By eighties, of the additional water resources made available nearly 70 per cent was devoted for the cultivation of sugarcane and horticultural crops. As a result in 1991, sugarcane claims about 60 per cent of the irrigation water. The need of protective irrigation has thus not received the

due attention and the emphasis has been on irrigation of commercial crops. Consequently agricultural production in the State, particularly of foodgrains and cotton continues to depend mainly on monsoon and fluctuates considerably from year to year.

Distribution of Benefits

Over the decades the sub-division of land by inheritance has resulted in an increase in the number of landholders from about 49.5 lakh in 1970-71 to 81 lakh in 1985-86. During this period the number of landholders with land below one hectare increased from 1241900 to 2488000. Considerable increase in the number of agricultural labourers is also noted, their number increased from 45 lakh in 1961 to 83 lakh in 1991.

Studies show that the benefits of green revolution that introduced hybrid and high yielding varieties were reaped mainly by the farmers with irrigation facility and access to adequate working capital to buy seed, fertilizers, etc. The major beneficiaries of irrigation were the farmers who received perennial irrigation and could grow sugarcane. In Maharashtra, sugarcane gives the highest return per unit of land as compared to other irrigated crops. The crop is 12 months or 18 months duration and demands large amount of working funds. The cooperative sugar factory together with the network of cooperative credit provided a basis for the rich land-owning sections to increase their economic power. The middle peasant section looks to these leading sections for economic betterment for obtaining credit, fertilizer, etc., with their support. The small peasant, lacking adequate land and other resources has by and large remained a subsistence farmer. In dry tracts even the middle peasant has not improved his position.

The plight of small peasant and agricultural labourers has worsened because the wage level has not kept up with the rise in prices. Consequently their real wages have somewhat declined.

Animal Husbandry

The cattle population in the State did not increase from 1951 to 1978, however between 1978-1982 growth is reported particularly in the number of cows. The proportion of cows to bullocks increased from about 71 per cent to 78 per cent. It is considered adequate to have 65 per cent cows in relation to the male stock for the reproduction of bullock stock, as cows are maintained primarily not as milch animals but for procuring bullocks. The number of cows is more than the optimum number in Maharashtra. Bullocks are imported in the State, e.g. Khilari bullocks are imported from Karnataka and Malva bullocks from M.P.

Estimates of fodder, grass and other feed resources are compared with the requirements of the livestock. It is found that the resources are adequate to meet only about 60 per cent of the requirements. In 1982-83 the estimated requirements were 40 million tonnes while the production was 24 million tonnes. If the situation in 1961 is compared with the present, three factors emerge that led to some increase in the gap between the fodder-feed requirements and the availability. (i) There is a reduction in the quantity of jowar kadba due to the shift from local varieties to hybrid varieties that yield less kadba. (ii) There is a decrease in the grazing land, because of dwindling of forests and cultivation of village commons. (iii) There is a sizable increase in the milch cattle accompanied by a considerable increase in the demand for green fodder and concentrates particularly for the exotic breeds.

Problem of Milk Supply: The problem of milk supply became acute in the major cities of Maharashtra, particularly Bombay because of the rapid increase in the urban population during the World War II and the influx of refugees after partition. Therefore, State Dairy Development and Coordination Committee was appointed by the Government in April 1948

to study the problem. The Committee recommended that (1) The riverine areas in the State, particularly near the towns be surveyed and utilized for dairy development. It was suggested that the five river basins near Pune should be considered for dairy development. Exploration of Ulhas river valley was recommended to augment the milk supply to Bombay. It was further suggested that sugarcane should be rotated with fodder crops of leguminous type in all the canal irrigated areas to ward off the danger of soils suffering from salinity and dairy development should be supported on the basis of sugarcane tops and fodder crops grown in these areas.

To promote dairy development in irrigated areas efforts were made in Miraj-Kolhapur-Karhad belt through cooperative organization. In most of the other parts of the State the emphasis was on organization of milk collection network, transportation and processing of milk for the urban supply. The Operation Flood II (1978-79 to 1984-85) emphasized augmentation of milk supply through increase in the number of cross-bred cows and extension of modern technological inputs to rural areas viz. a network of artificial insemination centres, mobile veterinary clinics, cattle feed compounding facilities, dairy processing units, etc.

The number of cross-bred cows increased rapidly and now constitute 10 per cent of the cows in milk and have a share of 30 per cent in the production of cow-milk in the State. The number of buffaloes increased from 16.4 lakh in 1961 to 23.1 lakh in 1982. As a result the production of milk doubled within a decade. It increased from 1003 thousand tonnes in 1973-74 to 2110 thousand tonnes by 1984-85. About one-third of the milk produced is collected mainly through the cooperative network, half of which or about 11 lakh litres are supplied daily to Bombay.

Cross-breed cattle are found profitable for dairy business and they serve a subsidiary source of income to resource rich landowners who can afford the necessary investment for feed and can maintain a number of animals to spread risk and uncertainty in breeding and heifer rearing, which the small farmers or the landless cannot afford. They may get attracted to the scheme because of subsidy. They, however, find it difficult to achieve economic viability due to small scale and lack of resources.

The major source of milk supply is the collection of milk in small quantities from thousands of farmers from the villages in the State. Cooperative societies have been established for milk collection and the attraction of ready cash induces delivery of milk to the cooperative even at the cost of consumption of milk/buttermilk in the household and proper feeding of the calf which leads to long term adverse consequences. A malnourished calf does not grow into a healthy productive cow. Thus the short run gains in terms of cash means the risk of long term degeneration of cattle and under-nourishment of children in the poorer families, as the cash may not be used for purchase of nutritive food for the children.

The major cattle breeds in Maharashtra are Khilar, Dangi, Gaulau and Deoni which are maintained for the reproduction of bullocks and their milk yield is low (less than 1 litre per day). It is not therefore profitable to incur expenditure on feeding these animals; they are sustained mainly on the basis of free grazing resources and crop by-products. As the pressure on fodder resources is increasing it means deterioration in cattle, both the working bullocks and the cows. The dairy development programme has not been able to help bring about improvement in the fodder resources despite a plethora of scheme. The incorporation of the rural small producer of milk in the market nexus without strengthening the resource base is thus leading to long term adverse consequences.

Working Bullocks: In Maharashtra tractorization has spread mainly in the tracts where sugarcane cultivation is concentrated. For vast rainfed agriculture bullock power is the main source of power. Even though the work for bullock is restricted to only about 60 to 90 days in a year a pair has to be maintained if the farmer can afford it for executing agricultural operations on time. The need of bullocks for the State on the aggregate basis came to 55 lakh in 1983-84 (Bhat, 1989, p.75). For 2000 A.D. when the projected production of foodgrains is 147 lakh tonnes the number of bullocks needed work out to 68 lakh. So long as agriculture remains the main source of livelihood for a large population and is operated individually on a small scale replacement of bullock power will not be possible. Even though there is a reduction in the types of work done by bullocks and hence the number of working days per year, the number of bullocks that need to be maintained for ploughing cannot be reduced.

Sheep and Goat: In Maharashtra the sheep population in 1982 was 26.71 lakh and the goat population was 77 lakh. The sheep population increased by 30 per cent and goat population by 50 per cent between 1961-1982. The sheep population is concentrated in the semi-arid tract of the State. Sheep folding is useful for manuring the farms and the leftovers in the farms are grazed by sheep. This traditional arrangement is still mutually complementary. About 85,000 families are engaged in sheep rearing; the average size of flock ranges from 20 to 55. The wool is of coarse quality and the return therefrom is negligible. The main source of income is the sale of animal, slaughtered for mutton, and the manure. Gross annual income for 50 sheep is about Rs. 9050.

The goat population in the State is rapidly increasing. Goat provides supplementary income through sale of kids and manure and small quantity milk (milk yield is about 60 to 100

litres per lactation or 0.5 to 0.7 litre/day) for home consumption without incurring cash expenditure and therefore small farmers or the landless prefer to keep a few goats. The estimated number of families maintaining goats is over 15 lakh, each family having on an average 1 to 6 goats. Gross cash income for a unit of 4 goats is about Rs. 2930.

To examine the relative importance of various animals gross return from animal husbandry is examined. Excluding the work done by bullock the gross value of animal products came to Rs. 2129 crore in 1986-87. The share of milk was 50 per cent, that of manure 27 per cent and the share of meat was 21 per cent. Since milk is the main livestock product, the contribution of cattle is the largest followed by that of buffaloes. In the case of sheep 75 per cent and in the case of goat half the return is from meat. For goat, share of milk is 25 per cent, that of manure 17 per cent and the rest is from sale of hides, skins, etc. Contribution of manure is 14 per cent, of hides and skins 4 per cent and of wool only 3 per cent in the case of sheep. Despite the fact that the yield of wool is negligible, the programme of sheep breeding has all along laid emphasis on wool production because India has to import wool of superior quality. However the programmes have met with little success as the conditions in the State are not favourable for exotic breeds. It is overlooked that it is the needs of shepherds that must receive a priority consideration in preparing schemes for development.

The estimated value of work done by bullocks comes to about Rs.900 crores. Thus the contribution of bullock comes to Rs.1700 per annum, that of cow (excluding the value of reproduction) Rs. 920 per annum, that of buffalo Rs. 3400 per annum, that of goat Rs.300 per annum and of sheep Rs. 340 per annum.

If the various schemes in relation to development of animal husbandry are examined it is clear that the schemes are

more oriented towards satisfaction of market demand than balanced development of primary resources so as to progressively augment the resource base, and thereby improve the level of living of the people dependent on primary resources for their livelihood.

As noted above so long as agriculture remains the means of livelihood of a large number of small holders, a sizable bullock population and cow population has to be maintained, and provision for adequate fodder must be made. In view of this compulsion it is necessary to look for alternative organizational arrangements, and also to take an integrated view of agriculture, animal husbandry, fishery, forestry, etc. These aspects will be considered in Chapters VIII and IX.

II. RAJASTHAN

Rajasthan desert was once the centre of flourishing civilization. From about 2000 to 1700 B.C. this region was the centre of the Harappan civilization. The relics suggest that the area was very favourable for human habitation. Excavations at a site near Kalibangan near Ghaggar river revealed a number of dessicated valleys suggesting a system of rivers that fed into the river Indus. The second phase, the painted grey ware culture, is dated 500 B.C. The last phase, the Rangamahar culture, flourished in the early centuries A.D. Evidence suggests that the gradual decline in the soil after the Rangamahar period is largely the result of human activity (Das, 1968, p. 95).

Prior to 1947, the present Rajasthan State was composed of several princely states of varied size, population and level of development collectively known as Rajputana and the British-controlled region of Ajmer. After independence the princely states were integrated by stages to form the State of Rajasthan. The total area of the State is 342000 sq.km; it is the second largest State in India by area. Compared to the size, the

population in 1991 was only 43.8 million or 128 persons per sq.km. while the density for the country as a whole was over twice as much (267).

Physiographic Regions

The State can be divided into four broad physiographic regions. (1) The Aravali range and hill region, (2) Western sandy region, (3) Eastern plains, (4) South-eastern plateau.

The Aravali range is the dominant mountain range and forms the watershed between the catchments of streams falling into the Arabian Sea and those falling into Yamuna river and finally in the Bay of Bengal. The plains to the west of Aravali form the Western Sandy plains. This region is semi-arid to arid. The principal drainage in this area is Luni river and its tributaries, the important tributaries being Jowai, Ladle, Sukri, Sagari and Badi. Most of the remaining tributaries of Luni are misfit streams with no definite channel. Though Luni does not possess a well-defined valley, it serves as a first natural barrier against the spread of desert eastwards. The plains to the east of Aravali are drained by Banas river. The south-eastern plateau comprises Vindhyan scarpland and the Deccan lava plateau. The plateau is dissected by numerous south-eastern flowing streams, most of them draining into the Chambal, the perennial river bordering the State in the east. The important tributaries of Chambal are Banas, Kalisindh and Parbati rivers.

The Banganga river originating from the hills near Shahpura in Jaipur district and Gambhiri river originating from Karauli hills both drain into Yamuna. The Sabarmati drains part of its water from Udaipur and Sirohi districts and the catchment of the river Mahi is largely confined to Dungarpur and Banaswara district.

Climate

The climate of Rajasthan is characterized by great extremes

of temperature, long periods of severe drought accompanied by high winds and low to semi-arid conditions of humidity. There are considerable variations in the amount of rainfall and temperature in the east and south of the Aravalis. There is a rapid and marked decrease in the rainfall west of Aravalis. The rainfall varies from above 80 cm in the south-east to less than 20 cm in the western margin of the State, encircling the Thar desert. More than 90 per cent of the annual rainfall is concentrated between mid-June and mid-September. July and August are the wettest months. The number of rainy days ranges from less than 15 in the western part to more than 55 in the south-eastern part of Rajasthan.

Wind acts as an important agent of denudation in the semi-arid region. Desertification of the western part of Rajasthan has been basically due to the absence of high hill ranges and due to the lack of abundant vegetation cover. Wind velocity is greatest in the summer months and varies from 10 to 20 kmph. At Jaisalmer the wind of 20 to 60 kmph prevails for the maximum number of days followed by Jodhpur, Ganganagar, Jaipur and Ajmer. In the eastern part of Aravali, wind velocity is checked by the undulating scarpland extending from Aravali ranges. Aravali forms a barrier for the dry and hot summer winds blowing west to east from across the heated Thar desert.

Soils

Desert Soils: The desert soils are found in the desert plain of western Rajasthan and mostly in interdune areas. These are considerably extended over the districts of Ganganagar, Bikaner, Churu, Barmer, Jaisalmer, Jhunjhunu, Jodhpur and Jalor. Geologically this area is formed of alluvium and wind-blown sands, with yellowish to yellowish brown, sandy to sandy-loam soils, loose, structureless, well drained with rapid permeability. Kankar layer is present below 75 cm and wind erosion is

severe because of scanty vegetation. Cultivation is strictly limited due to climate and dryness of the soil.

Sand-dunes: The sand-dunes are fairly well distributed in the western Rajasthan. These are non-calcareous soils, sandy to loamy sand, loose, structureless and well drained. In favourable localities they are occasionally cultivated, once in three or four years.

Red Desertic Soils: Red desertic soils are found on the uplands of Nagaur, Jodhpur, Jalor, Pali, Churu, Jhunjhunu and Barmer districts. These are pale brown to reddish brown soils, structureless, loose and well drained. Texture varies from sandy loam to sandy clay loam. Kankar layer is present below the depth of 50 cm. Soils are suitable to agriculture but suffer from adverse climatic conditions.

Sierozems: Sierozems are arid soils, found in Nagaur, Pali and Ajmer districts. These are yellowish brown to brown-sandy loam to sandy-clay loam soils, and are deep, often calcareous, with a layer of lime concretions at a depth of 100 to 150 cm. Large-scale cultivation is limited due to climatic factors.

Saline Soils of Depressions: These saline soils are found in the depressions or ranns of Barmer, Jaisalmer, Bikaner and Nagaur districts, including the ranns of Pokran, Jaisalmer, Pachpadra, Sambar and Didwana salt basins, Bap, Thob and Sanwarla and also in Bhawatra in the Rann of Kutch. These are dark gray to pale brown heavy soils with water-table very near to the surface, and are distinctly saline. Cultivation is not possible because of impeded drainage and high degree of salinity.

Lithosols and Regosols of the Hills: These are found on the Aravalis, hills of the eastern Rajasthan and also in the isolated hills of western Rajasthan and sloping hill sides. Soils are shallow with gravelly materials very near the surface, light textured, fairly drained, reddish brown to grayish brown in colour. Cultivation is restricted because of limited root zone.

Red and Yellow Soils of Foot-hills: These soils are found along the foot-hills of the Aravalis in the west in Sirohi, Pali, Nagaur and Ajmer districts. These are reddish to yellowish red, sandy loam to sandy clay loam soils of varying depth.

Yellowish Brown Soils of Foot-hills: These are the foot-hill soils of the Aravalis along its eastern scarp and are fairly distributed over Udaipur, Chittorgarh, Bhilware, Ajmer and Jaipur districts. These are developed on Vindhyan, Dharwarian and unclassified crystalline rocks. The soils vary from loam to medium in texture, moderate to good drainage, and are yellowish brown in colour and well drained.

Red Loam: Red loams are found in the Mahi catchment of Dungarpur, Banswara, Udaipur and Chittorgarh districts and also in the undulating plains of eastern Kota district. These are reddish coloured, medium textured, non-calcareous, well-drained soils.

Brown Soils (Saline Phase): These soils are found in Chittorgarh, Bhilwara, Kota and Tonk districts and are developed mainly from Dharwarian rocks and alluvium. These are associated with high seasonal water-table and are saline. The soils are pale brown to yellowish brown, medium textured, well to moderately drained. Cultivation is limited because of soil salinity.

Black Soils: Geologically these are confined to the Deccan trap (lava) and its adjoining sloping terrains of Kota, Banswara, Chittorgarh, Bundi, Bhilwara and Udaipur districts. These are medium to heavy textured and vary in colour from gray to dark grayish brown. These are moderately drained soils. Soils are cultivated but impeded drainage is one of limitations.

Old Alluvium: These are found in the plain lands of Jaipur, Tonk, Ajmer, Alwar, Sikar and Bhilwara districts and derived from alluviums. These are non-calcareous brown soils

having loamy sand to sandy loam texture. These are well drained and occupy gently sloping terrains.

Recent Alluvium: These are found along the flood plains of the Chambal and Alwar districts. The soils are deep, well drained, sandy loam to loam in texture and non-calcareous.

Agroclimatic Zones

The State can be divided into five macro agro-climatic regions, viz., the western arid, the transitional, the semi-arid, the southern sub-humid and humid. These can be sub-divided into micro regions on the basis of cropping characteristics that are determined by rainfall quantum and pattern, and irrigation facility.

Water Resources

Water has been the most scarce resource of the State. The surface water resources of the State are limited and localized in humid and sub-humid zones of the State. River Chambal forms the only major source of the surface water potential for the State. River Chambal has a total catchment area of 72000 hectares within the State, including the catchment of Banas, Kalisindh, Parbati and Parwan. These basins have provided optimum locations for dams. The total surface water potential in the State is estimated at 1.946 mm. out of which planned utilization is 1.000 mm. In addition water from outside source is brought through Gang, Bhakra and Rajasthan canal projects.

Sub-surface and groundwater is the major source of water in the arid and semi-arid zones where prospects of tapping surface runoff are either very meagre or do not exist at all. The south-eastern half of Rajasthan is characterized by shallow water-table occurring in hard and consolidated sedimentary rocks comprising of sand stone, lime stone, gneisses, schist and gravels, while in the north-western half the water-table in consolidated to unconsolidated sediments is comparatively

much deeper generally over 30 m in Thar region to over 100 m in Jaisalmer and Barmer, Bikaner. The Jaisalmer region is the lowest spot in Rajasthan with more than 100 m of water-table depth. The groundwater in parts of western and central Rajasthan is highly saline. Relatively fresh water occurs along the foot hills and Aravali tracts. The salinity of groundwater is observed to be on the increase.

The monthly potential evapotranspiration (PET) is higher than the normal monthly rainfall throughout the year in western Rajasthan except for Jodhpur where in August the precipitation and PET are the same. Thus, there is no surplus available during the year of normal rainfall for either runoff or addition to water-table.

Natural Vegetation

Climate, altitude, soil, water availability determine the distribution of natural vegetation. Vegetation in its turn, provides favourable micro-climate, checks floods, conserves soil, promotes infiltration of water. It thus forms the most vital renewable resource. Its misuse and abuse leads to irreparable damage to the eco-system. Rajasthan once a region of fertile land and rich vegetation (Rangmahal culture flourished in this region some 1800 years back) has turned into dry barren landscape with thorny scrub and grasses.

Irrigation

The scope for flow irrigation is limited in Rajasthan because of the paucity of local precipitation and absence of stream flowing from outside the region. For provision of irrigation facility from streams outside the region, the surplus water of Punjab rivers has received considerable attention. In 1927 the then ruler of Bikaner constructed the Gang canal to irrigate lands from Ganganagar district. Since the early fifties canal irrigation through major and

medium projects is being developed. Dug wells are the traditional means of irrigation. But many of them (particularly in western Rajasthan) suffer from inadequate recharge and salinity. The districts in the central belt have a substantial area under tank irrigation. Tanks not only provide direct irrigation but also help in recharging groundwater.

The net irrigated area in Rajasthan increased from 1283 thousand hectares in 1952-53 to 3481 thousand hectares by 1988-89. Additions to surface irrigation through Bhankra, Rajasthan and Chambal Projects were made during the Plan period. There was some increase in the tank irrigated area upto 1957-58 when about 222 thousand hectares were under tank irrigation. There was no further expansion thereafter. The area under well and tubewell irrigation increased from 684000 hectares in 1951-52 to 2089000 hectares by 1988-89. Even though there is a considerable increase in the well-irrigated area, the year to year fluctuations, largely related to the annual precipitation, are marked. Following the years of deficient rainfall like 1966, 1968, 1969, 1972, 1974, 1979, 1980 a decline in the well irrigated area was noted in the following year while in the year after normal rainfall growth in the well irrigated area is noted. There are large inter-district variations in the availability of irrigation facility. The western arid districts have less than 5 per cent of the area under irrigation except Ganganagar district which receives irrigation from the major multipurpose projects in Punjab. Bhilwara, Bundi and Jaipur are well-developed in irrigation with over 40 per cent of the area under irrigation. The main source of irrigation in Bundi and Kota is Chambal canal. In Jaipur, wells and in Bhilwara wells and tanks are the important sources of irrigation. In Sirohi, Pali, Ajmer, about 30 per cent of the cultivated area receives irrigation, wells being the major source.

The groundwater potential in Rajasthan is very limited because of scant rainfall. In the arid region the groundwater of good quality being altogether limited it has to be mainly used for drinking water purposes and area under irrigation cannot be extended. In the semi-arid region it is already being over-exploited particularly in Jaipur and Alwar districts and care has to be taken to limit further expansion. In humid region there seems some scope for further expansion of well irrigation in Bundi, Kota and Jhalwar districts. On the whole the State has reached the limit of groundwater exploitation and only in pockets where irrigation potential by surface sources increases some expansion in well irrigation through the use of return water would be possible.

Land Use

The arid region of Rajasthan covers about 60 per cent of the area of the State. District Ganganagar which is also characterized by arid climate is not included in the arid region because of its transformation due to extensive irrigation. Owing to harsh climatic conditions the region is devoid of forest cover. Only 0.8 per cent of the land is under scrub classified into northern Acacia scrub, northern Euphorbia scrub, inland dune scrub. The arid region of Rajasthan can be divided into three zones on the basis of soil, water and vegetation. Zone I or the north-western part which is extremely dry forms about 56 per cent of the area of the dry region but accounts for only 20 per cent of the population of the dry region. It is fit only for animal grazing and unsuitable for crop raising. Zone II that covers 22 per cent of the area with 37 per cent population is suitable for animal raising and very restricted crop culture. Zone III with 22 per cent of the area accounts for about 43 per cent of the population. It has a relatively better soil cover and water conditions for crop farming on a

sustained basis. In 1956 about 26 per cent of the total area of the arid region was net cropped and 8 per cent of the area was under current fallows which is a part of crop rotation. By 1983-89 the net cropped area increased to 40 per cent and the total area used for crop raising was 47 per cent of the total area. There was thus a significant extension of the margin of cultivation. The inevitable consequence of using sub-marginal lands for ploughing under arid conditions is progressive elimination of natural plant cover, intensification of wind action and accentuation of soil erosion. However for want of any alternative source of livelihood peasants are forced to reduce the fallow period and bring more area under current cultivation to eke out bare subsistence.

As more land is brought under plough the number of trees and shrubs are getting reduced. The increasing demand for fuel-wood, for timber, fencing, animal feed is resulting in over-exploitation of the vegetal resources. Digging of phog roots (Calligonum polygonoides) for fuel loosens soil and accelerates wind erosion.

Agriculture in the arid tract is highly risky. It is noted that about 30 to 40 per cent of the villages in one part of the region or the other are affected by scarcity conditions every second or third year. This leads to huge losses in crop and animal production and thrusts untold misery on the people. As a result of high variability in the rainfall the yields are highly variable; this imparts a high degree of instability to the economy of the region. Due to poor soils and low rainfall the average yield is quite low, though some increase in the yield has been noted in the case of bajra over the last two decades. Because of the limitations of agro-climatic conditions, only a few crops viz. bajra, gaur, moog, moth, jowar, sesamum can be grown in this region, bajra being the

main crop. Despite the low productivity and high variability in yield, agriculture is the major occupation of 86 per cent of the total workers in this region, as there are no alternative avenues of employment. 82 per cent of the workers are cultivators and about 4 per cent are agricultural labourers. Only 3.6 per cent workers reported livestock rearing as their major occupation. Crop husbandry and animal husbandry are combined by nearly all the workers.

Only in Ganganagar district the crop pattern has changed, the yields have increased and the variability in production reduced due to canal irrigation. However, irrigated agriculture, in arid zone brings with it, its own problems.

The Rajasthan canal system runs through vast sandy plains and dunes. The risk of sand storms and shifting dunes blocking the water ways and disturbing the system and erosion of canal banks is high. Crops also get covered with sand. Because of waterlogging the problem of mosquito breeding has become serious. There is a danger of increase in the waterlogged area because about 30 per cent of the command area is hard pan area i.e. having hard pan within 10 m depth, where percolation is hindered creating perched water-table conditions. Annual rise in water-table has been noted for the period 1981-82 to 1985-86; the critical area (where water-table has risen to 6 m below land surface) increased from 10.4 per cent to 16.4 per cent by 1985, it declined again to 10.4 per cent in 1987 due to drought. The projected growth in the critical area is 25 per cent by 1990 and 35.6 per cent by 1995. There is thus a need for strict monitoring of the rise in water-table and implementation of drainage system to combat waterlogging. If the drainage water cannot be recycled because of salinity huge investments would be needed for collection and disposal of the saline drainage water. A hydraulic barrier is also

built up near India-Pakistan boundary due to differential water levels as a result of which movement of groundwater from Rajasthan canal command area may not have any exit towards the west to Indus river systems.

The construction of canals and extension of agriculture have disturbed the stable dunes. The development activity has been taken without assessing inherent morphological properties of land forms. Canals and tanks have been constructed across buried courses of drainage channels resulting in waterlogging, capillary rise of subsurface salts and spread of salinity into agricultural lands. There is a danger of 2.35 million hectares developing salinity problem under Bhakra, Gang and Rajasthan canals and 2390 hectares in Luni Block in Jodhpur.

Extension of cultivation in the arid zone through development of irrigation is thus fraught with many serious problems. Hence the challenging question is whether to continue agricultural activity in Zone I and Zone II of the arid region, when it does not provide subsistence to the population and is ecologically disastrous.

In north-eastern Rajasthan that accounts for nearly 25 per cent of the area of the State, about 60 per cent of the area is under cultivation and as the extent of fallow is small, about 52 per cent area is net cropped. The region has a high proportion of the cultivated area under wheat (20 per cent), followed by bajra (19 per cent), jowar (9 per cent), maize, barley, gram (13 per cent) and other pulses, rape-mustard (9 per cent), groundnut, linseed and other oilseeds, cotton, chillies, condiment and spices. The cropping pattern is, thus, diversified and the yields are relatively higher compared to other parts of the State. The major changes noted in this region is the increase in area under wheat and rape-mustard with the extension of irrigation.

The hilly Udaipur region has only 30 per cent of the area under cultivation, maize being the most important crop (30 per cent), followed by wheat (17 per cent), rice (8 per cent), gram and other pulses. In the Kota-Jhalwar plateau region about 47 per cent area is under cultivation, the net cropped area forming about 43 per cent in the total area. Wheat (20 per cent) and jowar (4.6 per cent) are the main cereal crops and gram (12 per cent) the important pulse crop.

The changes in the cropping pattern noted during the last three decades are primarily due to the introduction of irrigation which has displaced certain crops e.g. bajra and gaur in Ganganagar district by wheat and cotton. Compared to 1956-57, the area under irrigated barley, maize and jowar has declined, that under sugarcane has remained stationary and the area under wheat, rape-mustard, chilli, coriander and other spices and cotton has increased.

Crop Production

About 50 per cent of the area in the State is under cereals, nearly 20 per cent under pulses and about 8 per cent under oilseeds. Cash crops occupy a small proportion of the total cultivated area. Only 2.2 per cent area is under cotton (of this over 70 per cent is concentrated in Ganganagar district) and 0.18 per cent is under sugarcane, while in Maharashtra, area under oilseeds and cotton each accounts for about 13 per cent of the total cropped area while sugarcane covers about 2 per cent area. In Gujarat as much as 17 per cent area is under cotton and 20 per cent is under groundnut. As agriculture in Rajasthan is largely subsistence oriented, even though the productivity is relatively low, the production in a normal year is sufficient to meet the needs of cereals and pulses in each district. The staple cereals in various districts viz. bajra in the arid districts, maize

in hilly districts are grown in adequate quantities. In a normal year, the State is surplus in production of pulses and oilseeds even after meeting the needs of the urban population.

Production of cereals increased from 32.64 lakh tonnes in 1956-57 to 92.31 lakh tonnes in 1990-91 and that of pulses from 15.86 to 17.22 lakh tonnes.

Contribution of Agriculture

Development of agriculture in Rajasthan has thus inherent agro-climatic limitations. However, the economy of Rajasthan is not getting diversified. Primary sector continues to be the major economic sector in Rajasthan. Around 50 per cent of the net domestic product is contributed by agriculture and 12 per cent by animal husbandry.

There is only a marginal increase in the per capita income between 1960 and 1985. Despite the development efforts the year-to-year fluctuations in income, the predominant position of the primary sector in the economy and low level of income persists. This means that the direction of development needs to be critically reviewed as the basic problems persist in spite of large investments.

Livestock Economy

The animal husbandry sector is quite important in the economy of Rajasthan. It provides intra-year stability in employment and income in the arid and semi-arid region. In fact, the lands in these tracts can yield mainly grass and sustain animal husbandry. In the dry sandy soils livestock also contributes, significantly, in terms of organic manure. In the arid, semi-arid region the share of livestock in the total rural assets was noted in a village study to be 15 to 20 per cent (Ahuja, 1987, p. 74).

Cattle: The primary purpose of maintaining cattle in India is to secure bullocks still essential for tillage except

for Punjab-Haryana where tractors have displaced bullock power to a significant extent. In Rajasthan there are marked differences between regions in the size of the cattle population. In arid zone it is not bullocks but the camel capable of withstanding the severe stress of the arid climate, that is the main source of motive power. There are about 69 camels per 1000 hectares in the arid zone as a whole. In Ganganagar district the number of tractors is considerable. In north-eastern Rajasthan the number of bullocks works to 258 per 1000 hectares i.e. about eight hectares are worked by a pair of bullocks. In the south-eastern region it is 364 while in Udaipur-hilly region there are as many as 581 bullocks per 1000 hectares.

The number of cows in a State like Maharashtra where the cows are primarily maintained for reproduction of bullocks (except for the cross-bred cattle) comes to about 75 per cent of the total bullock population whereas in Rajasthan there are 140 cows per 100 bullocks, the number is as high as 357 in the western region, where cows are maintained mainly as milch animals.

There are seven well defined breeds of cattle in Rajasthan viz. Haryana, Gir, Nagauri, Kankrej, Tharparkar, Rathi and Malvi. Of these Rathi and Tharparkar are classified as dairy breeds, Nagauri and Malvi are important for draught animals while the remaining three provide both. The average daily yield of milk per animal varies from 1.63 litres for Malvi to 4.21 for Rathi. In the case of Rathi and Tharparkar breeds milk yield can be improved with selective breeding and adequate and nutritious feed.

The bullock population for the State as a whole has remained around 40 lakh from 1961, only in 1983 it declined to 36.47 lakh. Population of cows has remained around 48 lakh, but it declined to 46 lakh in 1972. 1966 was a drought year in parts of Rajasthan, there was a widespread drought in

1968 and 1969, again 1971 and 1972 were drought years. Consequently there was a decline in the cattle population.

The programme of promotion of cross-bred cows has not picked up in Rajasthan. In 1982 there were only 16000 adult cross-bred cows, with 10000 cows in milk as against this the number of local cows in milk was 21 lakh.

In the case of buffalo, a steady increase in the population is noted; The increase has been considerable since 1966. The increase has been highest in Western Rajasthan where the number increased from 5.8 lakh in 1961 to 15.7 lakh in 1982. The number of cows and buffaloes and the milk supply is thus increasing. The milk production increased from about 23 lakh tonnes in 1970-71 to 39 lakh tonnes by 1985-86. However, there is not adequate network for collection of milk. It was noted in a study in 1985-86 (EMPR, 1986, p. 7) that about 28 per cent of the milk is used for home consumption, 56 per cent converted into milk products, primarily ghee and khava, chena, etc., and only 16 per cent is sold as liquid.

Even though the State, particularly the western region is eminently suited for milch animals and not for crop husbandry and schemes for improving the breed, feed and the infrastructure for collection of fluid milk have been operative yet the facilities are extremely inadequate. As against estimated daily milk production of about 100 lakh litres the collection by cooperatives is only about 4 lakh litres. The experience of the recent years brings to the fore many problems (TOI, 1990). In January 1990 it was reported that the prices of milk have been lowered by 50 paise a kg (3.05 a kg as against 3.55 kg in November 1989) and even at the reduced prices there were no takers. With highly erratic power supply the milk powder processing unit also had to function below its capacity. The prices of 'khoya' and 'ghee' reportedly plummeted from Rs.45 a kg to Rs.15 a kg and Rs.85 a kg to Rs.60 respectively.

The prices of cattle feed, fodder and gaur are however going up making it uneconomical to the farmer to maintain milch cattle. There is also the problem of supply feed and fodder as the number of livestock is increasing. The problem cannot be handled through isolated schemes like Feed and Fodder Programme, Goshalas, cattle fairs, dairy cooperatives but has to be tackled through a comprehensive approach which will be considered in Chapter VIII.

Sheep and Goat Husbandry: The relatively small proportion of the total land that is suited for cultivation and a larger proportion of land fit for grasses and scrub vegetation makes sheep and goat rearing an important occupation in many districts of Rajasthan. These animals are important particularly in the arid region as sheep and goat can withstand water scarcity and survive on poor fodder resources. In arid districts the small as well as large land owners maintain flocks of sheep and goat; these are fed mainly on the basis of grazing on common lands and tree loppings by the small land owners. The availability of child and woman labour to look after the goats is an important consideration that influences goat keeping. The very poor landless, with no access to own fodder at the one end and the prosperous farmers owning a large size cattle herd at the other end, generally do not keep goats. Goats are kept primarily to provide the household needs of milk, supply of manure, and the small cash receipts (obtained through the sale of male kids and sale of milk products like dahi or ghee) that come handy particularly to small farmers.

The population of sheep and goat has been increasing continuously since 1961, though between 1966-1972 there was some decline in the sheep population due to high incidence of drought (4 out of six were drought years).

Rajasthan produces about 40 per cent of country's total

output of wool. The arid districts produce about 65 per cent of the total wool produced in the State though it has about 50 per cent of the total sheep population. The wool produced in Rajasthan is predominantly of medium quality. There is only one breed viz. Shekhawati or Chokla that produces fine grade wool. It supplies excellent carpet wool and medium quality apparel wool. The main breed of the arid and semi-arid districts is Marwari - a highly stabilized breed that produces carpet wool of medium and coarse type. In the sub-humid and humid areas Sonadi predominates, a breed that withstands heavy rainfall. Sonadi yields coarse wool; Sonadi and Malpura breeds are suited for mutton production.

Goat is a versatile animal. It provides milk, meat, hair, manure and is an efficient converter of whatever feed that is available in the desert. Goat milk is used mainly for home consumption (about 60 per cent), about 24 per cent is converted to milk products and 16 per cent is sold direct. Average daily milk yield varies between 0.4 and 1.0 litre. In the total life span goat provides 8 to 10 kids, the male kids are sold while the females are sold at the close of the reproductive age.

The important breeds of goats are Marwari, Alwari, Lohi, Jhakrana, Sirohi, Jannapari and Barbari. Jumnapuri is a heavy animal and can adopt to most regions of the State. Jhakrana is reputed for high milk production. The Barbari is prolific. The Marwari mutton breed is a hardy breed kept exclusively in the dry western region mainly for mutton. The Sirohi breed is well adapted to arid and semi-arid conditions. It is dual purpose milk and mutton breed.

Sheep and goat have special adaptability for ecologically fragile tracts. When minimal feed is available the animals lose body weight to a greater extent in comparison with other animals and still survive. As soon as the area regenerates the animals

increase and maintain their body weight yielding some output to the human population who have but a few resources for sustenance in the fragile ecosystem. They help dispersal of seed. Goats, in extreme conditions go even for unpalatable bushes and forbs and help control many woody weeds. Goats select about 60 per cent shrubs, 30 per cent grass and 10 per cent forbs whereas sheep prefer 50 per cent grass, 30 per cent forbs and 20 per cent shrubs. The small size, light weight and high utilization of coarse fibres (lignin) are some forms of adaptation to ecologically fragile zones.

Low production per head of these animals compels a breeder to increase his flock size to get at least a subsistence income. Low financial inputs as compared to cattle makes sheep and goat rearing an important source of subsistence for the weaker sections.

Between 1951 and 1983 the total livestock population in Rajasthan increased from 10.27 million to 24.12 million. At the same time the area available for grazing has been declining. Consequently the grazing lands with their low carrying capacity are getting depleted because of overuse. The deterioration of the grass lands and pastures - the main sources of fodder and forage for livestock means high incidence of mortality and degradation of livestock. It means increase in the plight of particularly the nomadic pastoralist.

The Pastoralist: The pastoral people e.g. Raikas, Sindhis, Parihars, Billocks, etc., inhabiting the Rajasthan desert have been carrying on livestock breeding for generations. The pastoralists have a permanent home and generally a parcel of land. Their nomadism is dependent on the availability of water and forage in the given season. Their economy is largely dependent on the harvesting of available water and efficient use of the extensive grazing lands. Water harvesting for livestock is in vogue since generations. A hard plot of land

with very low porosity and good catchment is searched for construction of a dug out pond or toba for efficient use of the meagre available water and the grasses. If the rains fail pastoralists have to migrate. Prior to partition they used to migrate to Bahawalpur region. However since the strict closure of the boundary from 1965 they migrate to Ferozpur, Ganganagar districts. On their way the migratory pastoralists exchange milk, ghee, mutton, wool at the village and also provide sheep manure to the farmers and graze their livestock in the village. They thus used to perform a complementary function. However with the improvement in marketing facilities, commercialization of agriculture and growth of irrigated agriculture mutual dependence between the nomads and the villagers enroute have broken down. The villagers are no more keen on buying various goods from the migrating herders. Even sheep folding is losing its value where use of fertilizers has increased. Shrinkage of grazing lands due to extension of cultivation puts pressure on the existing grazing resources. At places even the standing crops in the villages get damaged. There is also a pressure on local water and other resources. This is decried by the settled villagers. The pastoralists faced with shortage of resources and hostility of the local population find migration all the more arduous and hard. With the opening of Rajasthan canals extensive grazing lands got converted into crop lands; this is creating further hardship for the nomadic pastoralists.

Both from the point of view of controlling periodic pressure on the villages enroute and the economic betterment of the pastoralist through ensuring better health and survival of their livestock and better organization of wool-shearing, mutton industry, etc., planning for progressive settlement of the pastoralists is essential. These aspects are discussed in Chapter VIII.

Supply of Fodder and Feed: Animal husbandry, if viewed as a business, demands proper supply of feed and fodder and supporting infrastructure like health service, breeding service, drinking water supply, shelter, marketing and processing network for the produce. However, traditional animal husbandry is complementary to subsistence agriculture and helps in sustenance of agriculture, and using the by-products of agriculture provides part of the subsistence needs of the farmer. Except for the dairy business oriented to urban markets, the animals are still fed mainly on free grazing or by-products of grain viz. fodder; they are given some purchased fodder and concentrates only when in milk or working. Little special effort is taken to improve or augment the fodder resources and as the number of livestock is increasing, the pressure on the available resources is increasing. The needs of livestock are met through fodder/straw of cereals, pulses and oilseeds, some special fodder crops like maize, jowar, gaur, free grazing in forests, pasture lands and waste lands and lopping of trees. Estimates of fodder resources are not available, they have to be worked out on the basis of average grain/straw ratios, and productivity estimates of trees, grasses, etc., under different climatic conditions. They are necessarily crude approximations but have been worked out to get broad dimensions of the fodder situation in different regions of Rajasthan.

By-products of agricultural crops constitute about half the fodder resources, fodder crops provide about 10 to 12 per cent of the fodder and the rest has to be met through free grazing. With the increase in the pressure on the free grazing resources the natural supply deteriorates and shortages increase particularly in a drought year when incidence of migration increases considerably. The fluctuations in rainfall make for wide variations from year to year in the supply of

crop based fodder. The shortage mounts to 60 per cent or more of the requirements in a drought year.

There are considerable variations in the extent of shortage experienced in different regions. In the arid tract even though the estimated resources appear adequate they may not be exploited due to distant locations and non-availability of drinking water in the tract. It is only in the irrigated Ganganagar district that the supply seems adequate at the aggregate level. However, shortages are experienced by the landless and the poor who do not have their own fodder. Deficit to the extent of about 20 to 30 per cent of the need is experienced in most districts in normal year. These shoot up considerably when rains fail.

Despite schemes of pasture and fodder development augmentation of fodder resources is not experienced. The schemes fail mainly because of the problem of protection. The animals are not productive enough to be stall fed, however unless they are properly looked after and fed their productivity will not improve. We are thus caught up in a vicious circle and unless we break it we will continue on the downward spiral. The alternative approach for rehabilitation and redevelopment of animal husbandry sector which besides agriculture is the main land-based sector in Rajasthan will be considered in Chapter VIII.

III. GUJARAT

The physical features of the State indicate the following three distinct physiographic units based on relief, slope and land forms, physiological features such as soil, drainage pattern, climatic variations and agricultural development.

- a) Mainland Gujarat
- b) Saurashtra
- c) Kachchh

(a) Mainland Gujarat

The Coastal Area: The low lying areas are inundated by

sea water. In addition, the overdrawal of groundwater resources for irrigation in some parts has caused the problem of salinity ingress. The problem of drinking water is also acute in some parts of the coastal area. The Gulf of Khambhat region is characterized by vast tracts of salt marshes which get flooded at spring tides. The soil is soaked with salt and the water is brackish. The region around little Rann of Kachchh forms another salty waste. The Sabarmati which drains into the Gulf of Khambhat becomes a sluggish changeable stream here and deposits a layer of sand on the fertile loamy river soil.

The Plains of Gujarat The plains are the most fertile part of Gujarat and lie beyond the reach of tidal waters. It forms a narrow plain 25 km. wide in the southern-most part in Surat and widens towards the north in Vadodara, Ahmedabad and Mehsana within its limits. The plains of Gujarat are drained principally by the rivers viz., Sabarmati, the Mahi, the Narmada, the Tapi and their tributaries. The region presents varied aspects of soil, climate and relief which divide the plain into Southern plain, Central plain and the Northern plain.

The Eastern Highlands: The eastern hill region consists of the outliers of the Aravali system, the Vindhyas, the Satpudas, and the Sahyadris. The northern region belongs to the Aravali system, while the southern section belongs to the Vindhyas, the Satpudas and the Sahyadris. While the whole region is eroded by many streams there are some variations. In the southern part, the land is poor and merges into the tract of hilly forests known as the Dangs. In Dharampur the hills are barren of trees. The principal range in the Reva Kantha hills is in the Rajpipla hills,

(b) Saurashtra

Saurashtra is the peninsular part of Gujarat and stands out in the Arabian Sea. The physical features of this region

suggest that it might have been once an island or a group of islands of volcanic origin. Between Saurashtra and mainland Gujarat, the land is interspersed with occasional marshes, lakes and saline pockets. It suggests that the silt of Indus, Sabarmati etc., has gradually filled in what was once a shallow channel and joined the north-western saurashtra to the mainland.

The Coastal Lands: The coastal region comprises the area on the coastline from the Gulf of Khambhat to the Gulf of Kachchh. The coastline on the whole is broken by the mouths of the rivers and creeks and sometimes the sea gains an access to salt marshes and mangrove bushes.

The Inland Plain: The highly fertile inland plain is drained by several rivers radiating from the Central highlands. The inland plain consists of the basins of the two rivers of Shetrunji and Bhadar. The inland plain also has a region of low lands of Bhavnagar and the Ghogho plain where rivers run sluggish in parallel streams and towards the coast. The region tends to become salty, marshy and brackish.

The North-eastern and South-eastern Highland Region: The North-eastern series comprise barren hills indented by several streams into ridges and valleys. For Anandpur and Bhadla, it throws off branches to the right and left till they end in the plains of Morvi. The surface rocks are sandstones.

(c) Kachchh

The crescent-shaped region called Kachchh forms part of the north-west Gujarat. Though on the whole treeless, barren and rocky, the physical features of Kachchh are characterized by ranges of hills and isolated peaks by deeply cut river-beds and by well tilled valleys and tracks of rich pastureland. On the south, behind a high bank of sand that lines the sea coast lies a low fertile and well-cultivated plain. Beyond this plain, the region is broken by three hill ranges, viz., those of

Kachchh proper, of Vagad in the east and the Rann elevation in the north. The entire expanse of the Rann of Kachchh and Little Rann of Kachchh situated on the northern and eastern side respectively is covered with a thick layer of salt mixed with fine sand and clay, devoid of vegetation and habitation.

Climate and Rainfall

Climate of a region has a decisive effect on the nature of crop pattern and agricultural practices, livestock and forest resources.

The entire State of Gujarat lies in the monsoon area and the climate is acknowledged as "Monsoon Climate" and the rainfall period is confined to four months from the middle of June to middle of October.

There are, however, large regional variations in the climate. Latitudinally, the State astrides the tropic of cancer and has got the maritime and continental location and hence it exhibits a variety of climates representing a transition between heavy monsoon area of Konkan and arid Rajasthan.

From the point of view of rainfall, the State can be divided into four major zones.

i) Area receiving rain more than 100 cm. - Valsad, Dangs, Surat and eastern parts of Bharuch district and Rajpipla hills.

ii) Areas receiving rain between 80 cm - 100 cm. - Vadodara, Panch Mahals, Kheda and parts of Ahmedabad.

iii) Areas receiving rain between 40 cm - 80 cm. - whole of Saurashtra and areas north of Ahmedabad.

iv) Areas receiving rain less than 40 cm. include Kachchh and Banaskantha and Western part of Sabarkantha districts.

Soils

The soils of Gujarat can be broadly classified into seven groups on the basis of standards adopted and the groups established by the All India Soil and Land Use Survey

Organization. These seven groups are:

- (i) Black soils
- (ii) Alluvial soils
- (iii) Saline/Alkaline soils
- (iv) Desert soils
- (v) Lateritic soils
- (vi) Hilly soils and
- (vii) Forest soils.

(i) Black Soils: Black soils with soil depth varying from a few centimetres to about 0.6 metre or more are found in Saurashtra region except in coastal belt, parts of Sabarkantha and Panch Mahals districts, south-west of Ahmedabad district, part of Vadodara and Kachchh districts. These are shallow black soils and do not pose any drainage problem.

The deep black cotton soils with depth varying from less than one metre to as deep as 6 metres cover major part of Bharuch, Surat and Valsad districts. Soils have very high clay content and are not easily workable during monsoon. Drainage is not satisfactory due to clayey nature of soils. These soils situated in low lying areas are suitable for growing rice.

(ii) Alluvial Soils: These soils in Gujarat are formed due to silting by Indus river system. The soils are very deep and uniform throughout the profile. They are further sub-divided into alluvial sandy and alluvial sandy loam to clay loam.

(iii) Alkaline/Saline Soils: These soils are formed due to effect of tidal waters all along the sea coast. These soils are found the 'Bhal tract' consisting of parts of Bhavnagar, Ahmedabad and Kheda districts and also southern parts of the State along the sea coast. Inland saline soils are found in parts of Mehesana and Banaskantha districts and major parts of Kachchh district due to less rainfall and high evaporation rate during summer. Saline/alkaline soils in Kheda and Ahmedabad districts are caused due to high underground water-table and faulty drainage conditions.

(iv) Desert Soils: These soils are mainly found in the

Rann of Kachchh and are not suitable to any kind of vegetation.

(v) Lateritic Soils: Strictly speaking there are no lateritic soils in Gujarat State. However in the Dangs district, abundant forest vegetation and very high rainfall resulted in laterites of some sort. Soils are yellowish red in upper horizons and reddish brown in lower horizons. Topography is highly undulating.

(vi) Hilly Soils: These soils are shallow in depth. Due to different degrees of erosion on sloppy lands, these soils are nutritionally poor and are found in patches in Vadodara, Surendranagar, Amreli, Junagadh, Kachchh and Dangs districts.

(vii) Forest Soils: Out of the total area of the State, about 10 per cent is under forests. Profiles from the forests of Dangs and Junagadh show that organic matter content is very high.

A major part of the State suffers from poor soil and undulating terrain. Large parts of riverian lands adjoining the rivers of Tapi, Narmada, Mahi, Sabarmati, Saraswati and other minor rivers have remained uncultivated owing to progressive soil erosion by winds and surface run-off. The soils in the districts of Kachchh, Banaskantha, Sabarkantha and Mahesana are susceptible to wind erosion specially due to dry saline winds over the Rann area. Continuous progress of erosion adversely affects the fertile cover of the vulnerable adjoining lands. Large areas of cultivable lands are being rendered useless due to salinity ingress in Saurashtra. This can be attributed to over-drawing of water for irrigation and water supply. Lands are also rendered uncultivable due to deposits of salt brought by the winds. It is estimated that nearly 40 lakh hectares of land need various soil and water conservation measures to prevent water and wind erosion.

The Government of Gujarat had appointed a High Level Committee in December 1976 to examine and recommend appropriate

measures to arrest salinity ingress and to chalk out a timebound programme of action to contain the problem. Khar Land Development Board has been constituted under the Khar Land Act, 1963. Gujarat State Land Development Corporation has been established with a view to accelerating the process of reclamation of ravine lands through scientifically planned soil conservation, afforestation, development of pastures and horticultural development.

Central Arid Zone Research Institute (CAZRI), Jodhpur, has identified 17 talukas as arid and 82 talukas as semi-arid talukas of the State. Eleven Talukas of Gujarat viz., Deodar, Tharad, Kankrej, Radhapur, Santalpul and Vav of Banaskantha district, Sami and Harji of Mahesana district and Abidasa, Nakhatrana and Lakhpat of Kachchh district, are selected for the Desert Development Programme of Government of India.

Minerals

Gujarat is not rich in metallic minerals but there is abundance of non-metallic minerals. Important minerals are limestone, manganese, bauxite, lignite, gypsum, china clay, fire clay, flurospar, dolomite, glass bentonite, agate, sand, quartz, pipe clay, soapstone, etc. Gujarat leads in the production of agate and salt, is second in calcite and third in china clay in the country.

The efforts of Oil and Natural Gas Commission to locate oil and natural gas started in 1957 since then it has discovered various structures of different types and sizes producing oil and/or natural gas. The discovery of oil and natural gas in commercial quantities and rich deposits of flubrite, lignite and bauxite have raised the States importance on the mineral map of the country.

Forests

The total area under forests in Gujarat (1979-80) was about 20,000 sq.km. which is about 10 per cent of total area.

Forests are unevenly distributed. Major concentration is found all along the eastern border of the State and the hilly portions of Saurashtra. The forests are mainly in the Dangs, Valsad, Surat and Junagadh districts. The forest growth varies from scrubs and thorn forest of north and north-west part of Gujarat to luxuriant and valuable forest in South Gujarat. The forests of the State can be classified into four main types: (i) Moist Desiduous, (ii) Dry Mixed Desiduous, (iii) Dry Scrub, (iv) Mangrove.

(i) Moist deciduous forests occur in regions with more than 120 cm. of annual rainfall. These forests, found in southernmost portions of Surat, Valsad and Dangs districts are the main source of commercial timber in the State and contain good quality of teak and important commercial species like haldu, sisam, khair, kalam, etc. Katas and Manvel are the bamboo species grown in these forests.

(ii) Dry mixed deciduous forests are found in areas with 60 cm. to 120 cm. annual rainfall, i.e. the Central part of the State comprising Bharuch, Vadodara, Panch Mahals and Sabarkantha districts and parts of Amreli, Junagadh and Jamnagar districts in Saurashtra. They produce teak of low quality, timber, bamboos and firewood.

(iii) Dry scrub forests are in regions with less than 60 cm. of annual rainfall. These forests contain sparse and stunted growth of species like khair, tembhurni, etc., and thorny bushes. Grasses occur all over these forests.

(iv) Mangrove forests are found in the coastal creeks in the State in Kachchh, Junagadh and Jamnagar. The main species found are cher of inferior variety which are crooked, small and stunted.

Land Utilization in Gujarat

Of the total area of about 19.6 million hectares, land

utilization is reported for around 18 million to 19 million hectares.

The proportion of net sown area is more or less stable at about a half of total land. There is substantial reduction in barren and uncultivable waste which indicates extension of agriculture to inferior lands. So also there is a reduction in the permanent pastures and grazing lands. There is a substantial increase in the cultivable wasteland indicating deterioration in the land resources of the State.

The proportion of net sown area is 50.73 per cent for the State as a whole. However this figure is somewhat misleading. If the Kachchh district, which is mainly barren with around 40 per cent of land as uncultivable and another 35 per cent as wasteland, is taken out, the proportion of net sown area is 62.54 per cent. Except for the hilly parts of Panch Mahals, Bharuch, Surat, Valsad and the Wasteland district of Kachchh, all the districts have between 60 and 75 per cent of land under cultivation with Mahesana (74.9 per cent), Gandhinagar (75.4 per cent), Kheda (76.2 per cent), Amreli (72.6 per cent) having more than 70 per cent of the total land under cultivation. All the areas with deep and medium black soils of Saurashtra and South Gujarat, the alluvial sandy loam and clay soils of North Gujarat are being exploited for cultivation for years together.

The average size of holding in Gujarat was 4.11 hectares in 1971 and decreased to 3.16 hectares in 1986. There is, correspondingly, a marked deterioration in the man-land ratio in the State.

Irrigation

Surface Irrigation: Gujarat is one of the States with relatively limited surface water resources for irrigation and these are mostly confined to southern mainland. Moreover, there are physical limitations on the availability of appropriate

sites for storage and utilization of the water resources particularly because of the flat terrain in the region where through the principal rivers flow.

At the beginning of the planning era in 1951, the region now belonging to Gujarat State had no major or medium irrigation projects and the total irrigation potential as well as utilization by all sources except by dug wells was just 0.52 lakh hectares.

Highest priority was accorded to irrigation sector right from the inception of the plans. The ultimate irrigation potential for major and medium irrigation projects excluding Narmada Project as estimated by the G.M. Shah Committee (1984) stands at 18 lakh hectares out of which 10.81 lakh hectares potential was harnessed by June 1985. Ultimate irrigation potential for minor irrigation schemes was estimated by the Shah Committee at 3.48 lakh hectares out of which 1.66 lakh hectares potential was harnessed by June 1985. The estimated ultimate irrigation potential of Narmada Project is about 18 lakh hectares.

One of the reasons why major and medium dams get emphasized is the way in which cost benefit ratio for irrigation projects is calculated. The figures from the project administration reports for Mahi-Kadana, Ukai-Kakrapar and Dantiwada reservoir project show that cost of irrigation was around Rs.2500 per hectare; it was Rs.1800 per hectare in the Shetrunji Project (Asopa and Tripathi, 1975, p.18). The cost of minor irrigation was estimated at Rs.5200 per hectare through tanks and Rs.8700 per hectare through check dams (Ibid., p.19). It must be noted that command area is sometimes inflated to get a better B/C ratio on paper (Ibid., p.32). Moreover, minor irrigation works are essential for maintaining or raising the water-table and their real worth is realized in the event of conjunctive use of surface and sub-surface water resources.

The average level of utilization of surface irrigation is around 50 per cent for major and medium projects and 60.24 per cent for minor irrigation schemes. An analysis of the actual discharge data in Mahi Kadana and other major and medium irrigation projects show that canal irrigation supplies are generally variable, undependable and unpredictable and tail-enders' quotas are often pre-empted during transit (Ibid., p. 48).

Groundwater Resources: In Gujarat, out of the total geographical area of 1,95,984 sq.km., 86,680 sq.km. is covered by alluvial formations (including 35,000 sq.km. of Rann of Kachchh) and an area of 1,09,304 sq.km. is covered by hard rock formations. The groundwater investigation in Gujarat started in 1918 in the alluvial tracts of the State. A detailed groundwater investigation was done in Mahesana district as early as in 1939 and later it was carried out in other districts. The Gujarat Water Resources Development Corporation is currently entrusted with this responsibility. Based on the net irrigation water requirement in each district worked out by Groundwater Resource Development Corporation (GWRDC) in each district, the Group on Estimation of Groundwater Resource and Irrigation Potential from groundwater in Gujarat (1986) have estimated the status of groundwater resource as presented in the following.

	Unconfined aquifer	Confined and semi-confined aquifer
Ultimate Irrigation Potential (lakh ha)	43.7	4.4
Irrigation Potential already created (lakh ha)	13.7	2.5
Balance Available (lakh ha)	30.0	1.8

Thus the ultimate irrigation potential available from all aquifers is of the order of 48.1 lakh hectares out of which 16.2 lakh hectares potential is already created and the balance of irrigation potential that can be created is 31.8 lakh hectares.

There were 7.29 lakh irrigation wells with about 5 lakh pump-sets in 1984.

The Group estimated the then average cost of construction of an open well with pumpset to be around Rs.25,000 which can irrigate about 2 hectares on an average. For flow irrigation scheme, the investment is Rs.25,000 per hectare and the beneficiary is not required to pay any share towards this investment. The water rate for irrigation is also substantially low (about Rs.200 per hectare) as compared to the cost of well irrigation which is around Rs.500 per hectare. The Group, therefore, recommended that subsidy towards capital costs be provided to the farmers.

Cropping Pattern

A little less than half of the gross cropped area is used for cultivation of foodgrains and an equal proportion is used for commercial crops. There has not been much of change in these proportions over the last twenty years or so.

Among foodgrains, there has been a shift from jowar and to a lesser extent bajra in favour of wheat and pulses. Among oilseeds, there has been diversification of cultivation of other oilseeds crops, particularly rape and mustard and castor. Major crops of Gujarat are jowar, bajra which are food crops, cotton and groundnut that are main cash crops. These four crops on an average accounted for 73.42 per cent of gross sown area in 1962-65 period and 65.92 per cent in 1980-83 period. The diversification in cultivation has been mostly in terms of wheat and tur among food crops and rape and mustard, castor, tobacco and some sugarcane in cash crops. The proportion of area under cotton has declined over the entire period.

Among irrigated crops, wheat is the major user of irrigation. Cotton, groundnut, tobacco and sugarcane are the important cash crops grown under irrigation. In addition,

crops like rape, mustard, fruit and vegetables, and fodder crops like lucern are gaining in importance.

Production

Production of cereals has increased from 1719 thousand tonnes in 1960-61 to 4717 thousand tonnes in 1990-91. Production of pulses increased from 169 thousand to 626 thousand tonnes during this period. The area under cotton and groundnut has declined, so also the total production. Large year to year fluctuations in the total production depending upon the rainfall pattern persist. The contribution of agriculture and allied activities to the State Domestic Product therefore range from 45 per cent in good years to less than 30 per cent in bad years.

Stabilization of agriculture can be achieved through stabilization of water availability by proper water and soil conservation measures and proper management of irrigation. Else irrigation in Gujarat has its own problems. In the command area of Ukai-Kakrapur irrigation project the soils are deep black cotton soils, the terrain is flat. Consequently problem of waterlogging is faced. In Saurashtra and Kachchh coastal area the fertile tracts are affected by salinity. Continuous heavy withdrawals of groundwater for purposes of irrigation have created problems of salinity ingress and inundation. The entire coastal area of Gujarat, in fact, is faced with the problem of salinity ingress resulting in damage to agricultural lands and aggravating the problem of drinking water supply.

Livestock in Gujarat

Gujarat is famous for many breeds of cattle, buffaloes, sheep and goats. Among the cattle breeds, Gir and Kankrej breeds are dual purpose breeds producing working bullocks and milch cows. Among the buffalo there are three good quality breeds viz. Surti, Mahesani and Jafrabadi. Patanwadi and Marwadi are the famous sheep breeds in Gujarat. Kachchhi,

Gohilwadi, Zalawadi, Mahesani and Surti are the better known breeds of goats in the State. The State exports quality breed bullocks, cows, sheep and goats to other States.

Among cattle, the population of bullocks is more or less stable while the cow population has increased only marginally. Buffalo population has increased substantially over the period as also has the population of sheep and goats. Total livestock population has increased by 37 per cent, between 1961 and 1982. Among the breedable cows, Gir breed accounts for around 40 per cent, Kankrej for 37 per cent, exotic crossbred cows account for just one per cent and non-descript for 22 per cent. This is quite different in Maharashtra where 85 per cent of the breedable cows are non-descript. Among breedable buffaloes, Surti breed accounts for 40 per cent, Mahesani for 28 per cent, Jafrabadi 25 per cent, Banni 2 per cent and non-descript only 5 per cent. Among sheep, Patanwadi breed accounts for 52 per cent and Marwadi 44 per cent, the non-descript accounts for 4 per cent only. The density of livestock population, according to 1982 census was 5.77 livestock units per hectare of cropped area, 3.38 per hectare of geographical area and 0.51 per capita of human population (NWDB, 1986, table 1.4).

Gujarat government has been providing support and encouragement to dairy development through the cooperative sector. The Operation Flood Programme was launched some 20 years ago in 1970 in six districts viz. Kheda, Mahesana, Banaskantha, Sabarkantha, Vadodara and Ahmedabad. Setting up of dairies is reflected in the changing composition of female bovine animals in the State. In 1961, buffaloes formed 48 per cent of total adult female bovine population; this proportion has increased over the years to 57 per cent.

Of the marketed and marketable production of the livestock, milk is clearly the most important product contributing

61.6 per cent of total value of livestock output in 1980-81. Ghee, which is a milk product, generally prepared out of surplus milk, contributed 16.6 per cent of total value of output. So milk and ghee together accounted for 78.2 per cent of total value of output of livestock in 1980-81. Meat and meat products constituted about 9.16 per cent of total value of livestock output in Gujarat. Eggs and poultry meat contributed 3.44 per cent to total value of output in Gujarat. Gujarat having a little over four per cent of livestock population in the country contributed around 8.78 per cent to the total value of livestock output in the country in 1980-81.

Problems in Livestock Development in Gujarat

Gujarat has well defined and recognized breeds of cattle and buffaloes. Cattle breeds are dual purpose animals and buffalo breeds are good milk producers.

Preservation of the indigenous breeds is of utmost importance for the State economy. However, there are two types of problems in this regard. One problem arises because of the huge demand for cows, bullocks and buffaloes from Gujarat in other States, particularly in Maharashtra, Rajasthan, etc. The animals are allowed to be exported outside the State under the existing rules. However, with a view to preserve the cattle wealth of the State the Government have from time to time promulgated order viz. the Gujarat Cattle (Export Control) Order, 1961 or Gujarat Milch and Draught Cattle (Control and Movement) Order of 1983 and has regulated the movement of cattle under the Bombay Essential Commodities and Cattle Control Act of 1958. However, there is a lot of unauthorized export of animals by road and it is well-nigh impossible to check it. At times, indiscript cattle is replaced for good breed cattle at the State border and to check it, the State also promulgates orders like Gujarat State (Import Control) Order of 1981.

The State Government runs four cattle breeding farms and the Gujarat Agricultural University also maintains four cattle breeding farms. The National Dairy Development Board also has a breeding farm. All these are for selective breeding of Gir and Kankrej breeds where selection is made on the basis of milk yield of 1200 litres (for 305 days) for Kankrej and 1500 litres for Gir.

The other problem is that of fodder. Although fodder crops cover eight per cent of the gross cropped area there is a shortage of fodder. The norm of about 3 livestock units per hectare of gross cropped area is exceeded by the actual density of livestock population (5.77 livestock units per hectare). Further there is an acute shortage of fodder seed. The State Government has extended its efforts by directly establishing seed farms as also by extending assistance for seed multiplication. Banni area of the Kachchh district with a grass land of over 1300 sq.kms which is practically denuded of grass, needs development with the existing species of grasses. Banni has got *Dichanthrum Annulatum* and *sporobolus* species of grass which survive both in good and alkaline soils and are also nutritious for the animals. A systematic development of grass lands on scientific lines and storage of grass are called for.

Sheep Development: As per 1982 census, the sheep population of the State was about 23.57 lakh, mostly concentrated in the arid and semi-arid zone of North Gujarat, Saurashtra and Kachchh. About 35000 sheep breeders, mostly Bharwads, entirely depend on sheep rearing. The average flock size is 56 with average income of about Rs.3,000 per year. About 70 per cent of the sheep are migratory and need medication and protection against contagious and infectious diseases. Goats are maintained mostly by landless labourers and marginal farmers. The main component of income from goats is sale of

male lambs for meat (70 per cent), manure (10 per cent), and milk (20 per cent).

IV. CRITICAL PROBLEMS IN WESTERN ZONE

In relation to land use, the Western Zone of India is facing the following major problems.

1) Problems of Coastal Areas: The low lying areas are inundated by sea water. The overdrawal of groundwater for irrigation purposes is accentuating the problem of salinity ingress. The destruction of mangrove forests in the coastal creeks has aggravated the problem of inundation. As a result extensive strips of lands are being lost, and unless long-term measures for rehabilitation are taken, larger areas would go out of use.

2) Problem of Hilly Areas: The Western Ghats, the Aravalis and other ranges have lost, due to commercial exploitation, much of their vegetative cover. Consequently soil erosion is heavy, lakes are getting silted at a fast rate, hydrological balance is affected, the timber and other valuable forest resources are depleted. The effectivity of Aravalis as a barrier to the eastward spread of Thar desert is getting reduced. The livelihood of tribal and other inhabitants of the hilly tracts is endangered. Unless long-term measures for revegetation of the hilly areas are taken the productivity of the hilly areas would be totally lost and in addition the productivity of the agricultural lands beyond would be threatened.

3) Problem of Desert Areas: Considerable areas of the Western Zone fall in arid and semi-arid tracts. Overgrazing and cultivation of marginal lands are accentuating the problem of desertification. The process of desertification must be arrested to preserve the productive use of the land resources in the arid and semi-arid tracts.

4) Problem of Agricultural Lands in the Plains: The

agricultural lands are losing their fertility due to soil erosion, monoculture and imbalanced use of fertilizers. The green revolution technology has thus led to depletion of the natural resource base and the earlier productivity gains are no more sustainable. Unless a new approach with emphasis on restoration of soil fertility and water retentivity is adapted in returns from the land with given inputs would diminish and the lands would support less number of livestock and less number of people.

5) Problem of Irrigated Agriculture: Irrigated agriculture without proper drainage is creating problems of water-logging and salinity and leading to wasting of the fertile land resources. Proper planning and management of irrigation is essential for sustaining productivity in irrigated agriculture.

6) Problems Created Due to Changes In Land Use: Changes in land use for construction of reservoirs, industrial development, mining activity, etc., have led to displacement of the inhabitants of the affected villages. Planned rehabilitation of the displaced families, and proper provision of land for this purpose must form an integral and essential part of development planning.

7) Urban Encroachment : Unplanned and uncontrolled growth of urban activities and land speculation is affecting the land use in rural areas. Speculative capture of land rather than productive use is gaining in importance. Strict control on the change in land use and on speculative activity has to be enforced and necessary investments in conservation have to be made so as to maintain the productive use of the agricultural lands.

The above sums up some of the major problems in relation to land use in the Western Zone of India and most of these problems are problems have arisen due to the nature of developmental strategy adopted so far in India. A radically

different approach to development planning and land use planning is called for if India is to remain self-sufficient in foodgrains production, if year -round work is to be provided in agriculture and other primary activities and adequate income is to be ensured for the rural population including the landless. This new approach will be discussed in Chapter III.

Table 2.1.: Land Utilization Pattern in Western Zone of India 1988-89

('000 hectares)

State	Geographical area	Reporting area for land utilization statistics	Forest	Classification of reporting area excluding fallow land						
				Not available for cultivation			Other uncultivated land			
				Area put to non-agricultural uses	Barren and unculturable land	Total (5+6)	Permanent pastures and other grazing lands	Land under misc. tree crops & groves not included in net area sown	Culturable waste land	Total (8+9+10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat (h)	19602	18825	1878	1089	2676	3765	846	4	1950	2800
Maharashtra	30769	30758	5373	1110	1699	2809	1407	204	1034	2645
Rajasthan	34224	34248	2307	1657	2802	4459	1800	26	5718	7544
Goa	370	361	105	20	13	33	1	1	80	82
Daman and Diu (i)	11	10	-	1	2	3	-	(a)	4	4
Dadra and Nagar Haveli	49	48	20	3	(a)	3	1	-	(a)	1

(continued)

Table 2.1 : (continued)

State (1)	Fallow lands			Net area sown (15)	Area sown more than once (16)	Total cropped area (15+16) (17)
	Fallow lands other than current fallows (12)	Current fallows (13)	Total (12+13) (14)			
Gujarat (h)	43	937	980	9402	982	10384
Maharashtra	1346	566	1912	18019	1600	19619
Rajasthan	2288	1527	3815	16123	2716	18839
Goa	(m)	(m)	(m)	141	12	153
Daman and Diu (i)	(m)	(m)	(m)	3	-	3
Dadra and Nagar Haveli	(a)	(a)	(m)	24	3	27

Notes : (a) = Below 500 hectares.

(h) = Relates to the year 1985-86.

(m) = Not available separately, included under culturable wasteland.

(i) = Relates to the year 1986-87.

Table 2.2 : Area, Production and Average Yield Per Hectare of Principal Crops in Western Zone of India 1990-91

A = Area in '000 hectares
P = Production in '000 tonnes
Y = Yield in kg/hectare

State	Area/ Prod./ Yield	Rice	Wheat	Jowar	Bajra	Maize	Ragi	Small millets	Barley	Total cereals
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Gujarat	A	530.7	717.0	852.7	1152.3	368.8	29.9	38.8	-	3690.2
	P	791.1	1443.7	379.0	1024.6	529.8	25.4	23.4	-	4217.0
	Y	1490.7	2013.5	444.5	889.2	1436.6	849.5	603.1	-	1142.8
Maharashtra	A	1581.4	873.4	6331.1	1927.0	107.9	207.5	111.4	2.5	11142.2
	P	2313.7	918.7	5948.0	1114.3	134.7	213.8	95.1	2.0	10740.3
	Y	1463.1	1051.9	939.5	578.3	1248.4	1030.4	853.7	800.0	963.9
Rajasthan	A	120.1	1814.1	928.9	4845.6	982.0	-	33.8	234.8	8958.7
	P	141.5	4308.5	515.1	2516.4	1299.1	-	13.0	438.0	9231.6
	Y	1178.2	2375.0	554.5	519.3	1322.9	-	384.6	1870.2	1030.5
Goa	A	53.5	-	-	-	-	3.7	-	-	57.2
	P	145.0	-	-	-	-	3.8	-	-	148.8
	Y	2710.3	-	-	-	-	1027.0	-	-	2601.4
Daman and Diu	A	2.7	-	-	0.3	-	-	-	-	3.0
	P	6.2	-	-	0.4	-	-	-	-	6.6
	Y	2296.3	-	-	1333.3	-	-	-	-	2200.0
Dadra and Nagar Haveli	A	12.5	0.1	0.8	-	-	2.8	0.5	-	16.7
	P	18.4	0.3	0.6	-	-	3.6	0.4	-	23.3
	Y	1472.0	3000.0	750.0	-	-	1285.7	800.0	-	1395.2

(continued)

Table 2.2 : (continued)

State	Area/ Prod./ Yield	Gram	Tur	Total pulses	Total food- grains	Ground- nut	Soya- bean	Total oil- seeds	Sugar- cane (cane)	Cotton *
(1)	(2)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
Gujarat	A	170.2	401.9	931.6	4621.8	1701.6	12.9	2714.8	118.3	921.0
	P	115.8	352.4	626.6	4843.6	1052.6	14.7	2106.2	10599.7	1322.9
	Y	680.4	876.8	672.6	1048.0	618.6	1139.5	775.8	89600.2	244.2
Maharashtra	A	672.9	1007.6	3257.3	14399.5	881.1	200.0	2845.9	444.0	2730.2
	P	357.8	420.9	1443.9	12184.2	991.3	189.3	1892.7	38416.2	1880.3
	Y	531.7	417.7	443.3	846.2	1125.1	946.5	665.1	86523.0	117.1
Rajasthan	A	1652.8	37.4	3685.0	12643.7	231.3	144.1	3079.1	22.8	587.1
	P	1014.2	25.2	1722.3	10953.9	218.0	160.4	2354.7	1201.1	380.5
	Y	613.6	673.8	467.4	866.4	942.5	1113.1	764.7	52679.8	110.2
Goa	A	-	-	-	57.2	0.7	-	0.7	1.8	2730.2
	P	-	-	-	148.8	1.0	-	1.0	84.0	1880.3
	Y	-	-	-	2601.4	1428.6	-	1428.6	46666.7	117.1
Daman and Diu	A	-	-	-	3.0	-	-	-	-	454.6
	P	-	-	-	6.6	-	-	-	-	918.3
	Y	-	-	-	2200.0	-	-	-	-	343.4
Dadra and Nagar Haveli	A	0.2	1.6	4.4	21.1	-	-	0.3	-	-
	P	0.2	1.2	3.2	26.5	-	-	0.1	-	-
	Y	1000.0	750.0	727.3	1255.9	-	-	333.3	-	-

Note : * Thousand bales of 170 kg each.

Table 2.3 : Gross Irrigated Area by Crops in Western Zone of India (1988-89)

	('000 hectares)					
	Gujarat (h)	Maha- rashtra (d)	Raja- sthan	Goa	Daman and Diu (i)	Dadra and Nagar Haveli
Rice	249	318	49	11	-	1
Jowar	35	406	6	-	-	-
Bajra	140	59	121	-	-	-
Maize	19	40(h)	89	-	-	-
Wheat	353	377	1591	-	-	(a)
Total cereals	809	1200	2060	11	(a)	1
Gram	14	120	231	-	-	-
Tur	30	N.A.	(a)	-	-	-
Total pulses	47	124	250	-	-	(a)
Total foodgrains	856	1324	2310	11	(a)	1
Sugarcane	123	345	15	2	-	(a)
Groundnut	93	124	48	-	-	-
Rapeseed and Mustard	207	-	940	-	-	-
Total oilseeds	430	124	1050	-	-	-
Cotton	513	30	278	-	-	-
Tobacco	86	N.A.	2	-	-	-
Total irrigated area under all crops (gross)	2381	2381	4365	14	(a)	2
Net irrigated area	2039	1881	3481	14	(a)	2

Notes: (a) = Below 500 hectares.

(d) Relates to the year 1987-88.

(h) Relates to the year 1985-86.

(i) Relates to the year 1986-87.

CHAPTER III

ALTERNATIVE APPROACH TO LAND AND WATER USE PLANNING

I. It is inherent in the nature of the model adopted in India for planning to pursue growth in national income at the maximum possible rate. The technology adopted is developed in the labour-scarce Western economies while the situation in India is exactly the opposite. Consequently, even though industries and other economic activities have grown we have failed to provide productive employment to all seeking work. We have enclaves of capital intensive development - electricity, airways, railways, telecommunications, T.V., modern industry, and green revolution in agriculture side by side with vast areas where people are living in mud huts, burning firewood engaged in semi-subsistence agriculture or village industries, using primitive equipment and bullock power. Science and technology that we have borrowed from the West is used only as a tool of production and has not become the 'outlook' even among those in the modern sector. Further, we are reducing the complexity and diversity of our rich subtropical ecological patterns by mono-culture; e.g. a few hybrid varieties of wheat or jowar, plantation of teak or pine, promotion of cross-bred cows and exotic sheep without realizing the rich genetic potential of our diverse natural resources. The need is to evolve methods and techniques that draw upon our diverse natural wealth combining creatively the knowledge built through experience of centuries with the modern science and technological developments, and not borrow ready-made simplistic answers to our complex problems. Similarly, we have diverse socio-cultural and life patterns, developed in relation to multifarious eco-settings over a period of centuries, and we will be the losers if we try to

reduce it to fast foods and T.V. culture that turn people into passive receivers rather than active and creative participants in economic, social and cultural spheres.

The present approach to natural resource use is competitive and exploitative; this has to be changed and we must adopt a cooperative and adaptive approach. For instance, in Varud taluka of Amravati district (Maharashtra) it was profitable to grow oranges. The area under orchards grew, so also the number of wells. With increased competition for the groundwater those with larger resources deepened their wells. The competition became so fierce that it resulted in shortage of water and the orchards started wilting. Had the water resources of the taluka been taken into account and orchard area restricted keeping in view the sustainability of groundwater, the disaster could have been averted. However, to ensure this there has to be first a systematic collection of information on land and water resources followed by scientific planning on a long term basis and implementation of the plan so prepared.

This means that the resource planning has to begin at the grassroot level, starting from a watershed, moving to a group of watersheds in a river-basin, then to major river basins considering all the land and water resources in an integrated manner. As is well known the hill tops and hill slopes need the protection of forest or grass and shrub cover for soil and water conservation. If the land is forest clad it takes thousands of years to remove through wind and water erosion, the top soil, but if it is under cultivation the top soil gets removed in a few years. Experimental runoff plots at Nurpur (Himachal Pradesh) showed that the soil loss in Cho area was 22443 kg/ha for grazed plot as against 306 kg/ha for grass and shrub plot for one storm of 24.89 cm in 19 hours on 1 in 4 slope. The runoff from the areas

regularly grazed was 95 per cent of the total rain compared to 20 per cent from the area under shrub and grass cover (Sinha, 1975). In addition the sub-tropical forests being stratified they utilize the available space and radiant energy very efficiently. The average annual net primary production of sub-tropical rain forest is 15 tonnes per hectare while it is about four tonnes for agriculture.

For keeping ecological balance it is considered vital to have about 33 per cent of the land under forest cover. In India of the total land area of 328.7 million hectares about 33 per cent land (113 million hectares) has 30 per cent or higher slopes, and needs to be kept under forest cover. Protection of existing forests (today only about 36 million hectares are under forest) through ban on clear felling, encouragement of natural regeneration in heavy rainfall areas and revegetation of degraded forests for meeting the commercial and domestic needs of the population must be taken up on a war footing. The programme cannot be successful unless it is taken in full cooperation of the people and the people get a direct benefit from it. Suitable organizational forms essential for these programmes are discussed in Chapter IX.

It has so far been assumed that the sustainability of livelihood in drought-prone regions and the productivity gains can be ensured by providing exogenous water mainly through large reservoirs where water from large catchment areas lying in tracts of dependable rainfall is stored. It is also assumed that income augmentation is possible only through market oriented production. Measures like soil conservation, rain water harvesting, afforestation though considered necessary, have not been viewed as providing solution to the problem of drought.

Over the last decade, information has accumulated on experiments that emphasize use of endogenous resources adopting suitable techniques and practices along with appropriate regulation of use of land and water resources. Particularly by integrating trees into the production system, the vulnerability arising from the variability of rainfall and irregularities of hydrological cycle can be overcome. In view of this, the current concepts on soil and water conservation that practically equate it to erosion control have to be reoriented to include measures for soil amelioration by organic inputs and runoff suppression by suitable mechanical structures and vegetative barriers. Scientific land use plan that includes components of forests, horticulture, fuelwood plantation, pasture, fodder cultivation, fish-culture and agricultural crops have to be prepared for each watershed considering the land shape, soil quality, climate and rainfall.

1. Conservation Measures for Low Rainfall Regions

The planning exercise for the improvement of land use will have to begin with the preparation of the present and the potential land-use capability maps. As most of the hill tops and hill slopes are bereaved of vegetation, it means a fast runoff and heavy soil loss; this has resulted not only in the retrogression of vegetation but also has caused considerable damage to the agricultural lands situated below the hill slopes, since the water retention capacity in the upper region is almost wholly lost. Therefore, the hilly area will have to be treated as a conservation area and a ten year plan for checking the damage and gradual restoration of the soil and vegetation cover will have to be worked out through measures like gully plugging, nala bunding, trench-cum-mound fencing and agave plantation for protection, followed by plantation of pioneering species. This area can yield fodder, fuel,

timber, agave fibre, fruit, nuts etc., within a period of two to six years. The hilly areas will have to be kept permanently under appropriate tree and grass cover so as to check the soil erosion and to ensure moisture conservation.

It is necessary to resort to contour trenching and afforestation to protect the steep areas. The prescribed standard trench is 2' x 1' x 200' with an unexcavated portion of 5'. The trenches are to be provided at horizontal distances varying from 75' to 200' depending upon the slope of the land. The trenches are to be partly refilled and the remaining excavated material should form a small bund on the downward side. Hardy varieties like Neem, Babul, Kasheed, are recommended for afforestation. If the top catchment is unfit for growing trees or grass-cover it is necessary to divert the water from such a catchment by a diversion trench to a suitable valley so as to prevent the runoff from such lands entering the cultivated area.

Nala bunding scheme has to form a part of the soil conservation programme so that the upper slopy lands are protected by contour bunds, the lower flatter lands are protected and flooded by 'nala bunds', and the minor water courses are plugged by stone-plugs. Bunding will help retention of the rain-water runoff against the embankment for 2-3 days so that the silt will get deposited in the basin and the impounded water will soak into the ground. With these measures, adequate soaking or flooding of a part of the nala basin and catchment area can be secured even in years of inadequate rainfall, and at least one crop will be assured. Trees like Ram-kanta Babul or Neem can be suitably planted to form a shelter belt that can help reduce the velocity of wind and thus minimize evaporation losses (Gadkari, 1956, pp. 37-40).

The areas of moderate slopes and the flat lands will have to be put to crop cultivation with some areas being earmarked for pasture, fruit trees, fodder and fuel trees plantation. In the very low rainfall belt, major emphasis will have to be placed on the development of pasture lands. Contour furrows, trenches and bunds will have to be appropriately provided for where the topography is rolling and soils shallow. In this area perennial fodder legumes and suitable grass species can be established. Intensity of pasture-use will have to be regulated according to the carrying capacity of the pasture land. Forage yield can increase considerably with managed and controlled rotational grazing.

For areas under dry cultivation, the major limiting factor is the quantum of precipitation. Soil and water conservation measures are of vital importance for the stabilization of crop yields in this area. The low-lying areas which are liable to flooding can get protection if the harvest of the runoff is properly planned in the upper reaches. An integrated scheme of soil and water conservation which will include measures like afforestation, grass land development, terracing, contour bunding, nalla bunding, etc., together with a programme of effective tapping of groundwater and surface water resources including water harvesting and farm ponds will have to be prepared for a sub-water shed. Controlled rotational distribution of water to maximize the crop production per unit of water used will be appropriate in the drought-prone areas. Suitable crop planning according to agro-meteorological data and soil moisture retention data and keeping in view the basic consumption needs of the farming population will have to be prepared. In addition, contingency plans will have to be kept ready to suit various weather probabilities. Planning of crops in suitable blocks will help application of water

in a controlled measure so that the available water is optimally used.

Agronomic practices like proper tillage, contour cultivation, strip cropping, appropriate crop rotation, maintaining optimum plant population, mulching, etc., will help conserve moisture and the quality of soil. Appropriate blend of organic, inorganic fertilizers together with bacterial, algal, microbial fertilizers and proper crop rotation can help achieve better utilization of the available fertilizers. Integrated pest and disease management involving agronomic, genetic, biological and chemical methods as well as appropriate crop rotation and mixed cropping methods can make for effective pest control. Intermixing of tree/shrub rows with cereals, intermixing of pulses and cereals, judicious mix of leaf-matter, manure and chemical fertilizers are important to maintain soil fertility and increase productivity.

2. Conservation Measures for Vertisol Regions

Contour bunding and graded bunding are traditionally practised even in deep black soils. However bunding causes water stagnation affecting the growth of dryland crops. Cracks developed during the hot summer along the sides of the bunds and upstream soil layers result in gushing out of rainwater with season's first heavy shower leading to extensive breaches of the bunds. Waste weirs provided for surplusing the excess water are costly and unstable. Graded bunds which drain out the excess water safely to natural or artificially constructed waterways do not create problem of water stagnation. However the excess water drained, unless stored in small ponds, cannot be used for irrigation. There is also heavy scouring in the end reaches of the channels of long graded bunds. Hence the need for conservation ditching.

Conservation Ditching : Conservation ditching consists of laying out shallow trapezoidal ditches on contour at the

usual bund spacing. When suitably designed the ditch intercepts and stores within its confines most of the interditch runoff from a rain storm. The upstream side is kept flat so as to be safe against the scouring action of the incoming runoff. The downstream side slope is kept steeper to conform to the angle of repose of the soils. Due to better moisture regime the ditch banks can be utilized for growing fodder grass. Due to low permeability of the black soils, substantial quantities of stored water became available till 7 to 10 days for utilizing for supplemental irrigation to downstream crops. The low lifts at which the water is available enable its easy lifting by traditional devices like swing baskets or Archimedian screws.

As water does not backup upstream of the ditch, there is no water stagnation. The rain-water is stored in situ which can be used to augment the soil profile moisture which helps improve yields. Higher increase in yields are obtained during drought years as compared to good rainfall years. Thus stabilization of yields is achieved by conservation ditching (CDSWC, 1987).

About 7 per cent of the gross area is lost under conservation ditches. However this can be well compensated by growing useful grasses like Dichanthium amalatum on the side of the ditch. Yields upto 18 tonnes of green grass per hectare were reportedly realized in two cuttings. Rooted slips of the grass planted when the ditch is full ensured over 90 per cent survival. Two cuttings each in October and December can be taken (CDSWC, 1987).

In spite of the low intake rates of the black soils it is observed that about 2 cm per day is the net seepage loss. To tap the deep percolated water trees useful for fuel and

small timber like Azadirachta indica and Acacia nilotica can be grown along the banks.

Due to the low intake rates of deep soils and their easy dispersibility, overland flow quickly transforms into channelized flow with the resultant rill erosion. Left unchecked this results in high rates of soil loss. To overcome this and to provide barrier against head extension, two rows of Agave americana at 60 cm x 60 cm staggering have been found to be successful in checking rill damage. Agave plantation is useful to establish good bond with bottom soil due to their extensive rooting system, they are not grazed by cattle, can withstand drought and provide useful fibre.

The construction cost and areas lost under different conservation measures were noted as follows : (See Figure 3.1).

Conservation measure	Area occupied by structure	Cost of construction	
		per metre Rs.	per hectare Rs.
Contour bunding	5.7%	3.50	583
Graded bunding	4.8%	4.30	717
Conservation ditching	7.1%	5.15	858

Even though conservation ditching is somewhat more costly, it is a more effective soil and water conservation measure. The area occupied by the structures can in part be used for grass and tree plantation and the loss in area can thus be compensated (CDSWC, 1987).

In India, cognizance is being taken of the vital role of watershed planning in natural resource conservation and boosting up of primary production from mid-eighties and some experimental work in that direction has begun. A brief review of this experimentation is attempted in the following to appraise the role of watershed planning and the problems faced in its implementation.

3. Watershed Planning: Sukhomajri in Haryana

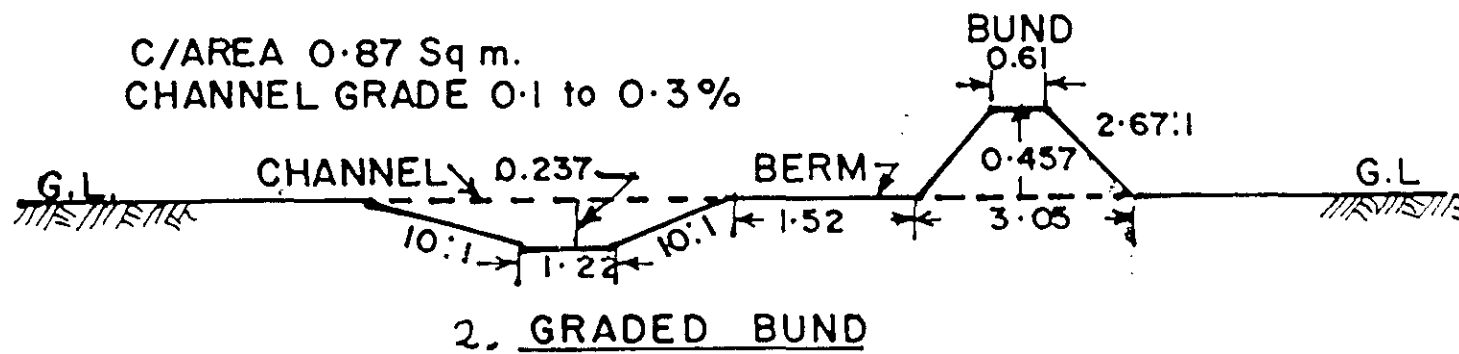
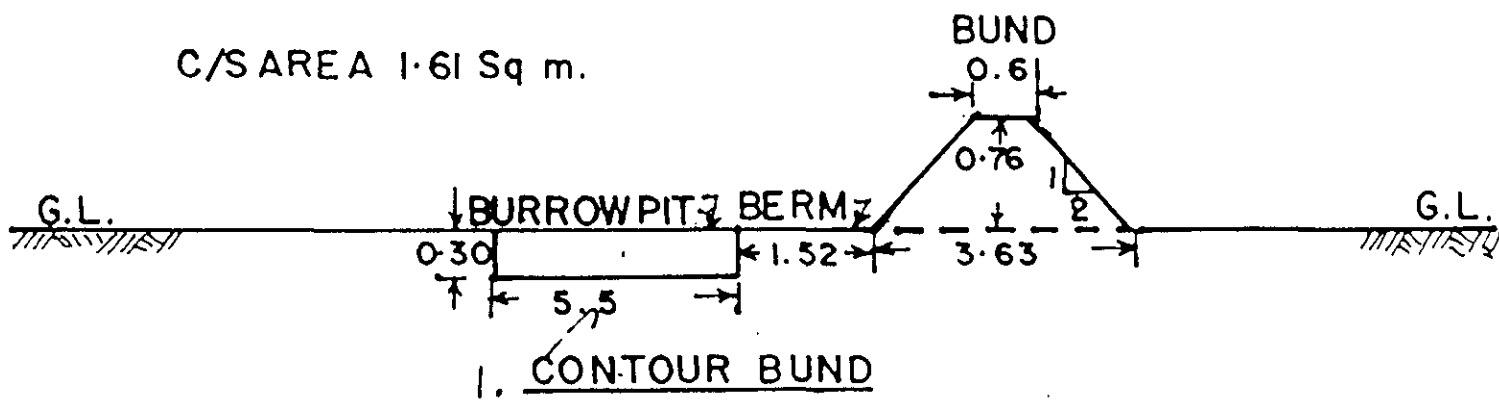
Sukhena lake in lower Shivalik near Chandigarh lost sixty per cent of its storage capacity in 5 years due to heavy siltation. The Central Soil and Water Conservation Research and Training Institute (CSWCRTI) took up a scheme in 1979 for protecting the catchment (Chopra, 1988). Four small dams were built in the catchment area. To prevent soil erosion shallow contour trenches were dug and bhabhar grass (Eulaliopsis binata) was planted on the ridges. Seedlings of Khair were planted on slopy areas and Shisam was planted to provide protection to gully walls where stone check dams were provided. The per hectare cost of the storage and watershed treatment came to Rs.17000 (1984 prices).

To ensure people's cooperation, the Sukhomajri water user society was set up in 1982. It was decided to give equal right to water to all including the landless. The right to water was contingent on the observation of stall feeding of cattle. Fodder harvesting was allowed to one member from each household. With increased fodder availability the composition of livestock changed; the number of buffaloes increased from 136 to 182 and the number of goats declined from 89 to 10. The watershed development measures helped preservation of moisture, improved water yield and production of fodder, and brought about growth in crop productivity and in incomes. Scientific planning of land and water resources taken up in cooperation with the people have given positive results within a short period. One of the enabling factors in Sukhomajri is that it is a homogeneous village (80 Gujer families and 2 Jat families) and land distribution in the village is not so unequal that the dominant groups could create obstructions.

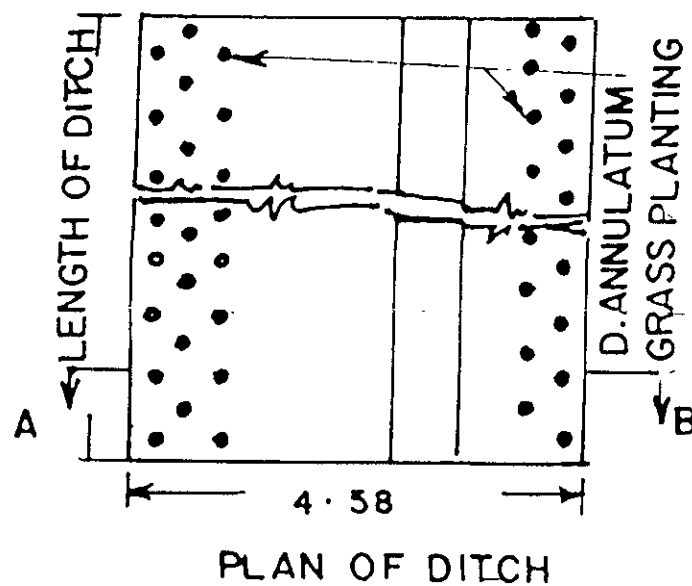
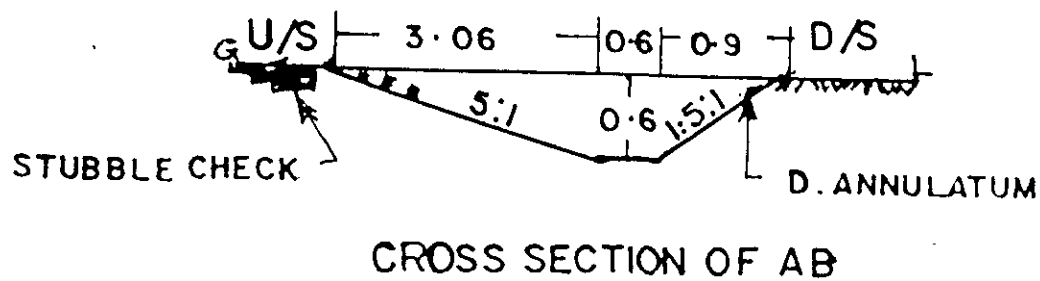
4. Watershed Planning: Mittemari in Karnataka

Till 1983 Mittemari was like any other drought-stricken

SOIL & WATER CONSERVATION TECHNIQUES



3. CONSERVATION — DITCHING



ALL DIMENSIONS IN METRES

SKETCH NOT TO SCALE

village in Kolar district with barren rocky hill slopes and parched fields. The experiment of watershed management programme was started by the State Government in 1984 (Katar Singh, 1988). To arrest soil erosion, graded bunds were constructed. Waterways and diversion drains were stabilized through grasses. On the non-arable lands the existing gullies were treated by 413 gully checks reinforced with vegetative barriers of brush wood dams and agave. At the lower reaches of the gullies dams were constructed. The normal rainfall in Mittermari is 690 mm. During the drought of 1985 the village received 387 mm of rainfall but amidst the widespread drought Mittermari smiled with well-grown fields of groundnut and pigeonpea. There is improvement in yield and adoption of inter-cropping is helping stabilization of yields

Of the total area of 1245 hectares in the watershed, 583 hectares are cultivable and 167 hectares are classed as forest, but were actually bare. About 130 hectares were afforested and the hillock now is covered with Acacia, Eucalyptus, Pongamia and cashew. The rocky hills are planted with bor and custard apple. To augment the fodder supply that consists of groundnut haulms and ragi straw, trees like Shisam and subabul are planted on bunds and in wasteland. Bunds are seeded with stylosanthes. The runoff from hill slopes is harvested and stored with earthen dam and the water is used for fish culture and irrigation.

The key factor in success of the watershed development programme is farmers' organization - the Village Resource Management Society. The inter-departmental coordination and the cooperation between farmers' organization and the government agencies made for the successful implementation of the programme. The cost amounted to Rs.1595 per hectare for developing crop land and Rs.5030/hectare for developing forest and non-arable area.

5. Navamota Watershed in Gujarat

When extreme drought conditions caused widespread failure of crops in Gujarat, Navamota watershed area had enough fodder to feed its cattle and plenty of water and food to help villagers tide over the crisis.

The watershed area lies in Aravali belt, in Sabarkantha district. The total area of watershed is 313 hectares with gentle to moderate undulating slopes. The hills are completely denuded. The average annual rainfall is 819 mm. Ninety-three per cent of the families of the watershed belong to scheduled tribes and scheduled castes.

About 197 hectares have been given protection by construction of bunds. The soil for construction of bunds has been taken from downstream of bunds instead of upstream as practised by the Soil Conservation Department. The earth work required for levelling gets reduced in the new method thus saving on cost. A series of earthen as well as loose boulder gully plugs have been constructed in small gullies. Two masonry check dams have been constructed in the main drainage channel. The gully plugs and check dams help in recharging the groundwater. The Class VI and Class VII lands have been put to silvi-pastoral usage. Fifty hectares of such land has been afforested. In order to give protection a trench of 50 cm width and 50 cm depth was dug around the afforestation area, and the soil dug out was piled on the inner side of the trench and sown with Prosopis juliflora seed. Seedling of Acacia nilotica (46000), Acacia tortilis (11000), Eucalyptus (28500), Albizia lebbek (3500), Dendrocalamus strictus (100) were planted. Because of trenches, staggered pits, rubble gully plugs the plantation has come up well. In unprotected area outside the watershed the average grass cover is 10.8 per cent whereas within the afforested area it is 26.4 per cent in the peak summer month. The expenditure for the project was as follows:

	<u>Rs.lakh</u>
Land reclamation and water resource development	2.88
Afforestation and grassland development	3.15
Bunding and levelling	4.00
Agriculture and horticulture development	3.90
Animal husbandry programme	1.50

	14.93

The overall expenditure came to about Rs.5000 per hectare.

The tribal population of watershed had been traditionally growing local varieties of maize, tur, udid and cotton; the yields were low because of poor soil. A package of improved varieties and fertility management has been developed. This has helped growth and stabilization of yield (Subhash Chandra, 1989). Central Soil and Water Conservation Research and Training Institute, Vasad is being approached for replicating the watershed management programme.

Two cases from Maharashtra, Ralegan Shindi and Adgaon Khurd are presented in some detail as it was possible to conduct field investigations and collect primary data for these villages.

6. Comprehensive Approach in Ralegan Shindi

Ralegan Shindi is a small village in Parner Taluka, Ahmednagar District of Maharashtra, covering an area of 971 hectares. It is at an altitude of about 750 metres and is surrounded by small hillocks on the north-eastern and southern sides. The terrain is undulating and slopy. The soil cover of 70 per cent of the area is shallow, but the plains have a black soil cover which is suitable for rabi cultivation. The water-table was 12 to 15 metres below ground level. There were 76 wells for drinking water and irrigation purpose, but most of the wells went dry by December or January.

The village is situated in a drought-prone zone. It falls in a rainshadow area with an erratic rainfall. The annual

rainfall series for the last 85 years showed the maximum rainfall at 1072 mm in 1916 and the minimum rainfall at 203 mm. in 1972. Rainfall at 80 per cent dependability came to 430 mm. Much of the rainfall was wasted in the form of runoff. In 80 per cent of the years it is estimated that of a runoff of 7,74,000 cu.m. of water, only 16 per cent was utilized for irrigation and domestic use.

New Initiatives: Anna Hazare, a native of the village retired from the service and returned to Ralegan Shindi in 1976. He was concerned over the social, educational and economic issues of the village. He vigorously campaigned against liquor consumption, which he felt was responsible for the plight of the village. He faced stiff resistance. He donated his entire service benefits (about Rs.20,000) to the village and appealed to the villagers to rebuild the village temple with the money he gave, contributing shramdan. He succeeded in resolving petty village conflicts and persuaded the villagers to send their children to school.

At an early stage, he realized that no permanent social change could occur without perceptible economic benefits. He studied the current government rural development programmes and came to the conclusion that schemes like the IRDP are inadequate to generate collective action for the benefit of the community, since these schemes emphasize benefits to individuals.

As water is the key to economic development, he studied the topography of the village and what could be done to conserve rain water and decided to take the necessary measures.

Repair of Percolation Tank: Since the percolation tank constructed under EGS in 1975 was defective, the district authorities were approached for carrying out repairs. It was ascertained that impervious layer was not provided in the foundation trench and in the embankment above ground level.

This defect was overcome by providing a cut-off trench and rectifying the impervious core. An outlet was provided for regulating releases and a series of nala bunds were provided on the downstream, which are diversion structures and function essentially as recharge works.

Ordinarily masonry check dams would have been necessary to restrict the submergence at the diversion structure. However, the free overfall flank spillways in the diversion channels have been able to cope with the limited flood flows. The technology adopted is well-suited to the region and full use was made of the local labour. The necessary repairs were carried out by the district authorities owing to Hazare's persistence, backed by the local people. The estimated cost of repair is Rs.3.91 lakh almost equal to the original cost of the tank.

Watershed Development: The next priority was soil conservation measures, like nala bunding, contour bunding, land shaping, etc. This was done under the State government Comprehensive Watershed Development Programme (COWDEP), introduced in 1980. Thirty-one nala bunding sites were identified and an area of 605 hectares was covered under nala and contour bunding. The storage capacity of these nala bunds is estimated at 282.18 cu.m.

The work of land shaping/grading was completed in an area of 181 hectares, against a potential area of 257 hectares. Twenty new wells were dug, of which 7 were community wells. The water-table has risen from 45 ft. to 25 ft. due to the measures taken for storage of water in situ. While the works were under construction, Hazare and the village people through constant supervision saw that technical norms were adhered to by the department and contractors. This indirect form of village participation in the collective works executed by the State agencies has helped maintain the quality of work.

Lift Irrigation: The Kukadi Canal flows 3 km. away from the village. It was decided to lift water for irrigation from this canal. The "Krishna Pani Puravatha Society" was formed for installing the lift. The labour was provided by the beneficiaries. Hazare raised a loan from a bank and successfully completed the scheme, estimated to cost Rs.38 lakh and benefiting an area of 300 hectares and 170 farmers.

Individuals who can afford to, have dug individual wells. However, they have been persuaded not to take up the cultivation of water-intensive crops like sugarcane. Substantial augmentation of water resources and its judicious use have resulted in a considerable increase in the area receiving irrigation. Irrigated area has increased from 80 hectares in 1975-76 to 626 hectares. Productivity has recorded significant increase in the case of all the crops. The production at aggregate level has increased three-fold because of the expansion in irrigated area. Consequently the village has become self-sufficient in foodgrains production even in a year of deficient rainfall. A grain bank is run by the Tarun Mandel of the village and charges an annual interest at 15 per cent to be paid in kind.

Afforestation: A programme of afforestation has been taken up in the village in which the soil conservation office has also participated. Almost two lakh trees, mainly Eucalyptus and Subabul and some fruit trees like bor, custard apple, tamarind have been planted. Trees are planted along the roads, field bunds and in government forest land, gayren area, etc.

Fuel: Previously, the villagers used firewood and cowdung cakes as fuel. As a part of the project, about 30 gobar plants have been installed, of which two are large-size, having an installed capacity of 14 cu.m. each. These plants serve the school hostel inmates and four scheduled caste

families, who look after the plant. These plants are fed by human excreta. The remaining plants are near the residences of the villagers and are fed by cow dung and individual latrines.

Manure: With the installation of bio-gas plants, manure is easily available locally. Manure from individual plants is used by the individual farmers, while manure from the communal plants is regularly auctioned. Another innovative method has been evolved to augment the manurial resources of the village. Urinals for the school children have been designed, whereby the urine is collected in a small pit. A mound of soil is kept nearby and the children are instructed to spread a thin layer of soil after urination. Once the pit is filled, the soil is collected and stored in bags. Over a year, 200 bags of 50 kg. each were collected. A chemical analysis of the matter showed that the alkalinity of the soil was reduced, while it was rich in potash, superphosphate and nitrogen. The collected soil is filled in horticultural pits laid out in areas unfit for regular crop raising. It is hoped that villagers, seeing the impact of this manure (locally known as Hirekhat) on the fruit trees, will start to recycle human urine in their own homes.

Pit latrines are being popularized for those who cannot install biomass plants. Experiments have shown that a family pit latrine can give Rs.25 worth of manure per month. Hazare is confident that over the next 5 years, the village would be able to recycle all human and animal waste, and attain self-sufficiency in manures and fertilizers.

All the animals are now stall-fed. Whenever they are taken out, the owners use masks to cover the mouths, so as to minimize the damage to the pastures and trees. Further, no stray animals are to be seen in the village (Datye, 1988).

Special Features: The Ralegan experiment in rural uplift is unique in many respects. It is located in a resource-poor

area and is, in a sense, built through the efforts of a devoted social worker with active cooperation of the villagers. Though economic uplift was an objective, it was strongly underpinned with moral values and the awakening of a social conscience. Unlike the IRDP, where the objective was to raise the living standards of the families below the poverty line (BPL) dealing with them individually, the Ralegan experiment emphasized the village collectivity/community, in a compact village with some 250 households mainly Maratha cultivators and a few artisan and landless families.

Most of the developmental activities have been carried out making use of the various government schemes. For lift irrigation scheme loans were raised from a Bank. Grants and donations from Indian and foreign philanthropic agencies are declined, as Hazare believes that free grants and donations make the villagers idle, irresponsible and power-hungry.

The experience of the last ten years shows that Hazare has been successful in attaining his key objectives. There has been a distribution of benefits in favour of the poorer sections. Alcoholism is virtually eliminated. A system of community marriages has been established, so that marriage expenditure is minimized. He has also been successful in settling local disputes locally, without any reference to the judicial courts. The decision-making process has been democratized, with about 10 per cent of the villagers taking active part in the monthly meetings. Perhaps the success of the project can be attributed to the fact that the activities undertaken have been all-encompassing, ensuring all-round improvement of the villagers' lives (Awasthi, 1989).

7. Watershed Planning in Adgaon-Khurd

Adgaon-Khurd is set amidst the undulating topography of hillocks and flat farms of Aurangabad district. Agriculture

is totally dependent on the vagaries of the monsoon. The weathered and fractured basalt extending upto a depth of 20 to 25 mts., form the only unconfined aquifer in the region, and the average precipitation even in the wettest month of July is 169.67 mm. Added to the paucity of rainfall was uncontrolled grazing and cutting of trees, accelerating the process of erosion. With the rainfall carrying away the rich top soil, formation of gullies and furrows was very common. The degraded soil could, in the end, only support grass and thorny scrub.

The unrelenting struggle for survival was compounded by the acute shortage of fuelwood. While the basic fuelwood is 'babul' and crop residues, only 380 tonnes of the total requirement of about 650 tonnes per year for the village was locally available. A scheme to introduce gobar gas and biogas plants by the KVIC, IRDP and Special Component Programme did not succeed.

The Marathwada Sheti Sahaya (MSS) Mandal discussed the fuelwood scarcity situation with the farmers. As a remedial measure, plantation of bor plants, each of which would provide 5-6 kgs. of wood per year, was taken up.

The total area of the village is 1063 hectares. The main crops in 1984 were jowar and bajri intercropped with kharif pulses like tur and moog. Only 8 hectares were under mosambi orchard. Though there were 153 wells in the village, the wells dried up by the end of January and well-water was used mainly for kharif or rabi jowar that needs only a few waterings.

Construction of Check Dams: The situation in Adgaon after 1983 witnessed a dramatic change with the construction of the first check dam by the MSS Mandal. Soil conservation measures were also introduced resulting in the storage of water in the check dams, impounding groundwater through contour trenches.

Water stored in the first check dam could be used to recharge 40 of the surrounding wells. Although rainfall for

1985 was only 435.4 mm., farmers owning these wells could irrigate the bajri crop, resulting in a bumper harvest. Since then, the farmers of Adgaon are assured of at least one crop. By 1987, the MSS Mandal completed seven check dams.

A series of gully plugs have been erected to arrest soil erosion and check runoff in steep land. Since the gully plugs were made of earthen dams, they can also store about 200 mm³ of water. The dry land treatment dependent on soil and slope characteristics was also introduced. This consists of shaping land by broad-based ridges and furrows method along with farm drains with the use of Agricart. All agricultural operations are carried out along the contour while spacing of bunds are decided on the basis of the slope. The treatment covers about 300 hectares of land.

The MSS Mandal chose two types of structures - overflow and non-overflow structures. The overflow structures were chosen in the middle and lower parts of the watershed where land slopes are gentle and the adjoining lands are deep vertisols or grassland. In such locations, submergence of land for storage and land loss are a major constraint. Hence, these have to be essentially low structures storing as much water as possible within the stream course itself. The dam heights are upto 2 mt. masonry type gravity weirs. At places, where the dam site is located in the marginal and degraded lands, the submergence of moderate areas upto 2 hectares, was agreeable to the people and earthen dams with separate overflow section have been designed. After the completion of above the structures they were filled by runoff water in 1987. There was a notable increase in the gross cropped area and the area irrigated. The recharging capacity of all the 153 wells got enhanced.

Depending on the physical characteristics of soil and

slopes, soil has been divided into four groups for further treatment, including land shaping by broad based ridges and furrow method along with farm drains with the use of Agricart for deep soil. The treatment to light shallow soils consists of contour bunding and trenching across the slope, broad ridge and furrow with ties and farm ponds. The spacing of bunding, 6 to 10 m., depends on the slope of the land. In between the bunds, strip cropping of rainfed crops is being practised. The light shallow soils are to be developed as grass lands. Hillock and rocky lands are recommended for intensive afforestation with trenching and bunding.

Information about yields was collected from a cross-section of 15 farmers from Adgaon. The productivity has increased two to three times mainly because of the increase in the moisture retention so that the crops do not face water stress.

Afforestation: Afforestation is taken up to promote soil conservation on private wasteland. The tree selection is based on drought resistance, deep rootedness and fast growth. The selected species are neem, wood apple, tamarind, Eucalyptus, drumstick, markingnut, bamboo, custard apple, pomegranate, black plum, mango, etc. In order to supply the saplings at the required time a nursery was developed on the land of Saraswati Bhuvan High School of Pimpri Raja. Seventy-two acres of land has been given to MSS Mandal for development in 1984-85.

Horticulture : Horticulture plays a crucial role in the overall village economy. Some of the mosambi orchards are as old as 35 to 40 years. Prior to 1980, investment on plantation including pits and sapling plus fertilizer, manure, pesticides, irrigation and management, with gestation period of seven years implied that only rich farmers could take up the plantation. After 1985-86, when irrigation was brought within the reach of middle farmers due to check dams there was a dramatic

increase in the area under plantation. At present, there are 27,000 mosambi plants on 82 hectares in the village.

The saplings were procured from Sikrapur from Ahmednagar district. Now some growers have started developing saplings from their own orchards. However, inadequate dose of manure, lack of attention to soil quality, selection of deep waterlogged soils unsuitable for plantation, have affected plantations leading to mortality of almost 25 per cent. Apart from mosambi plantation, the other fruit trees grown are tamarind, bor, pomegranate, mango, black plum, wood apple, grapes and guava. At present only tamarind and raiwal mangoes are being harvested but not on a commercial basis.

Livestock: After initiation of MSS Mandal programme, it was unanimously decided to ban stray grazing and goat keeping to protect new plantation. The Bhills, Matang, Kolhati, Harijan and other economically weaker families used to rear goats for income generation without involving any cash expenditure. In order to make alternate arrangement of income, these families were given crossbred cows under IRDP and Special Component Programme.

The village is now self-sufficient in fodder. Green grass is available for almost eight months and there is enough dry fodder for the lean period. The Mandal and the Soil Conservation Department have planted many nutritious varieties of fodder on waste land. The Rahuri Agricultural University is also conducting experiments on silvi-pastoral development and agro-forestry. Subabhul is also planted on a large scale as a supplement to fodder. Better varieties of grass have been introduced, these would gradually replace the local, inferior grasses. The farmers also grow irrigated nutritious grass and maize for milch animals.

In order to promote village unity and integrity MSS Mandal initiated the Muktabai Mahila Mandal in 1985, which

conducts several functions for local women including adult education, small savings of women, bhishi system, training related to health and nutrition, training in family planning, child care and development and a Balwadi. Monthly health check-up is conducted with the help of a medical officer (Datey, 1989).

Achievements: Adgaon experience shows that integrated watershed planning and judicious water use that emphasizes stability in yield rather than voracious water consuming crops like sugarcane, can help increase productivity almost across the village rather than confining benefits of irrigation to a small section. In Adgaon, the investment per hectare came to about Rs.12,000 to Rs.17,000. The productivity increased 2 to 4 fold and the overall net return per hectare increased from about Rs.1,100 to Rs.3,400 at 1985-86 prices. In addition, the problems of shortage of fodder, fuelwood and drinking water that are acute in the villages in semi-arid tract are solved. Moreover there is a definite growth potential through crop diversification, horticulture, animal husbandry, processing of local produce, etc. Watershed planning has thus pulled the village from acute shortages and prepared a basis for future development relying mainly on the local resources. The bandharas and other structures need proper maintenance and care and only the concerted efforts of the villagers will make it possible. In Ralegan it is the leadership of Shri Hazare while in Adgaon the Mandal is playing the leadership role.

So far we have discussed the experiments which had been fairly successful in achieving their objectives. Such cases are few. There are a large number of failures due mainly to (1) faults in preparation of plans and design, (2) lack of inter-agency coordination, (3) deficiencies in execution of plans, (4) lack of people's involvement or obstructions by

vested interests. A brief review of the experience of watershed development programme initiated by a voluntary agency in a Rajasthan village, and of the Comprehensive Watershed Development Programme of the Government of Maharashtra, would help bring out some of these problems.

8. Samithed Watershed Project

The People's Education Development Organization (PEDO), Meda initiated a watershed development project in 1987 in the catchment area consisting of two villages, Samithed and Manatslai in Bichhiwara Block, Dungarpur district, Rajasthan. The terrain is hilly inhabited by Bhils, eking out a living through subsistence agriculture and seasonal migration to Gujarat for agricultural labour work. The project was initiated by PEDO with technical and financial support from the Society for Promotion of Wastelands Development (SPWD), New Delhi.

PEDO made its entry in Samithed in 1981 and the first activity that they started was a primary school. In 1984-85 PEDO used its resources to plant the denuded common lands. In 1986, attempt to involve the community in the plantation of common lands was made. The project villages had a common stream passing through them with a catchment of 400 hectares. It was planned to construct a 160 metre long dam across the stream. Soil and water conservation and afforestation work was taken up in the catchment area, which covered both the common land and some private land. It was decided to bring the common land under grasses and tree cultivation and the private lands in the villages were to be terraced for crop cultivation. About 110 hectares of common lands were treated with staggered trenches on contour (2 m x .5 m x .5 m). Saplings were planted in pits on hill slopes at a spacing at 2 m. Interspace between the trenches was sown with grass. During 1987, 78,000 saplings of Acacia nilotica, Butea monosperma,

Prosopis juliflora, Subabul, bamboo, neem were planted. The survival rate of trees was about 10 to 20 per cent and grasses failed to establish due to browsing by cattle and failure of monsoon in 1987.

An evaluation study carried out in 1988 (Raju, G., 1988) found that immediate cash returns through labour input needed for trenching, etc., was the primary concern to the people. People were dissatisfied with the choice of species planted. They were interested in Eucalyptus, babul and bamboo. The villagers from Manatalai had got excluded from the consultation. The drought situation caused a severe shortage of fodder and consequently people let their cattle graze in the project area. The benefits of water recharging the wells were unequally distributed, this made for strife.

The case thus highlights the importance of first, a thorough understanding of the concept of watershed, its implications in terms of benefits, and the need to think in terms of a common single watershed area rather than the traditional field boundaries. Having understood the implications, consensus has to be reached for building up a social organization that will execute the project. Differences in benefits accruing to different groups have to be balanced. People have to be consulted on the choice of species, explaining to them the differential benefits - ecological and economic - of various species. Continuous interaction with the people and assessment of the progress, availability of experts and proper technical advice at each stage of implementation are equally important. There is also a need of contingency plan in case of natural calamity like failure of rains. For example, special provision of fodder might have overcome the problem of cattle grazing in the project area because of drought.

9. Experience of Maharashtra Government

Watershed development was expected to constitute the core of planning effort at the village level from the Sixth Plan. The Planning Commission conceived it as a lever through which the planning exercise at the State level becomes a regional planning exercise placing local resource endowments and local needs at the core of this exercise. In this context the experience of Maharashtra State is reviewed briefly to note the problems faced in actualization of the aims.

COWDEP: In the initial period viz., 1974-1980, a traditional pattern of schemes with orientation to individual beneficiary was followed. Since 1980 focus on eco-development was emphasized and in 1984-85 Agricultural Department was entrusted with the Comprehensive Watershed Development Programme (COWDEP). From 1983-84 to 1987-88 COWDEP was taken up for development of 40,897 watersheds spending Rs.142.56 crore outside the Western Ghat Region and in Western Ghats work on 727 watershed commenced with an expenditure of Rs.19.44 crore. An Evaluation Report on Western Ghat Development commissioned by the Planning Department in 1988 has made the following observations on COWDEP.

(i) The implementation has suffered various limitations due basically to faulty perception of the Agricultural Department at the planning stage. This failure is carried forward through the implementation process which resulted in poor results. (ii) The lack of coordination with allied departments such as Forest and Dairy resulted in the exclusion of worthwhile opportunities related to dairy and fisheries development in the Western Ghat region. (iii) As regards mango plantation sometimes the sites chosen were shallow and slopy not suitable for mango plantation. The quality of grafts used in plantation was not hardy. Often the pits were dug and grafts planted during heavy rainfall; this resulted in a high mortality.

(iv) In the case of cashew plantation the overall performance is erratic and achievement was 25 per cent. The scattered and haphazard plantations do not make the scheme viable. (v) Work of terracing has been taken up in Thane and Raigad districts but the response was poor because the prospective beneficiaries prefer to keep the varkas lands for grass and rab, instead of paddy cultivation. Cultivation of grass is more profitable because of nearby large Bombay market. Due to the paucity of labour the farmers prefer to keep the terrace lands under grass, rather than going in for paddy cultivation which is labour intensive.

The Report concludes that the Watershed Development Scheme for Western Ghats as currently designed and implemented is ineffective, and inefficient to achieve the basic objective of eco-conservation and development of Western Ghats.

The approach in Maharashtra is basically bureaucratic that leads to adoption of standardized schemes without deep study of the local conditions, local resource potential and the needs of the people. Unless proper studies are made on the basis of which appropriate plans are prepared and full involvement of the people is secured at all the stages, the full potential of watershed planning cannot be realized. Some benefits from bunding, terracing, etc., will accrue, but they may not be commensurate with the costs and may prove to be short-lived due to lack of maintenance.

10. Integrated Planning of Land-Based Activities

It is essential to integrate agriculture with other land-based activities like forestry, livestock rearing, fishery, etc., so as to promote recycling of resources from one sector to another so that productivity in all the sectors gets enhanced through complementarity and the returns per unit of input increase. There are a large number of combinations feasible. We will examine here only two examples for illustrative purpose.

Wetland Agriculture: Integrated approach can be profitably adopted in rice culture, which can be combined with pisciculture.

Addition of earthworm culture taking advantage of wet culture can help enhance the productivity as earthworm waste is rich in nitrogen and phosphorus. Earthworm gives 60 per cent protein and if used as fodder for chicken, faster growth of chicken is attained and the egg laying rate of hens increases. The chicken waste in its turn can be used as manure or used as feed for pig. The animal waste fed to biogas digester yields both gas as fuel and rich manure for crop cultivation. The biogas slurry and sludge is valuable also as a feed to fish and earthworms (See Figure 3.2).

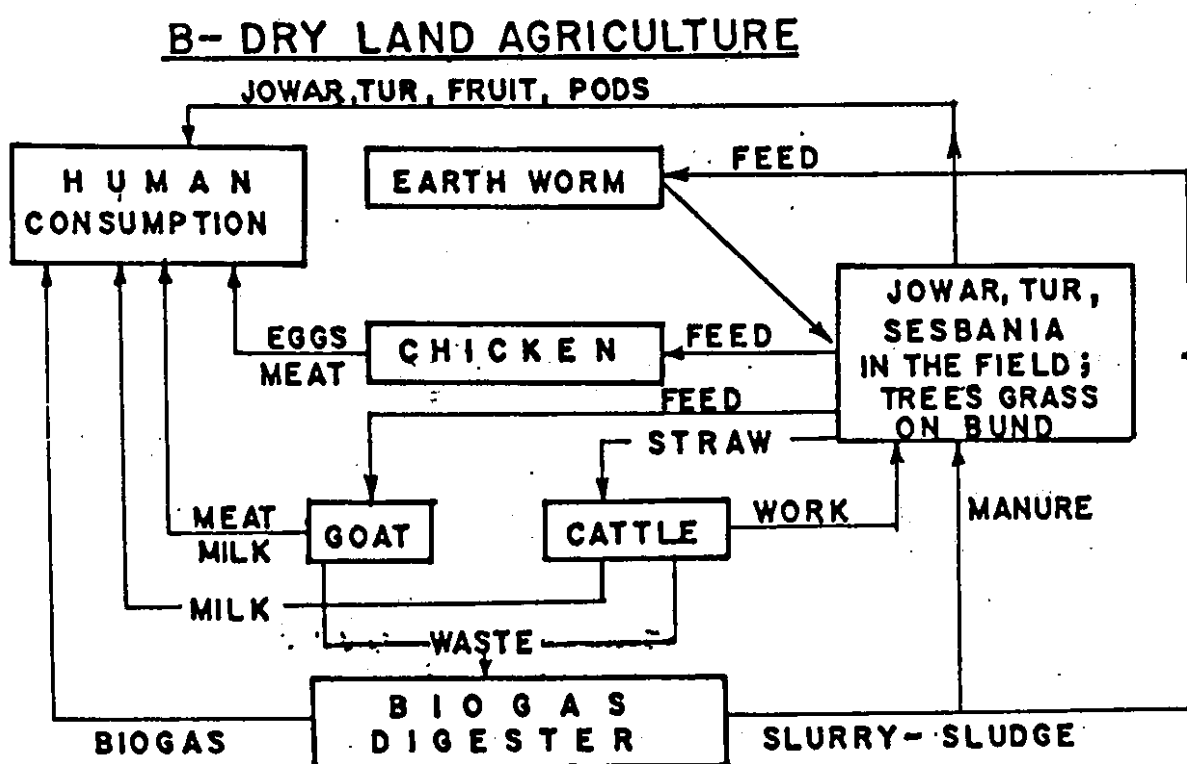
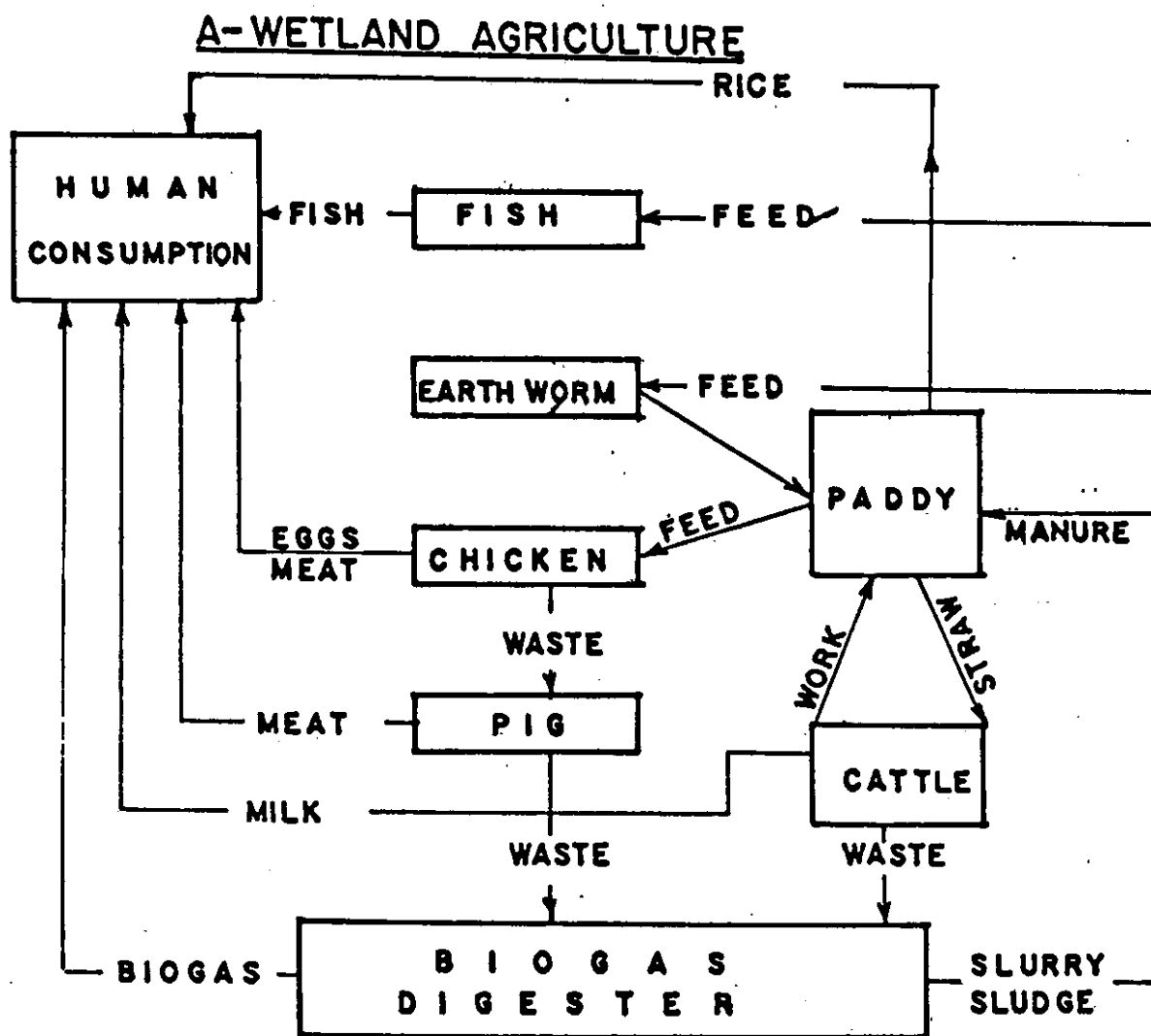
Dryland Agriculture: Jowar could be the main crop; tur or Sesbania bispinosa can be planted as intercrop. Tur and Sesbania help fix nitrogen. Leaves of Sesbania are useful as fodder. Tur stalk or Sesbania stalk can be used as fuel. In addition rows of trees like babool, neem can be planted at the lower edge of the plot. The trees will supply small timber and fodder. Thus the recycling within agricultural and livestock production enhances productivity on a sustainable basis and avoids waste and pollution while the use of the chemical fertilizers to ensure increase in productivity leads to deterioration of soil quality and water pollution. The integrated approach that involves careful husbanding and recycling of indigenous resources means more labour and careful resource planning. Integrated schemes suitable for a variety of agro-climatic conditions have to be worked out on the basis of experimentation. Information dissemination and training will have to be undertaken to promote these schemes and they can be refined with further experimentation.

11. Experiment in Integrated Planning: Baliraja Dam in Sangli District

A brief review of Baliraja dam project in Khanapur taluka of Sangli district, Maharashtra State would illustrate how integrated planning can be achieved if the toiling peasantry, concerned scientists and experts join their talents and efforts, towards an agreed social goal.

INTEGRATED PLANNING OF AGRICULTURE AND ANIMAL HUSBANDRY PRODUCTS AND WASTE

Fig. 3.2



Balwadi and Tandulwadi villages in Khanapur taluka of Sangli district lie in the drought-prone tract and crop failure is frequent because of erratic rains. The peasantry has militant tradition of Satya Shodhek movement and 1942 liberation movement (Prati Sarkar) when several villages in Satara and Sangli districts were liberated by the peasantry who established their own administration, courts and militia.

The economy of the villages has become particularly precarious after the 1972 drought. The EGS instituted by the State Government since then does not compensate for the loss in agriculture. Agriculture has degraded over time mainly because of ecological imbalance. The 1885 District Gazetteer notes that the Yerela river in the vicinity of which Balwadi and Tandulwadi villages are located, was a perennial river and supported irrigated crops. However the denudation of hills in the source region and the excessive drawal of sand from the river bed destroyed the delicate ecological balance and shortage of even drinking water is faced during summer.

The idea of integrated land and water planning was born during a Vidngana Yatra (Science Fair) organized in December 1984 jointly by the Lokvidnyana Sanghatana (Peoples Science Organization, Maharashtra State) and Mukti Sangharsha Movement (MSM), the toilers organization in Khanapur taluka. The people were enthused due to the fresh and innovative approach of the Science Fair and efforts to examine the development potential were started in cooperation with the students and research faculty of the Kolhapur University and a few concerned specialists - engineers and agronomists from Bombay, Pune. A scheme for a small dam, named Baliraja, across Yerela river was prepared. The designed length of the dam was 120 mtrs. with a live storage of 20.5 mcft to irrigate 300 hectares. MSM demanded that the Government should stop auction of sand from the river bed as it was resulting in over-exploitation

of sand, and instead adopt permit system and allow only a measured quantity to be drawn from the river bed. There was a considerable opposition from the contractors and officials but the MSM succeeded in moving the State Government and could obtain permit for sale of sand that provided the necessary funds for construction of the dam.

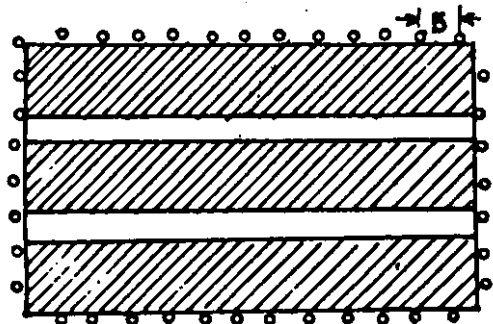
The entire command area of Baliraja dam is treated as one unit and integrated plan for land and water use is prepared for the command. The area is divided into four zones according to land capability: land under trees, under fruit trees, under cash crops and under cereals-pulses in proportion of 25 per cent, 15 per cent, 15 per cent and 55 per cent respectively. The layout of crops and trees to be planted and the water requirements are indicated in Figure 3.3. Combination of trees and crops is so designed as to provide adequate leaf litter for manure and fodder; fuelwood and small timber; jowar, tur, vegetables and fruit for home consumption, and groundnut, chilli, vegetables, fruit and wood/timber for sale, maintaining at the same time soil fertility and optimizing the return per unit of water applied.

The basic distinguishing features of Baliraja Dam Project are (i) exclusion of all the crops with high water demand, (ii) adoption of an agreed norm of water dose that enabled provision of irrigation to 300 hectares with a small storage of water, (iii) equitable distribution of water among all the families in the village. Those who do not own land (such number is small) are offered land on lease by other land owners to permit use of their share of water, (iv) the crop planning of individual plots is made through detailed discussion with the cultivators following the broad scheme of multi-varietal and diverse production avoiding monoculture, (v) the multiple cropping meets diverse needs viz. food, fodder, fuel, timber, of the population leaving enough marketable surplus to meet the cash

PROPOSED LAND USE PLAN (BALIRAJA DAM PROJECT)

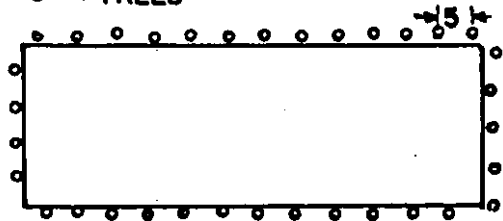
Fig 3.3'

AREA IN WATER(m³)
Sq. m.



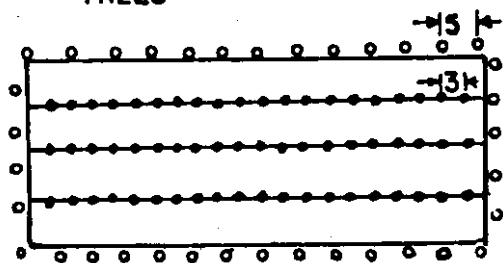
ZONE IV FOODGRAINS 5300 600

HYBRID JOWAR
 PERENNIAL TUR, SESBANIA
 TREES



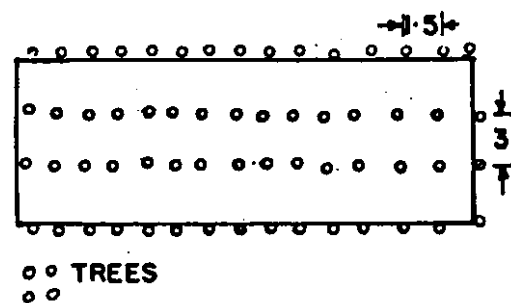
ZONE III CASH CROPS 2000 200

CHILLI VEGETABLES GROUNDNUT
 TREES



ZONE II FRUIT TREES 2000 200

TREES
 FRUIT TREES



ZONE I TREES, GRASSES 2500 200
SHRUBS

TREES

SKETCHES NOT TO SCALE ALL DIMENSIONS IN METRES
LIST OF SUGGESTED PLANTS ENCLOSED

arriving at the estimates of cereals, pulses, oilseeds, milk,

expenditure, (vi) financing of the scheme through sale of sand in the river thus mobilizing resources at the local level at the same time ensuring that the drawal of sand is so regulated as not to disturb the river ecology, (vii) mobilization of students to help plantation of trees which has to be completed within a short period when the monsoon rains set in.

II. Perspective Land Use Plan for Western Zone

The major considerations in arriving at the perspective land use pattern for Western India is to minimize the deviations from land use capability so as to promote optimum use of the available land resources. In making choice of trees/crops, etc., the following requirements are set: (a) in view of the fact that agriculture and animal husbandry are likely to continue till 2000 A.D., to be oriented towards satisfaction of the family needs, objective of regional self-sufficiency of basic consumption requirements of the rural population is set. Particularly the needs of foodgrains, firewood, fodder are to be satisfied at the regional level. (b) Use of natural resources is to be made not on an exploitative and exhausting basis but on a sustainable basis. (c) Use of chemical inputs is to be kept to the minimum and they are to be used in a manner that will benefit the regenerative factors. (d) Specialized crops, animal husbandry and agro-processing are to be developed as educational and skill formation facilities and service infrastructure expand.

Western India is divided into zones and sub-zones considering the agro-climatic variables viz. rainfall, topography, soil type (Table 3.1). The population estimates as worked out by the Expert Committee on population for 2001 A.D. are taken to arrive at the food consumption requirements and the labour force estimations. The recommended dietary intakes for different age and sex groups as worked out by the ICMR are taken as the basis for arriving at the estimates of cereals, pulses, oilseeds, milk,

etc., needed in 2001 A.D. While estimating production allowance for seed, waste, etc., is made.

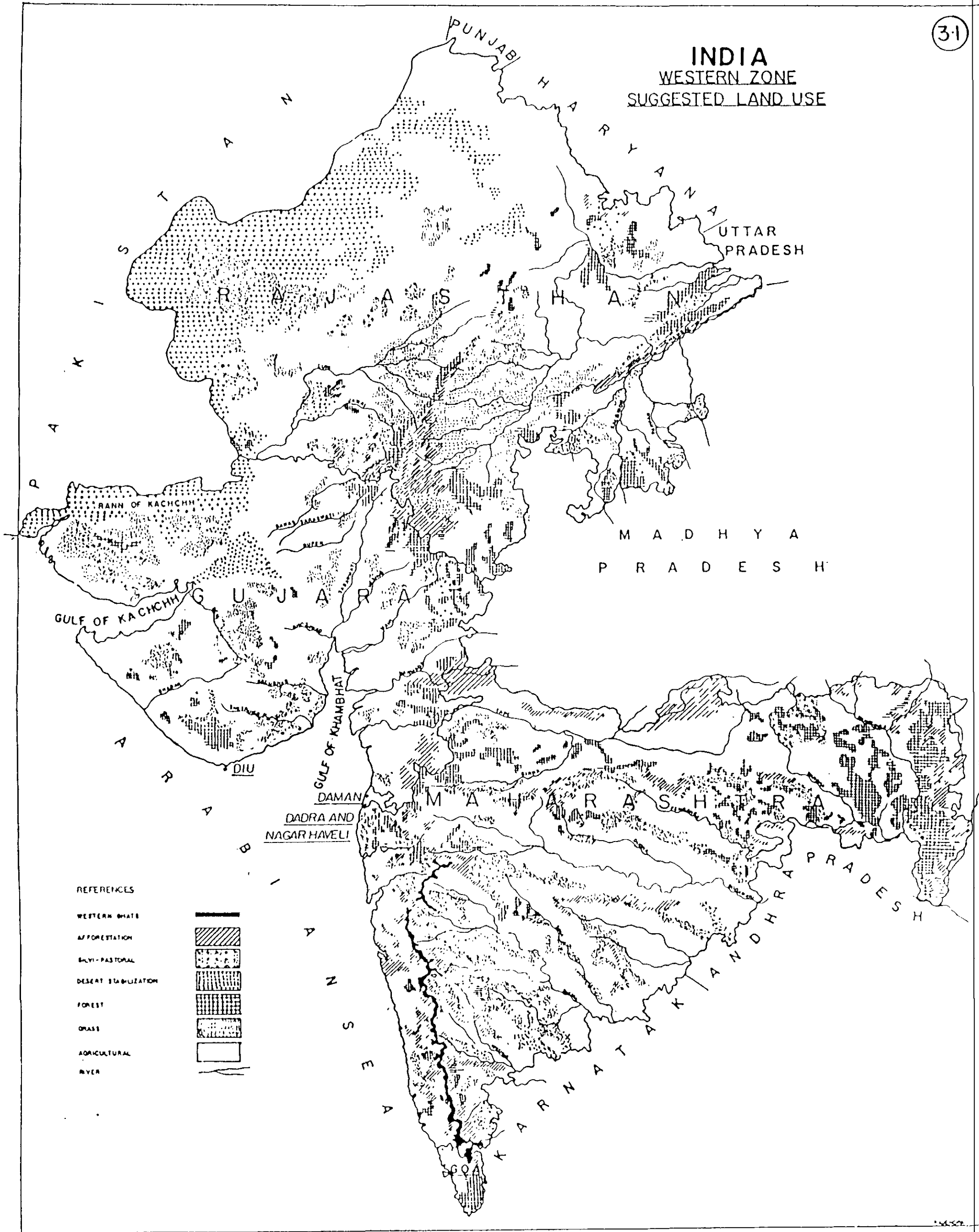
The population estimates by age and sex groups are presented in Table 3.2, the estimates of food-items are given in Table 3.3 and the estimates of work force in Table 3.4. The work force is estimated by applying the labour participation rate by sex as noted in 1981 Census to the projected population in 2001 A.D. The population of the region will be 1911 lakh of which 745 lakh will be in urban areas and 1166 lakh in rural areas.

The perspective land use plan is prepared keeping in view the following: (a) Reduce runoff and encourage infiltration so as to improve groundwater resources, and bring about stability in water supply particularly in summer. This will help check soil erosion and siltation of reservoirs. To achieve this, cultivation of hill tops and hill slopes, urban encroachment on hill tops and hill slopes are to be prohibited and the hill tops and slopes above 10° slope are to be reserved for vegetative regeneration. (b) Discourage agricultural use of fragile arid, semi-arid lands, and stabilize these lands by putting under silvi-pastoral use and encourage animal husbandry. (c) Emphasis on recycling of local resources and promoting symbiotic biological relationships; replace mono-cultural practices by synergic multi-cultural practices that have a regenerative potential. (d) Plan for conjunctive use of groundwater and surface water, and improve the use of available surface water resources to enhance the productivity per unit of water and avoid the problems of waterlogging. As water is a scarce resource in most parts of Western India the return to water rather than return to unit of land, should receive priority.

The broad land uses for the Western India viz. forest lands, grass lands, afforestation area, silvi-pastoral area,

INDIA

WESTERN ZONE
SUGGESTED LAND USE



desert stabilization area and agricultural areas are shown in Map 3.1. The development strategy for introducing the suggested changes in the land use are discussed in the subsequent chapters separately for the various States that constitute the Western Zone of India.

Table 3.1 : Agro-climatic Features of Zones of Western India

Region/Zone	State	Districts	Rain-fall (mm)	Climate	Soils	Crops
<u>VI. Trans Gangetic Plains Region</u>						
Arid	Rajasthan	Ganganagar	360	Arid	Calcareous, Slerozemic alluvial (recent) desert	Wheat, cotton, gram, bajri
<u>VII. Eastern Plateau and Hill Region</u>						
Eastern Plain	Maharashtra	Bhandara Chandrapur	1271	Dry sub-humid	Medium to deep black, red and yellow	Wheat, gram, jowar, groundnut, linseed
<u>VIII. Central Plateau and Hill Region</u>						
South Eastern Plains	Rajasthan	Bundi, Kota	760	Semi-arid (half drier and wetter half)	Medium black	Wheat, jowar, gram, maize
Southern Plains	Rajasthan	Banswara, Dungarpur	760	Semi-arid (wetter half)	Medium red and black, grey, brown	Maize, rice, wheat, gram

Contd...

Table 3.1 : (Continued)

Region/Zone	State	Districts	Rain-fall (mm)	Climate	Soils	Crops
Transitional Plain	Rajasthan	Pali, Sirohi	490	Semi-arid to arid	Desert soil, grey brown	Bajri, wheat, sesamum, rapeseed, jowar
Southern Plains and Aravali Hills	Rajasthan	Bhilwara, Udaipur, Chittorgarh	500	Semi-arid (wetter-half)	Red and yellow, grey brown	Maize, wheat, gram, jowar
Semi-Arid Eastern Plains	Rajasthan	Ajmer, Tonk, Jaipur	500	Semi-arid (drier-half)	Alluvial	Wheat, bajri, jowar, gram
Flood-Prone Eastern Plain	Rajasthan	Alwar, Bharatpur, S.Modhopur, Dholpur	500	Semi-arid (drier-half)	Alluvial (Recent)	Bajri, wheat, rapeseed, gram, jowar
IX <u>Western Plateau & Hills Region</u>						
Hill Zone	Maharashtra	Kolhapur, Nashik, Pune, Satara	988	Semi-arid	Medium to deep black, shallow red, red loamy	Jowar, bajri, rice, groundnut
Scarcity Zone	Maharashtra	Ahmednagar, Dhule, Sangli, Solapur	602	Semi-arid	Medium black, deep black	Jowar, cotton, wheat, gram

Contd...

Table 3.1 : (Continued)

Region/Zone	State	Districts	Rainfall (mm)	Climate	Soils	Crops
Plateau Zone North	Rajasthan Maharashtra	Jhalawar, Akola, Amravati, Aurangabad,*	374	Semi-arid (wetter-half)	Medium black, deep black, mixed red and black, shallow red	Jowar, cotton, wheat, gram
Plateau Zone South	Maharashtra	Nagpur, Nanded, Wardha, Yeotmal	1040	Semi-arid to dry sub-humid	Medium black, shallow black	Cotton, jowar, tur, wheat
XII. <u>West Coast Plains and Ghats Region</u>						
Coastal Hilly	Maharashtra Goa	Ratnagiri, Kolaba, Thane -	3640	Humid	Laterite, red loamy, coastal alluvium	Rice, ragi, sesamum, nigerseed
XIII. <u>Gujarat Plains and Hills Region</u>						
South Gujarat	Daman Dadra Nagar Haveli Gujarat	- Dangs, Valsad	1793	Semi-arid to dry sub-humid	Deep black, coastal alluvium	Rice, ragi, sugar- cane, jowar
South Gujarat	Gujarat	Surat, Bharuch	974	Semi-arid to dry sub-humid	Deep black, coastal alluvium	Jowar, tur, cotton, wheat

* Beed, Buldhana, Parbhani, Jalgaon, Latur, Osmanabad

Contd...

Table 3.1 : (Continued)

Region/Zone	State	Districts	Rain-fall (mm)	Climate	Soils	Crops
Middle Gujarat	Gujarat	Panchmahals, Kheda, Vadodara	904	Semi-arid	Medium black	Rice, cotton, maize, bajri
North Gujarat	Gujarat	Mehasana, Ahmedabad, Banaskantha, Gandhinagar, Sabarkantha	735	Arid to semi-arid	Grey brown, coastal alluvium	Bajri, cotton, jowar, wheat
North-West Arid	Gujarat	Kachchh	340	Arid to semi-arid	Grey brown, deltaic alluvium	Bajri, groundnut, jowar, cotton
North Saurashtra	Gujarat	Amreli, Bhavnagar, Jamnagar, Rajkot, Surendranagar	537	Dry sub-humid	Medium black	Groundnut, cotton, bajri, jowar
South Saurashtra	Diu Gujarat	Junagadh	844	Dry sub-humid	Coastal alluvium, medium black	Groundnut, wheat, bajri, cotton
XIV. Western Dry Region						
Western Dry	Rajasthan	Barmer, Bikaner, Churu, Jaisalmer, Jalore, Jhunjhunu, Jodhpur, Nagaur, Sikar	395	Arid to extremely arid	Desert soil, grey brown	Bajri, gram, wheat, rapeseed

Source : Agro-Climatic Regional Planning, An Overview, 1989, pp. 12-16.

Table 3.2 : Projected Population for Maharashtra, Rajasthan and Gujarat in 2001 A.D.

Age-group	(Population in '000)				Total
	Rural		Urban		
	Male	Female	Male	Female	
Maharashtra					
0 - 14	6809	6256	4665	4476	22206
15 - 29	6216	6273	6586	5746	24821
30 - 44	5191	5310	5089	3939	19529
45 - 59	3649	3749	2653	2324	12375
60+	2562	2541	1418	1424	7945
Total	24427	24129	20411	17909	86876
Rajasthan					
0 - 14	7638	7195	3169	3099	21101
15 - 29	5039	4934	2982	2603	15558
30 - 44	3573	3362	1756	1483	10174
45 - 59	2067	1930	890	800	5687
60+	1255	1238	461	509	3463
Total	19572	18659	9258	8494	55983
Gujarat					
0 - 14	4216	4031	2338	2266	12851
15 - 29	3925	3850	2861	2644	13280
30 - 44	3199	3171	2261	1997	10628
45 - 59	1960	1969	1154	1084	6167
60+	1191	1217	574	624	3606
Total	14491	14238	9188	8615	46532
Goa, Diu, Daman	493	503	314	296	1606
Dadra, Nagar, Haveli	78	67	6	5	156
Grand Total	59061	57596	39177	35319	191153

Source : Census of India, Occasional Papers No.4, 1988.

Table 3.3 : Requirements of Foodgrains and Other Products in Maharashtra, Gujarat and Rajasthan in 2001 A.D.

(In lakh tonnes)

	Requirement in 2001		
	Maharashtra	Rajasthan	Gujarat
Cereals	155.5	100.2	83.3
Pulses	16.5	10.6	8.8
Vegetables	64.3	41.4	34.4
Milk	78.2	50.4	41.9
Oil	11.0	7.0	5.8
Sugar	12.2	7.8	6.5

Source : Computed for the projected population for 2001 as given in Table 3.2.

Table 3.4 : Projected Rural Workers in Western Zone in 2001 A.D.

('000)

State	Rural Population		Projected Total Workers(Rural)		Workers in Agriculture	
	Male	Female	Male	Female	Male	Female
Maharashtra	24427	24129	13007	7706	10103	7100
Rajasthan	19572	18659	9941	2000	6692	1646
Gujarat	14491	14238	7690	2063	6004	1808
Goa, Diu, Daman	493	503	219	82	150	74
Dadra, Nagar Haveli	78	67	43	18	14	16
Total	59061	57596	30900	11869	22963	10044

Source : Computed on the basis of data in Table 3.2.

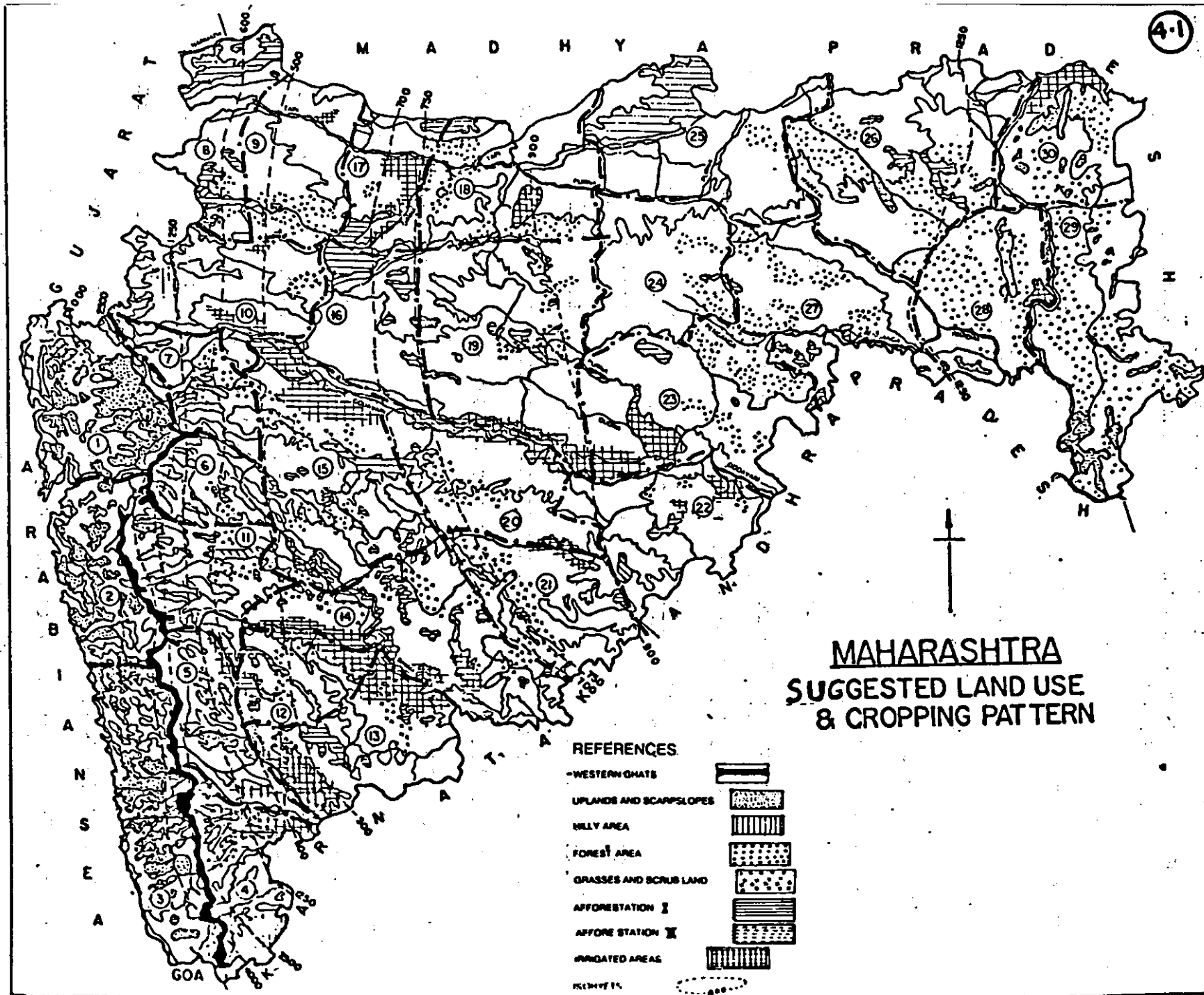
CHAPTER IV

PERSPECTIVE LAND USE PLAN FOR MAHARASHTRA STATE

The geographical area of the State is 307.5 lakh hectares. Under the suggested land-use plan, all the hills, hill slopes and the present area under forests is to be maintained under forests through conservation and afforestation measures. This area extends over 70 lakh hectares. The area presently under pasture, and the culturable waste (about 30 lakh hectares) is to be developed through silvi-pastoral treatment for fodder and fuelwood supply. It is suggested to restrict the net sown area to about 185 lakh hectares and 10 lakh hectares are to be kept for fallows. The remaining 12.5 lakh hectares are earmarked for urban settlements, mining, industrial estates, etc.

Land use for agriculture is a function of soil-water-plant relationship. Similar groups of soils occurring in different geomorphic units influenced by differential soil forming processes and environmental factors have different land use potentials. The soil climatic environment may create arid and humid moisture regimes due to changes in topography. The crop adaptability, and management are different in different parts of the State. The suggested land use plan largely takes into account these variations and is shown in Map^{4.1} for Maharashtra State and described in Tables 4.1 and 4.2.

In the coastal plain, the rainfall is as high as 400 cm and above, the climate is wet and humid and the soils are gray to dark gray, deep to moderately deep coarse loamy to fine loamy. These are subject to frequent inundation by tidal waters which render them saline limiting the growth of mesophytic species other than paddy. Under such conditions only salt resistant paddy can be grown. Along the coast, plantation of casuarina would act as an effective wind break



and it would also check sea erosion. This would give further protection to the coconut and cashew plantations on the upper terraces.

To the east of the coastal plain, lies the intervening valley in the western and eastern parts of Ratnagiri, Thana and Kulaba districts. The western part is wet and humid receiving rainfall as high as 400 cm. while the eastern part is humid to sub-humid receiving 250-125 cm. annual rainfall. The soils are moderately deep, brown to grayish brown. The drainage is poor in the valley creating aeration problems in the root zone. The valley portion is suitable for extensive paddy cultivation and some mesophytic species on the terraces. In the wet and humid region, plantations of arecanut, cashewnut, casuarina, pineapple and coconut are recommended. In the humid to sub-humid parts to the east, plantation of arecanut, casuarina, cashewnut, eucalyptus and adaptable moist deciduous species of hard wood would be more desirable along contours. There are intervening valleys and subdued hillocks and ridges on the windward side of the Sahyadri range. The soils are, however, somewhat severely eroded, reddish brown fine loamy shallow on the ridges and moderately deep, reddish brown, fine loamy on the subdued hillocks. Soils having moderate intake rate, moderately slow permeability and somewhat shallow rooting depth are subject to excessive runoff. Most of these are under somewhat degenerated tropical wet evergreen and tropical moist deciduous forests. With suitable soil conservation and afforestation measures, there is a sufficient scope to improve the productivity of these lands.

Both the windward and leeward sides of the Sahyadri crest reveal elevation differences. The elevated and elongated

ridges and steep escarpments in high rainfall zone in the west, moderately steep sub-humid to semi-arid zone covering south-eastern districts, Satpuda hill ranges in the Northern part of Amravati and Mahadeva range in north of Jalgaon intervened by sporadic mesas and buttes in the central part of the State are the relics of original plateau subjected to denudation. Due to sharp gradients, high intensity storms and degraded vegetation erosion is severe resulting in shallower soils exposing the substrata. The soils are coarse to fine loamy shallow having excessive runoff, low available moisture capacity limiting root growth. The high rainfall areas have sporadic groves with broad leaves, shrubs and medium trees in crevices and gullies while in low rainfall areas they are either barren or under sparse thorny plants. This has created ecological imbalances in the adjoining areas. Such areas should be put to alternate rows of agave and quick growing climatically adapted grasses including fodder crops at places along contours with restricted or protective grazing. Besides, there should be afforestation with appropriate soil conservation measures. Plantation of climatically adapted quick growing economic species of hard-wood including bamboo in drier areas in staggered trenches along contours would be more desirable. This will help stabilization and bring about improvement in the area. Further the need for pasture development in areas of intermittent subdued mesas and escarpments with somewhat gentle slope gradients needs to be emphasized.

The denuded and dissected relics of original plateau surface of higher elevation classified as upper plateau extend to higher rainfall areas of Ratnagiri and Kolhapur districts and low rainfall areas of eastern and central parts of the

State. The soils are reddish brown to pale brown shallow with gravelly substratum limiting cultivation of deep rooted crops, having inadequate available moisture capacity and not suited for normal crop husbandry. They support moist and dry deciduous forest in humid and sub-humid parts and dry mixed deciduous and thorny vegetation in the semi-arid parts of Osmanabad and Ahmednagar districts. However, people cultivate in patches maize and hill millets in humid areas and bajri in dry areas but with frequent crop failures. In the humid section selected patches may be utilized for fodder jowar and paddy. The entire area should be planted to economical moist deciduous species introducing cardamom and pepper. In the sub-humid and semi-arid parts cultivation is possible in moderately deep soils for kharif millets and short duration legumes like green gram, horse gram, etc. Plantation may include dry deciduous species like teak and bamboo. The pediment extends from windward to leeward sides of Sahyadri range and lower plateau on the leeward side from sub-humid to semi-arid parts of the State. Soils on the upper pediment are eroded, gravelly, shallow to bed rock. On lower pediment they are brown to grayish brown, moderately deep to deep fine loamy. In the high rainfall areas, erosion becomes severe with excessive runoff; sheet and gully erosion are common while dry areas are prone to drought. The former area is cultivated to maize, hill millets and paddy in patches and the latter to kharif jowar, bajri, groundnut and pulses. Yields are low and involve risk of crop failure. The pediment should be put under climatically adapted moist deciduous species. However, selected areas with deep soils may be cultivated for hill millets, maize, pulses and paddy.

In lower plateau and lower pediment areas, soils, being variable and available moisture capacity being low to medium, soils may not be able to support crops maturing beyond 70 to

80 days. In such soils short duration crops and pulses under dryland farming should be more beneficial. Crops like jowar, bajri, legumes, tur, cowpea, horse gram, etc., may be grown with contour rows of agave at broader intervals. Soil and water conservation measures with water harvesting techniques would be advantageous. The shallow soil areas should be put permanently under ley farming with alternate rows of agave.

The valley bottoms are intervened by elongated ridges just below the Sahyadri crest zone on its leeward side. Soils are moderately deep to deep brown to grayish brown, supporting patchy denuded forest with rest of the area put under cultivation of paddy and jowar in north Pune, central Satara and western Kolhapur, in parts of Ahmednagar and Osmanabad, pockets of denuded dry deciduous mixed forest areas are mostly under jowar, bajri, sugarcane and pulses. Since rainfall is considerably high in Kolhapur and Western Pune (250-125 cm), it may be possible to take a short duration legume after paddy by adjusting either sowing time of paddy or selecting short duration variety of paddy. In areas of comparatively lesser rainfall (125-60 cm), crops like jowar, bajri, tur and other pulses under dryland farming are recommended. With the development of irrigation wheat, fruit crops, sugarcane, jowar and oilseeds can be successfully raised.

The pediment alluvial plains and flood plains east of Sahyadri having rainfall of 125-60 cm consist of deep to very deep black clayey soils. Although some portion of this area is under mixed deciduous forest, most of the area is under cultivation for both kharif and rabi crops. Irrigation facilities are also available in certain parts of the area. The soil being deep are water retentive and as such one crop is assured while two crops are possible in areas with more than

100 cm rainfall or where late rains are also received. Alternately, cotton is favoured in deeper soils. There are many areas of moderately deep soils where cotton does not produce good yields. Such soils could more profitably be used for crops like jowar, sesamum, groundnut, tur or rabi crops with stored moisture. In areas receiving 100 to 125 cm or more rainfall, the possibility of growing two crops can be exploited on a larger scale with suitable soil moisture conservation practices. The possible crop combination would be hybrid jowar, moog, followed by wheat or gram. In some districts like Chandrapur and Bhandara, paddy forms the first crop followed by wheat, linseed or gram. Crops like rainfed chillies form the main cash crop in some parts of Nagpur and Bhandara districts where September/October rains are assured.

The flood plains are by far the most potential areas for crop production. There is considerable scope to introduce modern techniques even for dryland agriculture and more so for irrigated farming. The choice of crop varieties, and agronomical manipulation are also significant to achieve a break-through in agricultural production.

Beyond alluvial plain lies a tract of dissected rolling land and residual hills. The relatively shallow depth and coarse texture of soils coupled with unsuitable topography are not favourable for full utilization of fairly high precipitation (90-125 cm) with the result that considerable area is under forest. In these areas a balance between forest and cultivated areas should be maintained to reduce the erosion hazards. Afforestation programme has to be intensified with propagation of bamboo, tendu, mahua, dhawda, ain, awala, salai, teak and other indigenous species. (Soils and Suggested Land Use of Maharashtra, Murthy et al., National Bureau of Soil Survey and Land Use Planning, Nagpur, 1980).

II. Optimum Land Use Model for Maharashtra State

The decision regarding the crops to be sown in a given season is taken by individual cultivators; there are over 81 lakh landholders in Maharashtra whose individual decision determines the cropping pattern of the State. In Maharashtra, since the irrigated area is limited to about 12 per cent of the gross cropped area, the choice of crop is largely determined by the type of soil and climatic regime, particularly the quantum and distribution of rainfall. For maintaining soil fertility certain rotational practices are followed. Apart from agro-climatic conditions the second main factor that determines the choice of crop is the personal needs of the farmer. For majority of the cultivators agriculture continues to be oriented towards subsistence; a significant proportion of the area is put to cultivation of cereals and pulses to meet the consumption requirements of the family, the smaller the land holding the larger the component of subsistence farming. Cultivators venture into crop specialization mainly when irrigation facility is available. In most cases only a part of the holding is irrigated while the dry land is generally used for meeting subsistence needs or to grow rain-fed cash crop like cotton or oilseeds. The decision regarding the cash crops to be cultivated under given agro-climatic conditions is governed by the yield - quantum and variability in yield, the working capital needs, ease of marketing the crop, the prospective prices that determine the net return. Here again the degrees of freedom are limited due to both the physical factors and market factors.

An attempt is made to examine whether the existing cropping pattern satisfies optimality criteria and if not then what is the desirable cropping pattern if the aim is to maximize employment or the net monetary return or the

gross monetary return at the State level. The model is then used to arrive at the optimum crop pattern for the year 2001.

The model was constructed only for Maharashtra State as the data necessary for the model could be obtained through secondary sources and supplemented by detailed field studies made by the Gokhale Institute of Politics and Economics. It was not possible to get the necessary information on all the variables for the other States from western zone. Besides, field level experience is important in setting up the appropriate constraints. The researchers have considerable field experience for Maharashtra that facilitated construction of the model.

In constructing the model for optimum agricultural land use there are two types of constraints, one, technical and two, socio-economic. The technical factors relate to land availability, soil type, rainfall, irrigation facility, and crop rotation requirements. The major socio-economic constraints are demand for the crop, relative prices and returns from different crops. The prices, absolute as well as relative, are changing over time and have to be used with caution. Linear programming model is constructed to optimize the crop pattern to attain maximization of net return, gross return, labour days, and net return per unit of water.

The period of agricultural production is taken equal to one year. This period covers the monsoon or kharif - the main cropping season in Maharashtra, the rabi season when crops are grown on residual moisture and the hot weather or summer season. Summer cropping is possible only if irrigation is available, so also 12 month or 18 month sugarcane or banana or perennial fruit trees like oranges, grapes can be grown only under irrigation. In determining the crop

pattern, along with climatic conditions, soil type is important. In shallow soils only certain crops like millets can be grown. Well drained soils are needed to grow sunflower, chilli and spices and vegetables.

Thus, in defining the variable X, which is hectares under a particular crop three factors are considered, viz. season, irrigation status and soil type. The variable is defined as
$$X = \begin{matrix} I & J \\ K & L \end{matrix}$$
 where I runs for season, J for irrigation status, K for soil type and L for crop. There are 24 crops, 4 seasons 2 irrigation status classes and 7 soil types as follows :

Season

- I = K - Kharif
- = R - Rabi
- = S - Summer
- = A - Perennial

Irrigation Status

- J = I - Irrigated
- = D - Dry

Soil Type

- K = S - Shallow
- = M - Medium Black
- = D - Deep Black
- = L - Laterite
- = H - Hill slope
- = C - Coastal
- = Y - Yellowish

Crop

L = P - Paddy	L = GNH - Groundnut HYV
= N - Nachni (Ragi)	= SF - Sunflower
= BL- Bajri Local	= OO - Other Oilseeds
= BH- Bajri Hybrid	= C - Cotton
= JL- Jowar Local	= V - Vegetables and Chillies
= JH - Jowar Hybrid	= R - Other Crops
= OG- Other Cereals	= WL - Wheat Local
= T - Tur	= WH - Wheat HYV
= M - Moog	= G - Gram
= U - Udid	= S - Sugarcane
= OP- Other Pulses	= B - Banana
= GNL - Groundnut Local	= OR - Other Perennials

This brings in 196 total variables in the model.

Constraints

There are in all 135 constraints. They are categorized into 5 groups :

- 1) Land Availability (19)
- 2) Crop Rotation Requirements (21)
- 3) Individual Crop Production (87)
- 4) Demand in the year 2001 A.D. (6)
- 5) Water Availability (2)

The land availability is determined by the limitations of extension of the margin of cultivation. As noted earlier there is no scope for further extension of land under cultivation in Maharashtra. However, land can be augmented through increase in the area under double cropping. This is constrained by the date of onset of monsoon, the duration of the crops and the moisture availability for rabi crop. Intensity of cropping can be increased through extension of irrigation facility. In areas where the onset of monsoon is late it is not possible to take any kharif crop and in areas where rains recede by September rabi crop is not possible except in the

case of very heavy soils highly retentive of moisture. In shallow soils only one rainfed crop can be grown. Constraint of crop rotation is determined by the growth cycle and moisture requirements of the various crops. Consideration of maintaining soil fertility also governs the choice of rotation e.g. a cereal is followed by a legume; oilseed or cotton is followed by cereal, etc.

Individual crop production has been used as a constraint to ensure that production of each type of cereal, pulse, etc., presently grown continues where the other factors are the same. For example, moog and udid are both kharif crops, grown as dry crops in shallow, medium or deep soils and could be considered as alternatives so far as the variables considered in the present model are concerned. Minimum production constraints were therefore put for individual crops.

At the State level it is considered important to achieve a degree of self-sufficiency in food production. Demand for cereals, pulses, oilseeds, vegetables and sugar/gur were estimated for the year 2001 A.D. considering the nutritional requirements as given by ICMR for various sex-age groups for a vegetarian diet (see Table 3.3). However, in the case of cereals, it is noted that Maharashtra is not self-sufficient in wheat and rice mainly because of a large urban population (about 35 per cent) and the agro-climatic limitations the State faces in growing these crops. Wheat is a rabi crop and attempts to increase the area under wheat with the extension of irrigation facility are being made. However, even if irrigation is available unless there is a cold spell in winter, the productivity remains poor. In Maharashtra the productivity of wheat is quite low because of physical limitation. Hence it is not possible to increase the productivity and total production of wheat. In the case of rice also cultivation is

possible mainly in the Konkan districts and in eastern Maharashtra. The productivity of rice has increased in recent years in Konkan and there is some further scope for increase in productivity but the area under paddy can hardly be extended. Thus the urban needs that are restricted mainly to wheat and rice (jowar/bajri has a limited market in urban centres) cannot be satisfied by State level production. As a consequence the constraint of satisfying the total State demand of cereals by own production is non-feasible and hence has not been incorporated in the set of demand constraints.

Demand constraint for pulses and oilseeds is introduced as shortages are experienced at the State as well as national level and augmentation of production is essential as these crops are of vital importance in the Indian diet. Sufficiency in sugar/gur is no problem in Maharashtra, it is a surplus State in this respect. Hence production of sugar for satisfying sugar and gur demand in the State was taken as the minimum requirements of sugarcane production.

Water availability and hence the area under irrigation is likely to increase by 2001 because of better utilization of the present surface irrigation facility, availability of additional sources due to completion of new or ongoing projects and increase in the lift irrigation.

It was assumed that all the ongoing surface irrigation projects in 1982 would be completed and utilization of the completed projects would be improved to achieve 75 per cent utilization. It was also assumed that improvements in the water applications methods would be introduced so that the quantum of water available today for irrigation would be stretched over a larger area. In view of the decline in the water table in most parts of the State, it is assumed that

the groundwater would be conserved for drinking water purpose and domestic use and there will not be any increase in the well-irrigated area. The estimated net irrigated area under these assumptions came to 4570 thousand hectares. An increase in the gross irrigated area by about 38 lakh hectares over the 1983-84 hectarage is expected by the year 2001. In the perennial crops it is proposed to increase the area under fruit trees as they have modest water requirements. The distribution of irrigated area in different seasons is assumed as follows:

<u>Season</u>	<u>Area in 000 Ha.</u>	<u>Percentage</u>
Khariif	2500	38.5
Rabi	2950	45.4
Summer	400	6.1
Three seasons	550	10.0
	<u>6500</u>	<u>100.0</u>

The existing crop rotations or desirable crop rotations as shown in Table 4.3 were used in the model. For shallow soils and hill soils mono-cropping in kharif season was assumed. The suitable soil types for different crops are shown in Table 4.4.

Information about yields as recorded for irrigated and rainfed crops for the State in the official statistics, data on yield, employment, gross return and net return collected by the Gokhale Institute of Politics and Economics in the village surveys conducted in Maharashtra State and the information collected under cost of cultivation studies by the Government supplemented by field level discussion, formed the basis of estimation (Table 4.5). Figures of water requirement as suggested by the Department of Agriculture were used.

When optimization was carried out from the point of view of maximization of net return the crop pattern that emerged under rainfed conditions more or less approximated the existing crop pattern except for vegetables, chilli and wheat where increase in the area was indicated. In the case of vegetables the main constraining factor is the marketing organization which needs to be strengthened. However in the case of wheat the problem is climatic. Parameter of temperature was not used in the model; from the point of view of income optimization wheat is profitable if climate permits. This constraint had therefore to be considered in the case of wheat.

In irrigated agriculture the major marked departure from the present cropping pattern was the drastic reduction in the area under sugarcane. Sugarcane today covers about 3.6 lakh hectares, whereas according to the model the area went down to only 100440 hectares i.e. the area needed to meet the sugarcane/gur demand of the State in the year 2001 A.D. As sugarcane is a voracious water consumer the reduction of 2.6 lakh hectares from under sugarcane meant release of about 40 per cent of the irrigated water. Consequently the total water available for other irrigated crops increased substantially. As a result, in the cropping pattern that emerged from the model under irrigated conditions, the area under paddy, bajri, urid, rabi jowar, gram, rabi oilseeds like safflower and sunflower, summer groundnut and summer cotton increased substantially. However, as it is not possible to decrease the area presently under sugarcane since there are already over 100 sugar factories in the State that need the sugarcane produced today, the area under sugarcane has to be maintained at the existing level. The model was therefore modified to put the constraint of existing hectarage in the case of sugarcane.

The model was run to maximize total net return, total gross return, total employment and net return per unit of water. The cropping patterns that emerged from the different objective functions were not much different from one another barring the differences arising due to specific nature of the variable used in the objective function.

The values of total net return, employment, gross output and return to water for all the four models are given in Table 4.6. It will be noted that if net return is maximized then the sacrifice in employment is to the extent of three per cent. However, if the total employment is maximized the sacrifice in net return is to the extent of nearly 10 per cent. Considering the trade off it was decided to take for 2001 A.D. the projected optimum crop pattern that emerged from the model with maximization of net return as the objective function. The estimates had to be further modified in view of the latest productivity trends. When the data were being processed information was available only upto the year 1986-87. However in December 1989, the latest information for 1988 and 1989 kharif season could be obtained. In the latest years, growth in the productivity of gram, safflower, paddy and sunflower is recorded. In estimating production for the year 2001 these latest trends are taken into account.

The suggested cropping pattern is presented in Table 4.7. The total area under crop in kharif season records an increase from 138 lakh hectares to 150 lakh hectares. Except for the substantial increase in the area under chilli-spices and vegetables from about 326000 hectares to 1070000 hectares there are no major changes in the crop pattern. The land is diverted to vegetables through a small reduction in the area under jowar, paddy and tur. In irrigated agriculture there

is a substantial addition in area under hybrid bajri, moog, udid, groundnut, chilli and vegetables.

For attaining increase in the land under chilli and vegetables it is necessary to provide technological inputs (skill in husbanding vegetables - particularly pest control, timely picking and packing) and adequate marketing, storage, transport and processing facilities. If the nutritional requirements of the population are considered there is a need for a considerable expansion in the area under vegetables.

In rabi season total cropped area increased from 65 lakh hectares to 74 lakh hectares due to some increase in double cropping. The increase is in gram, safflower, sunflower, and vegetables in irrigated agriculture as well as in rainfed agriculture. There is some expansion in the area under summer groundnut, moog and sunflower. Among perennial crops no expansion in area under sugarcane and banana is suggested, hence there should not be any further expansion in the number of sugar factories. Increase by about 160 thousand hectares in fruit crops that consume relatively small amount of water like grapes, pomegranate, oranges, guava, bor, etc., is suggested. Fruit cultivation demands technical skill and marketing/processing facilities. Again fruit cultivation is important for improving ⁱⁿ nutritional standards. There is a trend, particularly in Western Maharashtra of rapid expansion of area under fruit cultivation where the young educated farmers are taking initiative supported by fruit growers' cooperative organizations. Fruit and vegetable cultivation is quite labour intensive and would thus add to rural employment, specially in the lean season.

The estimates of production are worked out for the crop pattern projected for 2001 on the basis of L.P. model

to maximize net return (Table 4.8). The production of wheat and rice is likely to be less than the total requirements for the State. The State will be self-sufficient in all the other cereals (jowar, bajri), pulses and oilseeds and surplus in sugar production.

The projected requirements of cereals in 2001 A.D. comes to about 155 lakh tonnes as against the projected production of 136 lakh tonnes. About 60 lakh tonnes would be needed in urban areas. Today the Government of Maharashtra receives about 11 lakh tonnes of wheat and 7 lakh tonnes of rice for public distribution. The shortfall in 2001 A.D. is of the same magnitude. The State will have to continue the import of wheat and rice particularly for the supply to the metropolitan cities.

The manpower requirement in kharif season equals the labour force likely to be available in 2001; in rabi season the requirement if calculated taking into account the employment in sugarcane harvesting and transport is likely to be short of the available supply by about 10 per cent and only in summer there would be a need, in some pockets, to provide supplementary work. This could be provided in the developmental work in silvi-pastoral schemes and afforestation. Land improvement works and work of trenching, pit-making can be taken up during the summer months. In addition year round work in nursery would be available. Seasonal work of grass-cutting and lopping of trees, fruit picking and transport would also be available once the schemes get started.

The projected crop pattern and crop production is examined in comparison with the existing crop pattern. The net cropped area remains the same but there is a considerable increase in the gross cropped area through increase in the irrigated area mainly through fuller and better utilization

of the irrigation potential created. There is some shift in the cropping pattern from foodgrains to cultivation of vegetables, fruits, spices and oilseeds. As a result the contribution of foodgrains in the value of agricultural production is expected to decrease from 45 per cent to 35 per cent and that of oilseeds and other crops to increase respectively from 11 and 29 per cent to 14 and 35 per cent (Table 4.9). The net return per hectare is expected to increase from Rs. 1200 to Rs. 1718 and the mandays per hectare from 78 days to 90 days mainly because of the increase in irrigated agriculture (Table 4.10).

The estimated production of fodder from crop residue is 300 lakh tonnes and that of fodder crops and the fodder available from forests is 80 lakh tonnes. Forty lakh hectares presently under grass and scrub and culturable waste are to be developed as grass-lands. Assuming average yield of 2 tonnes per hectare the production of fodder comes to 80 lakh tonnes. The estimated requirement for the projected livestock population in 2001 comes to 450 lakh tonnes; thus if concerted efforts for development of pasture lands and waste lands are made the requirements could be met. To meet the requirements of dairy business irrigated areas will have to be specially assigned for intensive fodder crop cultivation.

The fuels used for cooking and water heating purposes are not expected to change by 2001. At present firewood, brushwood, agricultural residue (especially cotton and tur stalk) and dung-cake are the main sources of fuel in rural areas. Use of biogas is very limited. Attempts will have to be made to augment the firewood and brushwood supply so that dung will be used for biogas and/or manurial purpose and not diverted to fuel-use directly. It is expected that afforestation and silvi-pastoral development will help augment the supply of fuelwood. If 30 lakh hectares under grassland are developed to include some trees and shrubs useful for fuel the expected supply would

be 60 lakh tonnes at an average rate of 2 tonnes per hectare. The estimated supply of agricultural waste, brushwood available through forest area and from trees/shrubs on field bunds works out to 90 lakh tonnes. The total supply of 150 lakh tonnes could just meet the fuelwood needs of the rural population in 2001 if improved chula and other fuel-saving methods get acceptance.

From the above estimates, it will be obvious that systematic and concerted efforts on an extensive scale are needed for afforestation and grassland development to meet the fodder and fuelwood requirements of the rural population in 2001 A.D.

III. The Western Ghats

The Western Ghats comprise a chain of hills running along the west coast of peninsular India from 20°-25' N latitude south of Tapi valley to 8°-15' N latitude in Nagercoil district (Kerala). The coastal plains in the west receive heavy precipitation from the western slopes resulting in a series of fast flowing rivers which empty into the Arabian Sea. Besides offering potential for hydel power, these rivers and estuaries provide extensive fishing facilities.

From 20°-25' N to 5°-30' N latitude - the portion that falls into Maharashtra State - the Ghats rise almost perpendicularly from a coastal plain to a height of 1000 metres. The annual precipitation exceeds 250 cm in the coastal belt and on the western face and on the crest line of Ghats it reaches levels of 622 cm a year at Mahabaleshwar in Satara district. In Lonavala region of Pune district it is around 450 cm.

The climax vegetation of Western Ghats ranges from moist deciduous to ever-green forests in the high rainfall zone of over 300 cm on the west coast and on the Ghats. In Maharashtra State, however, the moist deciduous, semi-

evergreen and evergreen regions have been severely disrupted beyond recognition due to commercial exploitation of forests during the last century.

The region north of 19° N latitude is inhabited by Kokna, Katkari, Thakur, Warli who were primarily dependent on hunting-gathering, but with the denudation of forests and depletion of wild animals and birds they have been forced to serve as agricultural labourers. The plateau region is occupied by pastoral groups including Dhangars engaged in cattle rearing. Settled villages inhabited mainly by the Kunbis and Kolis are located on the lower ridges. Shifting cultivation is practised on the hill slopes and paddy is grown wherever broader valley occur.

Although the region is endowed with abundant renewable and non-renewable natural resources, the hill areas of Western Ghats are dominated by subsistence agrarian economy with a dwindling resource base, partly because of the pressure of industrial and commercial interests on the resources of the region. The dwindling resource base cannot sustain the traditional mode of utilization of region's resources for the subsistence of the local population. However, due to lack of viable alternative the local population continues the traditional practices of cultivation and animal husbandry that makes for further deterioration of the resource base. For example the peasants traditionally cultivated rice in the valley region and ragi on the lower slopes. With the construction of a chain of dams in Pune and Satara districts, the rice lands got submerged and the peasants had to increase the area under ragi cultivation. To get an output equivalent to rice production about 4 times more area is needed for ragi cultivation. Besides it is necessary to give a rest period of 12 to 15 years after cultivation of crop for two seasons on this hilly terrain. However, since the production of ragi has to be considerably expanded the rest period is getting

reduced to 6-8 years or even less. This is adversely affecting the land productivity and the vegetative regrowth. On fallow lands inferior grasses and shrubs like Lantana camera, Woodfordia fruticosa are growing. Productivity of ragi is about 1 to 4 quintals per hectare and that of vari 0.8 to 3 quintals per hectare. It was estimated that the cereal production meets about 60 per cent of the consumption requirements of the local population. The cash income is derived from sale of milk of cows of non-descript breed with very low yields (250 litres per lactation), sale of fuelwood, bamboo, hirda and other forest produce and sale of trees for charcoal making. In a study carried out in Velhe taluka of Pune district in the Panshet reservoir catchment area it was noted that the average annual estimated income in 1987 was Rs. 6,000 (Brahme, 1985). Majority of the families were living in poverty and with the progressive deterioration of the resource base their hardship is increasing.

The problems can be summed up as follows: (1) Heavy rainfall and high gradient in the western Ghats stripped of vegetative cover makes the area erosionally active. Active erosional processes lead to coarse texture of soil. As soils are not fertile and cannot sustain continuous cropping shifting cultivation is resorted to that promotes further soil erosion. (2) Commercial exploitation of forest resources is resulting in fast denudation of forest cover. (3) Urban encroachment and construction of roads is making for deforestation, gully formation and soil erosion. (4) Heavy soil erosion is making for rapid siltation of the reservoirs located in the valleys of several rivers viz. Koyana, Krishna, Nira, Gunjavani, Ambi, Moshi, Pawana, Mula, Mutha, Ghod, Pravara, etc. (5) The dwindling of resource base is forcing people to reduce the period of fallow and to overuse the pasture and forest resources leading to further deterioration of these resources and increase in impoverishment of the people.

A radical approach to land use in Western Ghats is essential to protect the source region of the major rivers of Deccan. Unless strict measures for conservation are taken the hydrological balance of the Deccan will be threatened. The region is threatened mainly because of the demand for commercial exploitation of raw materials, water, energy and other resources including the "natural beauty" and congenial climate in summer.

For the protection of the catchment area, it is essential to prepare a comprehensive plan regulating the activities emanating from within the region and from outside the region. To control outside encroachment it is necessary to discourage activities within the region that are destructive of the environs. For example in a tourist centre like Mahabaleshwar the tourist pressure is leading to clearing of forests and building of motels, hotels, cottages, bungalows, etc.; the tourist business consumes large quantities of firewood and this puts pressure on the forest resources. The water supply in Mahabaleshwar is limited, this limit has to be kept in view in permitting expansion of tourist facilities and building activity. The growth in vehicular traffic is creating the problem of pollution. There is an urgent need to keep the vehicular traffic in check. The expansion of tourism at popular hill resorts like Mahabaleshwar, Matheran, Khandala, Bhimashankar, etc., should be guided by conservation aspects rather than revenue earnings so that the natural endowments are preserved. Instead of supporting passive and garish tourism, active use of the natural facilities and non-destructive use of natural resources should be encouraged. Activities like hiking, trekking, mountaineering, nature observation and study should be developed and support facilities for study and sport and for camping should be extended. Transgression by private motor vehicles, pollution of lake by motor launches and eating places, etc., should be controlled. A recent scheme launched

by the Maharashtra Government to turn the Panshet and Warasgey reservoirs into tourist resorts is unfortunate from the viewpoint of protecting these lakes that provide drinking water supply to Pune city, and also from security point of view. The same area could be used for hiking, trekking and study without disturbing the ecology.

A related issue is that of the hardship imposed on the forest dwellers through imposition of "protection" to forests without proper consideration of its implications. For example Bhimashankar region is declared as a sanctuary. Menace of wild boar has increased since the imposition of "protection" to all wild animals. Wild boars destroy the standing crops imposing great hardship on the villagers in the region. In taking measures for conservation, the needs of local population have to be kept in view and if their current activities are to be restricted provision for better source of livelihood must form a part of the conservation scheme.

The catchment areas of the reservoirs created on the east-flowing rivers rising from the Western Ghats need full protection to reduce siltation and risk of floods and, to protect the river source. For this, the following measures must be taken forthwith. (1) Put a total ban on commercial felling of trees and charcoal making through sale of trees in private plots. Large areas in Western Ghats are under private ownership and due to economic hardship, the farmers sell trees which are largely used for charcoal making as big urban markets are located nearby. (2) Prohibit further construction of motorable roads and encroachment of urban uses in the catchment areas. (3) Prepare a ten year programme for switching from shifting cultivation to horticulture, pasture development and forestry; and control of free grazing that makes regeneration of vegetation impossible even in this heavy rainfall region.

A ban on felling of trees, shifting cultivation and

free grazing would deprive the local inhabitants of their present means of subsistence. Alternative sources of income must be provided within the region. This can be achieved through following measures.

Since bulk of the land in this region is under private ownership it is suggested that the government should take over the land on a long lease (say 50 years) from the owners and take up the responsibility for all the developmental work with the help of local labour; the local population will have to be responsible for the protection of the vegetation in the region. Villagewise nurseries will have to be developed to meet the large-scale needs of the reforestation programme. As the plants/trees mature the land owners should be allowed to take the produce from the reforested area. In the meantime they will have to be provided with alternative sources of income to compensate the loss because of the ban on shifting cultivation and tree-cutting. It is suggested that the work of selective planting and eco-development of the region be taken up by the State Government under the Employment Guarantee Scheme (E.G.S.). The Government of Maharashtra spends about Rs. 120 crore per year under E.G.S. Allocation of about Rs. 10 to Rs. 15 crore for the Western Ghat talukas should not be difficult. The capital expenditure needed for land shaping, nala training, plantation, etc., should be met through the funds made available by the Central Government under the Western Ghats Development Programme.

It is essential that the payment of wages under E.G.S. should be regular and assurance of wage employment for a period of say 10 years be given to the local population. The situation should be periodically reviewed to estimate the economic yield of various plants in the region and the decision regarding the wage-component should be taken on that basis. If the local population so desires they should

be given part of the wages in kind (particularly millets). Continuous attempts for enriching the biotic composition of the vegetation and introduction of secondary activities like bee keeping, sericulture, bamboo working, fruit processing, etc., on the basis of local produce will have to be made to progressively improve the economic situation of the people, without over-exploiting the resource base.

Revegetation of Western Ghats

The Western Ghats have lost much of the protective vegetation cover and also the soil cover under the impact of torrential rains. It is difficult to re-establish vegetation as the soils are shallow and have little moisture holding capacity. Experimentation with re-plantation was carried out in the Panshet reservoir catchment area (Brahme, 1990) following both the conventional method of afforestation programme viz. planting seedlings of exotic and native species in dug pits and the successional approach.

Among the local trees performance of Pise, Limbara and Shiven was found promising. Ain, Behda, Hirda, Karanj though slow growing are valuable from economic point. Bamboo is the most promising plant. Rhizomes of Dendrocalamus strictus were planted in 1987. Nearly all the plants sent 2 to 3 shoots in the 2nd season i.e. in 1988 and they grew to the height of 5 to 7 metres in one season. In the 3rd season new shoots varying from one to seven per plant were added.

Stumps were also planted in the dug pits. In the case of stumps, the performance was encouraging for species like Erythrina stricta, Nitex negundo, Ficus sp.

Successional approach was adopted in view of the following. Plants have to combat several factors like stress, disturbances and face among themselves problems of aggression, competition and dominance. Each plant type viz. herbs, shrubs, trees plays a role in modifying the soil, enriching its organic

content and improve its water holding capacity. One plant paves way to the establishment of the next one leading to a stable system. In view of this suitable competitors i.e. fast growing shrubs and trees that would compete with dominant herbs, and stress tolerators were initially planted to pave way for a self-sustaining and stable system.

It was noted that in the plots dominated by Carissa congesta, germination of Terminalia alata, Bombax ceiba, Mangifera indica, Actinodaphne angustifolia was satisfactory, and the growth of Bridelia squamosa, Mangifera indica and Actinodaphne angustifolia was relatively better. In bare plots the seedlings remained stunted. Carissa congesta is deep-rooted, evergreen and unpalatable to cattle. It can thrive in a variety of climatic conditions. The favourable microclimate it creates could provide a good habitat and help the process of succession and species diversity. These preliminary findings of the experimentation have to be further tested.

The main findings of experimentation can be summed up as follows:

(i) Germination was relatively poor if the seed was planted in situ and even when seed germinated the sprouts dried and the seedling did not survive through summer in a large number of cases.

(ii) The survival rate in the case of seedlings (six month old) planted in dug pits varied between 40 and 70 per cent for different species but the growth was slow. The leaves of the seedlings planted in June were in many cases, eaten by cattle in February-March and the seedlings sprouted again in the following June after a few showers. Unless full protection from grazing is provided the seedlings get stunted due to cattle menace.

(iii) Even when protection is given the growth of new plants is slow because of adverse soil conditions and lack of nutrition and moisture after monsoon.

(iv) If full protection is given the shrubs and trees already existing in the plot but cut down grow and show a moderate to fast growth rate.

On the basis of the study of the local vegetation and experimentation with regeneration broad recommendations for re-vegetation can be made. For this purpose, the area is divided into four broad zones as follows:

	<u>Rainfall in cm</u>
Zone I	Upto 220
Zone II	221 - 360
Zone III	361 - 500
Zone IV	Above 500

Regeneration plan will have to be implemented in a phased manner. The work has to begin with the establishment of the plant nurseries in the villages and experimental stations in each of the four zones. Reforestation plan can be taken up when the nurseries are established. The priorities for plantation are road side, nala side, upper contours, reservoir bank, middle and lower contours. In addition economically valuable plants should be planted in the backyards and programme for grafting of local mango trees should be taken up. Rest of the area can be rehabilitated through natural regeneration. This would be possible if protection from cattle grazing and tree-cutting is provided. The process of regeneration can be selectively accelerated through broadcasting seed in suitable areas.

In the eco-development plan, moist deciduous trees are mainly suggested for Zones I and II. Trees like Butea monosperma, Terminalia alata, Hardwickia binata, Grewia tiliacifolia, Cassia fistula, Bauhinia racemosa, Careya arborea, Emblica officinalis, Bombax ceiba, Erythrina variegata, Bridelia squamosa can withstand the long dry months and can be grown in the first and second zones. Plants like Hardwickia binata, Bauhinia racemosa, Butea monosperma, and

Erythrina variegata fix nitrogen also. These trees occur up to an altitude of 1200 metres. Rainfall requirements range from 80 cm to 350 cm under natural conditions. All these trees grow well in open terrain. Leaves are generally not browsed by the cattle. Trees like Melia composita, Azadirachta indica, Dalbergia sissoo and Pongamia pinnata can be successfully grown on lower gentle slopes of the first and second zones. The places with silt accumulation on the lower slopes provide ideal conditions for these trees.

The third zone which experiences high rainfall exhibits a semi-evergreen type of vegetation. Some economically useful plants, which are otherwise threatened are preserved in the sacred groves. These include Bassia latifolia, Dysoxylum binectariferum, Xylia dolabriformis. These can be grown on the upper slopes in the mixed forests. Plants like Dillenia pentagyna, Actinodaphne angustifolia, Lagerstroemia lanceolata, Terminalia chebula, and Terminalia bellarica occur in the mixed and deciduous forests on the middle contour. Trees like Butea monosperma, Cassine glauca, Adina cordifolia, Heterophragma quadriloculare, Anthocephalus cadamba, Alstonia scholaris are suitable for the lower gentle slopes of the third zone.

Some trees like Syzygium cumini, Mangifera indica, Bauhinia racemosa, Dendrocalamus strictus can be grown in any of the three zones. These trees are adapted to a variety of climates.

The fourth zone which is at the crest of the Ghats exhibits a great diversity of plant and animal life. The animal life includes some threatened animals like Mouse deer. Hence this zone should be free from human interference and should be declared as a reserve.

Once the vegetal cover is established on the slopes grasses like Themeda quadrivolvris and Heteropogon contortus will give a way to more palatable grass species like Arundinella and Isachne.

To help the reforestation of the catchment area certain soil conservation measures are necessary to conserve the soil, specially during the monsoon when the gushing rain water washes away the upper layer of soil. To check the velocity of torrential rains strip agro-forestry technique should be followed. The plants planted along the strips could be harvested with 10 to 15 years rotation so that there is always a sizable plant mass along the contour that would check the speed of torrents. Gentle slopes with sheet and rill erosion in the second and third zones should be protected by constructing diversion drains to divert runoff coming from the hillocks or unbunded area. Stone terracing should be provided along the rough contours of upper slopes. They will have to be provided with terrace outlets at proper intervals to let out the excess water. Drop-pits should be provided at intervals to check the velocity of water.

Encouraging vegetation growth along gully sides and beds, is the best and the safest way of stabilizing them. Along the nala bank plants like Lasiosiphon eriocephalus, Zyzyphus rugosa, Emblice officinalis, Flacourtia latifolia should be planted.

The reservoir bank in the first, second and third zones should be covered with permanent vegetation which should not be allowed to cut. Strip plantation of Bamboo (Dendrocalmus strictus) together with other useful plants like Terminalia alata, Morus alba, Salix babylonica, Vitex negundo, Homonoia ripiraria, Acacia rugata along the reservoir bank will check the erosion and siltation of reservoir.

Kaccha roads have been built in catchment areas; this is resulting in gully formation and severe soil erosion. There is an urgent need of protecting the road sides by planting trees. Trees suited for road-side planting are Gliricidia maculata, Erythrina variegata, Bauhinia racemosa, Cassia fistula, Dalbergia sissoo, Gravelia robusta, Casurina equestiformis. These are fast growing trees with short branches and are unpalatable to the cattle.

There is a potential to grow medicinal plants like Shatawari, Sarpegandha, Kuda, Vavding, Nirgudi, and trees like awla, hirda, behda. Investigations ^{into} / the medicinal value of the local plants must be carried out to note the potential for future use.

Control of Grazing: Marked improvement can be achieved in the carrying capacity of grazing grounds by sub-dividing the area so as to check uncontrolled grazing over the entire area. By continuous thin grazing the better grasses are grazed down while the inferior ones are left more or less untouched and allowed to seed. In this way inferior grasses spread. Under monsoon conditions the grass season is so short that rotation must be a rapid one if full advantage is to be taken of all growth before it has become old and lost its feeding value. Areas once grazed early in the season are not found to yield sufficient regrowth for harvesting as hay. If grazing could be restricted to the middle parts of the region and the upper slopes are protected and utilized for hay or silage better utilization of the resources could be achieved. No grazing should be permitted after January. The grass from the reserved area will have to be cut and preserved and the animals will have to be stall-fed till the plots are ready for grazing after the onset of monsoon i.e. till August. The peasants will have to be paid the regular daily wage rates for the grass-cutting work and permitted to use the grass for feeding their animals. It is equally important to plant trees supplying good quality fodder so that most of the feed requirements could be locally met.

It is essential to involve the Gavli Dhangars inhabiting Western Ghats region, in the redevelopment scheme from planning stage through implementation stage e.g. pasture conservation, fodder production, proper rearing of the calves and feeding of the cattle. At the same time, arrangements for basic veterinary services and insurance cover for the animals will have to be

made. Drinking water facilities will have to be provided both for the inhabitants and their livestock.

It is noted that the local breed of cows are poor in feed energy utilization whereas the local buffaloes are better converters of forage. Buffaloes can be maintained once the fodder resources are improved. The price payable for milk must be worked out taking into account the costs involved so as to ensure proper feeding of the animals (including the calves who are today kept undernourished so as to sell larger quantity of milk). It is important that all these measures are taken simultaneously and not in an adhoc and isolated manner.

Economic Benefits: A broad estimate of the expected income ten years after the commencement of the replantation programme is worked out and compared with the income noted in 1937. The expected returns are worked out, assuming that the regeneration and plantation plan as suggested above will be implemented. Even though the average per hectare return from the reforested land is expected to be of the same order as the return obtained today from the shifting cultivation plot (the average return from the forested and plantation area is expected to be around Rs.1500/ha) the area under plantation-forest will be larger than that under shifting cultivation. Today, only about 11 per cent of the total area is under shifting cultivation in a particular year. The rest is fallow, almost devoid of any tree cover. With the progress in the redevelopment plan, it is expected that by the 10th year nearly 30 per cent the area will be under vegetation. In addition, the returns from milk production are expected to increase with the improvement in the fodder situation and provision of veterinary service. The estimated average family income of the families in the Panshet catchment in 1937 was about Rs.6000. The proposed plan should bring about an increase in their earnings by at least 50 per cent and place all the families above the poverty line.

As the biomass resources of the region get enriched part of the processing work can also be organized locally e.g. fruit processing, processing of medicinal plants, basketry, rope-making, structuralists using bamboo, chemical intermediates using palms and tubers, etc. There is thus a considerable potential to increase the return to labour. R & D efforts in this direction should form a part of Western Ghat Development Programme.

A new avenue of employment is the service industry. The region will have a vast potential for exploration and research when redeveloped. Particularly the IV zone will have rich and diverse flora and fauna after a few years of full protection. It will then offer immense opportunities for nature observation and research. Schools and colleges should be involved to take advantage of this outdoor laboratory. Nature camping should be encouraged. The local population can be involved in the development and maintenance of the nature reserve. Students should be involved in the study of local flora and fauna. Sheltered coves and bays can harbour wild animals if protection is afforded. Reeds and aquatic plants planted at the border of the bay will attract water birds. Fish farming can also be developed.

The region, if restored, on the line suggested above, will provide immense opportunities for nature observation, ecological research and experimentation. Considerable experimental work is needed to understand the population dynamics, growth rates, biomass production of the various plants in their natural environment. It is therefore essential to set up a few small agro-forestry experimental-cum-demonstration stations for exploratory studies and to familiarize the peasants with new techniques. The deforested lands owned by the forest department and the lands acquired by the irrigation department that are not submerged can be used for this purpose. Such farms should be developed for experimentation in methods of propagation, fertilization and various treatments so as to

conserve moisture in the dry season (use of earthen pots for delivery of water to the active root zone so as to save on waterings).

It is necessary to carry out research on the medicinal herbs in the region for further possible uses, study of other plants as potential chemical intermediates, biogas from digester using biomass, dry composting to meet the domestic needs, and producer gas for pumping water, etc., in the national laboratories to help further development of the Western Ghats region.

Environmental Degradation due to Urban Encroachment

A major problem noted in the study of Western Ghats that falls in Maharashtra State is that of urban encroachment. Lands in the catchment area are being purchased by the urban speculators. The process of urbanization and industrialization threatens to destroy the unique, natural landscape of these areas. Urban encroachment is leading to wholesale destruction of the vegetation, and degradation of dry agricultural lands, rudely disturbing the eco-system of the area. This will adversely affect the water sources and accelerate the rate of siltation and pollute the lakes. There are several major dams viz., Andra, Welwan, Shiravata, Bhatghar, Panshet, Warasgaon, Mulshi, Pawana, Koyana, Dhoni, Kanher in the Western Ghat region of Pune and Satara districts while Chaskamen, Yedgaon, Waduj, Manikdoh, Dimbhe and Pimpalgaon-Joge are under construction. The urban encroachment in all the catchment areas has to be controlled forthwith.

To control urban encroachment: (1) Legal provision for Prohibition of transfer of land from agricultural to non-agricultural uses must be made forthwith. In case the agriculturist desires to sell his land, the government should purchase the land and develop it or lease it out for agricultural or agro-forestry purposes only. (2) The development plan for the Western Ghat Region in Maharashtra should include (a) plan

for restoration of vegetation, (b) protection of lakes, (c) economic betterment of the local inhabitants on the basis of conservation and development of the forest and land resources, (d) development of roads only at selected points to serve the villages in the region and restrictions on motor vehicular traffic in the rest of the area, (e) the Region should be reserved for trekking, mountaineering, rowing, study of nature, historical monuments, etc., but not allowed to be used for vulgar tourism. This can be achieved by judicious planning of the roads and restrictions on motor vehicular traffic.

Urgent steps for the preservation of the Western Ghat region from urban encroachment must be taken so that the hill slopes and lakes are protected and programme for reforestation of the region could be taken up. Secondly, the region should be developed with a view to make it available to the public at large for healthy recreation, physical culture and study and for this immediate steps must be taken to see that it is not captured and destroyed by greedy speculators and the urban rich.

Table 4.1 : Suggested Land Use for Maharashtra

Zone	Sub-zone @	Per cent area under			
		Forest *	Grass	Horti- culture and other planta- tion **	Agri- culture
I. Coastal Hilly Zone	1, 2, 3	20	20	30	30
II. Western Ghats	4, 5, 6, 8	30	15	10	45
III. Scarcity Zone	7, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20	10	15	10	65
IV. Western Plateau- North	17, 18, 21, 23, 24, 25	20	10	5	65
V. Western Plateau- South	22, 26, 27	20	15	5	60
VI. Eastern Plain Zone	28, 29, 30	50	10	5	35

@ Figures refer to sub-zone numbers in Map 4.1.

* Forest tree species are given in Table 4.1-A.
For afforestation of denuded forest area the local tree species which provide timber and other products should be given preference. In reforestation a variety of species should be selected and not go in for monoculture.

** Horticulture and other plantation covers sizable area in Zone I. It is suggested to have mangrove, casuarina and coconut plantation along the coastal belt and uplands should be put under cashewnut, mango, coconut, arecanut, pineapple, pepper, cardamom, kokam, etc., plantation; Zone II plantations should include mango, jackfruit, jambhool, karvand, awla, kokam, medicinal plants, bamboo, shikekai and for other zones the hilly terrain is to be treated with alternate rows of agave and climatically adopted grasses and plantation of mango, tamarind, neem, bamboo, kadhilimb, sitaphal, bor, ritha, babul depending upon the rainfall and soil conditions.

Table 4.1(A) : Valuable Trees of Western Ghats and Other Hill Ranges and Forest Tracts of Maharashtra

Region	Trees	Uses	
North Konkan	<i>Acacia chundra</i>	Ti, DT, Md.	
	<i>Actinodaphne angustifolia</i>	Ti.	
	<i>Anogeissus latifolia</i>	Ti, Fo, RG, DT, Md.	
	<i>Careya arborea</i>	Ti, Fo, RG, DT, Fi, Md, F.	
	<i>Ixora coccinea</i>	Md.	
	<i>Lagerstroemia parviflora</i>	Ti, Fo, RG, DT, Fi.	
	<i>Mallotus philippinensis</i>	Ti, Fo, DT, O, Md.	
	<i>Memecylon umbellatum</i>	Ti, DT, O, Md, Fd.	
	<i>Mitragyna parviflora</i>	Ti, Fo.	
	<i>Olea dioica</i>	Ti	
	<i>Symplocos racemosus</i>	Ti, DT, Md.	
	<i>Syzygium cumini</i>	Ti, Fo, DT, Md, F.	
	<i>Syzygium caryophyllatum</i>	Ti, F.	
	<i>Tectona grandis</i>	Ti, RG, DT, O, Md.	
	<i>Terminalia bellerica</i>	Ti, Fo, RG, O, Md.	
	<i>Terminalia tomentosa</i>	Ti, Fo, RG, DT.	
	<i>Randia spinosa</i>	Ti, DT, Md, Fd.	
	South Konkan	<i>Actinodaphne angustifolia</i>	Ti.
		<i>Adina cordifolia</i>	Ti, Fo.
		<i>Anogeissus latifolia</i>	Ti, Fo, RG, DT, Md.
<i>Bambusa arundinacea</i>		Ti, Fi, Md.	
<i>Careya arborea</i>		Ti, Fo, RG, DT, Fi, Md, F.	
<i>Cryptocarya wightiana</i>		Ti.	
<i>Dalbergia latifolia</i>		Ti, Fo, O.	
<i>Dillenia pentagyna</i>		Ti, Fo, Fi, Fd.	
<i>Dendrocolamus strictus</i>		Ti, Fo, Fi.	
<i>Holligarna grahamii</i>		Ti, O.	
<i>Lagerstromia parviflora</i>		Ti, DT, Fi.	
<i>Myristica malabarica</i>		Ti, RG, O, Md, CS.	
<i>Sapindus laurifolias</i>		Ti, O, Md.	
<i>Terminalia tomentosa</i>		Ti, Fo, RG, DT.	
<i>Xylia xylocarpa</i>		Ti, Fe, Fi, Md, Fd.	
Kolhapur		<i>Actinodaphne hookeri</i>	Ti, Fo, O, Md, Fd.
		<i>Alstonia scholaris</i>	Ti, Md.
	<i>Amoora lawlii</i>	Ti.	
	<i>Clausena indica</i>	Ti, CS.	
	<i>Crotalaria retusa</i>	Fo, Fi, Md.	
	<i>Dillenia indica</i>	Ti.	
	<i>Diospyros candolleana</i>	Ti.	
	<i>Elaeocarpus oblongus</i>	Ti, F.	
	<i>Garcinia indica</i>	Ti, DT, O, Md, Fd.	
	<i>Glochidion ellipticum</i>	Ti.	
	<i>Holligarna arnottiana</i>	Ti, RG, O.	
	<i>Hymenodictyon obovatum</i>	Ti, Fo, DT, Md.	
	<i>Lagerstroemia parviflora</i>	Ti, Fo, RG, DT, Fi.	
	<i>Ligustrum neilgherrense</i>	Ti, Fe.	
	<i>Linociera malabarica</i>	Ti.	

(continued)

Table 4.1(A) : (continued)

Region	Trees	Uses
	<i>Mappia foetida</i>	Ti, Md.
	<i>Memecylon umbellatum</i>	Ti, DT, O, Md, Fd.
	<i>Mesua ferrea</i>	Ti, RG, O, Md.
	<i>Ochrocarpus longlifolius</i>	Ti, DT.
	<i>Olea dioica</i>	Ti, F.
	<i>Symplocos beddomii</i>	Ti, Fe.
	<i>Syzygium cumini</i>	Ti, Fo, DT, Md, F.
	<i>Syzygium zeylanicum</i>	Ti.
	<i>Syzygium hemisphericum</i>	Ti.
Satara	<i>Atalantia racemosa</i>	Ti, O, Md.
	<i>Beilschmiedia dalzellii</i>	Ti.
	<i>Celtis cinnamomea</i>	Ti.
	<i>Diosoryos candolleana</i>	Ti.
	<i>Dysoxylum binectariferum</i>	Ti.
	<i>Garcinia indica</i>	Ti, DT, O, Md, Fd.
	<i>Holigarna arnottiana</i>	Ti, O.
	<i>Homalium zeylanicum</i>	Ti.
	<i>Hydnocarpus laurifolia</i>	Ti, O, Md.
	<i>Litsea deccasensis</i>	Ti.
	<i>Maba nigrescens</i>	Ti, F.
	<i>Mammea siamensis</i>	Ti, RG, O.
	<i>Syzygium caryophyllatum</i>	Ti, F.
	<i>Xantolis tomentosa</i>	Ti, O, Md, Fd.
Pune	<i>Acacia arabica</i>	Ti, Fo, RG, DT, Fi, Md.
	<i>Acacia leucophloea</i>	Ti, Fi.
	<i>Anogeissus latifolia</i>	Ti, Fo, RG, DT, Md.
	<i>Azadirachta indica</i>	Ti, RG, O.
	<i>Bauhinia tomentosa</i>	Md.
	<i>Boswellia serrata</i>	Ti, Fo, RG, Md.
	<i>Cochlospermum religiosum</i>	Ti, RG, Fi.
	<i>Dolichandrone falcata</i>	Ti, Fo, Fi.
	<i>Flacourtia ramontchi</i>	Ti, Fo, RG, Md, F.
	<i>Heterophragma roxburghii</i>	Ti, Fo.
	<i>Odina wodier</i>	Fo, RG, DT, Fi.
	<i>Osyris arborea</i>	F(W).
	<i>Rhus mysurensis</i>	DT.
	<i>Santalum album</i>	Ti, O.
	<i>Stereospermum chelonoides</i>	Ti, Fo.
	<i>Tectona grandis</i>	Ti, RG, DT, O, Md.
	<i>Terminalia tomentosa</i>	Ti, Fo, RG, DT.
	<i>Zizyphus jujuba</i>	Ti, Fo, DT, Md, F.
	<i>Zizyphus xylopyra</i>	Ti, Fo, DT.

(continued)

Table 4.1(A) : (continued)

Region	Trees	Uses	
Nashik	<i>Acacia catechu</i>	DT.	
	<i>Adina cordifolia</i>	Ti, Fo.	
	<i>Adhatoda vasica</i>	Fo, DT, O.	
	<i>Anogeissus latifolia</i>	Ti, Fo, RG, DT, Md.	
	<i>Boswellia serrata</i>	Ti, Fo, RG, Md.	
	<i>Butea monosperma</i>	Ti, Fo, RG, DT, O, Fi, Md.	
	<i>Daemia extensa</i>	Fi, Md.	
	<i>Dalbergia lanceolaria</i>	Ti, Fo, O.	
	<i>Dalbergia sissoo</i>	Ti, Fo, O.	
	<i>Garuga pinnata</i>	Ti, Fo, RG, DT, F(W).	
	<i>Rhus mysurensis</i>	DT.	
	<i>Semocarpus anacardium</i>	Ti, RG, DT, O, Md.	
	<i>Syzygium cumini</i>	Ti, Fo, DT, Md, F.	
	<i>Tectona grandis</i>	Ti, RG, DT, O, Md.	
	<i>Terminalia orjuna</i>	Ti, Fo, RG, DT, Md.	
	<i>Terminalia bellerica</i>	Ti, Fo, RG, O, Md.	
	<i>Terminalia chebula</i>	Ti, RG, DT, O.	
	<i>Woodfordia fruticosa</i>	DT.	
	Khandesh	<i>Acacia catechu</i>	DT.
		<i>Acacia leucophlea</i>	Ti, Fi.
<i>Adina cordifolia</i>		Ti, Fo.	
<i>Anogeissus latifolia</i>		Ti, Fo, RG, DT, Md.	
<i>Dalbergia latifolia</i>		Ti, Fo, O.	
<i>Dendrocalamus strictus</i>		Ti, Fo, Fi.	
<i>Gmelina arborea</i>		Ti, Fo, Md, F(W).	
<i>Hardwickia binata</i>		Ti, RG, Fi.	
<i>Tectona grandis</i>		Ti, RG, DT, O, Md.	
<i>Terminalia tomentosa</i>		Ti, Fo, RG, DT.	
<i>Zyzyphus rugosa</i>		F(W).	
Amrawati	<i>Anogeissus latifolia</i>	Ti, Fo, RG, DT, Md.	
	<i>Bambusa nana</i>	Ti, Fi.	
	<i>Butea monosperma</i>	Ti, Fo, RG, DT, O, Fi, Md.	
	<i>Dalbergia paniculata</i>	Ti.	
	<i>Dendrocalomus strictus</i>	Ti, Fo, Fi.	
	<i>Emblica officinalis</i>	Ti, Fo, DT, Md, F.	
	<i>Hardwickia binata</i>	Ti, RG, Fi.	
	<i>Mangifera indica</i>	Ti, Fo, RG, DT, Md, F.	
	<i>Ougeinia oojeinensis</i>	Ti, Fi.	
	<i>Sterculia urens</i>	Ti, RG, Fi.	
	<i>Syzygium cumini</i>	Ti, Fo, DT, Md, F.	
	<i>Tectona, Grandis</i>	Ti, RG, DT, O, Md.	
	<i>Terminalia chebula</i>	Ti, RG, DT, O.	
	<i>Zizyphus rugosa</i>	F(W).	
	<i>Zizyphus xylopyra</i>	Ti, Fo, DT.	

(continued)

Table 4.1(A) : (continued)

Region	Trees	Uses
Chandrapur	<i>Boswellia serrata</i>	Ti, Fo, RG, Md.
	<i>Cleistanthus collinus</i>	Ti, Md.
	<i>Diospyros melanoxylon</i>	Ti, Fo, F(W).
	<i>Emblica officinalis</i>	Ti, Fo, Md, F, DT.
	<i>Lagerstroemia parviflora</i>	Ti, Fo, RG, DT, Fi.
	<i>Lannea coromandelica</i>	Ti, Fo, Fe, RG, DT, Fi, Md.
	<i>Madhuka latifolia</i>	Ti, Fo, RG, DT, Md, Fd.
	<i>Pterocarpus marsupium</i>	Ti, Fo, RG, DT, O, Md.
	<i>Tectona grandis</i>	Ti, RG, DT, O, Md.
	<i>Terminalia tomentosa</i>	Ti, Fo, RG, DT.
	<i>Xylia xylocarpa</i>	Ti, Fe, Fi, Md, Fd.

Note :

- Ti - Timber;
 Fo - Fodder;
 Fe - Fuel;
 RG - Resin, Gum;
 Md - Medicinal;
 DT - Dyes and Tans;
 Fi - Fibre;
 F - Fruit;
 F(W) - Fruit (wild);
 O - Oil;
 CS - Condiments and Spices;
 Fd - Flowers, leaves, etc., other edible products.

Sources : 1) Gazetteer of India, Maharashtra State, Botany, Part I - Medicinal Plants; Part II - Timber Plants; Part III - Miscellaneous plants.

2) A Dictionary of the Economic Products of India, G. Watt.

3) The Wealth of India, Raw Material.

Table 4.2 : Suggested Crop Pattern by Sub-Zone in Maharashtra

Sub-zone	Crop
1.	Paddy, ragi, pulses, sesamum, vegetables, banana, mango, chikku, guava, coconut.
2.	Paddy, ragi, pulses, sesamum, vegetables, mango, coconut.
3.	Paddy, ragi, pulses, sesamum, vegetables, mango, pineapple, jackfruit, coconut, arecanut, cashewnut, pepper, cardamom, <u>kokam</u> .
4.	Paddy, jowar, ragi, pulses, sugarcane.
5.	Paddy, jowar, bajri, ragi, pulses, vegetables, potato, onion, chillies, coriander, sugarcane, grapes.
6.	Paddy, jowar, ragi, pulses, sesamum, vegetables, potato, onion, garlic.
7.	Paddy, jowar, ragi, pulses, sesamum, vegetables, sugarcane.
8.	Paddy, jowar, ragi, pulses.
9.	Jowar, bajri, wheat, groundnut, vegetables, onion, garlic, chillies, sugarcane, grapes, guava.
10.	Jowar, wheat, pulses, groundnut, safflower, vegetables, onion, chillies, sugarcane, pomegranate.
11.	Jowar, bajri, wheat, groundnut, safflower, onion, garlic, chillies, sugarcane, banana, guava, fig, pomegranate.
12.	Jowar, bajri, wheat, pulses, groundnut, safflower, vegetables, chillies, coriander, turmeric, sugarcane, grapes.
13.	Jowar, wheat, pulses, groundnut, safflower, vegetables, onion, chillies, sugarcane, <u>bor</u> , pomegranate, cotton.
14.	Jowar, wheat, pulses, vegetables, sugarcane, <u>bor</u> , fig.
15.	Jowar, bajri, wheat, pulses, groundnut, safflower, sunflower.
16.	Jowar, wheat, pulses, groundnut, safflower, vegetables, chillies, sugarcane, <u>mosambi</u> .
17.	Jowar, wheat, pulses, groundnut, sesamum, chillies, sugarcane, banana, cotton.
18.	Jowar, wheat, pulses, groundnut, sesamum, vegetables, chillies, sugarcane, banana, cotton.
19.	Jowar, bajri, wheat, pulses, groundnut, safflower, sunflower, linseed, vegetables, sugarcane, cotton.

(continued)

Table 4.2 : (continued)

Sub- zone	Crop
20.	Jowar, wheat, pulses, groundnut, safflower, sunflower, linseed, sugarcane, cotton.
21.	Jowar, wheat, pulses, groundnut, safflower, sesamum, linseed, chillies, coriander, sugarcane.
22.	Jowar, wheat, pulses, groundnut, sesamum, vegetables, chillies, coriander, sugarcane, cotton.
23.	Jowar, wheat, pulses, groundnut, safflower, linseed, vegetables, sugarcane, cotton.
24.	Jowar, wheat, pulses, groundnut, linseed, vegetables, cotton.
25.	Jowar, wheat, pulses, groundnut, vegetables, chillies, orange, cotton.
26.	Paddy, jowar, wheat, pulses, sesamum, linseed, vegetables, chillies, orange, cotton.
27.	Paddy, jowar, wheat, pulses, groundnut, linseed, cotton.
28.	Paddy, jowar, wheat, maize, pulses, sesamum, linseed.
29.	Paddy, maize, pulses.
30.	Paddy, jowar, wheat, pulses, linseed.

Table 4.3 : Crop Rotation in Medium and Deep Black Soils in One Agricultural Year in Maharashtra

Crop rotation	Season		
	Kharif	Rabi	Summer
<u>Without irrigation</u>			
1	Hybrid Jowar	Gram	-
2	Hybrid Jowar	-	-
3	Bajri	Gram	-
4	Bajri	Wheat	-
5	Groundnut	Hybrid Jowar	-
6	Groundnut	Wheat	-
7	Groundnut	-	-
8	Cotton	-	-
9	-	Jowar	-
<u>With irrigation</u>			
10	Hybrid Jowar	Wheat HYV	Groundnut
11	Hybrid Bajri	Wheat HYV	Groundnut
12	Hybrid Bajri	Hybrid Jowar	-
13	Hybrid Bajri	Wheat HYV	L.S. Cotton
14	Hybrid Bajri	Onion	-
15	Groundnut HYV	Wheat HYV	L.S. Cotton
16	Groundnut HYV	Wheat HYV	Onion
17	L.S. Cotton	Gram	Groundnut
18	Cotton	-	Groundnut
19	L.S. Cotton	Hybrid Jowar	-
20	L.S. Cotton	Wheat	Groundnut

Table 4.4 : Requirement of Soils for Different Crops

Crop	Type of soil
Jowar (Kharif)	Medium to deep brown/black.
Jowar (Rabi)	Medium to deep brown/black.
Bajri	Shallow to medium deep brown/yellow.
Wheat	Medium to deep black.
Rice	Medium deep red/brown.
Maize	Medium to well drained brown.
Gram	Deep brown/black.
Tur	Deep brown/black.
Mung	Medium to deep gray/brown.
Udid	Medium to deep gray/brown.
Groundnut	Shallow to medium deep black/brown.
Sunflower	Shallow well drained brown/black.
Sugarcane	Medium to deep brown/black.
Tobacco	Medium to deep black.
Cotton	Medium to deep black.

Table 4.5 : Yield, Net and Gross Return and Labour Days for Major Crops in Maharashtra

Season/Crop	Dry				Irrigated			
	Yield kg./Ha.	Labour Days/Ha.	Net * Return Rs./Ha.	Gross* Return Rs./Ha.	Yield kg./Ha.	Labour Days/Ha.	Net * Return Rs./Ha.	Gross * Return Rs./Ha.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Kharif :								
Paddy	1320	85	1900	3300	1900	115	2600	4750
Ragi	300	55	300	500	-	-	-	-
Jowar-Local	575	55	720	1150	-	-	-	-
Jowar-Hybrid	1330	60	1200	2000	2000	72	1800	3000
Bajri-Local	300	50	300	450	800	55	800	1200
Bajri-Hybrid	400	55	400	600	1200	65	1200	1800
Other Cereals	600	55	750	960	1000	65	1100	1700
Tur	600	55	1600	3000	-	-	-	-
Moog	300	50	900	1350	1000	65	2000	4500
Udid	350	50	1050	1575	1000	65	2000	4500
Other Pulses	300	50	900	1350	900	60	1800	4400
Groundnut-Local	700	100	1400	3000	-	-	-	-
Groundnut-HYV	1000	115	2000	4200	1300	130	2400	5460
Sunflower	500	50	1200	2500	1100	70	2200	5500
Other Oilseeds	400	50	1100	2400	900	70	1800	5400
Cotton	100	130	900	1500	150	165	1900	2250
Chillies-spices- vegetables	-	120	2000	4200	-	130	2500	6000
Other Crops	-	50	850	1600	-	-	-	-
Rabi :								
Jowar-Local	400	45	550	800	1000	60	1000	2000
Jowar-Hybrid	700	50	700	1050	2000	70	1800	3000

(continued)

Table 4.5 : (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Wheat-Local	600	45	750	1200	1100	75	1250	2200
Wheat-HYV	850	55	1150	1700	1700	85	2000	3400
Other Cereals	500	45	600	1200	1100	70	1200	2400
Gram	430	53	1200	1935	800	58	1800	3600
Other Pulses	300	50	900	1350	-	-	-	-
Sunflower	600	55	1400	3000	1200	70	2500	6000
Other Oilseeds	350	55	1100	2100	1000	70	2000	6000
Chillies-spices-vegetables	-	-	-	-	-	220	2800	6000
Summer :								
Rice	-	-	-	-	1800	130	2400	5400
Moog	-	-	-	-	1000	70	2000	3800
Groundnut	-	-	-	-	1380	140	2600	5800
Sunflower	-	-	-	-	600	80	3000	4000
Perennial :								
Sugarcane	-	-	-	-	10000	360	7800	20000
Banana	-	-	-	-	-	300	7000	20000
Fruit etc. Other Perennials	-	-	-	-	-	200	6000	15000

* At 1981 prices.

Source : (i) Season and Crop Report; (ii) Field Data.

Table 4.6-A : Estimates of Total Return on the Basis of Optimum Crop Pattern With Different Objective Functions

Value of		Maximizing variable			
		Total net return	Total employment	Total gross return	Total water return
Total Net Return (Rs.)	10^{10}	4.3678	3.9873	4.3581	4.3082
Total Employment (mandays)	10^9	2.4765	2.5524	2.4219	2.4426
Total Gross Return (Rs.)	10^{10}	8.4819	7.1026	8.5167	8.2432
Total Water Return (Rs.)	10^{11}	1.4238	1.2689	1.4241	1.4251

Table 4.6-B : Trade off between Different Objective Functions

Value of		Maximizing variable			
		Total net return	Total employment	Total gross return	Total water return
Total Net Return (Rs.)	10^9	0	3.805	0.097	0.596
Total Employment (mandays)	10^9	0.076	0	0.131	0.110
Total Gross Return (Rs.)	10^9	0.348	14.141	0	2.735
Total Water Return (Rs.)	10^9	0.130	15.620	0.100	0

(The figures indicate the extent of reduction in values of the variables for different maximizing functions.)

Table 4.7 : Optimum Crop Pattern for Maharashtra[@] in 2001 A.D. and Crop Pattern in 1983-84*

Season/Crop	Optimum crop pattern in 2001 A.D.						Crop pattern in 1983-84*		
	Dry --(Area in 000 Ha.)--	Irri- gated	Total	Dry	Irri- gated	Total	Dry	Irri- gated	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>Kharif :</u>									
Rice	1063	481	1544	1614	1142	2756	1140	381	1521
Ragi	236	-	236	82	-	82	228	-	228
Jowar-Local	700	-	700	463	-	463	938	-	938
Jowar-Hybrid	1790	120	1910	2738	300	3038	1818	95	1913
Bajri-Local	695	-	695	240	-	240	695	-	695
Bajri-Hybrid	972	170	1142	447	255	702	1057	60	1117
Other Cereals	173	33	206	119	41	160	195	33	228
Tur	908	-	908	627	-	627	728	3	731
Moog	468	100	568	161	125	286	517	3	520
Udid	423	120	543	170	150	320	469	1	470
Other Pulses	491	10	501	159	11	170	539	6	545
Groundnut	552	125	677	566	203	769	594	19	613
Sunflower	176	110	286	101	151	252	136	-	136
Other Oilseeds	525	10	535	242	11	253	522	3	525
Cotton	2585	280	2865	297	53	350	2555	130	2685
Chillies-spices- vegetables	196	874	1070	-	-	-	96	230	326
Other Crops	600	40	640	-	-	-	516	40	556
Total	12553	2473	15026				12743	1004	13747

(continued)

Table 4.7 : (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<u>Rabi :</u>									
Jowar-Local	1600	273	1378	736	348	1084	2300	-	2300
Jowar-Hybrid	1000	730	1730	805	1825	2630	827	430	1257
Wheat	400	500	900	391	1063	1454	583	600	1183
Other Cereals	70	10	80	40	14	54	70	10	80
Gram	350	410	760	173	410	583	405	90	495
Other Pulses	200	-	200	69	-	69	200	-	200
Sunflower	150	85	235	60	128	188	57	-	57
Other Oilseeds	700	560	1260	232	700	982	786	30	816
Chillies-spices-vegetables	-	350	350	-	-	-	25	40	65
Total	4470	2923	7393				5253	1200	6453
<u>Summer :</u>									
Rice	-	40	40	-	90	90	-	29	29
Moog	-	15	15	-	-	-	-	-	ng.
Groundnut	-	230	230	-	483	483	-	98	98
Sunflower	-	35	35	-	26	26	-	-	ng.
Total	-	370	370				-	127	127
<u>Perennial :</u>									
Sugarcane	-	390	390	-	4875	4875	-	359	359
Banana	-	60	60	-	-	-	-	55	55
Fruit, etc.	-	200	200	-	-	-	-	41	41
Total	-	650	650				-	455	455
Grand Total	17023	6416	23439				17996	2786	20782

@ Obtained with the objective function of maximizing Total Net Return at 1981 prices.

* Statistical Abstract of Maharashtra.

Table 4.8 : Area and Production of Cereals, Pulses and Oilseeds for 1983-84 and for Optimum Crop Pattern (*) for Maharashtra

(1)	Area in '000 Ha.					%	Production in '000 tonnes			
	Cereals (2)	Pulses (3)	Oilseeds (4)	Others* (5)	Total (6)		Cereals (8)	Pulses (9)	Oilseeds (10)	Others* (11)
(I) Crop Pattern 1983-84										
Khariif :										
Dry	6071	2253	1252	3167	12743	61.32	5280	920	706	256
Irrigated	569	13	22	400	1004	4.83	1013	9	27	20
Total	6640	2266	1274	3567	13747	66.15	6298	929	733	276
Rabi :										
Dry	3730	605	843	25	5253	25.28	2092	234	310	-
Irrigated	1040	90	30	40	1200	5.77	1613	72	30	-
Total	4820	695	873	65	6453	31.05	3705	306	340	-
Summer :										
Irrigated	29	-	98	-	127	0.61	52	-	136	-
Perennial :										
Irrigated	-	-	-	455	455	2.19	-	-	-	3593
Grand Total	11489	2961	2245	4087	20732	100.00	10055	1235	1209	
%	55.28	14.25	10.80	19.67	100.00					

(continued)

Table 4.8 : (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
<u>(II) Optimum Crop Pattern for 2001 A.D.</u>										
<u>Kharif :</u>										
Dry	5629	2290	1253	3381	12553	53.56	5703	1127	909	297
Irrigated	804	230	245	1194	2473	10.55	1738	286	365	53
Total	6433	2520	1498	4575	15026	64.11	7441	1413	1274	350
<u>Rabi :</u>										
Dry	3070	550	850	-	4470	19.07	1972	242	342	-
Irrigated	1518	410	645	350	2923	12.47	3250	410	828	-
Total	4588	960	1495	350	7393	31.54	5222	652	1170	-
<u>Summer :</u>										
Irrigated	40	15	315	-	370	1.58	90	-	509	-
<u>Perennial :</u>										
Irrigated	-	-	-	650	650	2.77	-	-	-	4875
Grand Total	11061	3495	3308	5575	23439	100.00	12753	2065	2953	
%	47.19	14.91	14.11	23.79	100.00					

(*) Obtained with the objective function of maximizing Total Net Return.

* Others include for Kharif - cotton, chillies-spices-vegetables and other crops.
for Rabi - chillies-spices and vegetables.
for Perennial - sugarcane, banana, fruits, etc.

Table 4.9 : Gross and Net Return by Major Crop Groups for 1983-84 and for Optimum Crop Pattern* for Maharashtra

(1)	Gross Return (Rs. lakh)						Net Return (Rs. lakh)					
	Cere- als (2)	Pulses (3)	Oil- seeds (4)	Others @ (5)	Total (6)	% (7)	Cere- als (8)	Pulses (9)	Oil- seeds (10)	Others @ (11)	Total (12)	% (13)
<u>(I) Crop Pattern 1983-84</u>												
<u>Kharif :</u>												
Dry	97272	43586	34324	51264	226446	47.94	58694	26133	15958	29647	130432	51.44
Irrigated	22581	445	1199	16725	40950	8.67	12694	267	510	8220	21691	8.55
Total	119853	44031	35523	67989	267396	56.61	71388	26400	16468	37867	152123	59.99
<u>Rabi :</u>												
Dry	38118	10535	18237	-	66890	14.16	25650	6659	9456	-	41765	16.47
Irrigated	30759	3240	1800	3912	39711	8.41	17635	1620	610	1826	21691	8.55
Total	68877	13775	20037	3912	106601	22.57	43285	8279	10066	1826	63456	25.02
<u>Summer :</u>												
Irrigated	1566	-	5713	-	7279	1.54	696	-	2561	-	3257	1.28
<u>Perennial :</u>												
Irrigated	-	-	-	91060	91066	19.28	-	-	-	34745	34745	13.71
<u>Grand Total</u>	190296	57806	61273	162961	472336	100.00	115369	34679	29095	74438	253581	100.00
%	40.29	12.24	12.97	34.50	100.00		45.50	13.68	11.47	29.35	100.00	

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(continued)

Table 4.9 : (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
<u>(II) For Optimum Crop Pattern for 2001 A.D.</u>												
<u>Kharif :</u>												
Dry	104340	53876	43452	65098	266766	33.33	62900	31741	20386	37128	152155	37.78
Irrigated	37585	12925	16769	73425	140704	17.53	21336	5725	7000	33963	68024	16.89
Total	141925	66801	60221	138523	407470	50.91	84236	37466	27386	71091	220179	54.67
<u>Rabi :</u>												
Dry	35581	10894	22080	-	68555	8.56	23943	6900	10753	-	41596	10.33
Irrigated	55875	18450	48375	26250	148950	18.61	32550	9225	16656	12250	70681	17.55
Total	91456	29344	70455	26250	217505	27.17	56493	16125	27409	12250	112277	27.88
<u>Summer :</u>												
Irrigated	2700	713	22050	-	25463	3.18	1200	10413	375	-	11988	2.98
<u>Perennial :</u>												
Irrigated	-	-	-	150000	150000	18.74	-	-	-	58275	58275	14.47
Grand Total	236081	96858	152726	314773	800438	100.00	141929	64004	55170	141616	402719	100.00
%	29.49	12.10	19.08	39.33	100.00		35.24	15.89	13.70	35.17	100.00	

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* Obtained with the objective function of maximizing Total Net Return.

@ Others include for Kharif - Chillies-vegetables, cotton, other crops.
for Rabi - Chillies, vegetables.
for Perennial - Sugarcane, banana, fruits, etc.

Table 4.10 : Cropped Area and Estimated Returns for the Optimum Crop Pattern* and Crop Pattern in 1983-84 for Maharashtra

	For crop pattern in 1983-84			For optimum crop pattern in 2001			Difference between 2000 and 1983-84 for total
	Dry	Irrigated	Total	Dry	Irrigated	Total	
1. Gross Cropped Area (000 Ha.)	17996	2786	20782	17023	6416	23439	2657
2. Net Cropped Area (000 Ha.)	16258	2150	18408	14300	4200	18500	92
3. Crop Intensity	110.7	129.6	112.9	119.0	152.8	126.7	13.8 points
4. % Share in Gross Cropped Area	86.6	13.4	100.0	72.6	27.4	100.0	14.0 per cent
5. Net Return (Lakh Rs.)	172197	81384	253581	193751	208968	402719	149138
6. Gross Return (Lakh Rs.)	293336	179000	472336	335321	465117	800438	328102
7. Net Return/Gross Cropped Area (Rs.)	956	2921	1220	1138	3257	1718	498
8. Gross Return/Gross Cropped Area (Rs.)	1630	6425	2273	1970	7249	3415	1142
9. Mandays (Lakh)	12150	4053	16203	11916	9303	21219	5016
10. Mandays per Ha.	67	145	78	70	145	90	12
11. Net Return per Manday (Rs.)	14.2	20.0	15.6	16.3	22.5	19.0	3.4

* Obtained with the objective function of maximizing 'Total Net Return' at 1981 prices.

CHAPTER V

PERSPECTIVE LAND USE PLAN FOR RAJASTHAN

In formulation of land use plan the region where tracts suited for cultivation are very limited either due to the lack of precipitation or due to hilly terrain have to be treated separately. In Rajasthan these areas are clearly demarcated viz. (i) the Thar desert in the West and (ii) the Aravali range that separates the desert from the rest of the plains. The problem of ameliorating the condition in these two regions are discussed in the first two sections. The perspective agricultural land use pattern for the State is considered in the third section.

I. Rajasthan Desert

The adverse agro-climatic conditions of Thar desert can be summed up as follows: low annual precipitation, the average being 366 mm, high solar incidence of 450 to 500 calories per cm^2 per day, wind velocity of 10 to 20 km per hour resulting in high P.E.T. (6 mm/day), high mean aridity index of 78 per cent, sandy soils with organic matter content of only about 25 to 28 per cent, high infiltration rate of 9 cm/hour, soil salinity and alkalinity to the extent of 45 per cent (DAC, 1977, p. 90).

Despite these conditions land-use pattern in the arid zone of Rajasthan has been changing in the post-1947 period and the area under cultivation has increased from about 25 per cent in 1951 to 40 per cent in 1984 and the area classified as barren and uncultivable, culturable waste and permanent fallow lands declined from 62 per cent to 45 per cent by 1984.

The present land use is not consistent with the land use capability dictated by the inherent soil characteristics. About 25 per cent of the area is made up either of dunes highly susceptible to wind erosion and hummocky plains or

light-textured hardpan soil in danger of turning barren on account of surface stripping. This area has to be under permanent pasture for sustained production and resource conservation. Rocky pediments exposure form about 8 per cent of the area. They need to be brought under permanent silvi-pastoral cover with light grazing intensity.

The major tasks to ensure rational desert land use are:

1) Use of land according to land capability; this would mean withdrawal of lands unsuitable for cultivation from agricultural use.

2) The major land use in the arid zone would be pasture and tree crop; suitable measures for the development of pasture lands with appropriate protection from overgrazing are essential.

3) Sand-dunes stabilization for checking sand movement towards agricultural lands, canals, etc., is urgently needed.

4) Improvement in livestock to increase returns per animal and thus encourage decrease in the size of herds/flocks making for reduction in the pressure on pasture lands.

5) Provision of adequate storage for fodder and feed, and water supply at settlement points so that migration even during adverse season will not be necessary.

1. Land Use Capability

The soils in the Arid zone are of coarse sandy texture with low water retention capacity with proneness to severe wind erosion and a high salinity hazard. There are no class I and hardly any class II lands in the arid region. Class VI lands predominate and account for 45 per cent of the area (DAC, 1977, p. 90). Surveys have been conducted covering about 26.5 per cent of the arid area. Based on the assessment of the land resources and their examination in relation to the people, climate and the present land use pattern major land resources units have been worked out on the basis of the units having recurring pattern of biotic and abiotic

environment. The present land use, nature and magnitude of desertification hazards and the recommended management for 10 units are presented in Table 5.1.

Despite water scarcity about 40 per cent of the land in the arid zone in Western Rajasthan is sown to crop annually. About 90 per cent of the cultivated area is rainfed. The total area to be irrigated by Rajasthan canal and other groundwater resources would only be about 11 per cent. The rainfed agriculture is unstable and risky resulting in low and unremunerative yield levels. Harsh and unfavourable climatic conditions, coupled with windblown soils low in organic matter and poor in moisture retention are responsible for low and unstable yields of dryland crops.

Crop cultivation in the arid tract has therefore to be very selective as climatic factors are adverse to crop cultivation. Not only that the precipitation is inadequate and uncertain, but also a large part of the moisture is lost through evaporation. With high temperature and wind velocity, almost 90 per cent of the precipitation is lost. The desiccating winds, low atmospheric humidity, high surface temperature make for low efficiency of water use by plants. Moisture stress at sowing, seed germination and flowering stages adversely affect the crop production. The impact of desiccating winds during August-October is so devastating that it is compared in local parlance with a light attack of locusts. Even if this can be reduced it will help increase crop production.

2. Measures to Stabilize Crop Production

(A) Shelter belt of trees and shrubs against prevailing wind direction is a proven method of protecting crops. A comparative study of 80 plots with and without matts in Nagaur district indicated that crop yield and forage yield were higher by 20 to 43 per cent in the case of former (Jodha, 1969, p. 60). However without adequate water in the initial

stage it is difficult to raise a systematic shelter belt. If multiple rows are not possible narrow belts or matts which consist of drought hardy species such as khejri, bordi, jal, kair, lana, jhinjani are helpful. However even the existing matts are being used to meet the fuelwood requirements. Formerly it was jagirdars' responsibility to protect the matts. Unless new institutional arrangements for protection are made conservation of matts is difficult.

Micro-wind breaks or protective strips of perennial grasses such as sewan or munj or castor established right across the prevailing wind direction protect standing crops, minimize wind erosion and control soil moisture. For erecting new shelter belts and small wind breaks, the major problem is of providing protection from browsing/grazing in the initial stages, so that the grasses and shrubs get established. Mechanical barriers for protective purpose are costly and do not often prove effective. Social barriers would be effective but to enforce social barriers alternative institutional arrangements are essential. These aspects are discussed in Chapter IX.

(B) Contour bunding has also been found useful for areas having gentle to medium slopes. By reducing the runoff, bunding ensures maximum penetration of water in situ and facilitates better plant growth. Bunding demands high labour inputs both in construction and upkeep. Again it is difficult without the support of local institutional arrangements to maintain the bunds.

In desert region, rabi cultivation in khadin areas is possible in a normal rainfall year if bunding is provided; while in kharif season bunding helps ensure certain yield even during a drought year.

(C) Suitable water harvesting system is essential to conserve moisture in the arid zone. A portion of the land can be set apart for pond or tank to collect and store the

run-off water which may be applied as a life saving device during critical stages if there is a drought. If no land is to be sacrificed for water harvesting as catchment, inter row system of water harvesting is useful. It induces an additional runoff in the trenches from the ridges and from the micro-catchments provided in between the trenches.

(D) Measures for soil and moisture conservation are equally important. Use of organic mulches such as grass mulch, bajri husk, contour farming and wind strip cropping help conservation of soil moisture. For wind erosion control it is important to keep a reasonable plant cover as long as possible.

(E) Intercropping of annual grain legumes in perennial grasses is important to stabilize production. Grasses help soil conservation against wind erosion, and help soil improvement. The grasses would benefit from improved fertility conditions resulting from fixation of nitrogen by legumes. Mixed cropping of bajri and moog also helps increase productivity and stability.

(F) Agroforestry system - Properly distributed trees on the farm help protect crops against scorching and desiccating winds, conserve soil moisture, increase atmospheric humidity and improve soil fertility. Tree culture is important for supply of fodder, fuelwood, timber, fruit, etc.

Growing of field crops like bajri, legumes and oilseed crops in a field with khejri and bordi has been traditionally followed by the farmers of Rajasthan, Gujarat and Punjab. By a reasonable combination of tree plantation with agricultural crops impairment of the ecosystem can be avoided, crops diversified and yield stabilized. The trees suitable for growing on farms in different zones and the relative yields of forage under different tree species are shown in Table 5.2. In the selection of species consideration is given to such characteristics as nitrogen fixing ability, ability to coppice,

ability to grow successfully in harmony with a particular environment or compatibility e.g. trees that draw water from such a depth as not to compete with shallow rooted crops. Improvement in the traditional practices of growing trees, shrubs and grasses in combination with crops, suggestions for effective adjustments according to the changed situation, and adoption of these measures in practice is important for improving and stabilizing the yields in the arid zone.

3. Reseeding of Range Lands

Mere protection and conservation measures may not raise the productive potential because grass lands in the arid region have a poor vegetative cover ranging from 30 to 48 per cent. Moreover, this coverage is dominated by lower productive annuals and non-edible weeds. To improve productivity, these lands have to be reseeded with high forage yielding species of grasses like sewan, dhaman, kali dhaman, karad, etc.

For soil enrichment, seeding of fallow lands by perennial grass or ley farming is better than simple fallow because the fallow lands are not left to rest but get overgrazed and soil enrichment does not take place because neither roots nor grass are left in these lands to facilitate functioning of microbiological organism. Raising of perennial grass crop would entail some expenditure; however the yield more than compensates the costs involved. In spite of these benefits adoption of ley farming is difficult because all lands except those under regular crop are treated as pasture lands. As a matter of informal institutional arrangements, all grazing lands and even crop lands during non-crop season are open to every grazer. Cultivation of grass as a regular crop even though it gives stability and greater average return in poor rainfall areas, is difficult because of free grazing. New institutional arrangements are essential to change this situation.

4. Silvi-Pastoral Approach

An analysis of the rainfall data from 1901 reveals that a normal rainfall year (350-400 mm) and a good rainfall year (above 400 mm) occur with 48 per cent probability; this has to be capitalized. The erratic rainfall even though normal makes for failure of seasonal crops. However, the available precipitation can be used to advantage by perennials. The amelioration of arid region falling below 300 mm average rainfall can best be achieved by large scale afforestation and by developing grass cover, i.e., through silvi-pastoral approach to land use. Fodder trees and shrub species provide the much needed forage in scarcity period, give shade and shelter to grazing animals, help ameliorate micro-climatic conditions conducive to natural regeneration of grasses which are higher in succession. They are also important resources of firewood and timber. Trees have to be planted along boundaries and approach roads of compartment of pastures in single or double rows. They will also act as wind break. A good pasture may have 30 trees/hectare.

At 1981 prices the net annual per hectare income from fuelwood, fodder and grass growth under the canopy was estimated to be Rs.4100 for Prosopis cineraria with normal grass growth and Rs.1550 with subnormal growth in Sikar. The corresponding figures for Acacia tortilis and Albizia lebbek were Rs.3000 and Rs.500 respectively and only Rs.900 for Prosopis juliflora as it does not support grass growth under the canopy. The average annual income from trees-grass in Barmer-Bikaner is estimated to be about 35 to 40 per cent of the income that is obtained in Sikar, because of very low precipitation (Mann, 1980).

In experimentation with tree plantation under silvi-pastoral programme of afforestation exotic species like Eucalyptus species, Acacia tortilis, Prosopis juliflora, Leucaena leucocephala have received preference mainly because

of the faster growth rate. However in making selection it is most important to consider the adaptability and suitability as well as the uses to the local population. Eucalyptus species and Prosopis juliflora do not provide locally useful products and inhibit growth of grass, while Leucaena leucocephala did not survive due to menace of hares.

Prosopis cineraria, (khejri) a highly versatile native tree though somewhat slow growing, should be given special weight. Khejri does not compete with shallow rooted grass or crops; with its deep roots it draws water from over 35 metre depth. It thrives well in all arid and semi-arid habitats except saline soils. It is drought resistant and resistant to diseases. It improves soil profile due to input of microbial fertilizers in soil through nodulation. Grass or crop production is noted to be higher in plots with Khejri trees as the status of available micronutrients is improved under Khejri. The cut stump of Khejri coppices well. It gives shade, fodder, fuelwood, gum, and fruit if not cut. The density varies with rainfall from about 10 to 20 trees per hectare in Jaisalmer to 90-120 in Pali, Sikar, Jhun-jhunu and 120-150 in Ganganagar. The productivity varies from about 5 kg of firewood per full grown tree in Jaisalmer to 30^{kg}/of firewood in Sikar (Mann, 1980). From the point of improvement in soil profile and ecological balance it is the best suited tree for arid tract; so also for meeting the needs of the local population, whereas the exotics are of little use to the local population and are preferred mainly from commercial point. In such adverse climatic conditions as Rajasthan desert priority must be given to long term improvement of micro-conditions and satisfaction of local needs. From this point, the trees, shrubs and grasses suited for plantation under arid and semi-arid conditions are shown in Table 5.3.

5. Pasture Development and Management

For development of pasture retention of moisture is important which can be promoted through contour furrows (8 to 10 metres apart and 23 cm deep and 60 cm wide). The excavated earth should form a mound on the down slope side. It is reported that forage production increased by over six times as a result of contour furrowing.* Gully and nala plugging and bunding of nalas carried out on the rangeland, is also helpful for moisture retention.

Vast areas in desert region are highly saline. Digging trenches helps drain away excessive salts. In such a system grasses like Sporobolus helvolus come up. It is advisable to plant salt resistant tree species like Acacia nilotica, Tamarix articulata, Acacia tortilis on the mound of trenches to stabilize them. As reclamation progresses Dichanthium annulatum comes up in well-leached patches. Such managed pastures could yield 1.0 to 1.5 tonnes of air-dried forage per hectare.

Range management programme will not be successful unless adequate arrangements for drinking water are made. Vast stretches of grass lands under Lasiurus indicus (sewan) remain under-utilized due to non-availability of drinking water. Provision of Tankes or underground water reservoirs, with a capacity of 200 kilolitres is sufficient for 100 hectares of good rangeland.

The pasture has to be utilized through grazing in the case of low-set low-yielding grass species. To have regular supply of good and nutritious forage it has to be preserved

* The average yield of air dried forage for ten years (1961-70) from the grassland under different treatments compared to control gave following results (DAC, 1977, p.208).

	Yield kg/ha	
	Control	Experimental
Contour furrowing	212.7	1556.2
Contour bunding	602.7	1619.8
Contour trenching	498.6	1321.1

by making hay or silage. To have optimum nutrients, plants have to be harvested at pre-flowering to flowering stage. For improvement of rangeland, protection of land for optimum period to allow establishment of new seedlings, and control of animal number are essential. Carrying capacity of rangeland can increase by 20 to 50 per cent by protection and controlled grazing. Grazing capacity varies greatly from year to year; it ranged from 5.1 to 55.4 adult cattle units to 100 hectare block depending upon precipitation.

Continuous controlled grazing is equally effective in rangelands when compared to deferred rotational grazing whereas in re-seeded pastures where perennial species are better established deferred rotational grazing is more effective.

In arid zones shifting sand-dunes are active except during the monsoon. If stabilized and managed properly these sand masses offer a potential for afforestation. For stabilization of sand dunes protection against biotic influence and fixing of mulches from crest to heel of the dunes across the wind direction is essential, to be followed by afforestation by suitable tree species or perennial tussocky grass species. Afforestation through branch cutting, stump planting or seedlings (10-12 month old in pits of 60 cm³) have given successful results. Trees and shrubs recommended under different rainfall zones are shown in Table 5.4.

6. Protective Forests

Establishment of protective forests is an effective means of improving ecology of the arid region. Rehabilitation by afforestation need not be restricted to regions that formerly bore forest growth. The most urgent problem in afforestation is the development of practical methods under different soil types obtaining within the arid zone. CAZRI has carried out experimentation since 1958 to study (i) the

selection of species and their eco-types for different sites (ii) the production of seedling transplants (iii) Silvicultural characteristics of selected plants (iv) soil working techniques and cultural operations to conserve soil moisture (v) protection against diseases and pests. The relative performances of exotic and indigenous tree and shrub species is shown in Table 5.5. Despite the slow-growth particularly in the initial years, preference should be given to local species because of (i) superiority in providing products that are useful for local consumption (ii) lower risk as compared to exotics of succumbing to diseases and pests. (iii) When soil conditions are taken into account, the indigenous species are the best adapted to local conditions. The local species best suited to different land types are indicated in Table 5.6.

II. The Aravali Mountains

The Aravali mountain System extends for about 692 kms from the south-east in Palanpur in Gujarat through Rajasthan, Haryana and Delhi in the north-east and forms the main water divide between the Arabian Sea drainage system and the Bay of Bengal drainage system in the north. The Aravali system covers 33 per cent of Rajasthan and influences ecological equilibrium in nearly 50 per cent on the state area. The Aravali mountain system, through ages, acted as a constraint and checked the spread of desert towards eastern Rajasthan till it remained green and forested. However, any disturbance in the ecological equilibrium in the Aravali region leads to degradation of environment over wide areas.

At the time of independence, the Aravalis had high density of tree cover that provided a rich habitat for wild life. However, with the spurt in commercial and industrial demand for timber, pulp wood and fuel, Aravalis have come under a severe strain. The interpretation of multivariate RS

data products reveals that the area under forest in 16 districts of Rajasthan (Table 5.7) declined from 10462 sq.kms. in 1972-75 to 6115 sq.kms. by 1980-84 (Dhabriya, 1987). Deforestation has intensified soil erosion and siltation of basin areas. The washing of top soils has resulted in decline in soil fertility and water retention capacity and lowering of water-table. This has adversely affected the agricultural production system and has posed serious problem of scarcity of drinking water supply. Due to felling of trees drudgery of women in collection of firewood has increased. They have to move over long distances to collect a headload of firewood.

Aravalis provide natural habitat to tribals viz. Bhils, Garasias, Meenas and Damors with 41.8 lakh population in 1981. Deforestation and degradation of environment has cut the very basis of livelihood of the tribals. The forest resources have dwindled, game has turned scarcer, there is a shortage of fodder, water and firewood, and agriculture has deteriorated.

Sambhar and 9 other gap areas in the Aravalis have been enumerated as extremely vulnerable areas. The length of these gaps is 160 kms. and the width varies between 5 kms and 15 kms at different points. Due to massive deforestation and intensification of soil erosion, the Aravalis no longer act as a green barrier controlling expansion of desert sand through dust storms in the Indo-Gangetic alluvial plains. There is an urgent need to reforest these gaps under farm-forestry programmes to avert the danger of the march of desert towards alluvial plains.

As per the National Forest Policy of India, the Aravalis should have at least 60 per cent of its area under tree cover whereas the actual forest area is about 7.8 per cent as per the RS data products of 1984. To reverse this trend, the foremost requirement is that the Aravalis should be

included in the National Hill Area Development Programme and a scientific eco-development programme should be worked out. The programme should include (i) protection of the area from uncontrolled grazing and support to natural regeneration, (ii) ban on commercial felling of trees and a massive programme of pasture development and afforestation, (iii) wildlife preservation, (iv) sand-dune stabilization, (v) dense afforestation in gap areas.

To make the hill areas ecologically and economically viable agro-forestry and silvi-pastoral programmes have to be taken giving priority in the selection of tree species to food, feed and fodder and fuel yielding trees for local consumption. The schemes have to be formulated in consultation with the tribal and non-tribal local population and they must be given guaranteed minimum income till the pastures stabilize and trees begin yielding adequate income. Control on grazing and tree lopping can be effective only if they are assured an alternative source of fodder/income forgone, in the intervening period.

In the afforestation programme indigenous species should be given priority and not exotics on the ground of faster growth. Planting of exotics in fact means change of the land use from forest to plantation, as the exotics do not promote the growth of understory and diversity of plant life which is the essence of a forest. In a sensitive region like Aravali one should not go in for plantation but promote regeneration through protection, and in afforestation, local species of economic importance and their associates should be given preference.

Banswara, Udaipur, Kota, Bundi, Jhalwar, region have been rich in forest wealth, the dominant species being Boswellia serrata, Diospyros cordifolia, Dichrostachys cineria with a variety of herbaceous flora at the ground level. The denudation of forests has meant loss of shady moist microclimate and exposure of soil to glaring sun and

drying wind. This is resulting in considerable soil erosion. The valuable species adapted to natural conditions like Acacia catechu, Diospyros, Cassia arculata are yielding to unimportant species like Prosopis juliflora (IMIP, 1980, pp.8-74-76). It is necessary to arrest this degeneration and support regeneration and plantation of indigenous and economically important species. The tree species suited for different Hilly tracts in Rajasthan are indicated in Table 5.8.

III. Agricultural Lands

The entire State has been divided into 24 sub-zones taking into consideration the average precipitation, soil type and topography. In addition eight irrigated sub-zones are demarcated (Map 5.1). Marginal lands not suited for cultivation are to be put under pasture or silvi-pastoral or afforestation schemes. The extent of area, in each sub-zone, to be put under cultivation, grass and forest is indicated in Table 5.9. The trees, shrubs and grasses suited to various zones have been considered in the earlier sections. As regards agricultural lands, agro-forestry is desirable in the arid and semi-arid zones. The trees suited for agro-forestry have been already indicated.

In rest of the region no major changes are suggested or can be effected during the next decade. Basic changes are not possible because there is little scope for extension of irrigation in Rajasthan. In fact certain ameliorative measures are necessary in the tract receiving canal irrigation. In irrigated areas the natural vegetation has been considerably destroyed by the farmers. Moreover, the xenophytic plants unable to tolerate excessive water are getting eliminated. In Rajasthan canal system extensive plantations of species from outside the area like Eucalyptus spp. Dalbergia sisso and Acacia tortalis have been made along the main canals, their distributories as well as roads. In Luni Basin, along

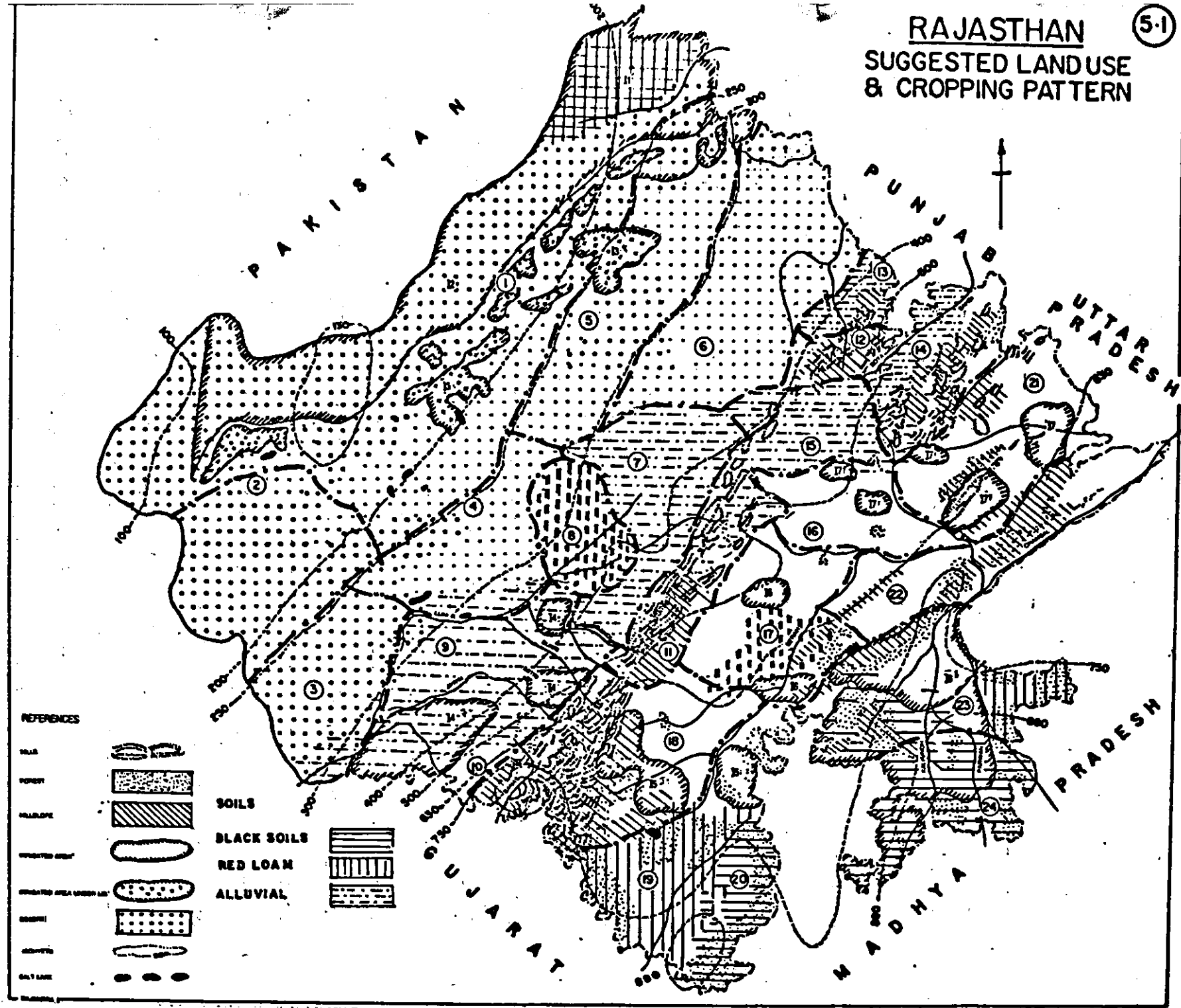
the distributory system of canal and reservoir waterlogging has resulted in creation of marshy lands which have developed marshy plants. Prosopis juliflora which was introduced in the area has become most prominent, and natural species of the area like Azadirachta indica and Acacia leucepholea are becoming rare. In Kota region, waterlogged conditions in Ramgarh, Mandi area has resulted in loss of forest species and marshy plants and water weeds have invaded the area. It is essential to take measures to re-establish the valuable indigenous species.

Apart from afforestation, proper arrangements for drainage to control waterlogging and salination, monitoring of rise in water-table, proper maintenance of water channels are essential to protect the valuable lands brought under canal irrigation in the arid zone.

Agriculture is the mainstay of Rajasthan economy and during the next decade the dependency on agriculture is expected to continue at about the present level. Consequently the orientation of agricultural production will have to continue as it is at present viz. meet the consumption needs of the family and not crop specialization for the market. The crop pattern is evolved over decades according to the agro-climatic conditions of each zone and since there is not much possibility of changing these, say through extension of irrigation so that double cropping can increase or new crops can be introduced, the basic cropping pattern is not likely to change. The suggested crop pattern by sub-zone is presented in Table 5.10. Spread of improved and high yielding varieties, better crop management can bring about certain increase in productivity and total production will record some growth. There is a scope for some increase in the area under oilseeds like rape, mustard, til, sunflower, safflower and groundnut. The projected area under different crops and the projected production is given in Table 5.11. The major suggested

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SUGGESTED LANDUSE & CROPPING PATTERN

(5-1)



generated would thus meet the critical minimum needs of all

change is a considerable reduction in the area under bajri due to withdrawal of marginal lands from cultivation and placing it mostly under silvi-pastoral development. The suggested reduction in the area under bajri is from 50 lakh hectares to 37 lakh hectares. The total net cropped area therefore gets reduced from 162 lakh hectares to 142.8 lakh hectares though there is some increase in the gross cropped area because of the increase in the intensity of cropping from 116 to 125.

Considerable increase in the production of wheat is expected due both to the increase in the area under wheat and increase in productivity. The estimated total production of cereals in 2001 is 103 lakh tonnes, as against 84 lakh tonnes in 1983-84. The estimated production of pulses and oilseeds comes to 22.2 lakh tonnes and 19.0 lakh tonnes respectively. Pulse production is higher than the 1983-84 level by about 34 per cent. The production of cereals, pulses and oilseeds would be adequate to meet the consumption needs of the entire population of the State (Table 5.12). Because of a certain shift to high-value crops and some increase in the productivity the per hectare gross return is expected to increase (at 1983-84 prices) from Rs. 1589 to Rs.2637 (Tables 5.13 and 5.14). The number of man-days of work are likely to increase because of increased intensity of cropping, to about 82 days per hectare. The total days of employment in agriculture come to 148 crore. The projected workers in agriculture in 2001 worked out to 83 lakh; full days work for about 180 days per year per person would thus be available. The estimated return per work day is Rs.21 which amounts to Rs.3780 per annum per worker. The average per family earnings come to about Rs.10,000. The poverty level income at 1983-84 prices for rural areas was Rs.5500 and the income needed to meet critical minimum needs was Rs.8100. At aggregate level the income generated would thus meet the critical minimum needs of all

agricultural families. However, the problem of distribution of income is crucial. It is determined by organization of agriculture and the price, subsidy, fiscal, etc., policy of the government. These aspects will be discussed in Chapter IX.

Apart from the food requirements, the other major local resource based needs are of fuel and fodder. Within the next decade no major change in the type of fuel is expected. Marginal shift to biogas and LPG is likely but the main source of cooking fuel would be firewood, brushwood and agricultural waste. Shortages are faced locally mainly because of uprooting of valuable plants like Phog as marginal lands are brought under cultivation. Deforestation is also resulting in shortage of brushwood. Massive silvi-pastoral schemes and conservation-cum-afforestation programmes covering respectively 20 lakh hectares and 5 lakh hectares is suggested, to meet the possible shortfall in fuelwood and fodder.

The requirement of fuelwood and brushwood comes to about 150 lakh tonnes in 2001, this means that the supplies will have to be augmented to the extent of about 50 lakh tonnes. If on an average 2.0 tonnes are supplied from silvi-pastoral areas and 5.0 tonnes from forest areas then the expected supply comes to 65 lakh tonnes.

The requirements of fodder are expected to be about 460 lakh tonnes in 2001. Of this 250 lakh tonnes are likely to be available through crop residue and fodder crops and 150 lakh tonnes need to be supplied from pasture, forest lands while the supply today is about 100 lakh tonnes. If the productivity of silvi-pastoral lands is put at 2 tonnes per hectare additional 40 lakh tonne production would be available.

These quantitative estimates are set here to give dimensions of the enormity of the problem involved. For augmentation of fuel and fodder resources twenty lakh hectares need to be brought under silvi-pastoral programme. To achieve this, vast organizational efforts are needed; these aspects are discussed in Chapter IX.

Table 5.1 : Present Land Use, Magnitude of Desertification and Recommended Management in the Major Land-Resource Units of the Western Arid Region of Rajasthan

Major land-resource unit (1)	Present land use (2)	Nature and magnitude of desertification hazard (3)	Recommended management (4)
1. Flat aggraded older alluvial plain	Kharif mono-cropping of mixture of moth and bajra, kharif pulses and oilseeds, e.g. til.	In low-rainfall areas (200 mm), severe wind erosion hazard is highly conducive to desertification. In rainfall areas above 200 mm, the desertification hazard is medium.	Single-cropped area to be managed by rational dry farming techniques: i) wind-strip cropping; ii) stubble-mulching; iii) windbreaks; iv) water-harvesting.
2. Sandy undulating aggradable alluvial plains	Rainfed crops, such as bajra + moth	Moderate to severe wind-erosion hazard, having about 25 per cent lower fertility than ideally managed soil.	To be developed for rangeland in blocks of 1000 ha; fencing essential. After initial grubbing, to be re-seeded with <i>Cenchrus/lasiurus indicus</i> @ 5-7 kg/ha.
3. Flat inter-dunal plains	Rainfed mono-cropping, such as bajra and bajra + moth with long fallows of 2-5 years rotation	Moderate to severe wind-erosion hazard. Cultivation on marginal lands is a menace to soil. Wind-erosion hazard and the casting of sands in the adjoining lands.	Farm forestry, runoff farming and development of rangelands, as per topographic location and micro-climate.
4. Sandy undulating inter-dunal plains	Mono-cropping of low intensity, with long fallows ranging from 3 to 5 years	Same as above	To be developed for rangeland, farm forestry and runoff farming

(continued)

Table 5.1 : (continued)

(1)	(2)	(3)	(4)
5. Flood plain :	Often mono-cropping; but	Wind- and water-erosion	Requires a judicious crop-
i) Narrow river	double-cropping on certain	hazard - reduction of	ping pattern; drainage
in tracts	occasions under irrigated	soil fertility	control essential
ii) Sandy com-	Sandy waste-grazing for	25 per cent to 50 per	To be used for grazing,
plex-graded	livestock	cent reduction in soil	silvipastoral management
river-bed		fertility	needed
iii) Dune area	Low-intensity mono-	More than 50 per cent	Development as range
of aeolian	cropping	loss in soil fertility	land; with <i>L. sindicus</i>
complex			and <i>C. ciliaris</i>
6. Sand-dunes :	Cultivated only in years	Severe wind erosion, lead-	Plantation of top-feed and
i) Below 200 mm	of good rainfall, otherwise	ing to 50 to 75 per cent	fuel species in a phased
of annual	wasteland (i) the base and	reduction in cropped and	manner in blocks of 1,000
rainfall	the lower flanks are cul-	plant population; degrad-	ha. or more. The reseeding
	tivated. Upper flanks and	ation fortunately is not	of suitable grasses reco-
	crests are grazing-land.	serious to develop range-	mmended on the windward
		management practices.	side, flanks and crests
ii) Rainfall	Wasteland comprises about		
above	70 per cent. Base and		
200 mm.	flanks are cultivated and		
	crests are sandy waste.		

(continued)

Table 5.1 : (continued)

(1)	(2)	(3)	(4)
<u>Land and Resource Utilization</u>			
7. Mobile or active sand-dunes	Sandy waste	Highly affected, severe desertification hazards	Closure of the area for 10-15 years. Silvipastoral managements are recommended
8. Gravelly aggraded older alluvial plains	Gravelly waste to rainfed mono-cropping grazing-land for livestock	Moderately severe wind-erosion hazard, leading to about 25 per cent lower fertility than in the ideally managed soil.	Water-harvesting and range-land development.
9. Eroded rocky lands	Stony and rocky waste grazing land	Already desertified, practically lost 70-80 per cent of soil cover.	Water-harvesting and catchment management
10. Saline depression	Saline waste-extraction of salt and gypsum	Highly desertified	Mining, rangeland development as post-mining operations

Source : Desertification and Its Control, 1977, pp. 92-93.

Table 5.2-A : Trees Suitable under Agro-Forestry System

Rainfall in cm.	Trees	Crops
Below 30 cm.	Prosopis cineraria Acacia nilotica Acacia senegal	Bajri, moth, gaur
30-50 cm.	Prosopis cineraria Albizzia lebbek Acacia nilotica Acacia senegal Azadirachta indica Tocomella undulata	Bajri, moth, moog, gaur, groundnut, til, castor, tur.

Table 5.2-B : Plant Growth under Tree Canopy

	Acacia senegal	Albizzia lebbek	Prosopis cineraria	Prosopis juli- flora	Tocomella undulata
Above ground biomass (g)	128.9	130.8	234.8	117.7	192.5
Litter (g)	30.3	23.4	68.0	23.0	39.2
Mean ht. of forage species (cm)					
Aristida sp.	52.8	47.9	66.6	34.9	54.6
Cyperus sp.	33.2	35.3	34.2	14.4	32.6
Dactyloctenium sindicum	50.6	57.8	59.3	38.7	48.8
Grass Production (T/Ha.)	0.78	1.32	2.34	0.85	1.66

Table 5.3-A : Trees Suited for Plantation in Arid and Semi-Arid Region

Trees		Uses		
<i>Prosopis cineraria</i>	-	Fodder	Fuel	Bean, flower edible
<i>Tocomella undulata</i>	Timber	Fodder	Fuel	-
<i>Albizia lebbek</i>	-	Fodder	Fuel	Dyes, tans, oil
<i>Acacia nilotica</i>	Timber	Fodder	Fuel	Dyes
<i>Salvadora oleoides</i>	-	Fodder	Fuel	Oil
<i>Azadirachta indica</i>	Timber	Fodder	Fuel	Oil
<i>Acacia senegal</i>	-	Fodder	Fuel	Seed as vegetable
<i>Anogeissus pendula</i>	-	Fodder	Fuel	-

Table 5.3-B : Shrubs Suited for Plantation in Arid and Semi-Arid Regions

<i>Zizyphus nummularia</i>
<i>Colligonum polygonoides</i>
<i>Capparis decicua</i>
<i>Cleradendrum multiflorum</i>
<i>Pyrotechnica leptadenia</i>
<i>Calotropis procera</i>
<i>Aerva pseudotomentosa</i>
<i>Crotalaria burnia</i>
<i>Haloxylon sulicornicum</i>

Table 5.3-C : Improved Range Grasses for Various Habitats in Arid Zone

Habitat	Grasses
Hills and Hill Slopes	Chrysopogon fulrus (Mhow), Sehimo nervosum
Alluvial Plains	Cenchrus ciliaris (Dhaman), Cenchrus setigerus (Moda Dhaman) Lasiurus sindicus (Sewan)
Sand Dunes	Panicum turgidum (Murut), Panicum antidotale (Gramna)
Saline Soils	Sporobolus marginatus (Kharada), Eleusine compressa (Tantia)
Medium to Heavy Soils	Dichanthium annuletum (Kerad)
Sandy Soils	Lasiurus sindicus (Sewan)
Buried Pediment	Dactyloctenium indicum Boiss (Ganthia)
Well Textured Soil	Panicum antidotale (Gramna)
Piedments and Inter-montane Plains	Oropetium thomeaum (Khargesh chutti) Aristida spp. (Lampra, Dholio Lamp)

Source : Agro-Forestry in Arid and Semi-Arid Zones, 1989, pp. 150-155.

Table 5.4 : Trees, Shrubs and Grasses Recommended for Sand Dune Stabilization

Rainfall (in cm.)	Trees	Shrubs	Grasses
15-30	Acacia senegal Cordia rothii	Calligonum polygonoides Zizyphus nummularia Ricinus communis	Lasiurus indicus Panicum turgidum
30-40	Prosopis cineraria Tecomella undulata Acacia senegal Parkinsonia aculeata Acacia arabica	Calligonum polygonoides Zizyphus jujube	Cenchrus ciliaris Lasiurus indicus Cenchrus setigerus Sacharum munja
Above 40	Prosopis cineraria Albizzia lebbeck Dalbergia sissoo Ailanthus excelsa Dichrostachys glomerata Colophospermum mopane	Zizyphus jujuba Cassia auriculata	Sacharum munja Panicum antidotale Cenchrus ciliaris Cenchrus setigerus

Source : Desertification and Its Control, 1977, pp: 209-213.

Table 5.5 : Comparative Performance of Selected Exotic and Indigenous Tree and Shrub Species

Species	Year of planting	Establishment (%)	Mean growth		Mean annual increment	
			Height (cm)	DHB (cm)	Height (cm)	DBH (cm)
A. Exotics						
1. Eucalyptus melanophloia	1961	82	1179	16.2	75.3	1.0
2. E. coolabah	1961	91	1112	16.8	71.8	1.2
3. E. terminalis	1961	46	1080	21.7	75.4	1.5
4. E. territicorins	1961	55	1038	16.4	62.8	1.1
5. E. camaldulensis	1961	73	941	14.3	62.5	0.9
6. Acacia tortilis	1962	100	704	15.9	95.7	1.2
7. A. raddiana	1963	100	667	15.1	44.8	1.0
8. A. selicina	1962	100	510	7.6	26.8	0.5
9. A. aneura	1962	85	500	4.3	34.7	0.4
10. Prosopis juliflora (Israel)	1965	31	858	19.3	65.8	1.7
11. Prosopis juliflora (Chile)	1967	33	468	10.1	46.1	1.5
12. Brasilettia mollis	1966	100	445	7.2	41.0	0.5
13. Colophospermum mopane	1963	84	439	7.5	29.3	0.6
14. Dichrostachys glomerata	1963	92	347	6.1	21.5	0.4
15. Zizyphus spinachristi	1964	100	389	5.3	17.9	0.4

(continued)

Table 5.5 : (continued)

Species	Year of planting	Establishment (%)	Mean growth		Mean annual increment	
			Height (cm)	DBH (cm)	Height (cm)	DBH (cm)
B. Indigenous						
1. Eucalyptus hybrid	1963	36	1454	18.9	119.0	1.2
2. Acacia planifrons	1962	77	569	10.3	37.5	0.8
3. A. nilocta	1973	42	300	2.2	89.8	-
4. Cassia siamea	1973	100	349	3.8	97.1	-
5. Dalbergia sissoo	1972	92	342	2.4	68.6	-
6. Albizzia lebbek	1973	85	198	2.3	51.4	-
7. Azadirachta indica	1962	100	576	14.1	40.0	1.0
8. Ailanthus excelsa	1963	77	537	16.1	39.5	1.2
9. Hardwickia binata	1962	100	489	9.2	33.7	0.7
10. Tecomella undulata	1962	92	432	7.9	27.9	0.7
11. Prosopis cineraria	1962	100	317	6.0	19.0	0.5
12. Albizzia amara	1962	92	436	8.1	26.9	0.6

Source : Agro-Forestry in Arid and Semi-arid Zones, 1984, pp. 250-251.

Table 5.6 : Tree Species Suitable for Various Land Forms in Rajasthan Desert

Land form	Rainfall (mm)	Trees
Shifting Sand Dunes	150 - 400	Acacia senegal Albizzia lebbek Cordia rothii Dalbergia sissoo Zizyphus jujuba
Shallow Soils	300 - 400	Albizzia lebbek Azadirachta indica Prosopis cineraria
Semi-rocky	225 - 350	Acacia senegal Tecomella undulata Acacia nilotica Prosopis cineraria Holoptelia integrifolia
Rock area	200 - 350	Acacia senegal Acacia tortilis

Source : Desertification and Its Control, 1977, pp. 198-201.

Table 5.7 : Decline in Well Stocked Forest Area in Aravali Region between 1972-73 and 1980-84

District (only Aravali Hill Portion)	Forest area (in sq.km.) 1972-75	Forest area (in sq.km.) 1980-84	Percentage increase/decline during 1972-75 and 1980-84
1. Dungarpur	309	167	-45.96
2. Banswara	348	197	-44.40
3. Udaipur	4266	2415	-43.39
4. Chittorgarh	587	489	-16.70
5. Sirohi	838	325	-61.22
6. Bhilwara	35	24	-31.43
7. Ajmer	551	266	-51.73
8. Jaipur	458	215	-52.54
9. Alwar	1146	694	-39.45
10. Nagaur	81	28	-65.44
11. Pali	821	433	-47.26
12. Sikar	251	156	-37.85
13. Jhunjhunu	201	77	-61.70
14. S. Madhopur	530	600	+13.20
15. Bharatpur	20	20	-
16. Tonk	20	10	-50.00
Total	10462	6116	-41.54

Table 5.8 : Valuable Trees of Aravalis and Other Hilly Tracts in Rajasthan

Botanical Name	Marathi Name	Region*
1. <i>Acacia catechu</i>	Khair	S, SE, AN, AS
2. <i>Acacia leucephloea</i>	Aroonj	AN
3. <i>Acacia nilotica</i>	Babul	S, SE, AN
4. <i>Acacia senegal</i>	Kumat	SE, AN
5. <i>Adina cordifolia</i>	Haldu	S, AS
6. <i>Aegle marmelos</i>	Bel	S, SE, AS
7. <i>Ailanthus excelsa</i>	Maharuk	AN
8. <i>Albizzia lebbek</i>	Shirish	S, SE, AN, AS
9. <i>Anogeissus latifolia</i>	Dhawda	S, SE, AS
10. <i>Anogeissus pendula</i>	Dhok	SE, AN, AS
11. <i>Azadirachta indica</i>	Neem	S, SE, AN, AS
12. <i>Bambusa strictus</i>	Bamboo	S, AS
13. <i>Bauhinia racemosa</i>	Kanchan	S, SE, AS
14. <i>Bombax malabaricum</i>	Sawar	AS
15. <i>Boswellia serrata</i>	Salai	SE, AN
16. <i>Bridelia retusa</i>	Asena	SE
17. <i>Butea monosperma</i>	Palas	SE, AN
18. <i>Cassia fistula</i>	Bawa	S, SE
19. <i>Dalbergia lalifolia</i>	Sissum	S, SE, AN
20. <i>Dalbergia sissoo</i>	Shisavi	SE
21. <i>Dendrocalamus strictus</i>	Bamboo	S, AS
22. <i>Diosphyros melanoxylon</i>	Timru	S, SE, AS
23. <i>Emblica officinalis</i>	Awla	S, SE, AS
24. <i>Ficus bengalensis</i>	Wad	S, SE, AN
25. <i>Ficus religiosa</i>	Pimpal	S, SE, AN
26. <i>Grewia tiliaefolia</i>	Dhamani	S, AS
27. <i>Holoptelea integrifolia</i>	Wavali	S
28. <i>Kydia calycina</i>	Ranbhendi	SE
29. <i>Lannea coromadelica</i>	Gundi	SE, AN
30. <i>Madhuka indica</i>	Mahua	S, SE
31. <i>Mangifera indica</i>	Amba	S, SE, AS
32. <i>Mimusops indica</i>	Khirni	SE
33. <i>Phoenix sylvestris</i>	Shindi	SE, AN
34. <i>Pongamia pinnata</i>	Karanj	SE
35. <i>Prosopis cinararia</i>	Khejri	SE, AN, AS
36. <i>Salmalia malberica</i>	Savar	SE
37. <i>Salvadora oleoides</i>	Jal	SE, AN
38. <i>Santalum album</i>	Chandan	S
39. <i>Soymida febrifuga</i>	Rohen	S
40. <i>Sterculia urens</i>	Gular	SE
41. <i>Syzygium cumini</i>	Jambul	S, SE, AN
42. <i>Tamarindus indica</i>	Chinch	S, SE
43. <i>Tectona grandis</i>	Sag	S, SE, AN
44. <i>Tecomella undulata</i>	Rohida	SE, AN
45. <i>Terminalia arjuna</i>	Arjun	S, SE
46. <i>Terminalia bellerica</i>	Behda	S, SE
47. <i>Terminalia tomentosa</i>	Ain	S

*S = Southern Hilly Tract; SE = Southeastern Hilly Tract;
AS = Aravalis - Southern Part; AN = Aravalis - Northern Part.

Table 5.9 : Suggested Land-Use for Different Subzones of Rajasthan

Sub-zone	Per cent area under		
	Agriculture	Silvipastoral	Afforestation and allied
1	10	65	25
2	35	45	20
3	50	30	20
4	35	50	15
5	50	35	15
6	60	30	10
7	55	35	10
8	50	40	10
9	35	55	10
10	20	35	45
11	15	25	60
12	15	25	60
13	70	20	10
14	50	25	25
15	50	30	20
16	50	35	15
17	20	35	45
18	15	40	45
19	20	35	45
20	30	30	40
21	60	15	25
22	40	30	30
23	40	35	25
24	40	35	25

Table 5.10 : Suggested Crop Pattern by Sub-Zone in Rajasthan

Sub-zone	Crops
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Rainfed Agriculture

1. Bajri, kharif pulses, sesamum
2. Bajri
3. Bajri, jowar, kharif pulses, gram, sesamum, rape, mustard, castor
4. Bajri, kharif pulses, sesamum
5. Bajri, kharif pulses, gram, sesamum, castor
6. Bajri, wheat, kharif pulses, gram
7. Bajri, jowar, wheat, pulses, sesamum, rape
8. Bajri, jowar, wheat, maize, barley, gram, cotton
9. Bajri, jowar, wheat, maize, kharif pulses, gram, sesamum, rape mustard
10. Bajri, wheat, maize, kharif pulses, sesamum, rape, mustard.
11. Maize, small millets, kharif pulses
12. Maize, small millets, kharif pulses
13. Bajri, wheat, kharif pulses, gram, rape mustard
14. Bajri, wheat, gram, rape, mustard
15. Bajri, wheat, barley, kharif pulses, gram, rape, mustard, groundnut
16. Jowar, wheat, gram, rape, mustard, groundnut, linseed/sunflower
17. Jowar, wheat, maize, barley, gram, peas, sesamum, cotton
18. Wheat, maize, barley, kharif pulses, gram, sesamum, groundnut
19. Wheat, maize, paddy, kharif pulses, gram, barley/sesamum
20. Wheat, maize, paddy, kharif pulses, gram, cotton/sesamum
21. Bajri, wheat, barley/sesamum, gram, rape, mustard
22. Bajri, jowar, wheat, gram, linseed, groundnut
23. Hybrid jowar, wheat, gram, linseed/rape, mustard
24. Hybrid jowar, wheat, maize, kharif pulses, gram, linseed, cotton

Irrigated Agriculture

- 11,12. Hybrid bajri, wheat, rape, mustard, groundnut,
13. sunflower, cotton, sugarbeet, vegetables, onion, garlic, chillies, berseem
14. Hybrid bajri, hybrid jowar, wheat, hybrid maize, gram, rape, mustard, vegetables, fruits
15. Hybrid jowar, wheat, paddy, gram, rape, mustard, vegetables, fruits
16. Hybrid bajri, hybrid jowar, wheat, gram, chillies, fruits, potato, methi, zira
17. Hybrid bajri, wheat, barley, kharif pulses, gram, rape, mustard, potato, vegetables, cumin, isabgul
18. Hybrid jowar, wheat, paddy, gram, rape, mustard, vegetables, fruits

Table 5.11 : Suggested Crop Distribution and Estimated Crop Production in 2001 A.D. and Crop Pattern and Production in 1983-84 in Rajasthan

Crop	1983-84		2001 A.D.	
	Area (000 Ha.)	Production ('00 tonnes)	Area (000 Ha.)	Production ('00 tonnes)
Rice	160	2175	200	3200
Wheat	2165	34512	2500	55000
Jowar	985	5911	900	7200
Bajri	5004	24566	3700	18500
Maize	893	12287	1000	15000
Barley	291	4311	240	3840
Other Cereals	45	223	52	260
Gram	1796	10888	1900	15200
Other Pulses	1851	5702	2000	7000
Groundnut	183	1738	320	3840
Rape mustard	821	6489	1000	13000
Other Oilseeds	476	1124	550	2200
Cotton	416	5540*	400	6800*
Sugarcane	34	14853	40	18000

* in 00 bales of 170 kg.

Table 5.12 : Estimated Production and Requirement of Cereals, Pulses and Oilseeds in Rajasthan in 2001 A.D.

	(in lakh tonnes)	
	Estimated Production	Estimated Requirement
Cereals	103.0	100.2
Pulses	22.2	10.6
Oilseeds	19.0	19.0

Table 5.13 : Cropped Area in 1983-84 and 2001 A.D. in Rajasthan

	1983-84			2001 A.D.		
	Dry	Irrigated	Total	Dry	Irrigated	Total
Gross cropped area (000 Ha.)	14864	4014	18878	12250	5600	17850
Net cropped area (000 Ha.)	12958	3276	16234	10280	4000	14280
Crop intensity	114.7	122.5	116.3	119.1	140.0	125.0
% share in gross cropped area	78.7	21.3	100.0	68.6	31.4	100.0

Table 5.14 : Gross and Net Return Per Hectare for Total Cropped Area in 1983-84 and 2001 A.D. in Rajasthan

	Per hectare of gross cropped area	
	1983-84	2001 A.D.
Net Return (Rs.)	1059	1736
Gross Return (Rs.)	1589	2637
Mandays	66	82
Return per manday (Rs.)	16	21

PERSPECTIVE LAND USE PLAN FOR GUJARAT

Gujarat is a state with varied topography, climatic conditions and soil types. For land use plan of Gujarat, the State may be divided into three types of land use patterns.

I) The Forest Area

II) Wastelands and degraded lands in forest, and non-forest areas.

III) Agricultural lands.

I. The Forest Area

According to 1983-84 land use pattern, 1892300 hectares of land or about 10 per cent of the reporting area in Gujarat is classified as forest. This proportion is substantially lower than the norm of 33 per cent set up in the National Policy. Besides, 680000 hectares of forest land, which is about a third of forest area is in degraded conditions and can as well be counted as wasteland.

1. Natural Forests

Rich forests of the moist desiduous type are found in hilly areas with more than 120 cm. rainfall i.e. the south-eastern parts of Surat and Valsad districts and most of Dangs. Properly maintained, they would be an important source of good quality teak and commercial species like haldu, sisam, khair, kalam, etc. Katas and manvel are the bamboo species that can be grown in these forests.

The hilly areas receiving rainfall between 60 cm. and 120 cm. in the Bharuch, Vadodara, Panchmahals and Sabarkantha districts in the mainland Gujarat and parts of Amreli, Junagadh and Jamnagar districts in Saurashtra have dry mixed desiduous forests. These forests produce teak of low quality, timber, bamboos and firewood. These forests are also degraded over large areas and need systematic regeneration.

Tribal villages are located in the forest area. The Forest Act of India excludes the people from the forests. In fact the tribal people whose way of life is symbiotically related to the forests would certainly care for the preservation of forests. It is the indiscriminate commercial exploitation of the forests started during the British regime that has caused damage both to the forests and to the tribals as well. The forests, as a result, are degraded and the tribals impoverished. The forest can be best conserved and maintained by those who draw sustenance from the forest. Hence regeneration and conservation of natural forest must be done in partnership with the local tribal population. A noteworthy experiment in this connection has been underway in West Bengal since 1971-72 and more vigorously since 1984-85. In this experiment the Forest Department took initiative and set up Forest Protection Committees from among the villagers under partnership agreement delineating duties and responsibilities as well as the rights of the local population. The essential component of this approach is that while the forest department provides the necessary inputs, the villagers who form the Forest Protection Committee, protect the forest against grazing, cutting, etc. Every adult is eligible to join the committee. In return, the villagers receive 25 per cent of the wood at the time of harvest. Plus they also receive the non-wood forest produce as intermediary benefit. The Gujarat Government can adopt this approach for protection of natural forests and regeneration of degraded forests in the state.

2. Social Forestry in Gujarat

Social forestry is a term used by the National Commission on Agriculture in 1976 to denote tree-raising programmes to supply firewood, fodder, small timber and minor forest produce to the rural population. The social forestry programmes of Gujarat are, however, designed to meet the commercial demand

for wood for construction, firewood, sawlogs, wood for pulp and paper and other wood products like charcoal, catechu. The goal seems to be to capture market within reasonable economic zone of haulage in Maharashtra and Rajasthan as also to establish wood based industry including dendrothermal power generation and ship-building.

There are three components to the U.S. \$ 67 million programme aided by the World Bank viz. (a) strip plantations along the sides of roads, canal banks and railway lines, (b) development of village woodlots for meeting the fuel and fodder needs of the rural population, and (c) distribution of seedlings to farmers for plantation in the farms. Of these it is the last component that is made very attractive. Ever-increasing urban demand for poles for construction and for pulpwood by rayon and paper industry coupled with active propagation of tree farming by the Government has lured many a farmer to switch land from crop cultivation to tree farming. Besides, if they plant trees like Eucalyptus which is not palatable, supervisory problems are also reduced. A government survey reveals that 61 per cent of farmers who took to tree farming did so because they found it more profitable than agriculture and 80 per cent of the seedlings distributed were Eucalyptus and subabul as fast-growing cash crops. Similarly, teak and bamboo plantations are promoted on tribal lands as they are expected to yield better financial returns than the uneconomic agriculture on the hill-slopes. In effect social forestry is reduced to commercial tree farming.

It is reported that the farmers and the Government are realizing the pitfalls in the indiscriminate plantation of Eucalyptus and the Government is now promoting plantation of fruit trees. Whereas the targets are being overfulfilled to the extent of 200 per cent in the case of commercial tree farming, the targets for woodlots component in which village

panchayat set aside land for fuelwood and fodder, are not met even upto 50 per cent.

Stressing afforestation of degraded forest lands along with the protected regeneration of natural forests must be made important components of social forestry programmes to meet primarily the needs of the poor and usufruct rights of the planted trees be given to the poor households near such lands.

3. Mangrove Forests

Mangrove forests are found in the coastal creeks in Kachchh, Junagadh and Jamnagar. They are the natural protectors of land from salinity ingress.

The Kathiawad Gazetteer mentions a number of mangrove islands along the coast of the Gulf of Kachchh like Kalumbhar, Dhumi, Chanka, Nalia Rohji, Bhaidar, etc., all covered with luxuriant mangrove bushes. The Jodiya Fort was said to be surrounded by high trees that could be seen from a distance of 12 miles in clear weather. The long tongue stretching beyond the Little Rann on the border of Jamnagar district was also said to have been covered with rich mangrove bushes.

Along the coastline of the Rann of Kachchh and the north-western coastline of Jamnagar district, coastal desert conditions characterized by high humidity in combination with high temperature and scanty rain are obtained. It is a long stretch of salt marshes interspersed with stray hillocks, sandy undulating plains and gravelly areas.

The Littoral type of forest is found in the creeks of this coastline. In the saline coastal areas of Junagadh and in Bhavnagar and Surat districts some patches of mangrove growth are found. The once rich mangrove areas are getting destroyed and at present the main species found are cher of inferior variety which are crooked, small and stunted.

Systematic development of existing mangroves and new plantation in the saline coastal belts of Gujarat will have

to be taken up. This will help protect the interior lands from ingress of sea water.

II. Wasteland Development

In Gujarat the bovine population has increased by over 20 per cent between 1961 and 1982 and the land under permanent pastures and grazing land has declined by about 19 per cent over the same period. Fodder production, therefore, will have to be taken up on a priority basis on the extensive wastelands that are available in the State. Gujarat has about 78.3 lakh hectares of degraded land of which 71.5 lakh hectares is non-forest land and 6.8 lakh hectares is forest land.

Silvi-pastoral system should be adopted for fodder production on wastelands. As the tree, grass and legume species suitable for different sites and climatic conditions vary, trials should be conducted extensively under different edapho-climatic conditions to determine the most suitable species of fodder trees, grasses and legumes. The selection will have to be done according to the land capability class of wasteland. In case of highly degraded areas where establishment of trees may be difficult and costly, seeding with grasses and fodder legumes may be done as a first step to improve the site.

Demonstration areas should be established to convince the farmers that fodder production through silvi-pastoral practice will be better than conventional agriculture on degraded sub-marginal land. Efforts have to be made to secure social fencing of such plantations through peoples' participation.

Gujarat has a variety of soil-types and climatic zones ranging from desert areas in the Kachchh to moist tropical areas in South Gujarat. So also it has saline-alkaline patches, ravines as well as patches of waterlogged areas in black cotton soils. Appropriate species of grasses, legumes and fodder and other trees suitable for different climatic zones are indicated in Table 6.1.

Rann of Kachchh

The most difficult area for propagation of trees is the Rann of Kachchh which is mainly an expanse of salty marshes and wasteland. On the whole this region is treeless and barren and the entire expanse of Rann of Kachchh and the Little Rann of Kachchh situated in the northern and the eastern sides of the Kachchh district is covered with a thick salt layer mixed with fine sand and clay devoid of vegetation and habitation. Vegetative cover for the Rann is crucial for the protection of the interior lands from salt brought by the westerly winds that increase their salinity. The existing vegetation, sparsely found in the region should be studied for propagation under different ecosystems viz. sandy strand, rocky sandy strand and salt marshes.

Sandy strand ecosystem :

- 1) *Hydrophylax maritima* - All along the coast
- 2) *Ipomoea pescaprae* - dominant community excellent sand binder.
- 3) *Asparagus plymosus* - on sandy bars.
- 4) *Halopyrum mucronatum* - coastal area
- 5) *Cyperus conglomeratus* }
6) *Cyperus aristatus* } - dry sandy spots
7) *Sporobolus termulus* }
- 8) *Leptadenia pyrotechnica* - on sand-dunes
- 9) *Cynodon dactylon* - ubiquitous grass found throughout the coast.

Rocky sandy strand ecosystem (Predominant plant communities):

(1) *Capparis cartilaginea*, (2) *Fagonia cretica*, (3) *Indigofera cordifolia*, (4) *Kickxia ramosissima*, (5) *Ipidagathis trinervis*, (6) *Sericostoma pauciflorum*, (7) *Enicostema verticillatum*.

Salt Marshes Ecosystem : (1) *Avicennia alba*, (2) *Suaeda nudiflora*, (3) *Aeluropus lagopoides*, (4) *Fimbristylis cymosa*, (5) *Scirpus maritimus*, (6) *Urochondra setulosa*, (7) *Artiplex stocksii*.

The dominant floristic species of the coastal desert are: Capparis deledua, Zizyphus jujube, Prosopis cineraria, Avicennia officinalis, Rhizophora mucronata.

III. Agricultural Lands

Agriculture and agricultural community can be stabilized only if scientific management practices are developed to improve productive capacity of land by optimum soil and moisture management. This can be done by adopting various measures of soil and water conservation technology in the form of contour cultivation, contour bunding, land levelling, land shaping, terracing, nala bunding and afforestation. Ravines and other wasteland can also be partially reclaimed and the process of ravine formation and desertification of land and general degradation of land arrested by using appropriate soil and water conservation techniques. It is important to emphasize that land and moisture management in non-arable lands through watershed planning is important for stabilizing agriculture particularly rainfed agriculture. Broadly the techniques to be adopted in arable and non-arable land are given in Chart 6.1.

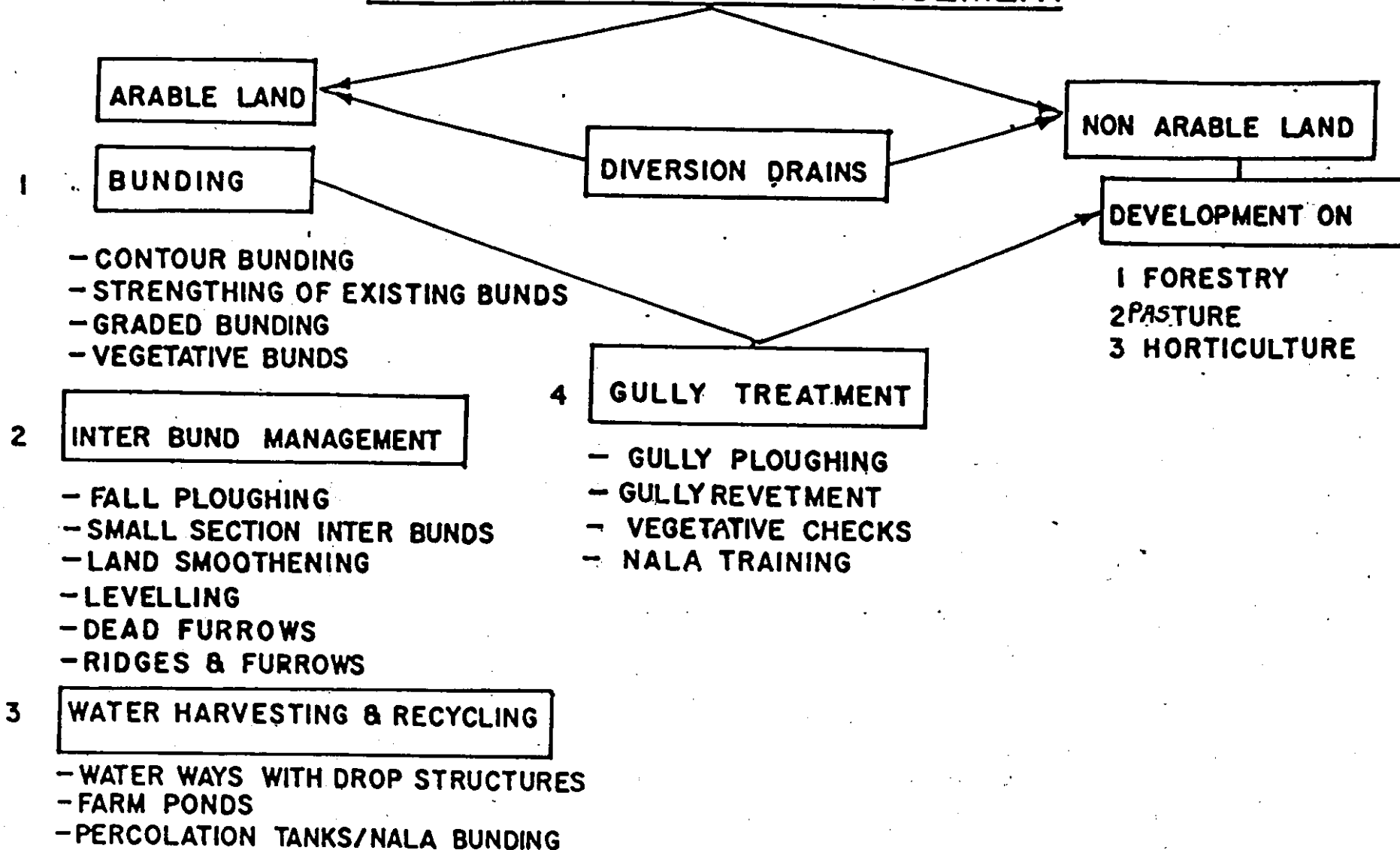
The measures to be adopted are soil and site specific. For soil and moisture management purposes, Gujarat may be divided into the following five zone-types.

1. Coastal lands.
2. Arid lands with shallow sandy soils.
- 3a. Semi-arid lands with shallow sandy soils.
- 3b. Semi-arid lands with shallow sandy loamy soils.
4. Non-arid region with deep soils.
5. Hilly region.

1. Coastal Lands

Out of the 1600 kms. of long coastal length of Gujarat, Saurashtra and Kachchh cover a coastal length of about 1125 kms. This coastal area which is very fertile and productive tract is affected by salinity ingress not only due to surface ingress through river mouths and tides but also due to man-made ecological imbalance created by continuous heavy withdrawals of

SOIL AND MOISTURE MANAGEMENT



of Gujarat have recommended a number of measures like tidal regulations, bandheras and recharge tanks as measures to

groundwater for the purpose of irrigation and water supply combined with decreased recharges and poor rainfall conditions. The coastal winds from the sea bring saline water vapour and affect the coastal agricultural lands upto about 15 to 20 kms. Similarly, the winds also carry saline silt and sand particles on to the agricultural lands. In the reach between Dwarka and Malia, several open salt pans have been responsible for spreading salt in areas around these pans increasing the salinity of agricultural lands.

The most heavily affected region lies within a coastal strip of 160 km. length between Una and Madhavpur. In this region fertile lands are getting fast converted into saline land and the salinity affected agricultural land increased from 35000 ha. in 1971 to about 100,000 ha. in 1977. Thousands of wells have gone out of commission affecting about 3 lakh population.

Coastal reaches of Bhavnagar to Una, Madhavpur to Dwarka, Dwarka to Malia and Malia to Lakhpat are also getting affected to varying degrees. Inadequate rains further intensify the problem due to very low recharge to the groundwater bodies. The situation gets aggravated if farmers start utilizing the saline water as there is no other alternative source of water. Persistent ingress of saline water inside the coastal belt has now created problems of drinking water supply and gradual desertification of agricultural lands.

These problems have already assumed serious dimensions and call for measures to arrest further ingress and retrieve the lands that are not yet completely desertified. Watershed planning in this area has to be designed to develop mechanical and vegetative obstructions to salinity ingress.

The two high level committees appointed by the Government of Gujarat have recommended a number of measures like tidal regulations, bandharas and recharge tanks as measures to

control salinity and artificial recharge of water. Along with these civil works, the committees have also suggested afforestation of over one lakh hectares all along the coastal strip.

It is necessary to emphasize the role of mangroves that are pioneers in land formation. Wherever mangroves are getting destroyed, desertification is evident on the southern coast of Saurashtra. Along with the mechanical barriers to obstruct ingress, steps must be taken to promote regeneration of mangroves and develop vegetative barriers as well.

In the northern coast of Saurashtra and coastal Kachchh, desertification is more evident and although there are no sand dunes as of today, this part is likely to turn into sand dunes if appropriate measures are not taken to create a biomass through development of pasture land and trees to retain whatever soil that exists and to reclaim the desertified soil.

On the western coast of Gujarat facing gulf of Khambhat, the main problem is to protect and retain the interface between the black soil region and the coastal region. The suggested strategy is to have plantations of saline resistant productive trees like coconut, banana, date palms, etc.

Even after the land and groundwater position improves in the area, it would be necessary to regulate withdrawal of water by regulating the digging of wells, use of electrical pumps, etc. So also the cropping pattern in the area will have to be designed to use salt-resistant varieties of crops with moderate water requirements.

2. Arid Lands with Shallow Sandy Soils

Most of Banaskantha, north Mahesana and the northern strip of Saurashtra peninsula come in this category.

Inadequate and erratic rains are the major hurdle in agriculture in this part. The thrust of watershed planning in these regions has to be on the conservation of water and full

utilization of the precipitation through such conservation for protective irrigation of crops. The rivers and streams in this region are sandy and a series of subsurface diaphragms or underground bandharas in the stream bed will be highly appropriate for downstream and lateral percolation and moisture retention in this region. The region is mostly plain but whatever slopes are there which are not cultivable should be contour trenched.

Formation of ravines near tributaries of Mahi and Banas can be arrested through terracing which will reduce the velocity of water and help deposition of soil.

Silvipastoral development in public and private degraded lands is essential for conservation of moisture in this area.

3a. Semi-arid Lands with Shallow Sandy Soils

Mehasana, Gandhinagar, Ahmedabad districts and south and east of Vadodara district would be included in this category.

In a sense, this is the most difficult part of Gujarat for soil and water management. Soil salinity in this region is caused by weathering of the marine sedimentary rocks in this region. It would take a relatively long time for getting visible benefits of scientific management of soil and water. Contour bunding and graded bunding wherever necessary would be the appropriate techniques for soil retention.

The streams and rivulets split into several ministreams before meeting the sea and gullies are formed which need be plugged at the mouth of the streams near the coast.

Vegetative cover in the form of grasses and shrubs and trees are essential elements of watershed planning for this region.

3b. Semi-arid Area with Shallow-loamy Soil

Kheda, West Panchmahal, north Vadodara and Kachchh central, and central Saurashtra would comprise this region. Sustainable prosperity in this region is possible only if salinity of the soils can be controlled through controlled

and closely monitored irrigation practices. The present emphasis on surface irrigation which if used in an unscientific manner will lead to increase in salinity. If the present trend continues, the lands that are most productive and prosperous part of Gujarat agriculture will be marginalized in less than a century.

This is a region where a whole range of integrated watershed planning techniques can be very profitably applied. The ridges should be brought under forest cover. Contour bunding and contour trenching, graded bunding and graded trenching, nala bunding, gully plugging, mini checkdams techniques can be adopted at appropriate sites.

There are a number of isolated hillocks and garland trenches would be appropriate in such cases for soil and moisture conservation. Water in the trench can be lifted and used for irrigation if necessary in a dry spell. The hillock can be treated as a total watershed and 5-7 per cent slopes and above should be developed as pasture lands, forest and horticulture and less than 5-7 per cent slope can be cultivated under terracing. Surface water harvesting measures like farm ponds, village ponds and check dams should be extensively adopted and encouraged.

4. Non-arid Region with Deep Soil

Bharuch, Surat and Valsad would be included in this category. The peculiarity of deep black soil and flat terrain is water stagnation which leads to loss of crops.

Conservation ditching consisting of laying out shallow trapezoidal ditches on contours at usual terrace spacings of the locality is a technique recently researched at the Central Soil and Water Conservation Research Centre, Bellary. The ditch creates a water barrier that prevents soil erosion downstream and helps conservation of moisture upstream. It is also

a handy store of water for supplemental irrigation well within the reach of even a small farmer. The ditches are estimated to cover about 7 per cent of land but can themselves be used for growing grasses of varieties that can grow in submerged conditions as well.

Results of the conservation ditches have been encouraging in terms of moisture conservation and even the ditches yielded 18 tonnes of green grass per hectare per year in two cuttings. Nalas can be quite destructive in flat terrain and nala training is essential to reduce the menace.

5. Hilly Region

East Panchmahal, eastern hilly strips of Vadodara, Surat and entire Dangs, Girnar hills area in Junagadh, Bhuj rudge are the major hilly regions in the State.

Watershed planning, dividing the hilly regions in mini-watersheds would be necessary. Hilly regions of Gujarat are the traditional abodes of the tribals. The tribals in these regions have a symbiotic relationship with the forests and their participation in forest regeneration as well as in watershed planning would be essential and fruitful.

6. Watershed Development in Panchmahals

Hilly regions of Gujarat are amenable to watershed planning through integration of miniwatersheds into a large watershed. It is important to launch location specific and relevant programme. An exemplary experiment in development is undertaken in Panchmahals district by Sadgum Water Development Foundation (SWDF).

The Plan is based on secondary data available with the Government supplemented by substantial amount of primary data collected in surveys conducted by teams of qualified engineers in six talukas viz., Dahod, Jhalod, Limkheda, Deogadh, Basia, and Santrampur of Panchmahals district.

Panchmahals is an area of hills and dales and undulating plains ranging between 200 metres and 400 metres above MSL rising gradually from the central plains to the hills in the east. The area has 17 rivers and several streams. The drainage length in the five talukas is 2967 kms. which offers great scope for water harvesting. The average annual rainfall is 92.5 cm., about 95 per cent of it is received in the June-September period.

Besides the water that is already harvested, there still exists a water runoff potential of 63527 MCFT that can be harvested to irrigate 2,18,020 hectares of land even if 50 per cent of it is harvested. The SWDF feels that this is an achievable task and that this can be achieved without constructing a single major dam.

On a selective basis, however, a few medium dams could be constructed with a height of less than 20 metres. Similarly the length of the irrigation canals should be kept to the minimum and should avoid deep rock cutting.

It is also suggested that a series of check dams or bandharas could be constructed each having a height of about 4 to 5 metres, so that water can be impounded without submerging the arable land of the tribals. Water thus impounded could be lifted by pumps. In Panchmahals area, this would economise on the use of water, reduce losses and thereby make possible the irrigation of almost double the area by way of canals and gravity irrigation.

Of the 2967 kms. of available rainwater drainage length, 1500 kms. is available for harvesting. Technically it would be possible to construct a check dam at every two kilometres. Two such dams are already constructed on the river Hadap at Limkheda within a distance of one kilometre and still store reasonable amount of water.

Each of the dams would cost around Rs.4 lakh and irrigate on an average about 100 hectares by lift irrigation. Thus about 50,000 hectares would be irrigated. Besides the check dams would augment the subsoil water downstream and provide water to wells. Five hundred such lift irrigation schemes will benefit about 62500 tribal families forming 54 per cent of the total tribal households in this area.

For any area with hilly and uneven topography and a reasonably good rainfall, watershed development programmes are extremely crucial. Some work has been done in area by the State Government in land development works like levelling, terracing, etc. However, other essential components like massive tree plantation, forestry, horticulture supported by trenches and mounds are lacking. Surface water harvesting measures like farm ponds, village ponds, check dams which would augment subsoil water as well have not received adequate attention.

Watershed development is not an engineering scheme alone. Creation of a forest-grass cover is crucial for harvesting water on a sustained basis. The extent of degradation in Panchmahals can be gauged by the fact that the actual forest cover has declined from some 60 per cent a hundred years ago to a mere three per cent today according to the recent satellite pictures.

Officially 31 per cent of the land is classified as forest. However, barring three per cent area of actual forest cover the remaining area is degraded. This area should be revegetated through social forestry in cooperation with the tribals. This would provide the tribals not only with work but also with a permanent source of fruit, fodder, firewood and other forest products.

What is possible in the case of Panchmahals is replicable in almost all areas of Gujarat which have similar topography.

7. Integrated Watershed Development Experiments in Gujarat

Gujarat Land Development Corporation has been doing some work in these directions since its inception in 1978 and is today the only one agency to implement all soil conservation activities including ravine reclamation in dry land areas on watershed basis. National Watershed Development Programme was launched in Gujarat in 1987-88.

The results of watershed planning are encouraging. Block demonstrations were organized in each of the 60 selected watersheds in 13 districts of the State. Data on yields for different crops in block demonstration along with the control plots for kharif and rabi seasons for 1988-89 are presented in Table 6.2

Integrated National Watershed Development Project in Sangani, Surendranagar district has promoted water conservation works involving contour bunding, land smoothing, interbund treatment, farm ponds, live hedge, diversion drain, key line formation, nala plugging, etc. Appropriate fuel and fruit species for different soils/sites were planted. Crop demonstrations were carried out in Sangani village covering an area of 470.4 ha. Irrigation potential was reported to have increased from 2.4 to 16.6 per cent on actual cropped area basis. The underground water recharge has significantly improved and helped in raising water-table from 20 metres to 10 metres. The availability of irrigation water through wells increased from 2-3 hours a day to 10-14 hours a day. Direct benefit of lift irrigation from nala plugging has been received in 15 ha. of land. The initial average productivity of land was around 6.60 qtl./ha. on actual cropped area basis which increased to 16.20 qtl./ha. after completion of soil conservation work in the watershed (Mehta, I.A., 1990).

Watershed planning using appropriate techniques including civil works and vegetative cover depending on soil, rainfall

and terrain conditions would be the most appropriate form of intervention / for stabilizing the rainfall conditions, agriculture and drinking water supply for the rural population.

Even the most difficult region for drinking water can be better handled through a comprehensive watershed plan which would be the appropriate development alternative for solving the water problem in Kachchh on a sustained basis.

8. A Comprehensive Alternative for Kachchh

Kachchh has, on an average, three drought years in every ten year period. If the money that is going to be spent in bringing Narmada water to Kachchh is spent in appropriate alternative manner, the utilization of Kachchh water can be raised substantially as the present level of utilization is 17 per cent in the case of surface water and 27 per cent in the case of groundwater (GWRDC, 1986).

For a balanced development of Kachchh, it is necessary to recognize the priorities of water related requirements of the entire community.

The first priority is provision of clean and adequate drinking water supply for every one of the 387 villages and 10 towns with a total population of about 10 lakh. The second priority is the drinking water requirement of the entire cattle and livestock population of Kachchh which is about 16.69 lakh. The third priority is irrigation for major food crops in order of importance viz., bajri, jowar, wheat and pulses and then for cotton, castor and groundnut. The fourth priority is social forestry and protective forestry. The fifth priority is industrial enterprises particularly agro-based industries and industries with modest water requirements such as electrical goods, electronics, etc. Instead of using fresh water augmented for higher priority uses, recycled municipal water and/or treated saline water should be used by industries.

The rationale behind these priorities is the objective of development with social security and environment sustainability.

The fifteen rivers traversing the district flow mainly during the monsoon season when the area gets about 36.0 cm. of rainfall. The rain is usually stormy and erratic in terms of time and space, resulting in bulk of the run-off flowing down to the sea or to the Ranns.

There are several formations which contain saline aquifers and the fresh water reserves are mainly contained in the central highland, in sandstone or shale formation and water is available from 25 metres to 150 metres below the ground level. The potential is estimated at 803 mcm per year from phreatic aquifers and 139.62 mcm a year from confined and semi-confined aquifers.

The Government of Gujarat recently launched a Technology Mission on Rural Water Supply and Related Water Management. The Mission has suggested (July 1988) that instead of the conventional 'canal irrigation' method, a 'Total Catchment Management Approach' should be used so as to cover cultivated areas, wastelands, forests and the coastal belt including the estuarine reaches. The report recommends recharge of groundwater through contour bunding, field bunding, furrow bunding and other techniques of rainwater harvesting and conjunctive use of ground and surface water. Such a programme according to the Mission, will recharge groundwater, leach out the surface salinity in coastal areas which are otherwise very fertile and improve the productivity of dryland cropping, pastures and forests. It would also support higher vegetative growth which would induce higher groundwater recharge and reduce erosion of soils thereby minimizing the siltation of tanks and reservoirs that has in some cases, reached alarming

proportions. The report further recommends a series of check dams and underground dams with tidal regulators for major streams. It also suggests that use should be made of local material such as Kankar lime, yellow stone, firewood clay, etc., so that local resources can be harnessed in the interest of the economy.

The Government of Gujarat should abandon the fancy idea of transporting 400 mcm. of water annually through canals from Narmada to Kachchh over a distance of 700 kms. of tortuous terrain and lift it by 780 feet at the Kachchh border. Instead of adopting the capital intensive and energy intensive method of dubious benefits, the Government should accept and immediately start implementing the recommendations of the Technology Mission which provide cheaper, long-term sustainable and ecologically sound options which also promise immediate benefits to the local population. The process would lead to gradual but purposeful development, dispersed over all the talukas of the district and ensuring sustainable growth.

Such an alternative investment of funds that are currently planned to be invested on Kachchh canal from Narmada (amounting to Rs. 374 crores for industrial and municipal water plus Rs. 286 crores for irrigation) would yield water use pattern of great efficiency, within the control and power of the district population and the productive capacity of land and water resources will be restored, giving the people of Kachchh a feeling of emancipation.

Approach suggested for Kachchh would be applicable to all the areas of Gujarat which are much less difficult than Kachchh. Drinking water problem in Gujarat for rural as well as urban population can be solved by adopting long term, sustainable and ecologically sound options which, in many cases, are likely to prove even cheaper than the conventional

methods of building huge canals to transport valuable resource exposed to seepage, evaporation and pilferation losses.

9. Irrigated Agriculture

A gigantic dam, 138.68 metres high and 1210 metres long, across Narmada, to create a live store of 4.73 MAF of water viz. Sardar Sarovar is under construction. This project is estimated to irrigate about 18 lakh hectares of land in 12 districts of Gujarat. This issue is crucial in determining irrigation in 2001. An objective assessment of the project based on facts provided officially leads to following major findings : (i) Past experience of surface irrigation in Gujarat indicates substantial underutilization of the irrigation potential created, due to several reasons. In the past 28 years or so, over two thousand crores of rupees were spent to irrigate about 18 lakh hectares of land in Gujarat. However, actually surface irrigation so far is being utilized only for 7.76 lakh hectares i.e. 43 per cent of the potential created. For example, in the Damanganga project the irrigation was planned for 56,000 hectares of land at the cost of over 140 crore of rupees. As against this, in 1987, only about 560 hectares received irrigation (Estimates Committee 10th Report, Suresh Mehta Committee, 1988). In the Shetrunji Irrigation Scheme in Bhavnagar district 34,000 hectares were to receive irrigation ^{every} /year. However, between 1965 and 1987, only about 12,000 hectares i.e. about 35 per cent of the estimated hectareage were under irrigation. The Gujarat Government should pay more attention to speedy completion of the ongoing projects, command area development of irrigable land and see that the potential created is more or less fully utilized before venturing into the mega project of Sardar Sarovar. The heavy draft on resources for Sardar Sarovar project would mean a further squeeze in the finances available for other irrigation works. (ii) Information on gross irrigated area in

1983-84 and proposed ultimate addition by Narmada Project in the twelve beneficiary districts in Gujarat is presented in Table 6.3

It may be observed that the already rich and developed districts like Kheda, Vadodara, Ahmedabad would have a major share in the irrigation benefits while Kachchh, Rajkot, Panchmahals, Bhavnagar will benefit only marginally. Surendranagar is the only needy district which will get significantly large benefit. However, alternatively, comprehensive watershed development programme in Surendranagar will augment the supplies of groundwater in the district at much less public cost and on a sustainable basis. Besides, to what extent the promised water supply will actually reach Surendranagar which lies on the branch of the main canal after it has traversed over 400 kilometres is a moot question.

Irrigation for 18 lakh hectares would be available assuming that the water availability at Navagam site is 28 MAF (million acre ft). However, recent calculations show that the correct estimate of the total flow is only 23 MAF (K.P. Anantharaman). Thus it is obvious that many areas planned to get water will never receive it, especially at the tailends.

(iii) Economic appraisal of Sardar Sarovar Project Report by TECS has envisaged a change in the cropping pattern with increase in area under wheat and decline in area under cotton. This Report has given a rather rosy picture about the yields of different crops under irrigated conditions. The past experience in Gujarat as also in other States is that it is difficult to impose the planned cropping pattern and a PEO study (Planning Commission) attributes this failure largely to farmers' lack of control over the timings and quantity of water surface irrigation supplies (Asopa-Tripathi). Studies have shown that minor and small irrigation sources are more amenable to effective water management and control. The

farmers have complete control over irrigation water supplies from minor and small irrigation sources and can use water according to their crop needs so that their crops have adequate irrigation. In contrast, canal irrigation supplies are variable with not much assurance either of timing or of quantity (Asopa-Tripathi).

In Gujarat the major cash crops are kharif groundnut and cotton and in the kharif season protective irrigation is needed in dry spells in monsoon. Timeliness of availability of water is crucial for kharif season. The major need for Gujarat therefore is not year-round irrigation but insurance against risk during the rainy season. This can be done through measures that reduce run off, augment groundwater, stabilize stream flow so that water is available in situ whenever the need arises at a specific location due to variation in monsoon.

The cropping pattern will change more in tune with the relative profitability of crops provided assured water supply will be made available on time which is feasible in Gujarat more through development and augmentation of groundwater resources than constructing a huge canal network of doubtful efficiency.

(iv) It is well known by now that canal irrigation brings along with it the serious problems of waterlogging and soil salinization rendering good agricultural lands totally infertile. This is all the more important in Gujarat because most of the regions through which the Narmada Canal System is planned are already suffering from soil salinity, and productivity of these lands can be maintained only through controlled use of irrigation and appropriate land development to prevent further deterioration. The practicability and implementation of preventive measures like conjunctive use of water on any large scale is questionable.

In the Sardar Sarovar Project Command area, hardly one-

fifth of the total command area is studied in detail for the probable problems with reference to waterlogging and soil salinity. This study comprises of the Regions 1, 2, 3, 4 of the command area - i.e. between the Narmada and Mahi - about 20 per cent of the total command. The estimated percentage of each zone which will be liable to waterlogging and salinization with irrigation development is as under :

Zone 1	Zone 2	Zone 3	Zone 4
Very small	54%	64%	100%

A detailed study of the full report (Core Consultants and Sir M. Macdonald and partners, 1982) is sufficient to make it clear that the proposed preventive measures are impossible to implement.

(v) The Operations Research Group (ORG) Vadodara have carried out a study to classify the Narmada Command, based on a number of factors such as soil class, irrigability, etc. It has divided the command into 13 regions.

Apart from the general study, ORG also carried out detailed studies on a few regions.

For region 7, for example :

"The Zone 7, with extended area is reclassified into super-critical, problematic and irrigable areas ..."

<u>Description</u>	<u>Total Area</u>	<u>% of Total Zone Area</u>
Super critical	2,36,585 ha.	40.53%
Problematic	1,94,150 ha.	33.26%
Irrigable	1,52,928 ha.	26.20%
	----- 5,83,663 ha. -----	

"In super critical area ... the introduction of canal water may not appear very promising ... so, two alternatives can be suggested for such areas (i) corrective measures and development of this area under rained conditions (ii) non-agricultural activity.

"In the problematic areas ... introduction of surface irrigation would require very careful soil and water management practices to avoid deterioration of soil and groundwater conditions.

"Irrigable area of Zone 7 can be treated on par with any other good area in the command. But as this forms a very small part of Zone 7, it remains to be seen whether this can be commanded by the proposed canal network (1)" (ORG, Baroda, 1981).

(vi) Drinking Water from Sardar Sarovar : Drinking water for human population has the first claim on the water resources in a region. Sardar Sarovar Project plans to provide drinking water to three million people all along the canal network of the project.

As we have seen, long term, sustainable and ecologically sound options are available for solving the problem of drinking water even in the most difficult areas like Kachchh. These options are suggested by the Technology Mission on Drinking Water appointed by the Government of Gujarat.

Taking Narmada water through a huge canal system, building storage tanks and pipeline network throughout the area to be serviced will not only be only extremely capital intensive but according to authentic sources, also of doubtful efficacy. According to the recent publication by Sardar Sarovar Narmada Nigam Ltd., the canals beyond regions 1, 2, 3 would remain dry during the summer - hence in the most critical months of the year, about 80 per cent of the area would have to fall back upon groundwater supplies for their domestic as well as agricultural needs.

The drinking water problem becomes acute in summer i.e. from the month of March and the Narmada canals beyond Mahi are going to remain closed precisely from 15th March through the summer months. It is, therefore, a highly misleading claim that the Narmada Project is going to fulfil the needs of drinking water for the water thirsty areas of Gujarat.

A better alternative for provision of water for non-agricultural use including water for human and cattle population and industrial use is development of groundwater resources and augmentation of groundwater through appropriate watershed planning for Gujarat.

So far, we have seen that many of the claimed benefits of Sardar Sarovar Project are of doubtful efficacy and are liable to lead to problems like waterlogging. Moreover the Project involves enormous costs in terms of destruction of forests, disturbance to ecology of the region and human suffering to the oustees.

(vii) Losses due to Submergence : The loss in area to be submerged by Narmada Dams will be as follows:

Project	Area to be submerged in ha.			No. of villages to be submerged (partially/fully)
	Total	Forest	Agricul-tural Land	
Sardar Sarovar	39,134	13,744	11,318	234
Narmada Sagar	91,348	40,332	44,363	254
Omkareshwar	9,393	2,471	-	27
Maheshwar	4,856	-	-	58
	144,731	56,547	55,681	573

Over 50,000 hectares of forest land will actually submerged mainly under the Narmada Sagar and Sardar Sarovar reservoirs. However, experience so far has shown that forests are actually destroyed much beyond the area of submergence. Once the roads are constructed to reach the dam site, this results in indiscriminate encroachment on the forests around.

These forests to-day have a variety of valuable species of trees, shrubs and creepers besides the commercial varieties of teakwood. The forests are important not only for the wealth they have in terms of trees, but they perform the important function of regulating the climate and water cycle in the region through retention of precipitation, helping percolation, arresting wind erosion, etc.

The Dehra Doon Forest Research Institute has estimated that a tree gives indirect benefits worth Rs.50,000/- per year in terms of oxygen supply, prevention of soil erosion, help water percolation, maintain climatic balance, etc. The tribals are dependent on forests for their sustenance. The rural population around also benefits in terms of timber, bamboo, fodder and fuelwood. The forest that is going to be submerged in the Narmada Sagar provides grazing land for more than 2 lakh cattle. The variety of fauna like tigers, panthers, bears, wolves, hyena, buck deer would be difficult to save and support once their natural habitat is destroyed.

The forest cover in the country is fast dwindling and it is essential to make every effort to conserve all the existing forest tracts and plan for systematic regeneration of native vegetation. Conservation of forests in the source region is of crucial importance for protecting hydrological cycle. Compensatory tree plantation in some other area cannot possibly make up for the loss of forests in the catchment area. That the forest is already degraded is no ground for its total destruction. Attempts should be made to prevent deterioration and bring about improvements in the existing forests.

The experience so far has made it amply evident that a chain of depletion of natural resources, degradation of soils, disturbances in the climatic and soil cycles begins with deforestation of catchment areas of large reservoirs. Large irrigation projects have proved to be inevitably hazardous to the ecological balance in the region.

Over a lakh of population will be displaced by Sardar Sarovar Project. Of these about a half would be tribals. The dislodgement of thousands of tribals from their traditional habitat and ways of life will cause untold human suffering. This cannot be compensated by any rehabilitation plans, as

they inevitably fail to consider the human aspects and view the issue only in monetary terms.

It is reported that the Maharashtra Government has been permitted by the Central Government to release about 2700 hectares of forest land in Dhule district for rehabilitation of the oustees. These forest lands have low fertility and are not suited for crop cultivation. The area which should be used for restoration of forest, if given to the oustees is a double doom - such a measure does not really help the oustees and the possibility of reviving forest in that area is also destroyed.

It is well nigh impossible to calculate in money terms either the value of destruction of ecological balance or the human suffering involved. It is, therefore, all the more necessary to examine the alternatives more carefully, scientifically so as to avoid the avoidable human misery and destruction of the natural resources.

Thus if we compare the two scenarios, watershed development programme for Gujarat and the Sardar Sarovar Project, several revealing implications become clear. While Sardar Sarovar Project will take ten years and more for construction and another decade or two for full utilization of the potential, watershed development will start giving results within three to five years. Again, experience shows that the actual life of a dam is often shorter than estimated in the beginning mainly due to much higher siltation rates consequent to denudation of forests in the catchment area. By contrast, the reduction of runoff, checking of soil erosion and establishment of vegetation through watershed planning will not only stabilize the productive activity in the area and reduce the flow of impoverished rural population to cities in search of work but productivity will improve over time and groundwater will get stabilized. The sustainability of development process, a

crucial element, is much better ensured in the watershed planning than in big dam projects. The problems of drinking water, fuelwood and fodder will be largely solved simultaneously.

The per hectare cost of irrigation under Sardar Sarovar Project is estimated at Rs.50,000/- per hectare. The recent experience in Karnataka indicates and the GLDC in their report also confirms this that if watershed planning is done this cost would be around Rs. 2000/- per hectare. If the hilly areas in the watershed area afforested the cost comes to about Rs.6000/- per hectare. The average cost would be about Rs. 4000/- per hectare. Thus, more than ten times as much area can benefit and agricultural production stabilized and yield levels improved through watershed planning. It is very likely that even with the existing crop pattern, enhanced yields and some diversification according to soil-site conditions, the production will be more than the projected figures for the command area as a whole. What is equally important is that the benefit will reach a much larger section of the farming community.

Irrigation will increase through fuller utilization of already created capacities and through extension of well irrigation based on development of groundwater resources. It is estimated that irrigation can be extended to 36 lakh hectares on net basis, without Narmada Project, by 2001 if about half the estimated groundwater resources are harnessed.

So, instead of facing the known and well established problems of waterlogging, salination of soils for the short run benefit of a privileged section of surface irrigation beneficiaries, it would be more appropriate to stabilize and improve the condition of most of local cultivators through stabilizing and improving the soil water regime through watershed planning.

10. Vansda-Wadi Programme of Integrated Planning

An experiment carried on by an NGO with close community participation is presented here as an illustration of how water harvesting can be used to reclaim wasteland and increase the incomes of the tribals by coordinated action. Committed to use science and technology to help improve livelihood and socio-economic status of the rural poor through establishing a meaningful and rewarding relationship between five basic resources - Land, Water, Vegetation, Livestock and MAN - Bharatiya Agro-Industries Foundation, Pune (BAIF) initiated a programme of tribal rehabilitation in the Vansda Block in Velsad district in Gujarat in 1982.

Each participating family operates on one acre of wasteland or degraded forest land. For those who are landless the Government has allotted one acre of wasteland on usufruct basis. The family spends part of the work-time on orchard development and the rest in wage work or cultivation.

To harvest runoff water nalla plugging was done by temporary check bunds erected by using old gunny bags filled with sand or silt. This low cost technique is labour intensive, speedy and simple. Thus water ponds are created all along the nallas, providing life saving water for critical irrigation. A pumpset is installed at every check bund and pipelines are laid. The water in the nallas is thus carried to the Plots or Wadis being developed by the tribals.

Fruit trees like mangoes, guava, papaya are planted in each Wadi (orchard). Subabul, Eucalyptus, Casuarina and Bamboo are also planted to provide fuel, fodder and timber. Vegetables are cultivated as inter-crops.

Financial support is given to the family in the form of cash of Rs.1070 in the first year which is reduced gradually, and Rs.3575 cash support is given over a period of five years.

BAIF has given input support of Rs. 1400 in the first year which is also reduced in the subsequent period so that total input support to the extent of Rs.4600 is given over a period of five years. Only 42 families joined the programme initially. The programme has attracted many more families in the subsequent years and 5350 participant families were taking care of 4850 acres of land in 1990.

The backbone of the programme is horticulture. In the early years of the programme about 17000 mango trees were planted and other trees planted numbered over 500,000. The work of mango grafting is done by the tribal youth reducing the cost of mango grafts to 10 per cent of the market price. A group of tribal youth is specially trained in the technique of stone grafting and soft-wood grafting under the programme.

The programme has a definite bias in favour of women. 'Walvi', a custom among tribals under which the income earned by the women is retained by them and no claim can be put by men on it, is used by BAIF to involve women in activities like nursery and cultivation of vegetables which ensures women a steady income. Participation in BAIF programme also requires that the family gives up drinking and is committed to working in the wadi.

Improvement in income levels of tribal families using waste land lying idle is being achieved and waste lands put to productive use through water harvesting. The initial investments for water harvesting and for establishing orchards, and for partial support to the families are made mainly through the funds available from the Government under various schemes and the extension personnel and technical services are provided by the BAIF. There are schemes of assistance and subsidies for tribal development, wasteland development, drought-prone areas development, etc. However results are

unsatisfactory due to lack of proper planning, bureaucratic management and leakages. If there is a full integration of land and water use planning, people's participation and technical knowhow these funds can help the process of development of waste lands/degraded forest lands and rehabilitation of the tribals.

IV. Projected Agricultural Production and Employment

The farming community of Gujarat consists mainly of small farmers. In 1986-87 about 49 per cent of the operational holders had land less than two hectares each, over a quarter of total holdings being less than one hectare each. The small holdings account for about 15 per cent of the land operated. A little over one-fifth of the land is operated in semi-medium operational holdings of area between two and four hectares. Only 4.5 per cent of the operational holdings are large i.e., above 10 hectares and account for 20.9 per cent of the land operated.

All lands that can be possibly brought under the plough are already being cultivated. In fact lands of inferior capabilities are also being used for crop cultivation resulting in low productivities. The net cultivated land, therefore, is expected to remain constant at around 96 lakh hectares in Gujarat.

Possibilities of double cropping will make for higher cropping intensity which depends chiefly on the availability of water/moisture for second and/or subsequent crops. The net irrigated area in 1983-84 was around 22 lakh hectares; through further harnessing of the irrigation potential, command area development enabling higher utilization levels, and better water conservation and harvesting through watershed planning, the target of extending irrigation to 36 lakh hectares could be attained without Narmada by 2001 A.D. The

cropping intensity for irrigated land was 123 in 1983-84 and the overall cropping intensity was 116. Better water management both in irrigated lands and dry farming can take the cropping intensity to 130 in irrigated lands and about 125 for the entire gross cropped area by 2001. Thus although the net cropped area would be the same, the gross cropped area will increase to 120 lakh hectares i.e., by about seven to eight per cent because of higher cropping intensities both in irrigated land and in un-irrigated land. The gross cropped area will increase from about 111 lakh hectares in 1983-84 to about 120 lakh hectares in 2001 (Table 6.4).

It is expected that 80 per cent of area under wheat will be cultivated in irrigated condition and 20 per cent will be dry. These proportions would be 60 and 40 respectively for rice, 10 and 90 respectively for bajri and 17 and 83 respectively for jowar. Other cereals would be mostly cultivated under dry conditions. Pulses would be mainly cultivated with protective irrigation wherever available. Groundnut is mainly a kharif crop grown under dry conditions with protective irrigation only and summer groundnut will be cultivated under irrigation. Rapeseed and castor will be mostly cultivated as irrigated rabi crops. In cotton, about 20 per cent will be grown under irrigated conditions and about 80 per cent will be unirrigated cotton. Sugarcane would be a hundred per cent irrigated crop and so will be the vegetable crops.

Improvement in agricultural incomes can be brought about through a better chosen cropping pattern, with reference to the capability of land, soil and climatic conditions, water availability through irrigation, and value of output.

1. Suggested Crop Pattern

Gujarat was divided into 18 subzones based on topography, soil type and rainfall conditions. Subzones 1 to 4 relate to

the different forest types existing in the State. Subzone 5 is the desert area and subzone 6 is degraded lands with annual rainfall of less than 400 mm. Subzones 7 to 18 relate to agricultural lands with different soil types and rainfall conditions

Suggested crop pattern based on the past trends, current practices and soil-climatic conditions is listed in Table 6.5 and presented in Map 6.1. The irrigated pockets in the State are numbered in the map and suggested crop pattern for different irrigated pockets in the State is presented in Table 6.6.

The main thrust in the suggested crop pattern is on utilizing lands according to their capabilities and climatic conditions with a view to make the State, as much as possible, self-sufficient in foodgrains and pulses. At the same time, importance of Gujarat in the production of oilseeds and cotton in the national economy has to be borne in mind. Gujarat will continue to remain a major contributor in the production of oilseeds. In the case of cotton, continuous cultivation of cotton depletes soil fertility; hence no further extension of area under cotton is suggested. Better agronomic practices and increase in irrigated cotton will, however, give better productivities in cotton cultivation. Sugarcane will not be a significant crop in Gujarat in 2001.

Among the cereals, area under wheat is growing and the relative importance of jowar is declining over the last 25 years. Soil and climatic conditions are such that wheat can be grown profitably in all the districts except Bharuch, Valsad and Dangs. As there is a good potential for expansion of area under wheat and the farmers are going in for wheat cultivation, increase in the area under wheat is suggested in the projected crop plan for the State.

In Gujarat, though the area under pulses is growing over the last 20 years, to-day all the pulses together account

only for a little over seven per cent of the gross cropped area in the State. Soil and climatic conditions are quite favourable for tur crop in Bheruch, Vadodara, Panchmahals, Sabarkantha and Surat. Moog and math are grown in semi-arid areas of Kachchh and Sabarkantha. Gram is an established rabi crop in Ahmedabad, Panchmahals, Junagadh and Jamnagar. It is suggested that the area under pulses should be increased further to about 11 lakh hectares by 2001 which will be around 10 per cent of the then gross cropped area in Gujarat. This will remove the deficit in pulses for the State in 2001.

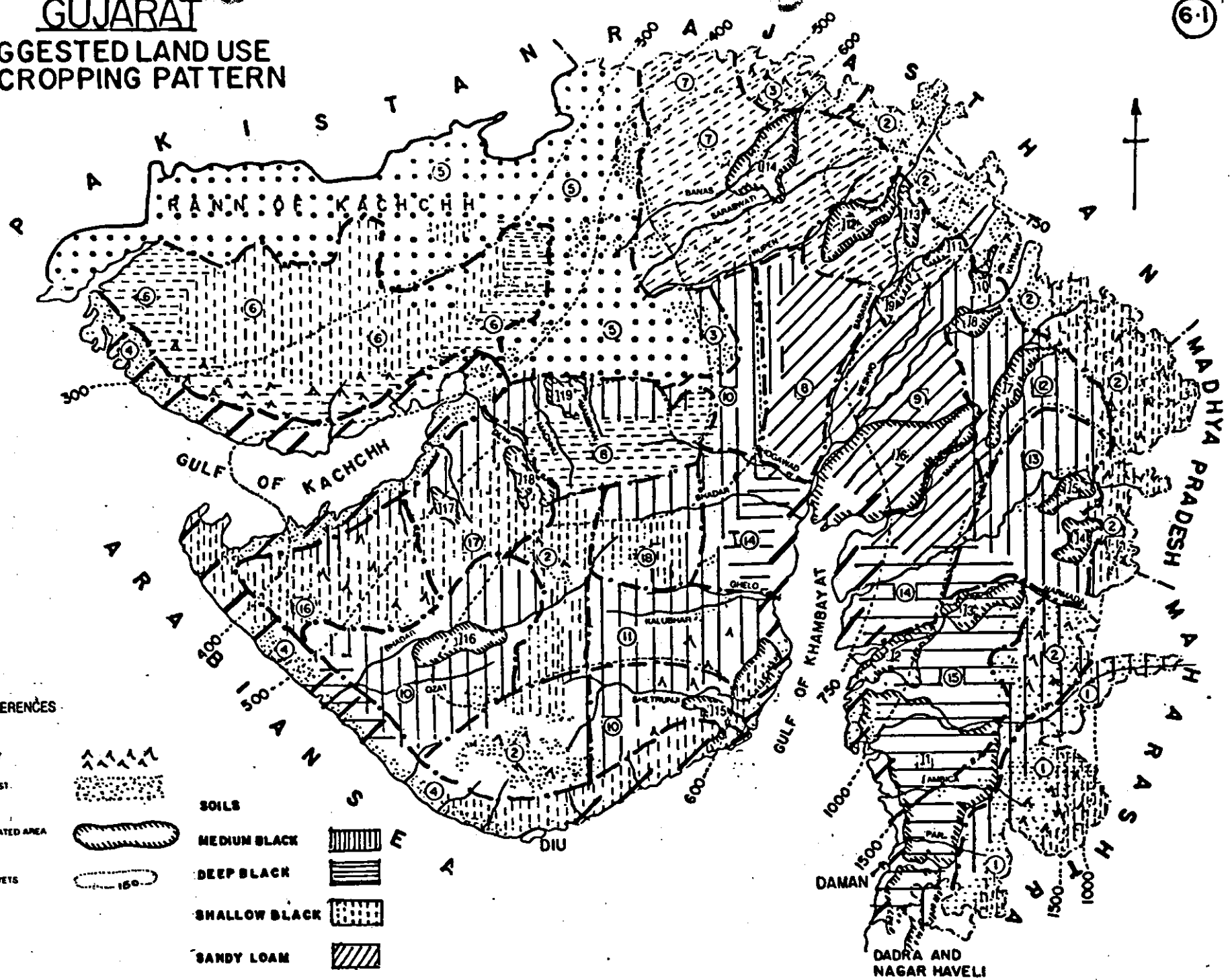
Among the oilseeds, although groundnut is still the major oilseed produced in the State, rape and mustard have entered in a big way as irrigated rabi crops particularly in Mahesana, Banaskantha, Jamnagar and Ahmadabad districts. So also area under castor is growing in Mahesana, Banaskantha and Ahmadabad. This trend should be encouraged since productivities are good and higher production of oilseeds is needed. Sesamum should be encouraged in Amreli and Bhavnagar districts. It is suggested that additional five lakh hectares of land should be brought under oilseeds by 2001 A.D.

Area under cotton has marginally declined over the last 20 years or so, and hardly one-third of the cotton area is irrigated. With extension of irrigation, area under irrigated cotton should be increased while total area under cotton should not be increased. This will benefit particularly the districts where unirrigated cotton is presently grown extensively of Ahmadabad, Mahesana, Bhavnagar, Kachchh.

With extension in irrigation most of which is likely to be in the form of well irrigation, it is suggested that farmers should not go in for crops like sugarcane which requires perennial irrigation but should further diversify the crop pattern and introduce or increase area under

GUJARAT

SUGGESTED LAND USE & CROPPING PATTERN



REFERENCES

- HILLY
- FOREST
- IRRIGATED AREA
- ISOHYETS
- SOILS
 - MEDIUM BLACK
 - DEEP BLACK
 - SHALLOW BLACK
 - SANDY LOAM

Consumption requirements and expected production of important agricultural produce for population in 2001 are

valuable short-season crops like vegetables, onion, potato, chillies and spices and condiments particularly garlic in Jamnagar and Rajkot, cumin in Bhavnagar, Banaskantha, Mahesana, Rajkot, Ahmadabad, fennel in Kheda, Mahesana, Sabarkantha, Ahmadabad, etc. Isabgul, a medicinal produce is almost a monopoly of Gujarat and particularly of Banaskantha, Mahesana and Kachchh districts. It is suggested that area under isabgul should be increased further.

Orchard crops like banana, mango, papaya, guava, chiku are some other high value crops in Vadodara, Surat, Bharuch, Kheda, Junagadh and Valsad. With better availability of water, it is suggested that farmers should extend the area for fruit crops.

Cropping pattern, production of major crops, and the gross value of agricultural output in 1983-84 and 2001 at 1983-84 prices are presented in Table 6.7. The impact of diversification in cropping pattern is clear when we compare the position of six major traditional crops viz., rice, bajri, wheat, groundnut, cotton and tobacco in the total agricultural scenario in 2001 (Table 6.8). These six crops accounted for 63.1 per cent of area under irrigation in 1983-84 and will account for about 40 per cent in 2001. These crops provided 71.6 per cent of mandays work generated in irrigated agriculture in 1983-84 and would provide for 47.7 per cent of mandays work generated in irrigated agriculture in 2001.

2. Impact on Agricultural Employment and Income

Gujarat will have about 46.5 million population in 2001 out of which about 17.8 million i.e., about 38 per cent will be living in urban area and 62 per cent in rural areas. There will be about 9.8 million workers out of which 7.8 million will be working in agriculture.

Consumption requirements and expected production of important agricultural produce for population in 2001 are

presented in Table 6.9. Although there will be significant growth in the production of cereals, Gujarat will still be a deficit state in cereals. It will be a surplus state in pulses and edible oil. The production base as compared to the requirement is quite small in case of sugar in 1983-84. Gujarat will continue to be a deficit state in sugar in 2001.

The annual fuelwood requirements of rural population in 2001 would be around 70 lakh tonnes. Estimated production/availability of fuelwood in 1983-84 was about 52 lakh tonnes while the requirement at 0.25 tonnes per person per year was 57 lakh tonnes. Regeneration of forests, silvi-pastoral practices in wasteland development and encouragement to rural households for planting trees would help in augmenting the supply of fuelwood. The estimated production of fuelwood in 2001 is 69 lakh tonnes. The expected fuelwood requirements would be nearly met if the necessary steps are taken for afforestation, development of wasteland, etc.

Comparative agricultural situation in 1983-84 and 2001 is presented in Table 6.10. The gross value of agricultural output in 2001 at 1983-84 prices is estimated to Rs.5917.1 crores which is about 32.5 per cent higher as compared to 1983-84. Work generated in agriculture will increase by over 20 per cent to 16103.2 lakh mandays. Gross return per manday in agriculture would increase from Rs.24.2 to Rs.36.7 i.e., by 51 per cent.

According to population projections, there would be 78 lakh workers in agriculture by 2001. Because of the increased number of mandays of work generated in agriculture, worker in agriculture would get work for 206 days in a year. At Rs.36.7 daily income per manday in agriculture, annual income per person will be Rs.7537 and family income with 1.5 workers per family would come to Rs.11306 at 1983-84 prices.

Table 6.1 : Suitable Grasses and Legumes for Different Climatic Zone/Sites

A. Grasses

Moist Tropical :

Brachiaria mutica, Echinochloa colonum, Euchlaena mexicana, Panicum maximum, Pennisetum pedicellatum, P. purpureum, Sorghum sudanense.

Subtropical :

Cymbopogon coloratus, C. martinii, C. citratus, Sehima nervosum, Themeda triandra, Rhynchelytrum repens, Brachiaria mutica, Cenchrus ciliaris, Chloris gayana, Setaria sphacelata, Cynodon plectostachyus, Dichanthium annulatum, Euchlaena mexicana, Arundinella nepalensis, A. bengalensis, Secale cereale, Bothriochloa bladhii, B. odorata, Eulaliopsis binata, Paspalum dilatatum, P. notatum, Phalaris tuberosa, P. canariensis, Themeda anathera, Panicum antidotale, Heteropogon contortus, Cymbopogon martinii, C. coloratus, Chrysopogon aciculatus, C. fulvus, Apluda mutica, Bromus inermis, Dactylis glomerata, Eragrostis curvula, Festuca elatior, Lolium perenne, L. rigidum, Pennisetum orientale, P. polystachyon, P. hohenackeri, P. pedicellatum, P. clandestinum.

Dry Tropical :

Eragrostis lehmanniana, E. tremula, E. curvula, Urochloa pullulans, U. mosambicensis, U. stolonifera, Dichanthium annulatum, Lasiurus indicus, Panicum turgidum, P. antidotale, Brachiaria ramosa, Cenchrus pennisetiformis, C. biflorus, C. setigerus, C. prieurii, C. ciliaris, Aristida hystrix, Eremopogon foveolatus, Eleusine compressa, Saccharum bengalense, Pennisetum orientale, Tetrapogon villosus, Cymbopogon jwarancusa, Sporobolus helvolus, Dactyloctenium indicum, D. aegyptium, Desmostachya bipinnata.

Tropical (includes Semi-arid Areas) :

Chloris gayana, C. dolichostachya, Cynodon plectostachyus, Dichanthium annulatum, Pennisetum pedicellatum, P. purpureum, Sorghum sudanense, Urochloa pullulans, U. mosambicensis, U. stolonifera, Sehima nervosum, Hackelochloa granularis, Cenchrus ciliaris, C. setigerus, Eleusine compressa, Heteropogon contortus, Chrysopogon fulvus, Iseilema laxum, Cymbopogon martinii, Eremopogon foveolatus, Eragrostiella bifaria, Desmostachya bipinnata, Eulaliopsis binata, Saccharum sp. Apluda mutica, Bothriochloa insculpta, B. odorata, B. pertusa, Cynodon dactylon, C. plectostachyus, Eragrostis curvula, E. lehmanniana, E. trichodes, Hyparrhenia rufa, Panicum coloratum, P. repens, P. laevifolium, P. antidotale, P. maximum, Setaria sphacelata, Themeda tremula.

Temperate

Cocksfoot, Phalaris tuberosa, Agropyron spp. bromoglass (Bromus inermis), Italianry grass (Lolium multiflorum), Kentucky blue grass (Poa pratensis), Orchard grass (Dactylis glomerata), perennial rye grass (Lolium perenne), Phleum pratense, tall Oat Grass (Festuca elatior).

 (continued)

Table 6.1 : (continued)

Black Soils :

Chloris bournai, *C. gayana*, *Dichanthium annulatum*, *Bothriochloa pertusa*, *Cenchrus setigerus*, *Chrysopogon fulvus*, *Eragrostis curvula*, *E. superba*, *Panicum maximum*, *P. antidotale*, *Pennisetum pedicellatum*, *P. polystachyon*, *Setaria nervosum*.

Laterite and Red Loam Soils :

Pennisetum clandestinum, *P. polystachyon*, *P. pedicellatum*, *Rhynchelytrum repens*, *Brachiaria brizantha*, *Cenchrus ciliaris*, *Chrysopogon aciculatus*, *Cynodon plectostachyus*, *Dichanthium annulatum*, *D. caricosum*, *Iseilema laxum*, *Paspalum dilatatum*, *P. notatum*, *Setaria nervosum*, *Eragrostis curvula*, *Hyparrhenia rufa*, *Panicum antidotale*, *P. coloratum*, *P. maximum*.

Saline and Alkali Soils and Coastal Sands :

Ischaemum muticum, *Latipes senegalensis*, *Lopholepis ornithocephala*, *Stenotaphrum dimidiatum*, *Thuarea involuta*, *Zoysia matrella*, *Myriostachyowitzia*, *Spinifex littoreus*, *Polytrias amaura*, *Sporobolus marginatus*, *S. helvolus*, *S. airoides*, *Dichanthium annulatum*, *Iseilema prostratum*, *Cynodon dactylon*, *Brachiaria mutica*, *Chloris gayana*, *C. barbata*, *C. bournai*, *C. viragata*, *Cenchrus ciliaris*, *Echinochloa colonum*, *Eleusine compressa*, *Eriochloa procera*, *Paspalum scrobiculatum*, *P. vaginatum*.

Para grass, Giantstar grass, Sudan grass, Marjol and Natal grass are medium salt tolerant while blue panic, anjan grass, dheman grass and weeping love grass are low salt tolerant species.

Ravines :

Dichanthium annulatum, *Bothriochloa glabra*, *B. ischaemum*, *Cenchrus ciliaris*.

B. LegumesDry Tropical :

Dolichos lablab var. *lignosus*, *Crotalaria burhia*, *Indigofera cordifolia*, *I. endecaphylla*, *I. linifolia*, *I. hochstetteri*, *Alysicarpus* spp., *Tephrosia villosa*, *T. purpurea*, *Rhynchosia minima*, *Clitoria ternatea*, *Alhagi pseudoalhagi*.

Subtropical :

Centrosema pubescens, *Desmodium confertum*, *D. triangulare*, *D. tortuosum*, *D. uncinatum*, *D. parviflorum*, *Pueraria phaseoloides*, *P. hirsuta*, *Stylosanthes guayanensis*, *S. hamata*, *Canavalia ensiformis*, *Dolichos lablab* var. *lignosus*, *Lespedeza cuneata*, *Macroptilum lathyroides*, *Indigofera endecaphylla*, *Lotus corniculatus*, *Medicago sativa*, *M. polymorpha*, *Trifolium* spp., *Clitoria ternatea*, *Leucaena leucocephala*, *Stylosanthes gracilis*.

(continued)

Table 6.1 : (continued)

Tropical (including Semi-arid Areas) :

Alysicarpus rugosus, A. vaginalis, A. monilifer, Atylosia scarabaeoides, Desmodium diffusum, D. curpureum, D. tortuosum, D. uncinatum, Dolichos lablab var. lignosus, Indigofera endecaphylla, I. hirsuta, Phaseolus trilobus, Centrosema pubescens, Clitoria ternatea, Macroptilium lathyroides, Vicia hirsuta, Goniogyna hirta, I. cordifolia, I. linifolia, Pueraria hirsuta.

Black Soils :

Aeschynomene indica, A. americana, Alysicarpus rugosus, A. vaginalis, Centrosema pubescens, Clitoria ternatea, Desmodium diffusum, D. laxiflorum, D. uncinatum, D. motorium, Dolichos lablab var. lignosus, Glycine javanica, Pueraria phaseoloides, Vigna umbellata, V. trilobata, Macroptilium lathyroides, M. atropurpureum, Melilotus alba, Vicia sativa.

Saline and Alkali Areas :

Alysicarpus rugosus, Indigofera linifolia, I. cordifolia, Cassia tora, Desmodium triflorum, Vigna umbellata, V. trilobata, Crotalaria spp., Sesbania sesban.

Red Loam and Laterite Soils :

Atylosia spp., Dolichos lablab var. lignosus, Glycine javanica, Indigofera endecaphylla, Pueraria hirsuta.

List of Fodder Trees for Various Climatic Zones1. Dry Tropical :

Acacia catechu, A. farnesiana, Acacia modesta, A. nilotica, A. senegal, A. tortilis, Adenantha pavonina, Ailanthus excelsa, Albizia lebbeck, A. procera, Anogeissus pendula, Azadirachta indica, Butea monosperma, Boswellia serrata, Capparis spinosa, Cordia dichotoma, C. rothii, Dendrocalamus strictus, Erythrina suberosa, Diospyros melanoxylon, Hardwickia binata, Holoptelea intergrifolia, Leucaena leucocephala, Madhuca longifolia, Mangifera indica, Melia azedarach, Ougeinia coelestis, Parkinsonia aculeata, Pongamia pinnata, Prosopis chilensis, P. cineraria, Pterocarpus santalinus, Salvadora oleoides, Taamarindus indica, Tecomella undulata, Terminalia crenulata, Ziziphus mauritiana, Bauhinia roxburghiana, B. variegata, Dalbergia sissoo, Gleditsia triacanthos, Samanea saman, Sesbania grandiflora, Cassia siamea.

2. Tropical :

Acacia leucophloea, Bauhinia variegata, Careya arborea, Cordia dichotoma, Ficus bengalensis, F. racemosa, F. semicordata, F. religiosa, F. retusa, F. rumphii, Hymenodictyon excelsum, Leucaena leucocephala, Mitragyna parvifolia, Pithecolobium dulce, Schleicheria oleosa, Terminalia alata, T. arjuna, T. chebula, T. paniculata, Toona ciliata.

(continued)

Table 6.1 : (continued)

3. Moist Tropical :

Acacia catechu, A. nilotica, Adina cordifolia, Aegle marmelos, Ailanthus excelsa, Albizia chinensis, A. lebbeck, A. odoratissima, A. procera, Anogeissus latifolia, Anthocephalus chinensis, Artocarpus chaplasha, A. hirsutus, A. heterophyllus, Azadirachta indica, Bauhinia purpurea, B. roxburghiana, B. variegata, Bombax ceiba, Cassia siamea, Cordia dichotoma, Dalbergia sissoo, Ficus religiosa, Garuga pinnata, Gmelina arborea, Holoptelea integrifolia, Kydia calycina, Lagerstroemia parviflora, L. speciosa, Leucaena leucocephala, Mangifera indica, Melia azedarach, Moringa oleifera, Morus alba, Ougeinia oojeinensis, Pterocarpus marsupium, Sesbania grandiflora, Shorea robusta, Syzygium cumini, Terminalia bellirica, T. chebula, T. crenulata, T. myriocarpa, Trema orientalis.

4. Wet Tropical :

Adina cordifolia, Aegle marmelos, Albizia amara, A. chinensis, A. odoratissima, A. procera, Artocarpus hirsutus, A. heterophyllus, Syzygium cumini, Azadirachta indica, Bauhinia purpurea, B. roxburghiana, B. variegata, Ficus spp., Grewia optiva, Kydia calycina, Mangifera indica, Pterocarpus marsupium, P. santalinus, Samanea saman.

5. Sub-Tropical :

Acacia catechu, Acacia leucophloea, Acer oblongum, Aesculus indica, Alnus nitida, A. nepalensis, Albizia chinensis, Bauhinia malabarica, B. racemosa, B. roxburghiana, B. variegata, Careya arborea, Celtis australis, Cordia dichotoma, Coriaria nepalensis, Cornus oblonga, Dillenia pentagyna, Ehretia laevis, Ficus bengalensis, F. racemosa, F. hispida, F. virens, F. palmata, F. religiosa, F. roxburghiana, Ficus rumphii, Flacourtia indica, Gardenia latifolia, Grewia elastica, G. optiva, G. tiliifolia, Lannea coromandelica, Leucaena leucocephala, Mallotus philippinensis, Manilkara hexandra, Mitragyna parvifolia, Morus laevigata, M. serrata, Quercus leucotrichophora, Soyimida febrifuga, Spondias pinnata, Stereospermum suaveolens, Toona ciliata, Trema orientalis, Wrightia tomentosa, Ziziphus xylopyrus.

Trees species suitable for different types of refractory sites

Sites

Suitable species

Saline/alkaline Soils Acacia nilotica, A. auriculiformis, Azadirachta indica, Prosopis chilensis, P. cineraria, Casuarina equisetifolia, Albizia procera, Tamarix aphylla, Leucaena leucocephala, Eucalyptus hybrid, Parkinsonia aculeata and Dalbergia sissoo.

(continued)

Table 6.1 : (continued)

Sites	Suitable species
Ravine land	Acacia catechu, Dalbergia sissoo (for gully slopes and humps), Acacia nilotica, Azadirachta indica, Albizia spp. (for saline and alkali patches); Dendrocalamus strictus, Gmelina arborea (gully beds); Eucalyptus hybrid, Pongamia pinnata, Ailanthus excelsa, Prosopis chilensis, Leucaena leucocephala, Gliricidia maculata, Bauhinia spp., Moringa oleifera, Morus alba, Broussonetia papyrifera. Grasses which have been found effective for planting on sloped fall are Cynodon dactylon, C. plectostachyus, Bothriochloa pertusa and for check dams Pennisetum purpureum, Panicum antidotale.
Waterlogged sites	Eucalyptus robusta, E. tereticornis, Anthocephalus chinensis, Syzygium cumini, Salix spp., Terminalia arjuna, Acacia nilotica, A. catechu, A. auriculiformis, Barringtonia acutangula, Lagerstroemia speciosa, Dalbergia sissoo, Bombax ceiba, Pongamia pinnata, Trewia nudiflora, Millingtonia hortensis, Taxodium distichum have been tried with success in beel areas of West Bengal. Lagerstroemia speciosa and Bischofia javanica.
Sand dunes	Prosopis chilensis, P. cineraria, Acacia tortilis, A. senegal, A. nilotica, A. aneura, Albizia lebbeck, A. procera, Azadirachta indica, Eucalyptus camaldulensis, Balanites aegyptiaca, Capparis decidua, Salvadora oleoides, Tecomella undulata, Dalbergia sissoo, Tamarix aphylla, Parkinsonia aculeata, Ailanthus excelsa.
Coastal sands	Casuarina equisetifolia, Anacardium occidentale, Borassus spp., and Eucalyptus spp.
<u>Fodder tree species suitable for different sites</u>	
Saline/alkaline soils	Acacia auriculiformis, A. nilotica, Azadirachta indica, Albizia procera, Leucaena leucocephala, Prosopis cineraria, Parkinsonia aculeata, Dalbergia sissoo.
Ravine land	Acacia catechu, Dalbergia sissoo (for gully slopes and humps); Acacia nilotica, Azadirachta indica, Albizia spp. (for saline and alkali patches); Dendrocalamus strictus, Gmelina arborea (gully beds); Pongamia pinnata, Ailanthus excelsa, Prosopis chilensis, Leucaena leucocephala,

(continued)

Table 6.1 : (continued)

Sites	Suitable species
	Bauhinia spp., Moringa oleifera, Morus alba. Grasses: Cynodon dactylon, C. plectostachyus, Bothriochloa pertusa, Pennisetum purpureum, Panicum antidotale.
Waterlogged sites	Anthocephalus chinensis, Syzygium cumini, Salix spp., Terminalia arjuna, Barringtonia acutangula, Lagerstroemia speciosa, Dalbergia sissoo, Bombax ceiba, Pongamia pinnata, Trewia nudiflora, Acacia catechu, A. auriculiformis, A. nilotica, Bischofia javanica.
Sand dunes	(A) Rainfall zone 15 to 30 cm; Acacia tortilis, Acacia senegal, A. nilotica, Prosopis chilensis, P. cineraria, Ziziphus spp., Grasses: Lasiurus indicus, Cenchrus ciliaris, C. setigerus. (B) Rainfall Zone 40 cm and above. Albizia lebbeck, A. procera, Azadirachta indica, Ailanthus excelsa, Dalbergia sissoo, Parkinsonia aculeata, Grasses: Cenchrus ciliaris, C. setigerus, Panicum antidotale.
Lateritic and laterite soils	D. strictus, Shorea robusta, Bombax ceiba, Adina cordifolia, Schlechera oleosa, Hardwickia binata, Gmelina arborea, Dalbergia sissoo, D. latifolia, Ougeinia oojeinensis, Anogeise latifolia, Holoptelea integrifolia, Albizia lebbeck, Xyda xylocarpa, Tectona grandis, Grass : Eulaliopsis binata.
Skeletal soils	Albizia lebbeck, A. amara, Cassia siamea, Hardwickia binata, Prosopis spp., Azadirachta indica, Pongamia pinnata, Acacia nilotica spp., indica, A. leucophloea, A. ferruginea, A. catechu, Dalbergia sissoo, D. latifolia, Tamarindus indica, Ailanthus excelsa.

Source : Report of the Committee on Fodder Grasses,
National Wastelands Development Board, Ministry
of Environment and Forests, Government of India,
1985.

Table 6.2 : Yield of Different Crops in Block Demonstration
Along with the Control Plots in 1988-89 in Gujarat

Crops	Average yield in kg./ha.		
	Block demon- stration	Control	% increase
<u>Kharif</u>			
Maize	3016	1813	66.35
Bajri	2012	1540	23.46
Groundnut	1765	1371	22.32
Bajri (Mixed with green gram)	1708	1148	32.79
Hybrid Cotton-6	1049	866	17.45
Green gram (Mixed with Bajri crop)	171	104	39.18
Sesamum (Mixed crop in cotton)	81.5	53.5	34.70
<u>Rabi</u>			
Wheat	3771	3410	10.58
Mustard	1290	1051	22.74
Gram	708	617	14.75

Source : Gujarat Land Development Corporation, Ahmedabad.

Table 6.3 : Gross Irrigated Area in 1983-84 and Proposed Ultimate Addition by Narmada Project

(Area in '00 Ha.)

District	Gross irrigated area 1983-84	% to gross cropped area	Proposed ultimate addition by Narmada Project	% villages to be benefited by Narmada Project	% rural population to be benefited by Narmada Project
Rajkot	2276	27	341	6.2	5.5
Surendra-nagar	961	14	3037	54.1	64.2
Bhavnagar	2107	27	483	12.1	9.2
Kachchh	814	10	378	7.7	11.6
Banaskantha	2652	26	3139	28.5	27.2
Mahesana	3812	43	1502	28.4	21.5
Gandhinagar	261	45	106	45.3	38.9
Ahmedabad	1314	22	3313	73.7	76.2
Kheda	3138	49	1160	27.8	23.6
Panchamahals	669	12	96	1.6	2.4
Vadodara	1416	25	3401	57.3	61.9
Bharuch	406	9	980	27.7	40.5
Total	19826		17936	27.6	28.5

Source : Sardar Sarovar Narmada Nigam Ltd., Gandhinagar - List of Beneficiary villages of Sardar Sarovar, FACTS - Sardar Sarovar Project.

Table 6.4 : Net Cropped and Gross Cropped Area in Gujarat 1983-84 and 2001

(00 Ha.)

	1983-84	2001 projected	Percent increase
Net cropped area	96165	96165	-
Gross cropped area	111497	120000	7.63
Cropping Intensity	116.00	125.00	7.76
Net Irrigated	22709	36000	58.53
Gross Irrigated	27974	46800	67.30
Cropping Intensity	123.00	130.00	5.69

Source : For 1983-84, Statistical Abstract of Gujarat State, 1985 and 1986.

Table 6.5 : Suggested Crops in Sub-Zones in Gujarat

Agricultural Sub-zone	Soil type	Rainfall (in mm.)	Crops
7	Alluvial Sandy/Loamy	Below 600	Bajri, cotton, tur, gawar (K), mustard, cumin, isabgul, wheat, gram, fenugreek, fodder (R)
8	Alluvial Sandy/Loamy	600-750	Bajri, cotton, tobacco, pulses, tur, moog, moth, groundnut, sesamum (K), wheat, potato, mustard, gram, chilli (R), sunflower, groundnut, moog, bajri (S)
9	Alluvial Sandy/Loamy	750+	Paddy, bajri, vegetables, pulses, cotton, spices (K), wheat, cumin, mustard (R), moog, groundnut, bajri (S), fodder
10	Medium Black/Shallow Black	Below 600	Bajri, tur, cotton, groundnut (K), wheat, gram, mustard (R), groundnut, bajri (S)
11	Medium Black/Shallow Black	600-750	Bajri, jowar, groundnut, cotton, sesamum (K), wheat, cumin, onion, fodder (R), groundnut (S)
12	Medium Black/Shallow Black	750-1000	Paddy, pulses, groundnut, sesamum, maize, cotton, hilmillet (K), wheat, mustard, potato, chillies, vegetables (R), moog, groundnut, bajri, cowpea (S)
13	Medium Black/Shallow Black	1000+	Paddy, pulses, maize, groundnut, sesamum, castor, tobacco (K), wheat, gram, potato, vegetables, fodder (R), groundnut, moog, cowpea (S), banana (psrennial)

Contd...

Table 6.5 : (Continued)

Agricultural Sub-zone	Soil type	Rainfall (in mm.)	Crops
14	Deep Black	Upto 1000	Cotton, jowar, bajri, paddy, vegetables (K), wheat, gram, rape and mustard, cumin, vegetables (R)
15	Deep Black	1000+	Paddy, nagli, jowar, groundnut (K), sugarcane (perennial), banana (perennial), tur, limabean, wheat, gram, ratoon jowar (R), moog, groundnut, cowpea (S)
16	Other	400-500	Bajri, pulses, jowar, groundnut, sesamum, castor, cotton (K), wheat, cumin, mustard, garlic, onion, isabgul, potato (R)
17	Other	500-600	Bajri, pulses, groundnut, cotton (K), wheat, mustard (R), groundnut, bajri (S)
18	Other	600-750	Bajri, jowar, gawar, castor (K), wheat, gram, potato, rapemustard, isabgul (R), bajri, moog, groundnut (S)

Note : Crops preceding K in bracket are Kharif Crops.
 Crops preceding R in bracket are Rabi Crops.
 Crops preceding S in bracket are Summer Crops.
 Crops preceding perennial in bracket are Perennial Crops.

Table 6.6 : Suggested Crops in Irrigated Areas

Pocket	C r o p s
1	Paddy, wheat, cotton, sugarcane, banana, vegetables, pulses
2	Cotton, wheat, vegetables, pulses
3	Cotton, wheat, paddy, tobacco
4,5	Paddy, wheat, tobacco, bajri, cotton
6	Onion, mustard, paddy, castor, cotton, wheat, vegetables, pulses, tobacco, chilli
7	Paddy, wheat, mustard, cumin, groundnut, cotton, vegetables
8,10	Cotton, groundnut, paddy, wheat, mustard, castor, summer bajri, summer groundnut
9,11	Wheat, bajri, summer cotton, cumin, summer pulses, phenogrik, lucern, vegetables
12,13	Wheat, mustard, paddy, groundnut, summer bajri
14	Wheat, mustard, gram, cumin, isabgul, potato, castor, summer bajri
15	Wheat, cumin, onion, vegetables, summer groundnut
16	Wheat, cumin, mustard, garlic, summer groundnut, summer bajri, summer moog
17	Wheat, garlic, gram, mustard, cumin, potato, isabgul, summer groundnut
18	Wheat, cumin, mustard, garlic, bajri, summer groundnut, summer moog
19	Wheat, mustard, gram, cotton, summer bajri, summer jowar, summer groundnut, summer moog

Table 6.7 : Area, Production and Gross Value of Output of Major Crops in Gujarat 1983-84 and 2001 in 1983-84 prices

Crop	Area : 00 Ha.		Output : Lakh tons		Value : Rs. crores	
	1983-84			2001		
	Area	Production	Gross value of output	Area	Production	Gross value of output
Rice	5403	7.5	226.3	5862	10.0	300.0
Wheat	7412	16.3	292.7	7830	20.0	360.0
Jowar	9476	5.8	93.1	9600	7.0	112.0
Bajri	14366	16.1	225.0	15215	20.0	280.0
Other cereals	4867	6.1	98.3	4985	7.0	112.0
Tur	2996	2.1	102.7	3650	3.1	155.0
Gram	1221	1.2	52.8	2000	2.0	90.0
Other pulses	3804	2.4	106.2	6000	4.7	211.5
Groundnut	21496	18.1	905.1	24535	29.4	1472.1
Other oilseeds	5026	5.6	309.7	7000	10.5	577.5
Cotton	13990	14.4	294.7	14000	14.8	301.2
Fodder crop)				10000	30.0	1200.0
Other crops)	21440		535.9	9323	-	745.8
Total cropped area	111497		3242.5	120000		5917.1

Source : For Area, Production for 1983-84, Statistical Abstract of Gujarat.

Table 6.8 : Crop Pattern and Mandays Work Generated in Irrigated and Unirrigated Agriculture in Gujarat 1983-84 and 2001

Crop	Area : 00 Ha.		Mandays in lakh			
	Irrigated area	Unirrigated area	Total	Mandays irrigated agriculture	Mandays in unirrigated agriculture	Total
<u>1983-84</u>						
Rice	2666	2737	5403	406.5	396.9	803.4
Bajri	1382	12984	14366	193.5	973.8	1167.3
Wheat	5956	1456	7412	953.0	101.9	1054.9
Groundnut	2690	18806	21496	556.8	1316.4	1873.2
Cotton	4175	9815	13990	1490.5	2453.8	5817.5
Tobacco	792	291	1083	290.7	72.8	363.5
Total six crops	17661	46089	63750	3891.0	5315.6	9206.6
Other crops	10313	37434	47747	1547.0	2620.4	4167.4
Total	27974	83523	111497	5438.0	7936.0	13374.0
<u>2001 A.D.</u>						
Rice	3517	2345	5862	536.3	340.0	876.3
Bajri	1510	13705	15215	211.4	959.0	1170.7
Wheat	6264	1566	7830	1002.2	109.6	1111.8
Groundnut	3000	21535	24535	622.5	1507.5	2130.0
Cotton	3000	11000	14000	1072.5	2750.0	3822.5
Tobacco	1200	-	1200	441.0	-	441.0
Total six crops	18491	50151	68642	3885.9	5666.1	9552.0
Other crops	28309	23049	51358	4246.3	2304.9	6551.2
Total	46800	73200	120000	8132.2	7971.0	16103.2

Contd...

Table 6.8 : (Continued)

Share of Six Crops*

Item	% share	
	1983-84	2001
1) Irrigated area	63.1	39.5
2) Unirrigated area	55.2	68.5
3) Mandays in Irrigated Agriculture	71.6	47.7
4) Mandays in Unirrigated Agriculture	67.0	71.1
5) Total Mandays	68.8	59.3
6) Total Gross Cropped Area	57.2	57.2

* Rice, bajri, wheat, groundnut, cotton and tobacco.

Table 6.9 : Production in 1983-84 and 2001 and Consumption Requirements of Major Agricultural Produce and Fuelwood in Gujarat in 2001

Crop	Requirement in 2001 (lakh tons)	Production (lakh tons)		% increase over 1983-84	2001 deficit/surplus (lakh tons)
		1983-84	2001		
Cereals	83.3	51.8	64.0	23.6	-19.3
Pulses	8.8	3.2	9.8	206.3	+1.0
Edible oil	5.8	5.9	9.7	64.4	+3.9
Sugar	6.5	0.7	1.0	42.9	-5.5
Fuelwood	71.8	52.0	69.0	32.7	-2.8

Table 6.10 : Comparative Agricultural Situation in Gujarat 1983-84 and 2001

	1983-84	2001	% increase over 1983-84
Net cropped area (00 Ha.)	96165	96165	Nil
Gross cropped area (00 Ha.)	111497	120000	7.6
Index of intensity of cultivation	116	124	-
Gross irrigated area (% of G.C.A.)	25.1	39.0	55.3
Value of agricultural output (Rs. crores)	3242.5	5917.1	82.5
No. of mandays per year (lakh)	13374.0	16103.2	20.4
Gross return per mandays (Rs. at 1983-84)	24.2	36.7	51.2
Total manpower in agriculture (lakhs)	50.0	78.0	56.0
No. of workdays per person per year in agriculture (No.)	267.5	206.5	-23.0*
Annual agricultural income per worker (Rs. at 1983-84 prices)	6473.5	7537.3	16.4
Workers (Rs. in 1983-84 prices)	9710.3	11306.0	16.4

* Number of mandays with present manpower generation would be 171.5 so effectively 20.4 per cent increase in work per year per man available.

CHAPTER VII

PROBLEMS AND PROSPECTS OF DEVELOPMENT OF GOA, DIU, DAMAN AND DADRA AND NAGAR HAVELI

Alfonso de Albuquerque, a Portuguese general captured port of Goa in 1510 to maintain supremacy over the seas and, by and by, annexed new enclaves on the coast. By the middle of the 16th century the Portuguese established their rule in four talukas of Goa. Despite revolts in 1787, 1852, 1870, 1895, 1912 to overthrow the Portuguese, the alien rule remain entrenched. Diu was conquered by the Portuguese in 1556 and Daman acquired by a treaty with Shah of Gujarat in 1559. Under the Portuguese rule and the district of Daman comprised two talukas: Daman, Dadra and Nagar Haveli. In 1954, the people of Dadra and Nagar Haveli overthrew the foreign yoke. After a prolonged people's struggle Goa, Daman and Diu were freed on 19th December 1961 through an armed intervention by the Government of India. Goa, Diu, Daman and Dadra and Nagar Haveli have been under the Central administration as Union Territories from 1962. Goa attained statehood on May 30, 1987.

In its geographical setting, Goa is an extension of Konkan plains with the difference that the alluvial stretch surrounding Aguada is much larger than the parallel tract in Konkan. The area of the State is 3702 sq.km. with a population of 11.7 lakh in 1991. The urban population formed 41 per cent of the total population in 1991 (Table 7.1).

The district of Daman is situated on the west coast of India with a length of 11 km and width of 8 km from north to south. The district is bounded on the east by the Valsad district of Gujarat and on the west by the Arabian Sea. The district is divided by the Damanganga river into two parts. The district receives an average annual rainfall of 160 cm. The net

sown area is 3727 hectares or 67 per cent of the geographical area. The important crops are paddy, ragi, pulses, beans, ground-nut, chiku, mango. The population of Daman was 62101 in 1991, with 26905 persons in Daman town.

The district Diu is a tiny island with 4.6 kms length and 13.8 kms width from east to west. It is situated near the port of Veraval, separated from the southern extremity of the Saurashtra peninsula by a narrow channel. The topography is generally plain. The soil is barren. The average annual rainfall is 54 cm. Only about 21 per cent of the geographical area or 924 hectares are sown. The major crops grown are jowar, bajri, ragi, pulses, beans, banana and mango. The population of Diu according to 1991 Census was 39485 with 12347 persons in Diu town.

Dadra and Nagar Haveli a Union Territory with an area of 491.0 sq.kms. comprises of two enclaves viz. Dadra with three villages and Nagar Haveli with 67 inhabited villages and one town - Silvassa. The territory is surrounded on the west, north and east by Valsad district of Gujarat and in the south and south-east by Thane and Nashik districts of Maharashtra. The total population in 1991 was 138542 of which 109380 were tribals. About 40 per cent area of the district is under forests and 50 per cent under cultivation. The main crops are paddy (45 per cent of cropped area), ragi (13 per cent) and pulses (17 per cent). Grass occupies about 16 per cent of the cultivated area. The average annual rainfall is about 200 cm.

I. GOA : Resources and Economic Activities

The relief is characterized by the highland backbone of the Sahyadries with its transverse members reaching in many places the shore line. The foot hills which form the junction between the highland and the riverine plains are marked by an extensive development of the 'low level' laterite. The low lying region surrounding the Aguada and Mormugao Bay is underlain by

extensive deposition of alluvium. Only the low line of hills ending in the promontories of the Aguada, Cabo and Mormugao point introduce variations in the relief of the riverine plain. The terrain is intersected by a number of rivers flowing westward meeting the Arabian Sea. The important rivers are Mandovi, Zuari, Tiracol, Chopora and Betul which are all navigable.

The State can be divided into three natural divisions viz. Coastal, Interior transitional and Interior Hilly.

The soils in general are laterite. The agricultural lowlands especially in the coastal tracts are alluvial flats formed through sedimentation along the principal rivers. The soils in hilly tracts are ferralitic and for the major part are formed of clay schist. At foothills where the murumy soils are mixed with humus to form a loamy soil the forest growth is thick.

The climate is warm and humid. From June to September heavy rainfall is received from South-west monsoons that ranges between 250 cm and 430 cm. The year round temperature ranges between 22°C and 32°C.

Goa had lost over the centuries, the tradition of self-governing institutions, under the Portuguese rule. What had made Goa different is the millennial institution of the village community of Gaumponn. However, with the imposition of centralized administration, the strict supervision of the Government over village councils and full control over their funds, the village community lost much of its vitality. Goa, when integrated with the Indian Union was insulated from the economic trends across its borders and was supported by a policy of building up overseas trade, and migration. In 1960 Goa had a population of about six lakhs and about one lakh Goans were employed outside Goa and provided an important source of income. With the end of Portuguese rule, Goan militia was disbanded. Banco Nacional and Portuguese Airways and subsequently Goa lottery were closed

and facilities for emigration were reduced. As a part of national policy, mineral production and exports went down, and high custom duties were imposed on imports. As a cumulative effect of all these factors living costs in Goa increased and problem of employment arose.

On merger with the Indian Union Goa was put under a Lt. Governor responsible to the Union Government. Most of the officers were from Delhi with no previous contact with Goa. The official language was changed from Portuguese to English. The plan for Goa included standard development schemes for various sectors without considering the peculiarities of resource endowments, institutional structure and the socio-cultural environment of Goa.

Goa is short of resources needed for the supply of power - the engine of development and has to depend on the neighbouring States. The cultivable land is limited. The transport infrastructure is underdeveloped in the hilly region and is costly to develop because of difficult terrain.

The advantages are its rich natural resource base - minerals, forests, fish - with immense development potential.

About 29 per cent of the geographical area of Goa is under forests, 27 per cent is classified as culturable waste and 34 per cent is under cultivation.

1. Forests

Forest is one of the most important natural resources of Goa. The forests are confined to the Western Ghat foothill slopes. During the Portuguese regime the accessible forests were recklessly exploited by overcutting and illegal fellings and were severely damaged, while the interior forest areas remained largely untapped for want of roads.

The Indian Forests Act was extended to Goa in 1965 and all the forests were treated as reserved. Of the 1053 sq.km. forest area, the wet evergreen forests extend over about 250

sq.km. and the rest is moist deciduous forest. The wet evergreen forests are found in patches along deep ravines and steep hills. The main tree species are Syzygium cumini, Mimusops elegi, Garcinia exanthochymus, Mangifera indica, Mesua ferrea, Artocarpus hisuta, Garcinia cambogia, Garcinia indica, Nuclea parvifolia, Ochrocarpus longifolia. These forests, under Portuguese regulations were set aside for conservation of soil and regulation of water flow.

The moist deciduous forests have understory of bamboos (Dendrocalamus strictus and Bambusa arundinacea) and overstory of deciduous species e.g. Tectona grandis, Sterculia foetida, Acacia catechu, Dalbergia latifolia, Aegle marmelos, Albizzia lebbek, Lagerstroemia parviflora, Terminalia alata, Terminalia paniculata, Terminalia arjuna, Adina cordifolia, Gmelina arborea, Salmalia malabarica, Pterocarpus marsupium, Artocarpus integrifolia, Terminalia belerica, Tamarindus indica.

Half of the moist deciduous forest is classed as teak-bearing and set aside for commercial exploitation. In the remaining area located near populated areas, free grazing, removal of leaf manure, removal of firewood and such privileges were allowed. About 200 sq.km. area was under shifting cultivation or kumeri.

Forest Department was set up in 1963 and began the work of survey of the forest area but the progress of work has been slow. The Department launched the programmes of forest road development and plantation of valuable commercial species such as teak, Eucalyptus, rubber. It was reported that upto 1979-80, 5231 hectares were brought under Eucalyptus plantation, 9175 hectares under teak, 9511 hectares under cashew and 528 hectares under rubber and Casuarina (District Census Handbook, Goa, Daman and Diu, 1981, p. 17). In 1986-87 the reported area under these plantations was as follows: Eucalyptus 5123 hectares, Teak 9808 hectares; about 10,000 hectares were under

cashew and 8000 hectares under rubber, sawar, Casuarina. Reportedly about 33000 hectares were brought under plantation. Information on survival and growth of these plantations is not available. In view of the need to conserve forests a ban on clear felling was imposed in 1981 and plantation of commercial species like Eucalyptus, and teak was reduced.

In conservation of forests Kumeri cultivation poses a big problem. Kumeri is extensively practised in Satari, Sanguem, Canacona and Quepem talukas. The Government tried to stop kumeri cultivation by notification and tried to rehabilitate the landless families by giving them forest land for cashew cultivation. This did not solve the problem of kumeri cultivators. The cashew plantations in many cases were away from their settlement. Besides, these plantations could not provide them with the necessary means of survival - particularly the staple cereals. Moreover, 77 per cent of the kumeri cultivators were small peasants and they were not covered by the scheme of rehabilitation (Padki, 1967, pp.210-218). Kumeri cultivation continues to be the source of livelihood for the small and landless peasant.

2. Agriculture

The gross sown area in Goa has remained around 130,000 hectares for the last three decades, though there has been some changes in the crop pattern. Some decline in the area under paddy, arecanut and considerable decline in the area under ragi is noted, while the land under coconut, cashewnut and sugarcane has increased. In 1986-87, 130575 hectares were under cultivation, one-third of this being under paddy, 36 per cent under cashewnut, 17.6 per cent under coconut, 3.1 per cent under mango. Horticulture thus occupied the major portion of the cultivated area and seasonal agricultural crops accounted for less than 40 per cent of the cultivated area.

In Goa the landholdings are small, 56 per cent of the landholders having less than 0.5 hectare of land and another 22 per cent between 0.5 and 1.0 hectare of land. Only 3 per cent holdings are above 4 hectares each that together own 48 per cent of the cultivated land. There are large variations in the crop pattern between different landholding groups. The area under rice and other foodgrains was as high as 80 per cent in the smallest size group (below 1 hectare) and 72 per cent in the holdings of 1 to 2 hectares, while it was only 13 per cent in the case of landholders with above 10 hectares holding. In the largest holding, 57 per cent area was under cashewnut, 16 per cent under coconut. The largest holders accounted for more than 40 per cent of the area under cashewnut.

Paddy is the principal crop of Goa and the staple cereal of the State. There are two paddy seasons, kharif and rabi, the area under paddy being 33950 and 8861 hectare respectively in 1986-87. The rice lands are classed as khajan, ker and morod. The khajan lands are marshy, situated near creeks and riverside. Most of the khajan lands are in coastal talukas and extend over about 17100 hectares. Khajan cultivation is risky in that any breach in the river embankment destroys the crop. Collective effort plays a crucial role for guarding the embankments. Since the lands are salty, salt resistant varieties of paddy can only be cultivated in khajan lands. Ker lands (about 15000 hectares) are alluvium type, and have a good drainage; these are the best rice lands in Goa. Yet optimum yields are not obtained due to the small size of the holdings. The rest of the lands, some 12000 hectares, classed as morod are situated on high lands with poor soils. Patches of high lands in forest areas are also put to paddy cultivation with rab (manuring with ashes of wood and leaves). The yields in morod lands are poor.

Ragi is the staple cereal of the poorer sections. It is cultivated on hill slopes, with 1490 hectares put under ragi in 1986-87. Pulses like kulith and beans are grown in borod lands which are hilly areas. These are cultivated largely for personal consumption.

The most important garden crop is cashewnut. Cashew trees are found on hill sides mixed with other vegetation or scattered on open pastures. There are on an average 25 trees per hectare. Except for occasional clearing of undergrowth and pruning of dead branches no attention is paid to cashew trees by the cultivator. Farmers visit the trees only during the harvests. Consequently the yields are low.

An estimated area of 23000 hectares is under coconut. Coconut thrives well in the coastal areas and near riverside where soils are sandy. Coconuts are planted in row of two/three trees along the bunds of khajan lands and bunds along the banks of river constructed to protect paddy fields from saline water. The root structure of coconut helps bind soil and stabilize bunds. The plantations are old and a number of trees do not bear any fruit, but they are not generally felled.

Areca - a delicate palm tree thrives well in regions of heavy rainfall and high humidity. It is shade loving and grows fast when planted with banana, mango, jackfruit and guava trees. As it requires abundant irrigation, areca plantations are located in the interior tracts where valleys are full of natural springs. Most of the areca plantations are old and overcrowded.

About 4000 hectares are under mango. Mango trees are intermixed with other plantations. Other fruits grown are banana, pineapple, jackfruit, papaya, etc.

Sugarcane cultivation started in Goa in the seventies. A cooperative sugar factory was set up in 1973-74, but the

locally produced sugarcane is not sufficient to feed the factory. The area under sugarcane was 1700 hectares in 1986-87. Tanks, ponds, springs, diversion bandharas, wells and canal are the main sources of irrigation in Goa. The main irrigated crops were paddy (6070 hectares) and arecanut (1720 hectares) around 1960, with a total of 7938 hectares receiving irrigation (Padki, 1967, p. 60).

By 1986-87 the total irrigated area increased to 11865 hectares, of this 8861 or 80 per cent was under paddy, 1304 hectares under arecanut and 1700 hectares under sugarcane. Irrigated area formed about 9 per cent of the total cropped area in 1986-87.

The major traditional source of irrigation is storage tanks where rain water from receding monsoon is stored at a higher altitude and utilized for irrigated low-lying areas. In interior tracts e.g. Ponda and Bicholim where rivers have post-monsoon flow small diversion works are constructed to irrigate rice fields and arecanut gardens. Besides, there are numerous springs in the valleys where forest cover is still preserved on the hills (as roads are lacking). They are harnessed for cultivation of arecanut and bananas. Well irrigation is confined mainly to the lowlying areas in Pernem and Bardes.

Productivity: The productivity of Khajan and Ker lands varies from about 1600 to 2400 kg. per hectare and that of morod lands is about 500-600 kg./ha., but can go up to 1400 kg./ha. if adequately manured. The ker lands can yield 4000 kg./ha. with proper cultivation and manuring but give sub-optimal yields due to tiny holdings. Currently the rice production in a year of normal rainfall is about 111000 tonnes (Table 7.2). Production of ragi and maize is about 3900 tonnes. The requirement of cereals for Goa is 170,000 tonnes. The State thus produces about 68 per cent of its requirements.

During 1986-87 the Central Government supplied 46315 tonnes of rice and 13012 tonnes of wheat to Goa. The production of pulses was only 4575 tonnes as against the requirement of 18,700 tonnes. The State has to import cereals, pulses, edible oil, sugar/gur, milk to meet the daily food requirements of the population. This is because the land available for cultivation is very limited. The available land resources are well suited for garden crops and forest trees.

The yield of coconut varies considerably from tree to tree and farm to farm depending upon the age, care and culture. A well cared mature tree yields 50-70 coconuts per year. The average yield however is low, about 20 coconuts per bearing tree. The total production of coconut in Goa was estimated to be 107 million in 1987-88 and the overall productivity was 4600 nuts per hectare. The average yield in Goa is much below the normal productivity of about 10,000 to 14,000 per hectare. Arecanut yield is about 1110 kg per hectare with the average yield per bearing tree varying between 0.3 kg and 1 kg. In 1987-88 the total estimated production was 1450 tonnes. Cashewnut tree yields nuts and the fruit juice is used for distilling feni (a liquor). The productivity of cashew is also low, less than one-fourth of the yield level in Kerala. The estimated production of cashewnut in 1987-88 was 11000 tonnes. The estimated production of pineapples was 6600 tonnes and that of mangoes 29500 tonnes.

Organization: Community organization is important in khajan cultivation and centuries ago an institution known as 'comunidade' had evolved. This indigenous institution had been prominent in the coastal region. In the three coastal talukas of Goa, Salcete and Bardez the comunidades held over 50 per cent of the area under paddy.

The Comunidade started as a cooperative organization centuries ago and under the Portuguese rule turned into a

kind of agricultural joint stock company. Originally the ownership was vested in the village body with an equal share to each adult male or Jana. Under the 'Jana' system, lands were cultivated collectively and the produce distributed according to established customs. A certain proportion was set aside for village expenditure such as remuneration to village servants, maintenance of temple, etc. The government's share in produce was also kept aside. The net produce was distributed according to the number of adult males in the participating household. The members had proprietary right in the produce and not in the land.

The Portuguese did not liquidate 'Comunidades' but encouraged their privatization. Over time collective farming system was abandoned and its membership got restricted. To raise finance for building embankment, etc., concept of 'shareholder' with interest on capital was added. These shares were transferable. The lands held by 'Comunidade' members were auctioned once in six years on a share cropping basis. The share amounted to about 50 per cent of the gross produce. This system was discontinued during mid-fifties, and tenancies of existing leaseholders were extended. The rent payable was reduced to one-tenth of the gross produce. The traditional collective organization was lost over time, though the need for collective action for cultivation of khajen lands remains.

3. Minerals and Mining

Goa is very rich in iron ore, the deposits of which are concentrated in the northern and central parts in the talukas of Bicholim and Satari. The iron ore deposits have been estimated at 150 million tonnes (50-60 per cent Fe content) of lumpy ore and 250 million tonnes (60 per cent Fe content) of powdery ore (District Census Handbook, Goa, Daman and Diu, 1981, p. 17). The annual ore production is around 10 to 12

million tonnes and accounts for about one-fourth of the country's iron ore production. Almost the entire production of iron ore is exported. Manganese is the next important mineral. Production of ferro-manganese is about 150,000 tonnes per year.

The prospecting of iron ore and manganese ore started in Goa as early to 1905, but regular exploitation started only in 1947 and gained momentum from 1949. The area under mining was leased to private parties for extraction of ore during the Portuguese rule and the practice has been continued subsequently.

There are more than 300 mines in operation, and all of them are of 'open-cast' type. The mining operations are carried out both manually and mechanically. Ore is transported by heavy vehicles upto the river jetties and from there by inland water-transport to the port Marmugao for export. A large number of mechanized river barges of varying capacity are used for transportation of ores.

Mining is the biggest single industry in Goa providing employment to a large number of workers, directly in mines and indirectly in road and river transport and dock and port work.

Employment in mining increased from about 5000 persons in 1950 to 22000 in 1960. There was no expansion in direct employment thereafter. In 1981 about 20000 workers were engaged in mining and quarrying works.

The export of iron ore increased steadily from 72,000 tonnes in 1950 valued at Rs.18 lakh to 6.5 million tonnes in 1961 valued at more than Rs.18 crore. There was further stepping up of the production and in 1970-71 about 10 million tonnes were exported valued at Rs.46.4 crore. The production in 1986-87 was about 13.5 million tonnes.

The open-cast mining activity has adversely affected agriculture and horticulture in the mining districts. The dumping of fines - mined ore rejected for export, has resulted

in the loss of an appreciable area of paddy fields. Silting of streams and rivers due to dumping of fines is impeding navigation. Ore-dust carried by wind settling on blossom destroys the fruit bearing capacity of the affected area and coconut trees. The abandoned waste-ore pollutes soils, bringing down their fertility. The inland navigation earlier was in small boats that did not disturb the embankments. With the ore movement in big barges the embankments breach, leading to inundation of paddy fields and thus loss of paddy area in khajan lands and of coconut trees along the embankments. The entire tract along the river route from the mining area to the port of Marmugao has thus been affected. The mined areas and the land going under overburdens are lying as waste lands difficult to reclaim. Loss of fertility due to the earth from blowing of overburdens that contains traces of iron ore was reported from large tracts. The change of land-use from agriculture to mining imposed great hardship on the tenant-cultivators. When the land owners sold their lands, the tenant cultivators were displaced without any compensation.

The export oriented mining activity in Goa has thus over years resulted in a considerable damage to agriculture, horticulture and forest tracts. Reclamation of the damaged areas poses a big problem, and so far very little is done in this regard.

4. Fisheries

With a coast line of over 100 kms., and 250 kms. of inland waterways and a number of tanks, Goa has rich fish resources. Rainwater impounded to irrigate rabi rice is also used for fishing. The coast is full of creeks and estuaries which provide a good shelter for fishing craft. As large stretches of coast are not surf beaten, shoaling fish like mackerel and sardine are abundant.

Fish is an important source of protein in the diet of the local population. Population dependent on fisheries in 1965 was about 25000 with 5929 persons returned as active fishermen. The major part of fish production comes from inshore fisheries. A beginning in off-shore fishing was made in 1957.

During the Portuguese regime little was done for the development of fisheries. Fisheries department was set up in 1963. Mechanization of fishing crafts was immediately initiated by the Department. Schemes of financial assistance and provision of various facilities like fishing jetties, cold storage, freezing facilities were extended by the Government. The volume of annual marine fish catch is about 30000 tonnes and inland fish production was 2000 tonnes. There are large year to year fluctuations in the composition and the quantum of catch.

In fishing activity in Goa, Rapan or beach-seine organization has been predominant. It is a cooperative organization. The group consists of 30-40 fishermen with each member contributing equally towards the acquisition of boats, the huge net and labour in all the operations. The organization is well-suited for formalizing into a cooperative society, so that the society can take a variety of functions like provision of credit, curing of fish, purchase of raw material, etc. The other type of fishing organizations are (i) gill net fishing carried in deeper sea waters by a group of 3-5 persons, (ii) creek fishing done by throw nets by a group of 3 to 4 persons, one of them owning a boat, (iii) stake-net fishing in the rivers trapping fish flowing with the tide. The State auctions the rights every three years. Stake net fishing is pursued all through the year except during exceptionally high tides during the monsoon.

5. Livelihood Pattern

Agriculture provided livelihood to 28 per cent of the

work force in 1981 but its share in the State income* was only 14 per cent (Table 7.3). Mining with 6 per cent of the employment claimed 8 per cent of the State income. Forest and fishing are important resources of the region, but in 1981, the employment in livestock, forestry, fishing, plantation and orchards was only about 5 per cent and the income from forestry, fishing was about 5 per cent. By 1986-87 the share of primary sector (agriculture, livestock, forestry, fishery) declined from 20 per cent to about 15 per cent. The total net State domestic product in 1986-87 was Rs.641 crore and the per capita income Rs. 5280.

In Goa, the fishing industry is in a state of stagnation; the forests have been indiscriminately exploited and plantations are old with low productivity. The opportunities for rehabilitating the rural economy are immense but organizational difficulties are formidable. Programmes for strengthening the embankments damaged by the heavy movement of river transport, reclamation of khar lands, provision of drainage facilities, repair and maintenance of traditional irrigation facilities, replantation and proper care of garden crops, beach-seine fishing, etc., call for organized community effort.

II. Development Potential of Goa

1. Agricultural Lands

The structure, nature and the practices of utilization of land and water resources have been noted above. Among the different types of land resources khajen, ker or waingan and morod types of resources are being exploited since long. In recent decades more and more of morod lands are being brought under cultivation either for paddy or coconut cultivation.

* The data on net State domestic product is not available separately for Goa State, but the share of Daman and Diu in the total net State domestic product of Goa, Daman and Diu is only about 5 per cent.

Khajen Cultivation: The khajan lands are considered to be most productive, but lately the productivity has been on the decline because of breakages in the bunds and increased salinity of the farms due to the lack of maintenance of the drains, sluice gates, etc. The khajan lands are mainly concentrated along the banks of the Zuari and the Mandovi rivers. Under the plan schemes embankments are repaired and the cost is recovered from the cultivator. However, the breakages are caused to a large extent due to the movement of the barges carrying ore and the cultivators have to pay the cost not only in terms of repair but also loss of production during the period (2 to 3 years) till the land is reclaimed. It is therefore essential to devise protective measures so that breakages are minimized. The preventive measures include protection of bunds by planting willow trees, broadening of bunds and plantation of coconut on bunds taking greater precautionary measures at vulnerable points. Since much damage is caused by the ore movement, the responsibility must be borne by the mining companies. Initially the programme of repair will have to be taken up by the Government with appropriate contribution to the costs from the mining companies. For routine maintenance farmers' organization is important. As most of the khajan farms are under tenant cultivation, the owners do not have any interest in the maintenance of bunds. Unless the actual cultivators join together it is difficult to watch and keep the bunds in repair. The traditional 'bhos' system that made provision for watching the bunds and collective cultivation of some of the farms is an example of organized effort and can be re-established for the upkeep of bunds and of sluice gates and the drainage system. Removing the mud from the drains and spreading it on the farm is important for protecting the fields from tidal water and improving their productivity. It is necessary to make

systematic efforts to regularize the drainage system. An organization of the tillers can alone undertake the task of systematic maintenance of the entire system to improve the productivity level of khajan lands.

Waingan Cultivation: A major part of the area under the waingan resource is used for growing two crops of paddy and in certain parts only a single irrigated rabi crop of paddy is taken because of flooding of farm during the monsoon. The nature of source of water supply influences waingan cultivation. Generally paddy is the only crop grown in these farms but there is a considerable scope for diversification of production making rational use of water. Study of waingan farms revealed that there was scarcity of water on some farms while there was surplus water on other farms. If a plan of rational utilization of water and land is made it would be possible to grow a number of crops like banana, summer maize, vegetables, etc. The water supply can be increased through the repair to the existing works. For this it is necessary to have full cooperation of the farmers to share water and participate in the rational crop plan. The lands presently flooded and hence not used in kharif season can be brought under cultivation through increasing the number of sluice gates and growing flood resistant varieties of paddy. There is a definite scope for increasing the productivity of paddy by changes in the method of cultivation, use of organic manure and regulation of water, control of snails, etc.

Morod Cultivation: During the last seven decades or so morod lands have been increasingly brought under cultivation. The low-lying lands are used to grow paddy. Cashew is the main crop grown along the hill slopes, and coconut at the foot of hills. The morod lands are spread over a larger territory and are scattered. Hence protection of these lands from stray cattle is a major problem.

There is a possibility of developing part of these lands through terracing and tapping water sources and crops like paddy, maize, groundnut, and tapioca can be grown near the foot of the hills where the soils are retentive. The unirrigated morod and hilly lands can be used for cultivation of cashew, mangoes, jackfruit, pineapples (dry), bamboo. However, protection from monkeys during the fruiting season poses a serious problem as watching the scattered morod lands is difficult.

Coconut Cultivation: Coconut cultivation is spread almost over the entire State. The coconut trees in coastal villages are watered, though irregularly and in the interior they do not generally receive irrigation. The small size of the holding makes it difficult to mobilize adequate resources for protection, irrigation, manuring, etc. With the rising prices of fishmeal which provided formerly a complete manure for coconut crop substitutes have to be searched for. Indigenous methods like burning husk, use of coir dust, green manuring can enhance potash supply. Inter-cropping the coconut gardens with mango, jackfruit, cashew and seasonal crops like maize, tapioca, cowpea, pineapple (dry) if irrigation is lacking, and rice, vegetables, pineapple, banana if irrigation is available would improve the productivity per hectare. Pineapple can be grown as a dry crop on slopes. Even though the size of the fruit is smaller, the fruit is sweet and well-suited for canning. Mixed cropping results in increase in the production of coconut palms as a result of better cultivation, proper weeding and manuring of the land. However, absence of irrigation and narrow spacing between the trees is a limiting factor in Goa. Narrow spacing means that only a limited area is available for interplanting and plants which can grow under partial shade e.g. banana, pineapple and tapioca can only be cultivated as inter-crops.

There is a considerable scope for improvement in coconut gardens, that will help improve the productivity. Removal of unproductive trees, replacement of gaps, proper spacing, provision of irrigation, manuring and inter-cropping will bring about considerable increase in the productivity. However, for planting of new trees protective fencing is needed. For provision of irrigation, cooperation between cultivators is essential. The small size of holding often makes it impossible to mobilize the necessary monetary and manpower resources. Under such a situation cooperation can alone help organize cooperative watch and ward, irrigation arrangements, etc.

Arecanut Cultivation: Arecanut cultivation is concentrated mainly in Ponda and Sateri talukas. Arecanut gardens are mixed crop gardens and it is possible to expand valuable crops like pepper, nutmeg, clove and cardamom in the arecanut gardens. There is also a scope for the cultivation of banana and pineapple as these gardens are watered regularly. Traditionally large trees like mango, jackfruit, breadfruit, kokem which do not require perennial supply of water are grown in arecanut gardens to provide shade. It is advisable to take banana, pineapple, betelvine, pepper, etc., as inter-crops, taking advantage of irrigation, adopt wider spacing between arecanut trees and plant cashewnut, bamboo on the border. Proper manuring and maintenance of water sources is essential to ensure higher productivity.

Micro-level Planning: In view of the special topography and climatic conditions of Goa, it is necessary to prepare land and water use plan at a micro-level. Crops have to be planned after taking into account the nature of an individual hill and the source of water. Today the main crops are paddy in low-lying land (31 per cent area), coconut on the flat lands on the shore and in the interior (15 per cent area),

and cashewnut on the hills (29 per cent area). It is possible to diversify crop pattern by increasing area under crops like banana, pineapple, tapioca, vegetables, spices and oil palm. The area under waingan paddy can be increased through reorganization in the use of water and through bringing additional area under irrigation. Change in the technique of cultivation of paddy introducing dibbled paddy in place of broadcast one and use of manures and fertilizers in adequate doses would help increase productivity of paddy crop. All these measures require labour and that is a limiting factor in Goa, shortage of labour for agricultural work.

As noted earlier the dependency on agriculture decreased steadily from 1950 due to the growth in mining activity and as a result shortage of labour is experienced particularly in the talukas where mining is concentrated viz. Bicholim, Quepem, Sanguem. A large proportion of cultivators in these talukas are engaged in mining. The other major factor that made for shortage of labour in agriculture is the change in the socio-cultural milieu. The socio-cultural ethos of Goa has dramatically changed during the last three decades. The nature of traditional economic activity—rice cultivation where maintenance of bunds was important and had to be organized on a cooperative basis, the rapan fishing which required a team of 30-40 families—involved cooperative organization, mutual trust and sharing. Pilferage was rare. With the development of market and souring of prices of coconut, cashewnut, and the breakdown of community organization and social cohesion the incidence of pilferage increased. Particularly some of the school-educated youth lacking white-collared job avenues, join such shady activities. Consequently it is difficult to secure cashewnut and coconut crop unless adequate watch and ward is provided. If the return is poor, the garden tends to

be poorly maintained reducing the productivity. Cattle menace is another problem. Stone fences are often used but unless properly maintained they become ineffective. All the above problems are difficult to solve at the individual level and call for concerted cooperative efforts. Innovative programmes that integrate production and processing, thus giving scope for experimentation, new skills and challenging tasks to the youth are essential to give a new direction to development.

2. Waste Lands

The waste lands form about 30 per cent of the geographical area of the State and in Quepem, Sanguem, Canacona and Sateri talukas the waste lands together with forests form 74 per cent, 82 per cent, 75 per cent and 71 per cent respectively of the total geographical area of these talukas. The land use planning problem in these talukas thus relates to the development and utilization of these resources. The official approach to utilization of waste lands was to distribute these lands to landless labourers or political sufferers. This did not succeed as the approach was piecemeal and the scheme was not integrated with the development programme of the taluka. It is necessary to collect information on ownership, quality of land, present land use, water sources in the region to form a basis to prepare a land use plan. The problem of waste land and forest land development has to be treated in conjunction with the problem of rehabilitation of kumeri cultivators. The waste land can be developed under a comprehensive scheme of integrated development that would include the following steps: (i) formation of cooperative of kumeri cultivators (say of 15 to 20 families), (ii) allocation of a stretch of waste land or denuded forest lands for development, (iii) provision of development support to put the land under cashew, jack-fruit, mango, kokum, bamboo and other valuable indigenous

species, (iv) payment of minimum wages to the members of the cooperative who would be working on the lands allotted to the society, (v) arrangements for purchase of processed products of fruit, bamboo, etc., from the cultivators through government depot at stipulated prices, (vi) the payment of wages to be gradually reduced as income is generated from the lands developed under the scheme. The area required for rehabilitation of all the active kumeri cultivators (with or without land) could thus be developed in a phased manner, giving priority to the tracts where there are no alternative employment avenues.

3. Forest Lands

About 95 per cent of the forests of Goa are concentrated in Quepem, Satari, Sanguem and Canacona talukas. As noted earlier large parts of forest areas have been destroyed or neglected. Only the section of inaccessible wet evergreen forests have remained relatively intact. The forest department launched schemes of plantation of forest lands by commercial trees viz. teak, Eucalyptus, cashew, rubber, bamboo, Casuarina. The forest development schemes should actually aim mainly at re-establishment of the diverse indigenous species suited to the physio-climatic conditions of Goa. The experience of the arboratum established in 1974 at Satpal indicates that the growth performance of the indigenous species is comparable with that of the exotics. The performance of Khair, Hedu, Sawar, Sissam, teak compared favourably with that of Eucalyptus (Table 7.4). In replantation it is important to stress adaptability, diversity and local use. Exotic species yielding timber or pulping material should be confined to a limited area and not cover large tracts because mono-culture is susceptible to pest attack and hence liable to sudden loss, and is not desirable from the point of maintaining ecological balance, particularly the hydrological cycle.

4. Mining Activity

As noted above the mining activity in Goa opened up new avenues for employment in mining, transportation, trade and service industry. This affected agriculture in two ways. Firstly khajan lands were affected because of breakage in embankment, and cultivation was affected directly or indirectly as a result of dumped overburdens. Secondly because of shortage of labour efficiency of agricultural operations like weeding, manure collection, etc., suffered. The ecological damage is considerable and reclamation of mining areas is difficult. The mining activity will have to be gradually reduced, and to make up for the damage it is necessary to levy special charges on the mine owners and use those funds for restoration of agricultural lands, embankments, etc., and reclamation of bad lands.

The development potential of marine and inland fishery is considered in Chapter VIII.

5. Tourism

Tourism is an important land and water based activity in Goa. Goa is blessed with long beaches of golden sand, along 100 km of sea shore and enchanting scenic waterways. The entire State is dotted with historical and cultural landmarks which together with the natural scenic beauty attract lakhs of visitors from over the country and abroad. The Goa landscape with its ever-green valleys with silvery rivers cutting across the hills and dales, fascinating golden beaches, picturesque villages amidst coconut groves offers a scenic kaleidoscope. Added to this are the imposing churches, temples and mosques. There are 274 hotels with 11065 beds in Goa and the number of domestic tourists in 1987-88 was 7.34 lakh and the number of foreign tourists was about 1.0 lakh. Domestic tourism is partly religious oriented while the foreign tourism is hedonistic.

6. Land Use Plan

Goa has such a rich natural scenic wealth and diverse flora and fauna that it can be an exciting laboratory for the study of wet evergreen forest, for experimentation in natural succession, for preservation of rare plant and animal species, for exploration of the variety of uses of its rich forest resources. It is very important to preserve the relatively inaccessible tracts of wet evergreen forests in its undisturbed state for study and research. It must not be traversed through with motorable roads, but there should be a restricted entry only for study; it should be maintained as a Reserve. Goa can serve as a centre for study and for healthy recreation to students and youth who could stay in remote villages in the arecanut-coconut orchards. The golden beaches must be preserved from encroachment of building construction and garish commercialization. The forests, the rivers, the springs, the orchards and the sea must not be tarnished by vulgar tourism. The unique natural serenity of Goa has to be preserved through strict control over industrial development (particularly polluting industries, like metal, chemical, etc.), urban encroachment and indiscriminate road network cutting through hills and forests. There is ample scope for providing employment in cultivation of garden crops, in fisheries, in cottage industries processing a variety of forest produce and horticultural produce, in trade and services supporting tourism, in study and research. The land use plan (Map 7.1) therefore retains all the hills, waste land and forest lands under forest and horticulture, rice lands are restricted to the plains and valley region and urbanization is strictly confined to a limited area. The basic principle in formulating the land use plan for Goa is to preserve its natural characteristics; since Goa is endowed with rich and diverse natural

resources it can provide a variety of employment opportunities to its population, yielding incomes that could provide a reasonable standard of living conserving at the same time the quality life.

III. Planning Approach for Diu, Daman and Dadra and Nagar Haveli

The erstwhile Portuguese possessions of Daman and Diu in Gujarat and Dadra and Nagar Haveli adjoining Gujarat-Maharashtra are administered as Union Territories. For Diu the land use approach suggested for Subzone 4 of Gujarat (Chapter VI) is appropriate as the geo-climatic conditions are similar. For Daman, part of the area (about 2800 hectares) falling under Damanganga irrigation project should be planned as II in Gujarat and for the rest, the plan for Subzone 15 of Gujarat should be followed.

Dadra and Nagar Haveli

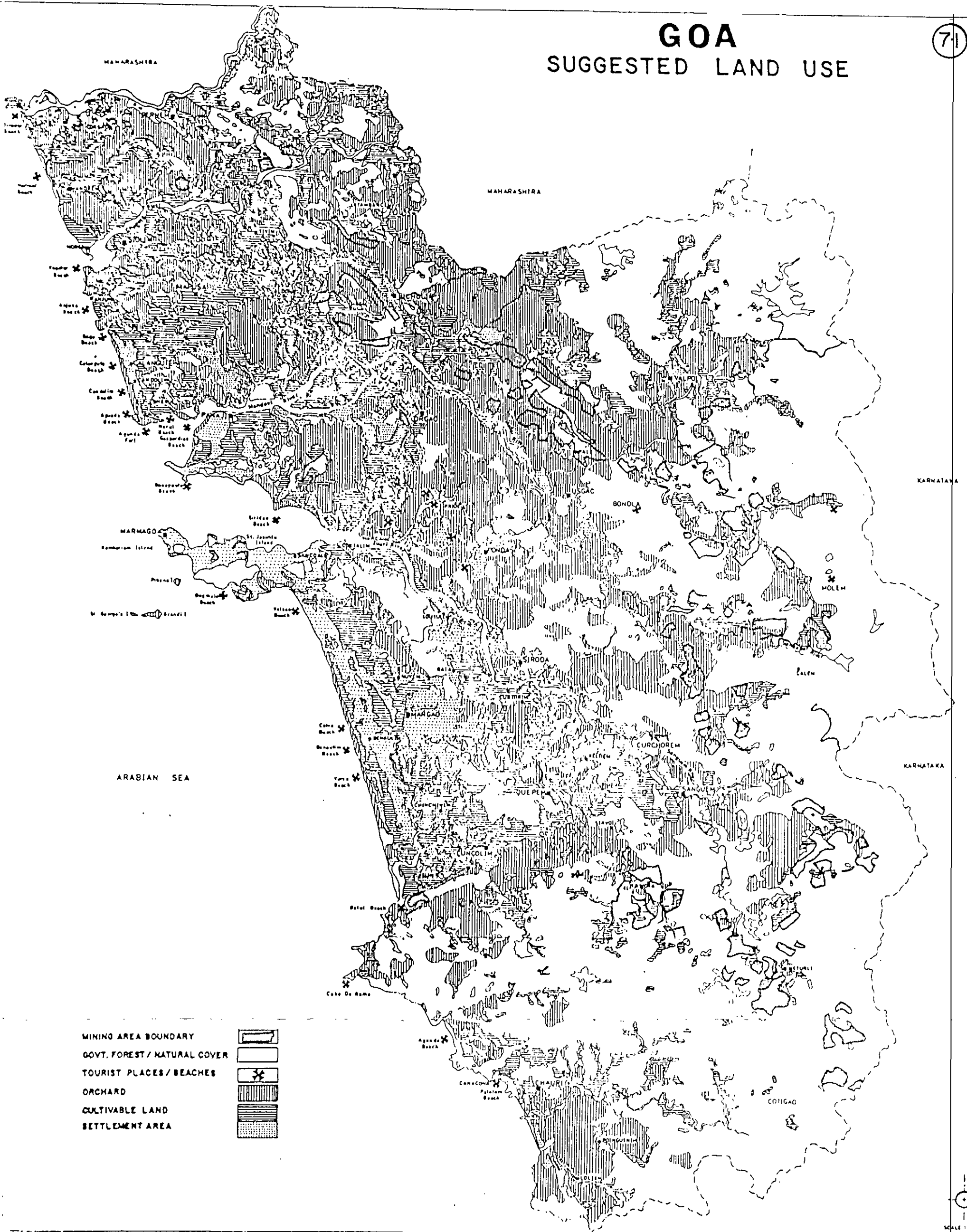
Dadra and Nagar Haveli has a hilly terrain especially towards north and north-east and is intersected by the river Damanganga. The central region is plain and the soils fertile. Cultivable lands occur in patches rather than in large compact tracts. The area under cultivation is about 24000 hectares; of this only about 500 hectares are irrigated. On completion of the Damanganga irrigation project about 7000 hectares would come under irrigation.

The cultivators are mainly tribals: Dhodia, Dubla, Kokna, Kathodi, Koli Dhor, Naikada and Varli. The cultivation methods are primitive. Paddy is the main crop grown in the plains and ragi in hilly terrain. The land holdings are small. According to 1980-81 Agricultural Census, there were 11825 land holders; of these 40 per cent had less than 1 hectare and 35 per cent had 1 to 2 hectares of land holding.

Except for the north-western part, most villages in the district have considerable area under forests. The forest

GOA

SUGGESTED LAND USE



- MINING AREA BOUNDARY
- GOVT. FOREST / NATURAL COVER
- TOURIST PLACES / BEACHES
- ORCHARD
- CULTIVABLE LAND
- SETTLEMENT AREA

area (20852 hectares) is spread over 58 out of 70 villages. The forests are government owned and declared as reserved forests. The forests are exploited for commercial use and are even clear felled to plant teak. The tribals get work in tree felling through forest labour cooperative societies. The forests are rich in teak, khair, sisam, mahua, haldu, sawar, etc., but are viewed only as revenue yielding assets and not used to improve and strengthen the tribal economy.

Forest Development: The aim of forest management should be basically changed from revenue earning to conservation, restoration and augmentation of forest resources and to use it on a sustainable basis keeping in view the needs of the local tribal population. The present method of forest exploitation should be changed and forests should be developed through active participation of the local population in planning, management and exploitation. The tribals should be considered as partners in reforestation plan to re-establish trees they value viz. mahua, khair, dhawda, bamboo, etc. In addition trees that yield valuable products that would provide a basis for advanced processes and can be harvested over a number of years rather than one time felling after a long waiting period should be included in the reforestation plan.

Alternative Approach: The present target group oriented and schemewise approach should be changed. The plan should be prepared on a watershed basis and should encompass the forests, water resources, cultivable lands, livestock, wild life, etc. The inputs from outside should be mainly in terms of study, research and design inputs so as to help improve the diet using forest wealth and seasonal crops, improve incomes on the basis of collection and processing of forest products, improve water retention and build small storages using local material, and increase agricultural production through appropriate techniques of manure and water application.

Social Infrastructure: Till the asset development work is completed so that higher outputs become available so as to meet all the critical needs of the tribals, it is necessary that the government takes the responsibility of (i) improving the nutrition and health status of the tribals through provision of cereals, pulses, oil, gur, etc., ration at subsidized price through special outlets, and basic health services, (ii) imparting literacy in Marathi/Gujarati and new skills necessary for agro-processing, forest-product processing, etc. Emphasis should not be given to remain within the traditional crafts like mats, brooms, tadi making, etc., but medicinal use and new chemical and other processes of the forest resources.

Organizational Imperative: It has been the experience of several decades that the present bureaucratic machinery is not appropriate for the provision of services, imparting education and organizing productive activities through active participation of the tribals. It is therefore necessary to take a departure from the present administrative set up. It is suggested that a new cadre which would include both tribals and non-tribals, specifically committed to live and work with the tribals in the remote areas be created, and stationed in the district to formulate and implement comprehensive plans prepared in cooperation with the local population. The experts and specialists from the universities, government departments can help in relation to specific tasks. Educational programme, including health education and health services should also be developed on similar lines.

For the protection and development of forest resources the villagers will have to be organized into forest development cooperatives with its members taking the responsibility collectively to control free grazing, illicit felling of trees, etc., and contribute members according to availability

for the routine work e.g. nursery, plantation, etc. To complete seasonal work like harvesting of fruit, nuts, etc., the entire community can participate. Norms will have to be worked out by the cooperative for sharing of the produce between the members and also a share to be paid to the government. But the claim of the custodians, the local population should be primary so that the forest resources are conserved and the local population benefits from it.

Table 7.1 : Area, Population and Land Utilization in Goa, Daman, Diu and Dadra-Nagar Haveli in 1991

	Goa	Daman	Diu	Dadra and Nagar Haveli
Area (sq.km.)	3702	72*	40*	491
Persons (1991)	1169793	62101	39485	138542
Density (persons/ sq.km.)	316	862	987	282
Percent urban population	41.0	43.3	31.2	8.5
Land utilization**				
Total reporting area for land uti- lization purpose (Ha.)	361113	5573	4337	49547
Forests	105294	52	308	20826
Not available for cultivation	33137	1737	1959	2857
Permanent pastures and other grazing land	1305	-	-	-
Land under mis- cellaneous tree crops and groves	580	-	-	-
Culturable waste land	98615	57	1146	1114
Net sown area	122132	3727	924	23978
Percentage of net sown area to total area	33.8	66.9	21.3	48.4

Note : * According to Surveyer General of India

** Land utilization of Goa, 1986-87 for Other States - 1981

Table 7.2 : Area, Average Yield and Production of Major Crops in Goa in 1967-68 and 1987-88

	1987-88			1967-68**
	Area* (Ha.)	Average* yield kg/Ha.	Total pro- duction (tonnes)**	Total pro- duction (tonnes)
Rice	52902	2101	111122	71880
Ragi	1176	914	921	21400
Pulses	5810	787	4575	-
Groundnut	881	1560	1374	-
Sugarcane	1700	50588	86000	25000
Cashewnut	47311	233	11000	5000
Coconut	23237	4660	106.9***	80***
Arecanut	1304	1112	1450	1000
Vegetables	6500	8500	55250	N.A.
Banana	1379	6309	8700	N.A.
Pineapple	440	27500	6600	N.A.
Mango	3285	8980	29500	N.A.

* Provisional

** Estimates

*** Million nuts

Source : (i) Estimates of State Income of Goa, Daman and Diu, 1967-68 and 1968-69

(ii) Department of Agriculture, Goa.

Table 7.3 : Occupational Distribution of Workers in Goa, Daman, Diu and Dadra and Nagar Haveli in 1981

Occupation	Goa		Daman		Diu		Dadra Nagar Haveli	
	Total workers	Per-cent	Total workers	Per-cent	Total workers	Per-cent	Total workers	Per-cent
Cultivators	58376	18.8	3013	22.1	1183	15.6	26144	61.8
Agricultural Labourers	30556	9.8	1431	10.5	405	5.4	4592	10.9
Livestock etc.	14583	4.7	1953	14.3	1976	26.0	938	2.2
Mining and Quarrying	18985	6.1	35	0.3	227	3.0	1	-
Other	188746	60.6	7186	52.8	3805	50.0	10640	25.1
Total	311246	100.0	13618	100.0	7598	100.0	42315	100.0

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Source : District Census Hand Book, Goa District, Daman District and Diu District, 1981.
District Census Hand Book, Dadra and Nagar Haveli District, 1981.

Table 7.4 : Growth Performance of Different Local Species and Exotics at Arboratum in Goa

Species	Vernacular name	Year of planting	No. of seedlings	Survival (%)	Girth (gbh) (in cms.)	Height (in m) as on April 1988
1. <i>Acacia catechu</i>	Khair	1976	100	57	34.86	6.89
2. <i>Adina cordifolia</i>	Hedu	1975	250	93	35.03	6.24
3. <i>Anacardium occidentale</i>	Caju	1975	100	53	-	7.43
4. <i>Bauhinia retusa</i>	Apta	1974	250	80	38.51	6.46
5. <i>Bombax ceiba</i>	Sawar	1976	100	97	25.87	7.18
6. <i>Dalbergia latifolia</i>	Sissam	1976	100	79	32.40	6.53
7. <i>Lagerstroemia lanceolata</i>	Nano	1975	200	59	38.63	6.02
8. <i>Terminalia bellerica</i>	Ghoting	1976	250	56	33.14	7.19
9. <i>Tectona grandis</i>	Sagvan	1974	500	70	30.34	6.74
10. <i>Terminalia paniculata</i>	Kindal	1975	250	58	27.77	6.75
11. <i>T. tomentosa</i>	Matti	1975	500	72	29.18	6.69
Exotics						
1. <i>Acacia auriculiformis</i>		1976	100	84	58.00	8.15
2. <i>Eucalyptus alba</i>		1974	100	57	35.78	9.61
3. <i>Eucalyptus grandis</i>		1974	500	53	25.15	11.80
4. <i>Leucaena leucocephala</i>		1976	100	78	20.70	6.02
5. <i>Peltophorum ferrugenum</i>		1974	250	96	57.66	11.48
6. <i>Swietenia macrophylla</i>		1976	100	92	43.15	7.65

Source : Records of Forest Department, Goa.

CHAPTER VIII

DEVELOPMENT OF ANIMAL HUSBANDRY AND FISHERIES

In Indian planning targets for production are set in relation to final demand. To work out the requirement in the case of food items the nutritional norms are taken into consideration and projected requirements for cereals, pulses, oilseeds, etc., are worked out. Of course, the need, not backed by purchasing power, does not get translated into effective demand and even if the aggregate production is equal to the requirement worked out on the basis of nutritional norms, the needs of the ^{poorer} families remain unsatisfied, while the 'excess production' either turns surplus (as is happening in the case of milk production in Rajasthan today) or the product is turned into luxury goods (khava or panir from milk) for the benefit of the rich. To fulfil the targets thus set which in fact results in distorted use pattern, various plan schemes are introduced without proper consideration of the availability of natural resource base and the long term effects of these schemes on natural resources. For example as noted earlier, dairy development schemes that aim at boosting milk production through propagation of cross-bred animals and collection of milk from rural hinterland have given rise to a number of adverse consequences. The growth in the number of cross-bred animals means diversion of concentrates to these animals and deprivation of the indigenous draught animals and young stock. Strengthening the network for collection of milk from rural hinterland means, at times, diversion of small quantities consumed at home by peasants to obtain ready cash which may not be spent to buy equally wholesome food. It may lead to under-nourishment of the young stock due to the lure of sale of milk. It also means increase in the number of milch animals without consideration of the fodder resources, resulting in overgrazing and

deterioration of common pastures, affecting adversely the productivity of grasses.

A totally different approach to planning is necessary, to ensure sustained use of the natural resource base of the country and improvement in the standard of living of the poor, and the weaker sections. The standard of living should not be judged only on the basis of cash income but must be assessed with reference to the quality of life. Plan schemes should aim at resource conservation and increase in the yield in the long run on the basis of augmented resource base, and not at short run exploitation that leads to exhaustion of natural resources. It is necessary that the marginal lands be put under grass and tree cover on the basis of which livestock can be sustained. But there will be a waiting period of two to three years till the grasses get established and trees begin to yield. Lacking any cushion the poor are driven to cultivate the marginal lands not fit for agriculture, which means a very low return and progressive deterioration of land. Institutional arrangements for subsistence during the waiting period have therefore to be made, so that the marginal lands could be put to proper use and income of the poorer families improved. Further the livestock to be maintained should be related to the feeding capacity of the land, so that the animals could be maintained in good health and give yield according to their genetic capability. Proper arrangements for health care (immunization, etc.) and marketing of the produce (milk, kid, hair, wool, etc.) depending upon the product-mix will have to be made. Instead of devising individual schemes for cross-bred propagation, poultry improvement, fodder development, etc., which often fail due to lack of complementarity a comprehensive programme of resource development has to be taken up.

I. Approach to Development of Animal Husbandry

In planning animal husbandry it is essential to consider the comparative ecological adaptations and economic merits of

different types of husbandry in different parts of India. This is not done. The plan for the development of dairy, poultry and sheep/goat in a particular state is in the hands of specialists in Animal Husbandry Department and producer interest groups; without giving consideration to alternatives certain percentage increase in plan expenditure is made from one plan to the next. For example, the relative advantages of dairy and poultry must be compared and the choice made instead of having separate schemes for dairy development and poultry development. Chicken is a highly efficient converter of concentrates into eggs and meat, and egg protein is ranked higher in terms of biological value. In the allocation of limited resources, comparative advantages of dairy and poultry have to be evaluated.

Maximum biological production and desirable ecological equilibrium, defined as the intensity of use which gives maximum economic production for balanced human nutrition, but which does not lead to erosion, (excessive run off or desiccation of environment) has to be worked out and made economically and socially feasible.

The immediate aim should be to improve the nutrition of indigenous herds and flocks so that they would exhibit their true genetic potential and would be ready for selection and improvement. It is important to improve the breed of the non-descript cattle by cross-breeding them with indigenous breeds and not go in for the exotic breeds alien to the tropical climate and farm level cattle management practices and capabilities. Upgrading the quality of indigenous breed should be emphasized rather than promotion of exotic cross-bred animals.

Zonation of Development: It is important to introduce a zonation in livestock and dairy development. An economic gradient in relation to factors such as proximity to markets, accessibility and investment in relation to return should be recognized and appropriate planning strategy should be adopted. Milch

bovine should be maintained by stall feeding on high quality fodder crops within a radius of 20 to 30 km. of urban centres. In this area, integration of dairy and poultry with high fertility demanding varieties of vegetables and fodder crops should be attained. Municipal systems have to be so designed that the treated sewerage and garbage would be used for cultivation of grasses and fodder crops. Special fodder farms growing lucerne and other legumes and grass hays should meet the requirements of the milch cattle in the inner circle. Dry dairy cattle should be housed in outer areas of the inner ring. For feeding the cattle a combination of grazing supplemented, wherever necessary with tree-loppings and fodder should be worked out.

In rural areas, priority should be given to breeding of draught animals of recognized indigenous breeds. These animals are better adapted to low level of nutrition, wide seasonal fluctuations in feed and fodder availability and are well-adapted to adverse conditions e.g. shortage of drinking water, intense heat, etc. Local cattlemen have been always engaged in this type of animal breeding suited to the village environment. These indigenous breeds would provide draught cattle and milk for the owner and for local use, and organic manure. The manure supply will get augmented as the cattle gets better fed. As the natural grasslands have little potentiality for providing fodder to support production of milk, the aim should be to improve and manage the natural pasture for reproduction and proper feeding of draught cattle, so that, they can be maintained at the optimum level.

As noted earlier large portions of land in Rajasthan, Kachchh and the semi-arid tracts in Gujarat and Maharashtra are not suitable for cultivation and are fit for pasture and silvi-pastoral treatment. The attempts at pasture development have so far met with little success because of unrestricted grazing that makes for deterioration of pasture both quantitative and qualitative and hampers the natural growth of shrubs and trees.

Regulation and control of animal grazing is the first essential in any pasture development programme. During the last decade, a few, isolated efforts at such protection have been made. Four experiments, one in Rajasthan and one in Maharashtra, one in Gujarat and one in West Bengal are briefly reviewed here to get an insight into the various development possibilities.

1. Grazing Ban in Seed in Rajasthan

Village Seed (Udaipur district) registered under the Rajasthan Gramdan Act of 1971 provides an excellent example of how the village eco-system can be managed by a Gram Sabha. Being a Gramdan village, the Gram Sabha has full control over all the land within the village boundary. The Gram Sabha devised rules for protection of village commons. The common lands are divided into two categories: (A) lands on which both grazing and leaf collection is banned, (B) lands on which leaf collection alone is banned. The villagers cut grass only once a year from category A lands. Consequently even during the drought of 1987, Seed had ample grass. The Gram Sabha has a system of penalties to enforce regulated use of village trees and grasslands. Often the fines were levied on people from the neighbouring villages. In the denuded Aravalis the village commons of Seed are lush green with grass, shrubs and trees. The grass is equitably distributed among the households. That Seed is a homogeneous tribal village is an important enabling factor in the relatively smooth functioning of the Gram Sabha and equitable sharing of the benefits of the village commons (Agarwal, 1989, pp. 24-25).

2. Ban on Grazing and Tree Cutting in Laling, Maharashtra

In Dhule taluka (Dhule district) in Maharashtra rehabilitation of Laling pasture under the control of forest department has been effected through the initiative of the forest officials in cooperation with the villagers. The Government pasture land extending over 4100 hectares was given in mid-seventies to Raymond Wool Company for sheep development project. The villagers

Thus lost their right to use the pasture lands and hence agitated against handing of the land to the company. The land was vacated by the company in 1984. It was barren with no grass or trees. In 1987 the Conservator of Forests, Dhule organized a meeting of the village level officials and workers to discuss the issue of re-greening the pasture. Subsequently a decision was taken to (i) close the pasture lands to grazing, (ii) ban tree cutting, hacking from the pasture area, (iii) provide alternative employment through EGS to all those who depended on collection and sale of fuelwood from Laling pasture. These families were provided work on the water harvesting and other developmental works that were taken up for pasture development. The project was launched in July 1987. The scheme involved digging of pits (5m x 2m) with depth varying with soil type. The excavated soil was used for check dams planted with Anjan, Neem, Babhul. Two hundred hectares were replanted with 173,000 trees of Siris, Subabhul, Neem, Shisoo, Anjan, Kaseed, etc. The growth on southern slope was noted to be remarkable due to favourable soil-moisture conditions.

The villagers act as guards and prohibit grazing or hacking of Laling pasture. The landless and scheduled caste, scheduled tribe families are issued passes at Re.1 per headload, permitting them to cut and carry the headload to nearby villages for sale. They can earn about Rs.20 per day. This provided income to the landless and supply of fodder improved due to regulated use of the pasture. This boosted the dairy business in the villages nearby. The protection given to the area promoted the growth of trees like Anjan, Bor, Behada, Apta, Karani, Khair, Neem, Chinch, Palas, Pangara, Shisoo. The bor trees are being grafted to get improved varieties. The villagers are permitted to cut grass for own use at a nominal charge.

The experiment is now being extended to nearby Babulwadi pasture, Wadel pasture. The slogan of "charaibandi" (ban on

grazing) and "kurhadbandi" (ban on axe) is spreading to Satpuda ranges in both Dhule and the adjoining Jalgaon district.

Control of free grazing can thus make possible increase of fodder supply from village pastures and help improve their capacity to conserve soil and water. For ecological management it is necessary to determine the correct proportions that would be needed to maintain a uniform level of nutrition as between (a) natural grass-land managed on the basis of ecological succession, (b) natural grass-land ploughed up and reseeded with the best adopted species, (c) dry land fodder crops to provide grain and crop residue, (d) irrigated fodder crops to provide high protein feed and a reserve for critical period. The regeneration of grass-lands can be accelerated by hoeing of soil before rains, contour furrowing to facilitate retention of moisture and planting of tillers of local superior perennial species on contours.

On reseeded rangelands with suitable grass e.g. Cenchrus ciliaris under semi-arid conditions in Rajasthan 5 ewes per hectare can be maintained. Under high rainfall conditions in Maharashtra it was recorded that ten hectares of protected grass-land yielded 5000 kg. of dry matter in the first year, 12,500 kg. in the second year, and 30,000 kg. in the third year. The potential for improvement in pasture resources is considerable provided that the people who are deprived of a right to a particular resource are provided with an assured and adequate alternative.

3. Gauchar Development in Gujarat

Mahesana district in north Gujarat is a semi-arid region with an advanced dairy industry which is constrained by the scarcity of fodder. In 1978, the Mahesana Cooperative Dairy Union took over about ten hectares of common grazing land in Charada village of Vijapur taluka and developed it into a well managed highly productive fodder farm to which all members of the village, particularly the land-poor and landless had access.

In 1983, Gujarat Government covered the gaucher farms under IRDP. Since then a total of 15 community fodder farms have been started in Mahesana and 15 more are in the process of starting.

If a village wants to develop a fodder farm, it passes a resolution to that effect and the revenue department provides 10 hectares of common grazing land to the village dairy cooperative and the Dairy Union on a 15-year lease. The land is developed with capital inputs from DRDA, Mahesana Union and/or an aid agency and some bank finance. About Rs.25000 per hectare are invested in land development which involves land levelling, bunding, fencing, construction of sheds and tube well, acquisition of farm implements, a pair of bullocks, etc.

The farm is managed jointly by the village cooperative and the District Union. The Union provides technical support and the village cooperative provides general management and supervision. Two permanent labourers are stationed on the farm to carry out all the farming operations and guard the farm's property.

Generally most farms take three fodder crops a year and the productivity of the farm is observed to be very high in comparison with the general productivity of common grazing land in the village. In 1983, the average productivity of the 57.6 hectares of land under the scheme was 54.75 tonnes of green fodder, 2.8 tonnes of dry fodder and about one tonne of seed per hectare (NWDB, 1986). When the demand for green fodder is not high, available surpluses are converted into dry fodder. The fodder produced on the farm is sold at 15 paise per kg. to any member of the community. The buyer has to cut the grass from the farms; grazing is not permitted.

The Dairy Union has taken up the responsibility of initial capital costs because supply of fodder at subsidized rates to the cattle owners makes it possible to improve cattle nutrition augmenting the milk supply. The replicability of the programme would, therefore, depend on the initiative taken by an agency

like Dairy Unions which have the necessary financial resources and can arrange for technical and managerial inputs.

4. Forest Protection Committees in West Bengal

West Bengal has a very small proportion of land under tree cover and it is concentrated in the northern and north-western parts of the State. However, Forest Department of the State has vast tracts of land under their control and management, more than half of which is in different stages of degradation.

Management of forest has, so far, meant keeping people out, and exploitation of the resources on commercial basis. When the resources have been depleted through indiscriminate exploitation, attempts made by the Forest Departments using the administrative machinery to regenerate resources in the degraded lands have not proved to be successful.

As a significant departure from the routine approach followed by Forest Departments in the past, the West Bengal Forest Department has initiated a new approach in involving the local inhabitants to regenerate the forest.

An experiment was initiated in 1971-72 by an innovative and imaginative District Forest Officer at Arebari in Midnapur district in an area of 1000 hectares of degraded land involving the inhabitants of three villages on the forest fringe. What was visualized was not just consultation but partnership implying giving duties and responsibilities to the people as well as recognizing their rights on the forest produce.

The essential component of this approach was that while the Forest Department would provide the necessary inputs, the villagers would organize themselves and form a Forest Protection Committee that would protect the forest from free grazing, from cutting and trespassing. In return, the villagers would receive 25 per cent of the wood at the time of the harvest i.e. about 10 years later which would fetch about Rs.4000 to Rs.5000 to the

family. Plus they also receive the non-wood forest products all through the period.

Investments of about Rs.400 per hectare was made in the initial stages; but in areas where root system of the Saal trees was intact, the expenditure was Rs.250 per hectare. The amount of forest land protected by a family varies over a very wide range between one hectare per person to 9 hectares per person depending on the availability of land and the number of families willing to become members of the Forest Protection Committee.

The approach became popular particularly over the last five years or so and 1300 Forest Protection Committees have been formed, functioning in over 2000 villages and the area under protection is about 1,52,000 hectares. This is about 40 per cent of the total forest area in the Western Circle, of West Bengal.

A major hurdle in implementing the programme was that the State Forest Department needed a document from the Central Government empowering it to make an agreement with the people regarding the management of forest resources. It was difficult to sustain the interest and involvement of the people without such an agreement. However, committed political leadership at the local level as well as interested bureaucracy helped in sustaining the interest of the people. With persistent efforts, the West Bengal Government finally procured in July 1989 the document empowering them to enter into an agreement with the people for the management of forest land.

The population in the area is mostly tribal. The Santhal and Munda tribes have strong religious and cultural ties with the forest, particularly, the Saal trees that dominate the forest in this area. The bureaucracy respected these ties and modified forestry operations to suit the traditional preferences of the local tribal population. For example, the people preferred shade of the trees to higher income in some distant future and, therefore, multiple-shoot-cutting operations were not carried out.

The people are also gradually changing their ways. They are adapting themselves to stall feeding of cattle (FRCP, 1989).

The above four cases indicate the development potential in hilly areas, forest tracts, semi-arid region, etc., in active collaboration with the people and equitable sharing of the produce. We will now consider the scenario for 2001 A.D. for the Western Zone of India, dealing first with the cattle population, then with sheep and goats and lastly the poultry.

5. Dynamics of Livestock Population

The basic wisdom of the rural population is reflected in the composition of bovine population in most places. Among the cattle, there are cows enough to breed a given population of bullocks for the next generation while in the buffalo population, there are male buffaloes just enough in number to fertilize the female buffaloes so that the lactation cycle is maintained without a break. That is why, at the village level it is not easy to put one's finger on a definitive surplus bovine.

The population dynamics of cattle shows that, to have a stable population of bullocks over a generation, assuming 80 per cent fecundity and four calvings on an average over the reproductive period, about 63 adult cows are necessary per 100 bullocks. In Gujarat, the proportion of adult cows to adult bullocks is about just the same.

For Maharashtra, however, this ratio was 78 cows per 100 bullocks in 1982. A large majority of the cows in Maharashtra are non-descript. Besides, general debility of cows because of malnutrition also results in a higher than normal level of sterility, still-births, etc. Hence the ratio between cows and bullocks is higher in Maharashtra.

In Rajasthan there are 140 cows per 100 bullocks as cows are maintained, particularly in Western Rajasthan for milk production.

If we examine the trend in the growth of different

categories of livestock in Western Zone of India and project the livestock population for 2001 assuming that the trend will continue (Table 8.1) it will be noted that the population of bullocks and cows is likely to increase only marginally. As a result of promotional efforts by the government over the last 20 years, the buffalo population has increased at a high rate between 1961 and 1982. The projected buffalo population for 2001 will be higher by about 30 to 40 per cent in relation to 1982 population, in the case of she-buffaloes.

Sheep and goat are the other major component of livestock population and their numbers are continuously on the increase. The biological dynamics and the economic rationale for sheep and goat breeding explain this phenomenon. Goats attain maturity early and the first calving is at around 18 months of age; it also has a shorter pregnancy period of 5 months. On an average a goat has three calvings in a period of two years. In the total life span of 10 to 12 years, a goat has a reproductive period of about 5-6 years and has 7 to 8 calvings. Besides there is about 25-30 per cent probability of twinning or multiple births among goats. All this makes for a higher rate of growth of sheep and goat population. Reared mainly as meat animals, the male kid obtains higher price. The females are not usually disposed off before they complete their reproductive cycle. The slaughter rate is about 40 to 42 per cent. Thus there is a built-in acceleration in the growth of sheep and goats. The projected sheep population in 2001 A.D. would be higher by about 30 per cent in relation to 1982 population in Gujarat and Rajasthan and 23 per cent higher in Maharashtra while in the case of goats, the expected increase is by about 40 per cent over the 1982 population.

The proportion of crossbred cows in Gujarat and Rajasthan is almost negligible according to 1982 Census. Efforts are however being made at the Government level to propagate crossbred

cows for milk. One has to re-examine the wisdom of propagation of crossbred cows in an economy which has its own celebrated cattle and buffalo breeds known for their genetic superiority and productivity in terms of overall economic functions of cattle in an agricultural economy.

As cattle in India are chiefly agents of production and only subsidiary sources of objects of consumption, lactation is less important than draught and tractive functions vital for the production and processing of food and cash crops. The Indian Council of Agricultural Research has specifically cautioned that if milk production is unduly pushed up, it may cause a deterioration in the draught quality of the cattle and affect the entire basis of agriculture in India (George, S., 1985).

Crossbreeding with exotic strains will increase milk yields substantially, but only if their large appetites for high cost rations are satisfied; the improvement in milch performance will be at the expense of work capacity (George, S., 1985). To feed the high yielders, arable land, irrigation facilities and fertilizer will have to be diverted from food to fodder production and to persuade farmers to make the switch, procurement prices for milk will have to rise sharply while those for agricultural produce increase less dramatically or remain static (George, S., 1985). Empirical evidence also shows that the crossbred bullock eats far more than the indigenous bullock and can work only during cool hours.

6. Dairy Development

Gujarat has had a long tradition in dairy business and a number of natural milksheds had grown. Milk being extremely perishable, there were definite limits on the amount of milk that could be transferred to the cities from the nearby rural milksheds. Traditionally, the surplus milk was converted into ghee and khava which was an inexpensive method of condensation, conservation, storage and transport of surplus milk. With the

introduction of pasteurization and refrigeration technology began the modern dairy development in Kheda district, known for its milk production. A beginning was made in 1911 by a German producer, followed by Polson - a Parsee entrepreneur who installed in 1929 a plant at Anand to manufacture milk powder and butter.

Anand Pattern: A cooperative union of milk producers societies - The Kheda District Cooperative Milk Producers' Union was formed in 1946. Introduction of cooperative network did result in the elimination of the middlemen and small and big milk producers in the rural areas became the owners of AMUL at Anand. The union performs three important functions for its members: (a) develop marketing facilities for all the milk the members want to sell, (b) sustain the growth of milk cooperatives and (c) provide a package of technical inputs to members to enhance milk production throughout the district. Thus the famous Anand Pattern emerged in Kheda and then spread to other districts under the Operation Flood Programme since 1960s. Further impetus to promotion of dairy business mainly based on distribution of buffaloes to small and marginal farmers and landless labourers was given by Operation Flood II, launched in 1979.

The number of cooperative milk societies as well as membership in Gujarat has almost doubled during the last decade and processing capacity for over 34 lakh litres per day has been created. The present production is estimated at 88 lakh litres per day or about 30 per cent of the total milk production of the State. Pushing up the dairy business has created competition between food and fodder production and yet there was an estimated deficit of over 18 per cent in dry fodder and over 28 per cent in green fodder in 1983-84 in this tract. Such shortages in fodder leave particularly the non-milch cattle and young stock underfed resulting in deterioration in their current and potential productivities.

The processing and marketing of milk in this pattern involves energy intensive processing and long haulage of fluid milk from far-off rural producers to the central dairy. The costs of handling ranged from 80 paise per litre for the conventional bottling of milk while it was as high as Rs.2.20 per litre for modern packaging like tetrapack. This excludes the initial capital investment which runs into crores of rupees. With rising prices of diesel, furnace oil, electricity, the handling costs are bound to increase further.

Aarey Pattern: The Greater Bombay Milk Scheme was a pioneering scheme in the distribution of milk to urban population. Aarey Milk Colony was established on the outskirts of Bombay soon after independence. It was a very successful suburban cattle colony bringing together, organizing and supervising urban milch-stock. Under this approach, good stable facilities were provided close to the urban dairy and the city cattle-keepers were encouraged to move their animals to these premises, thereby helping to clear the city of cattle while also creating assured supply of milk to city's dairy plant.

The compact and self-contained nature of Aarey Colony allowed for effective management as well as direct communication between officials and milk producers and has to be contrasted with the scattered, widely dispersed nature of rural dairying. The need for transportation of milk is kept to the minimum. In fact Aarey was able to provide steady supply to the urban consumers even in the early seventies when adverse agricultural conditions drastically affected the production of milk in the rural areas.

It is suggested that cooperative network should be used for the establishment of city dairy units on the Aarey pattern to serve the urban population in cities. That will save a lot of costs of preservation and transport and yet give all the benefits of cooperative network both to the milk producers and urban consumers.

As far as expansion of dairy business in rural areas is concerned, it is suggested that no further promotion of dairy business through government efforts should be made unless the present shortages in fodder supply are removed and the present livestock population is better fed.

7. Schemes for Propagation of Crossbred Cows

Propagation of crossbred cows is being done in different States through special schemes like IRDP or Special Livestock Production Programmes for farmers and landless labour on the basis of subsidies and loans. These units are expected to be set up to supplement the incomes of the rural poor.

The high yielding exotic breeds however can be profitable only as a regular industry with a sizable herd so that the risks are minimized. It needs an established infrastructural network for A.I. service, veterinary service and collection of milk. In the interior rural areas, it is more rational to maintain cows for production of bullocks, improve its breed crossing it with the indigenous dual purpose quality breed and keep the milk for home consumption or local sale.

8. Goat Keeping

Goat rearing as current today does not provide a reasonable cash return to the family. It was noted in a study carried out in Rajasthan in Ajmer and Sirohi districts in 1985-86 that the herd size varied between 1-3 and 30 animals, the average being 9 in Ajmer district and 14 in Sirohi district. As one person has to attend the herd, the per day return worked to only Rs.1.8 in Ajmer and Rs.1.2 in Sirohi (Ahuja, Rathore, 1987). Actually it is mainly the free labour of women and children that is being used for goat keeping and hence returns at the market rate are not expected. The free fodder from forest/scrub trees and free family labour sustain goat keeping. However, the increasing shortage of fodder resources creates a conflict between the opportunity to earn a small cash income

by the resource-poor families and the ecological considerations of conservation of natural resources.

Goat rearing can be the main occupation in the arid, semi-arid tracts particularly of Western Rajasthan as this tract is suited to range land development. For this, it is necessary to put all the marginal lands not suited for cultivation under silvi-pastoral system. The feed resources can be augmented through improvement of range lands - by reseedling, and introduction of trees like Prosopis cineraria. Fodder banks have to be established to meet the needs in lean season. The quality of forage can be enriched with urea and molasses. The animal stock in arid zone is basically of good quality breed even though breed deterioration is noticed. To ensure breed improvement, the important factor is distribution of good quality indigenous breed bucks. It is prudent to select superior quality animals from among the indigenous breeds and not go in for cross-breeding programme as the crossbred animals cannot tolerate the desert heat and forage over long hours on loose sandy soil, under the desert sun; go in search of water to far away points; tolerate parasites. Facilities for water supply have to be improved in the range lands through careful measures of conserving moisture in situ. Infrastructural facilities like prophylactic health cover against endemic diseases through regular vaccination, dosing, spraying, etc., facilities for sale of animals for meat at standardized prices and good quality bucks for propagation have to be improved. Stock improvement and provision of feed to meet the nutritional requirements will improve the return per animals. The herd size can be reduced once the income per animal is enhanced and the pressure on fodder resources can be reduced. If the available resources are optimally used it can give maximum return to the herder. To achieve this land use planning and controlled grazing have to be accepted.

In Maharashtra there are 17 lakh families scattered over 30,000 villages rearing over 90 lakh goats. On an average about 26 per cent households in a village rear goats. Such goat rearing to supplement the incomes of the asset-poor families can be sustained only under stall feeding. The waste land and village commons can be developed to yield rich fodder only if free grazing is prohibited, and appropriate measures for soil and water conservation, reseeding and plantation of fodder trees are taken. The fodder resources thus developed can be made available to the landless or land-poor goat keeping families at a nominal charge. Stall feeding would help conserve the energy spent in roaming and promote increase in milk yield. It will ensure better collection of manure. Uncontrolled mating can be prevented and incidence of contagious diseases reduced.

Once the feed resources are augmented and uncontrolled mating eliminated, it would be possible to bring about breed improvement. The improvement in health and marketing infrastructure where goats are purchased on weight basis together with the above measures will help increase the income per goat.

9. Sheep Herding

Sheep are reared in flocks and most of the shepherds are migratory. In Maharashtra sheep rearers are nomadic Dhangars. There are about 85,000 families engaged in sheep rearing. Sheep are concentrated in the scarcity tracts. The average size of flock is about 40. Sheep subsists on crop residues, weeds and forest and pasture lands. Because of migration the animals are exposed to health hazards due to lack of adequate feeding material en route, lack of shelter for young animals in winter, etc., and the rate of mortality is high. The shepherds maintain rams in their flocks. This practice results in, inbreeding. The estimated average annual income per sheep is Rs.60. About 70 per cent of this is from the sale of animal, and most of the rest from the sheep folding or sale of manure.

The income from the sale of wool is negligible. The present level of economics in sheep rearing does not permit any cash expenditure for feed for sheep. The shepherds are thus caught in a vicious circle. Unless there is an improvement and upgrading of breeds, shepherds cannot afford to pay for feed. However, unless the hazards of diseases and risks of mortality are reduced the shepherds cannot go in for improvement. Also unless there is pasture improvement and fodder development programme the necessary feed will not be available. Thus the programme has to begin with (A) Pasture improvement programme on Forest and Government waste lands coupled with controlled grazing, harvesting of hay and supply of hay to shepherds free of cost, (B) Processing of crop residues of wheat, maize, bagasse by treating with molasses and urea and baling the same and supply of these at low cost to shepherd, (C) Provision for supplementary feeding at the time of breeding, late pregnancy and lactation, (D) Prophylactic health cover against endemic diseases through vaccination, dosing, spraying, etc., have to be strengthened, (E) Promotion of insurance cover would increase the viability of sheep rearing activity. These services could be extended through sheep co-operatives.

10. Special Case of GOA

In Goa the problem of livestock development has its own peculiarities and must be addressed innovatively. The cattle in Goa is non-descript, small in size with low milk yield and draught capacity. The main fodder - paddy straw and grass - has low nutritive value. In coastal tract there are not many working animals and in hilly tracts cattle is maintained mainly for manure. Stray cattle is a great menace to horticulture and forestry, the two important sectors of the economy, get damaged by cattle. Attempts should therefore be made to work out of a strategy such that cattle, goat are not needed. Natural farming technique can be experimented in Goa. It is well-suited to rice

cultivation. Use of straw and addition of chicken manure is the best way of fertilization. Fish and rice culture also can be appropriately combined. Considerable experimentation must be carried out to arrive at appropriate technological mixes. The basic approach should be to confine dairy, piggery and organized poultry near urban areas to meet the urban demand, and to have indigenous chicken or other animals mainly for local use in the rural areas. The animals should not be left roaming but should be stall fed, so that regeneration of forests, development of cashew and coconut orchards will not be hindered.

11. Fodder Supply and Requirement

Fodder supply and requirement for projected livestock population in 2001 A.D. on the basis of economic feeding is presented in Table 8.2 for the Western Zone of India.

The main source for dry fodder is straw and hence the fodder supply would be dependent on the production of food crops in the State. The incremental supply of green fodder is expected to be drawn chiefly from grass production in the pasture lands and waste land development.

In case of grass production from pasture lands, production in 2001 is estimated on the assumption that silvi-pastoral development and better management will be extended to grass lands and this will increase the average productivity from the present level of 0.6 tonne per hectare of dry matter to 2.0 tonnes per hectare of dry matter.

The mainstay for grass production will have to be waste land development in the State. It is suggested that at least 25 per cent of the waste land should be developed for silvi-pastoral regime over the next ten years. The productivity in 2001 A.D. is assumed to be 2.0 tonnes per hectare.

All this development will need comprehensive and scientific management of the grass lands and the waste lands in these States. This will need tremendous and well coordinated effort at the

government level in cooperation with the village community. Even then, a small deficit is expected in Gujarat and Rajasthan. To achieve the desired levels of production, a holistic approach to the livestock development must be followed which alone will provide a realistic and sustainable development of livestock population which is symbiotically linked with the agricultural situation in these States.

12. Poultry

Growth of poultry business from a backyard activity to large modern agri-business can be traced to planned research and development strategies adopted since the mid-sixties leading to the massive application of modern technology of intensive system of housing and management, availability of genetically superior hybrid layer and broiler chicks, nutritionally balanced feed, better health care in short scientific breeding and management of large flocks.

The poultry population in Western Zone of India nearly doubled during the period 1961-1982 (Table 8.3). Poultry is considerably developed in Maharashtra State due to urban demand, while in Rajasthan poultry is much less numerous as local demand is relatively low due to vegetarianism among the Jains.

A special social role is being attached to poultry farming in rural development on the basis of its expected triple benefit viz. generation of self-employment, supplementary income and production of protein-rich food at a relatively lower cost in comparison with other animal foods.

Poultry production for weaker sections is undertaken through a number of Central and State sector schemes. Despite the formulation of several schemes to encourage poultry farming for weaker sections, the results have not been encouraging since a majority of the beneficiaries opting for poultry farming gradually withdraw from the occupation due to several constraints like high cost of feed, supply of poor quality chicks, lack of

adequate health cover and efficient marketing system (Panda, B., 1989).

The entire research in poultry breeding is oriented to the large hatcheries. This includes health cover, housing and post-harvest technology including transport of eggs and meat, technology for extension of shelf-life of poultry products, diversification and sophistication of poultry products, etc.

India has immense diversity of genetic resources in respect of breeds of poultry some of which possess superior genetic merit and are well adapted to different ecological conditions. Efforts must be made to improve their productivity by selective breeding or upgradation. It would significantly improve egg production.

Studies on native chickens undertaken at IVRI, Izatnagar and H.A.U. Hissar suggest that it is possible to improve the economic traits of native chickens by use of appropriate breeding technology. The research has also brought out several positive traits in native chickens.

The native chickens for example although produce fewer eggs and those too of smaller sizes, consume less feed and mature earlier (Mohapatra, S.C., 1989). Percentage fertility and percentage hatchability is also superior for native chickens as compared to exotic chickens. Native chickens are superior to White Leghorn in respect of edible meat and shrinkage loss. They are also found to be more resistant to common chicken diseases like spirochaetosis than White Leghorns and are also less susceptible to heat stroke due to their small size and compact feathers (Mohapatra, S.C., 1989).

The strategy of development of poultry has also to be a two-pronged one as in the case of dairy. Large commercially run poultry farms, organized as agri-business should be located on the urban fringe. Poultry development in the rural areas should be based on the improvement of local breeds, extension of veterinary services and guidance with a view to improve the

nutrition of the rural population. The weaker sections should be financially assisted to maintain a modest sized flock which could give them better nutrition and a few eggs and birds for local sale.

The essentials of the approach to livestock development can be summed up as follows:

(1) The funds available for Animal Husbandry should not be diverted to a variety of promotional schemes that support purchase and rearing of milch animals and goats on individual basis.

(2) Holistic policy for livestock development should be worked out which should include:

- (i) Development of pasture lands and waste lands on a priority basis with active cooperation of the villagers and voluntary enforcement of ban on free grazing.
- (ii) Provision of assured equivalent income if weaker sections get displaced due to pasture/waste land development.
- (iii) Equitable sharing in the developed pasture resources with priority being given to the weaker sections.
- (iv) Emphasis on provision of draught power and family consumption of livestock products in livestock development at village level.
- (v) Emphasis on improvement of local breed on the basis of quality indigenous breeds, and not alien exotic breeds.

(3) Animal rearing activity should not be encouraged as a supplementary source of income if local resources are lacking as it puts strain on the common local resources. It should be an integral part of the land use plan and developed mainly on the basis of by-products. As pasture and waste lands develop, the activity could be appropriately expanded.

(4) Special land allocation should be made near urban centres for development of dairy and poultry on scientific

lines to meet the urban demand, and to ensure conjunctive use of sewerage, compost, etc., with dairy farms.

II. Marine Fisheries

The Western Zone has three maritime States viz. Gujarat, Maharashtra and Goa with a total coastline of over 2500 km. and a huge continental shelf of over 2.6 lakh sq.kms. The declaration of the 200-mile Exclusive Economic Zone (EEZ) in 1976 marks an important milestone in the economic development of the country as it offers immense prospects of utilizing the marine resources of the extended economic zone. The fish resources, the most important among them offer a potential source of protein-rich food.

At present most of the marine fishing is done by exploiting only the resources of the coastal waters upto a depth of 50-60 m. which means that about 25 per cent of the continental shelf area and about 5 per cent of the EEZ is only utilized. The challenge is of utilizing the bountiful resources of the deep sea and oceanic waters.

With the declaration of EEZ, the need for collecting resources information was keenly felt. The Exploratory Fisheries Project in 1974 and later as Fishery Survey of India in 1983 started comprehensive survey of demersal and pelagic resources of the Indian EEZ. As a result, it is only recently that we have a fairly good knowledge of the demersal resources of the continental shelf and the continental slope upto a depth of 500 m. all along the Indian coast.

1. Gujarat

Gujarat has a long coastline of 1640 km. Introduction of mechanized boats started in 1956 in Veraval. However, the traditional fisheries accounted for the bulk of State's catches until late sixties. With the beginning of seventies, more and more private entrepreneurs entered business employing mechanized trawlers, dol netters and gill-netters. Now the mechanized

sector's contribution is over 80 per cent. The total landings was 1.94 lakh tonnes in 1975. The landings in 1985-86 were reported to be 3.31 lakh tonnes. Major groups of fishes in Gujarat landings are Bombayduck, Croakers, Pomfrets, Elasmobranchs, Catfish, Penaeid and non-Penaeid prawns, and crabs. Local consumption of fish and fish products is about 30 per cent of the State's landings and 70 per cent is exported to other States of India.

Exploratory Fisheries Project conducted test fishing operations along Gujarat coast between latitude 20°N and 23°N during January 1979 and September 1981. The findings are very encouraging and have shown that the Gujarat coast is the most productive area in the country which is by and large under-exploited. The survey reveals that the Gujarat coast has extensive trawling grounds with rich demersal resources. A large number of quality fish species including pomfrets, perches, croakers, carangids, squids, cuttle fish, etc., are available almost all along the Gujarat coast. Catch rates of all fish were observed to be generally high ranging from 208 to 524 kg. per hour.

In the case of Gujarat, the shelf area is vast and trawling grounds are extensive. A number of rivers and creeks in the State also contribute to the nutrients thereby increasing the organic production. Kachchh region is very rich in the resources of clam, cockle, oyster, chank, seaweed coral, etc. While shells and corals are being destroyed for manufacture of cement, large edible resources like clams, edible oysters, chank, etc., are not being properly harvested. The pearl oyster resource found in Gulf of Kachchh is also exploited only to a limited extent and a small pearl fishery is run on the Kachchh coast. The catch per unit effort has not generally reduced, there is therefore a further scope for introducing new units. Drift and set gill netters units may be introduced in South Gujarat and Jamnagar while more trawlers can be operated in Jamnagar coast region and

Kachchh region. Dolnetters units may be introduced in the Saurashtra Coast.

2. Maharashtra

Maharashtra has a coastline of 720 kms. and ranks second among the maritime States of India in terms of marine fish landings. There are 153 landing centres situated in the five coastal districts of the State. Several types of boats, mechanized and non-mechanized using different gears land their catches. Bombayduck, panæid and non-panæid prawns, croakers, pomfrets, catfishes, elasmobranchs, perches and ribbon fishes are some of the commercially important groups which form the bulk of landings. For early sixties, the marine fish landings in the State have been steadily increasing mainly owing to the increase in the mechanized fishing. This increase continued upto mid-seventies and thereafter the landings have more or less stabilized, around 2.5 lakh tonnes.

Mechanized landings have increased over the years from about 57 per cent in 1975 to over 93 per cent in 1984. Almost all the landings of two important varieties viz. Bombayduck and non-panæid prawns are landed by mechanized craft. There has been a considerable improvement over recent years in the landings in the districts of Raigad and Ratnagiri. These two districts hold a promise of yielding higher catches. Adequate infrastructure facilities for berthing, processing and marketing are essential prerequisites for promotion of the industry.

Matsya Varshini surveyed this coast during April 1980 and May 1983 between latitudes 16°N and 19°N upto 100 metres depth. In 16°N the shallow waters between 20-40 metres were found to be highly productive with a catch rate of about 464 kg. per hour. 17°N and 19°N also yielded fairly good catches of around 200 kg per hour in 20-40 metres and around 100-125 kg per hour at 70-100 metres. 18°N yielded highest catch rates of 487 kg per hour in 20-40 metres. Maharashtra area requires further survey especially in deeper waters beyond 100 metres. With regular

monitoring of the resources and proper management of material and marine resources the productive fishing grounds of Maharashtra will continue to yield higher and sustainable yields.

3. Goa

Goa has a coastline of 153 km. and a continental shelf of 10,000 sq.kms. The landings in Goa at about 38,000 tonnes in 1984 constitute between 1.8 and 2.6 per cent of total landings in the country. Mechanized fleet contributes about 34 per cent of total landings and non-mechanized contributes about 16 per cent.

Oil and other sardines, Indian mackerel, prawns, carangids, croakers are important species in Goa waters. Pelagic group of fishes constitutes around 57 per cent and demersal group constitutes 43 per cent of normal catch in Goa. It appears that there is a scope for increased landings from trawlnets while landings from purse seines, gillnets and non-mechanized gear do not indicate any scope for further increase. Penaeid prawns would continue to be the mainstay in commercial fishing while sardines and mackerel would continue to be the mainstay in landings.

Goa coast was intensively surveyed by Matsya Shakti and Matsya Vishwa in the depth ranges 0-300 metres during April 1985 and March 1986. The catch rates of 145 kg per hour obtained in latitude 15°N are comparatively low. 0-50 metres yielded a catch rate of 157 kg per hour and 100-200 metres yielded 245 kg per hour. The catch rates obtained in 50-100 metres and 200-300 metres were low and poor at 91 kg and 9 kg per hour respectively.

Maximum expected yield from Goa is estimated at 54,000 tonnes - with 45,000 from mechanized and 9,000 mt. from non-mechanized fishing. Considering the very low catch rate currently realized and also since increase in the total landings expected is marginal, it is not advisable to increase the fishing effort in Goa any more.

III. Inland Fisheries

Another important source of fish is inland waterbodies, rivers, etc. While riverine fishing is done usually under natural

conditions, extensive and intensive pisciculture is carried on in different types and sizes of stagnant waterbodies like ponds, lakes, reservoirs of dams, etc.

The important sub-sectors in inland fishing are (a) Fresh-water Fishing which includes fishing in (i) Ponds, (ii) Reservoirs of dams and (iii) Rivers. (b) Brackish Water Fishing which includes fishing in (i) Lakes, (ii) Farms either by capture or culture, (iii) Swamps and (iv) Estuaries.

Inland fishing on culture basis is done in small water bodies while it is done on capture basis in large reservoirs. Usually intensive pisciculture is done in 2 to 4 hectare ponds or tanks or lakes. In intensive pisciculture, fish food is added from outside. Semi-intensive pisciculture is done in medium sized waterbodies with say 4 to 60 hectares of surface area. In semi-intensive pisciculture, fertilizers or nutrients are added along with seeding and the fish food is produced in the waterbody itself. Extensive pisciculture is done in medium to large waterbodies with 60-1000 hectares surface area. In extensive pisciculture seeding alone is done and nature takes care of normal growth of the fish. In rivers and waterbodies over 1000 hectares of water-surface area fishing is done on capture basis. Capture fishing in large reservoirs is supported by stocking the reservoirs with young fish.

Fish seed is either collected from reservoirs, rivers, estuaries, etc., or produced in fresh water hatcheries, bunds, brackish water hatcheries, etc., and supplied to ponds, reservoirs, brackish water culture farms.

The most popular species for inland fish culture are the major carp viz., catla, rohu and mrigal and most of the fish culture carried on in Gujarat, Maharashtra and Rajasthan and Goa is practically based on major carp culture. At times composite carp culture which includes, besides major carp, exotic carp like silver carp, grass carp, common carp as also

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other species like labeo, bota and rebo, and catfishes like singhala is adopted by enterprising fish farmers.

Inland Fish Production: Inland fish production in Rajasthan, Gujarat, Maharashtra and Goa in 1980 and 1984 is presented below:

	Inland Fish Production (in 1000 tonnes)	
	1980	1984
Rajasthan	13.5	16.0
Gujarat	16.5	25.0
Maharashtra	24.0	28.1
Goa	12.3	14.1
India	887.6	1082.0

Source: Hand Book on Fisheries Statistics 1986, Ministry of Agriculture, Fisheries Division, Government of India.

These States are, today, not very important contributors to inland fish production as the development of inland fisheries is limited. Although the technique of intensive pisciculture involving pond fertilization, manuring, supplementary feed to the fish has proved highly successful in increasing the yield of fish per unit of area in experimental ponds, it has not reached the fishermen.

Fish Farmers' Development Agency: During the Fifth Five Year Plan, a new agency under the chairmanship of the district Collector was set up on pilot basis in selected districts. Upto 1980, the Central Government operated the scheme with 100 per cent financial assistance and later at 50 per cent financial assistance.

The broad objective of the Fish Farmers' Development Agency (FFDA) is to popularise improved techniques of fish culture so as to step up inland fish production in the existing tanks. The FFDA arranges to reclaim all culturable water area in the district and arranges to lease them to the fish farmers. It also acts as a nucleus agency for arranging finance to the

fish farmers through banks and for training fishermen for scientific pisciculture.

Between 1976 and 1979 FFDA's were established for Bhilwada, Tonk and Ajmer districts in Rajasthan, Surat and Panchmahals districts in Gujarat and Bhandara and Chandrapur districts in Maharashtra.

Evaluation of the FFDA programme done by the National Council of Applied Economic Research (NCAER) after about seven years of the operation of the scheme reveals that as against the poor yield rate of less than 50 kg per hectare in many of the ponds and tanks before the implementation of the scheme, the average yield rate for 1978-79 was 532 kg per hectare. However there is a further scope for increasing the yield and one of the main bottlenecks was identified as inadequate finance to buy the material inputs which are directly related to the yield rates (NCAER, 1981). The rates of return from inland fisheries from various departmental waters were also very low between Rs. 3.21 per hectare for forest department to Rs.62.99 per hectare for Revenue Department in 1971 as compared to Rs.349.35 per hectare for FFDA tanks in 1978-79 (NCAER, 1981).

The centre of fisheries development is, naturally, the fishermen. With low economic status, low bargaining power he faces natural and commercial risks which can be shared and therefore reduced if fishermen's cooperatives are formed. The strategy of fisheries development has to be an integrated strategy covering financial assistance and technical guidance, training in seed production, fish rearing, processing and marketing and this package deal should be offered by the State governments to fishermen's cooperatives. Marketing of fish through cooperatives as practised in Maharashtra, ensures better prices to the fish farmer as compared to the return secured under pre-harvest contracting or sale to wholesalers at pond site, common in Gujarat and Rajasthan. Reservoirs and public ponds/lakes should be leased out to the cooperatives on long lease basis.

For efficient use of reservoirs for fish production, there has to be a much better coordination between the departments for irrigation, power, fisheries and agriculture than what exists today. The pre-impoundment survey team should include representatives of fisheries department. Otherwise use of reservoirs for fisheries become difficult. The fisheries departments usually bear the cost of management and stocking of the lakes and pay a part of its revenue to the owner departments i.e. departments of irrigation and power. But the fisheries departments often complain that the owner departments do not consult the fisheries department before discharging water and this can damage the productivity of the reservoirs.

Fish Seed Production: One of the main hurdles in the development of inland fisheries is the non-availability of adequate quantities of fish seed. This results in seeding the waterbodies at sub-optimal rates which affects productivity. The area of waterbodies in ponds and the fish seed requirement in Gujarat, Maharashtra and Rajasthan at current seeding rates is presented in Table 8.4. Estimated potential for fish production in the reservoirs in Gujarat, Maharashtra and Rajasthan is given in Table 8.5.

The fish seed trade is, in most States, in the hands of the State governments and the main source for obtaining fish seed is Calcutta. The present source is localized in high rainfall region in the eastern India and adequate quantities of fish seed cannot be obtained due to the pressure of demand. State governments should, therefore, make all efforts to develop fish-seed farms and aim at self-sufficiency at an earliest date.

In Maharashtra, for example the present fish-seed requirement at optimum rate of seeding, which is almost double the current seeding rate, is about 50 crore. Maharashtra Government can buy about 12-14 crore of fish-seed from Calcutta which means that around 35 crore of fish seed must be produced locally. The

present level of local production, however, is only 6 crore. So, the inland fisheries development is at sub-optimal level both in terms of coverage and seeding rate. Technology for production of fish-seed is available and Maharashtra Government has already established 6 hatcheries in the State. By the end of Eighth Plan, the State government proposes to establish 21 hatcheries of different capacities at different places and aims at self-sufficiency at the end of Eighth Plan. The State Governments of Gujarat and Rajasthan have also included establishment of fish seed production/rearing farms as an important component of development of pisciculture in their Five Year Plans. Gujarat has conducted a survey of Gujarat coastal belt and located 132 sites of possible location for launching coastal aquaculture programme.

In 1980-81, inland fisheries sector contributed only one-third of total fish production in the country. By 2001, the domestic demand for fish in India is projected to be between 125 lakh and 200 lakh tonnes. Even if 50 per cent of it is to come from inland fisheries, the production will have to increase sevenfold (Srivastava and Vathsala, 1984). Thus, the scope for development of fish culture based on intensive fish-farming in moderate-sized ponds upto two hectares and extensive pisciculture in medium to large waterbodies of 60 to 1000 hectares of surface area is vast. Integrated planning and reorganizational efforts are needed to realize the potential.

Table 8.1 : Projected Livestock Population in Western Zone of India in 2001 A.D.

	Category						
	Bullocks 3+	Cows 3+	Young stock	She bu- ffaloes 3+	Young stock	Sheep	Goats
Projected livestock population in '000 in 2001 A.D.:							
Gujarat	3060	2035	2030	3340	2172	3123	4646
Rajasthan	3500	4862	4210	4115	2324	17431	21520
Maharashtra	6858	5350	4170	3099	1700	3297	10865
Goa	48	39	31	21	14	1	24
Total for Western Zone*	13491	12297	10455	10577	6213	23858	37073
Livestock population in 000 in 1982-83:							
Gujarat	3055	1942	1944	2558	1835	2357	3300
Rajasthan	3647	5097	4720	3115	2111	13431	15479
Maharashtra	6687	5247	4115	2307	1313	2671	7704
Goa	48	34	38	19	14	1	23
Diu and Daman	4.4	2.2	2.8	0.7	0.5	5.0	-
Dadra and Nagar Haveli	20	13	11	1	2	1	14

* Including Diu, Daman and Dadra and Nagar Haveli.

Source: Statistical Abstract, India, 1986, for 1982-83.

Table 8.2 : Estimated Fodder Production and Requirement for Western Zone of India in 2001 A.D.

		(In lakh tonnes)			
Year		Gujarat	Rajasthan	Maharashtra	Goa
1982	Fodder production*	155	313	240	2.3
	Crop residue as % of total fodder	80	54	80	35
	Fodder requirement	200	391	400	2.9
	Per cent deficit*	22	20	40	20
2001	Fodder production	255	440	460	3.0
	Crop residue as % of total fodder	75	57	65	27
	Fodder requirement	260	460	450	2.9

* In normal year

Table 8.3 : Statewise Distribution of Poultry in Western Zone of India, 1961-1982

State	(1000 No.)				
	1961	1966	1972	1977	1982
Gujarat	2048	2324	2736	3426	3572
Rajasthan	718	865	1235	1590	2219
Maharashtra	10578	9902	12217	18751	19844
Goa	N.A.	311	320)	413	610
Diu, Daman	N.A.	17	26)		33
Dadra and Nagar Haveli	N.A.	39	38	45	56

Source : (i) Statistical Abstract of India
(ii) Statistical Year Book of Goa

Table 8.4 : Area of Waterbodies in Ponds and Fish Seed Requirement in Gujarat, Maharashtra and Rajasthan, 1980-81 and 1990-91

	Gujarat	Maharashtra	Rajasthan
Potential area (000 Ha.)	33.67	54.86	66.38
Area under stocking (000 Ha.):			
1980-81	1.25	8.89	7.00
1990-91 (projected)	5.51	39.21	30.88
Seed rate (No. per ha.)	3438	2020	4311
Seed requirement in 1990-91 (lakh standard fingerlings)	275.50	1960.50	1544.00

Table 8.5 : Fish Production Potential in the Reservoirs of Gujarat, Maharashtra and Rajasthan

	Gujarat	Maharashtra	Rajasthan
Area of reservoirs (00 ha.)	1251	1052	1200
No. of reservoirs included	22	72	32
Potential production (00 tonnes) at:			
30 kg. per ha.	37	31	36
45 kg. per ha.	56	47	54
60 kg. per ha.	75	63	72

Source : Gupta, G.S. Freshwater Culture Fisheries, Present Status, Prospects and Policy Issues.

CHAPTER IX

REORGANIZATIONAL IMPERATIVE AND NEED FOR POLICY REVISION

I. Institutional Alternatives

The present approach to planning is growth oriented mainly on the basis of new technology of hybrid/improved seed, fertilizer and irrigation, which is mainly profitable to rich land owners and resource rich regions. This means continuation of exploitation and degradation of natural resources. It militates against socially optimal level of utilization of resources and promotes accentuation of inequality in the distribution of assets and income. The strategy therefore leads to perpetuation of poverty along with prosperity and growth, which remains confined to a narrow base of well-endowed regions and resource-rich land owners. The disparities in landholdings and incomes are tinkered with through state support to target groups such as small and marginal farmers, drought-prone areas, by offering subsidies or writing off loans, etc. Such palliatives do not solve the problem of non-viability of small land holding, under-employment, low wages and poverty. As the small peasant sector is inter-meshed in the powerful market system, state support cannot provide any solution to their problem.

At present many of the development measures like surface irrigation projects, well digging programme, bunding schemes are in operation either through the government agencies or with government assistance in the form of loans. A variety of schemes for agricultural improvement in the form of package of new inputs are being implemented. Special agencies like Small Farmer Development Agency are also in operation in selected areas. However, the present approach takes a factionalized view of the problem. Separate schemes are prepared for different size groups of cultivators on the basis of the existing distribution of

land ownership. Consequently, due to the lack of the essential complementarities the schemes show little impact on small farmers, so that the yield levels do not show significant changes in the case of a bulk of the farmers. Only a small section of cultivators with highly advantageous asset position is benefiting from such measures and as such the overall productivity levels do not show considerable improvements.

The alternative approach implies a thorough-going reorganization of the agrarian system. In this approach land redistribution and scientific land use are to be given a high priority. The state policy should extend support and help establishment of a network of cooperatives providing integrated service of credit, inputs and marketing facilities. To avoid creation of non-viable holdings after redistribution of land cooperative organization has to play a vital role.

The above alternative means opting for certain restrictions on the private property rights; however the proposition is not entirely new. In the past, the village community rights covered regulation and use of common lands including forests, ponds, waste lands, etc. It extended to private fields by way of rights of passage, right to graze, etc. However, under the colonial rule village communities disintegrated. Because of the loss of traditional community control, community resources got either privatized or over-exploited and this led to their degradation. The First Five Year Plan envisaged legislation which would entrust the village community with the management of the entire area of the village, both cultivated and uncultivated. The actual cultivation was envisaged to be arranged in family holdings through small groups of working blocks of land or through a combination of arrangements adopted to the operation to be carried out. However, no progress in this direction has been made largely because it is not in the interest of the large land owners.

Restrictions could be relatively easily acceptable in certain aspects e.g. (a) conservation and development of village commons including waste land, forest land, lakes, streams and such other natural resources, (b) development and maintenance of common social facilities like drinking water, workshop for village craft, community biogas plant, power distribution network, village roads, etc. Going beyond, community action needs to be carried out at the level of a village or a group of villages, for conservation and development of land and water resources that include contour bunding, rehabilitation of ravinous or sandy areas, provision of drainage system and minor flood control, conservation and regulation of groundwater, revegetation of waste lands, etc. Appropriate institutional arrangement and legislation to strengthen community rights e.g. right to determine layout of private holdings and fields so as to implement scientifically designed land use plan, right to graded development levy with a provision for exemptions to landless and small holders, etc., will have to be worked out. In this model, the community would be vested with a set of superseding and regulatory rights leaving to the producers the choice of organizing their production individually or cooperatively.

As noted in Chapter III, attempts so far have been made in India mainly to initiate development of village commons including waste land, forest land, etc. There are only a few cases of planning at the village level for conservation and development of land and water resources. We will briefly examine the types of institutional alternatives that are being experimented on for waste land development and watershed planning and then discuss the institutional arrangements needed for comprehensive land and crop planning.

1. Development of Waste Lands

The search for appropriate institutional framework to prevent degradation of waste lands has usually covered three broad sets of options: (i) Privatization of ownership and/or

usufruct rights. (ii) Assignment of property and/or usufruct rights to a cooperative/community. (iii) Ownership of waste lands by government/forestry departments/panchayats.

In India, experience of entrusting the task of redeeming degraded lands to government machinery has not been uniformly encouraging while community efforts today are confined mainly to small scale voluntary organizational efforts. The experience of farm forestry in Karnataka and Gujarat where lands have been transferred from crop cultivation to Eucalyptus plantations, shows that profit maximization strategies used by private entrepreneurs are not consistent with social and ecological goals.

Different institutional arrangements have several built-in advantages and disadvantages along several dimensions. The arrangement that prevails today which confers overriding rights to the government on forest lands, and to rural communities - now panchayats on village commons are, of course, a product of history and are becoming increasingly unviable as overall conditions in the society are changing rapidly.

Nine different institutional/organizational types of ownership of waste land and/or usufruct right on waste lands ranging from lands leased to private parties through open auction or leased to poor families with or without support system, to cooperative organizations and communal organizations, grampanchayats or retained by the forest department itself are examined for observed efficiency in development of land, investment effort, need for management at community level, possibility of poor families benefiting from the waste land development and replicability of the model on a large scale. A mapping of available institutional alternatives along with the experience on selected dimensions of performance is presented in Table 9.1 (Fodder Production, NWDB).

Broadly speaking, efficiency in the development and use of land was found to be high when land was leased to individuals on

short or long term basis, more so for long term lease. However, there is a tendency towards over-exploitation of land and the chances of poor families benefiting from such arrangement are low except where there is a strong support system to help them.

If the ownership is vested with the community and rewards are directly linked to the quality of individual effort, the efficiency of use of land was observed to be high and the investment effort to regenerate and develop productive resources was also observed to be high and the possibility of over-exploitation of resources moderate. The chances of poor families benefiting from the project were also noted to be high. However, such an organization needs effective management and control at the community level and unless local leadership is conscientious and effective, the organization has low replicability.

Grampanchayats, on the whole, showed a poor performance in efficient use of land, investment possibilities and benefits accruing to the poor families. There was also a tendency to over-exploit the land, probably by the economically and politically powerful in the village. The performance of the forest department, bureaucratically organized, has been proverbially unsatisfactory except a few pockets where the official hierarchy has recognized the need for people's participation as noted in the case of West Bengal.

Ownership and use rights vested in a cooperative of members have shown good results on all counts in Gujarat. While level of efficiency of development and investment effort for regeneration and development of productive resources were observed to be high, only moderate tendency to over-exploit land was noted. The need for good management and leadership is high. Given good leadership the possibility of poor benefiting from the project was also observed to be high. With due vigilance on the part of members and concerted community effort, the experiment can be replicated.

2. Watershed Planning

Implementation of a watershed plan is much more complex as it involves change in the use of private marginal lands from cultivation to silvi-pastoral use or afforestation. Unless arrangements are made for the subsistence of the families who will have to stop the use of their marginal lands for growing foodgrains, it will not be possible to implement the plan.

The marginal lands could be taken over by the community if they are in excess of the ceiling limit. However, if these lands are owned by small farmers their interest in the land will have to be retained, but for operative purposes they will have to be taken over by the community. These lands will have to be put under grass, tree cover, ponds, etc., according to the watershed plan. For executing these works the small farmers owning land in this tract and the landless labourers who are willing to work on these lands on a sustained basis will have to be organized in a co-operative. They will have to work in land shaping, nursery, tree planting and maintenance work and yielding grass, fuelwood, fruit, honey, gum, etc. They should be permitted to cut and take grass or fuelwood for personal use. Sale of headloads of grass/firewood should be allowed after they complete the necessary development/maintenance work. The wage component could be reduced gradually as the area develops and yields a critical minimum income. To restrict free grazing and collection of fuelwood by the villagers, the villagers will have to be assured of some benefit through the watershed development scheme. They can be given a share in the water resources augmented through watershed planning. A number of organizational experiments depending upon the community composition and interrelations, the resource development potentials will have to be undertaken to arrive at appropriate arrangement in each locale.

Suitable cropping plans will have to be prepared, keeping in view the water resources available for irrigation (surface

and ground), land capability and the community needs and crop specialization possibilities. The access to water should be made contingent upon observing the stipulations laid under the planned crop pattern for the area. To check over-extraction of groundwater, loan facilities should be tied to use of groundwater according to the stipulated plan. Cases of violation will have to be controlled through levy of fines.

For the formulation and implementation of land and water use plan the village community will have to be organized in a two-level system - a village assembly comprising all the villagers forming the general body and taking major policy decisions and an executive body representing various occupational/landholding groups in proportion of their numerical strength. The executive will oversee the implementation of regulatory measures and development schemes, and will be accountable and responsible to the village assembly. There has to be a continuous feed back of information, resources and know-how between neighbouring villages and with the district level planning body providing the necessary technical designing and planning services.

3. Comprehensive Land Use and Crop Planning

If the aim is to reach the benefits of agricultural development to the entire village community including the landless and small peasants, and to obtain optimum returns from the land and water resources it is necessary that all the natural resources in a given area unit are treated as a whole and operated with proper soil and water conservation measures, a comprehensive plan of land use, an appropriate crop pattern and scientific cultural practices. Execution of such a plan will not be possible unless the land resources along with the complementary resources like draught power and labour are pooled and utilized in a rational manner.

Pooling of land will mean a complete consolidation of holdings. This will result in saving in the effort and the cost

involved in operating a number of scattered fragments. Considerable amount of additional land will be available for cultivation if the field boundaries of the numerous fragments are removed. With the pooling of land resources, the measures of soil conservation, water conservation, forest and pasture development can be better implemented. Integrated pest control and fertilizer application will be facilitated if the land is pooled so as to form an optimal unit from the point of view of scientific crop management. Pooling of land resources can also help eliminate the malutilization of bullock power experienced today in the form of shortage of bullocks on small farms and idle capacity on medium farms. Judicious combination of mechanical power and animal power can also be achieved. Introduction of improved seeds, new crops, new agronomic practices will be possible if the risk is spread over a larger area and larger number of crops. Experimentation and innovations will be thus stimulated as the risk-taking capacity of the unit increases appreciably. All the above measures viz. improved agronomic practices, judicious combination of different types of fertilizers, measured water supply, pest control, etc., require scientific planning and certain technical and managerial skills. A small or medium farmer is not often in a position to get access to these services; moreover the scattered and small size of plots do not make it possible to apply the new methods even if he learns about them. With the pooling of land, problems of scientific planning and crop management can be easily handled. Necessary resources for the investment in equipment, machinery, vehicles, storage space, etc., can also be more easily mobilized. Storage and processing of farm output, use of cow dung to produce methane, collection and transport of milk, eggs, etc., will be facilitated. At the community level, improvement in the drinking water facility, use of agricultural waste and night soil for energy purposes, education and training programmes, etc., can be organized once a basis for community activity is firmly laid

down through joint farming.

Many of the development works are such that due to the indivisibility and lumpiness of the investment their execution is beyond the means of an individual cultivator. Some of the works, once started have to be completed upto specific limit. Programmes like afforestation, pasture development, cannot be undertaken without concerted efforts and full cooperation of the village community. The pooling of manpower, money and other resources will make deployment of the requisite investible funds and the manpower for the execution of different works possible. This will increase the level of effectivity of such programmes and help full and early realization of the benefits of the investments.

The programmes of conservation and development of natural resources are largely labour intensive. With proper organization, it should be possible to stagger the work schedule such that the manpower and the bullock-power available in the lean season can, with advantage, be utilized for construction and maintenance of land-shaping and water-harvesting programmes. The nature of many of these programmes is such that they can be suitably dovetailed to the work schedule in agriculture.

In the process, land and water resources will be augmented and intensive agriculture would be possible over larger areas increasing further the work available in agriculture. Pooling of land and other resources will make it possible to ensure better complementarity between land, labour and the capital assets and through this the work potential in agriculture can be increased.

A shift from subsistence agriculture to the scientific management of agriculture will help revise the present appraisal of a variety of potentially productive opportunities which are not currently being exploited. A number of non-resources of today could be converted into resources. The culturable waste and other under-utilized land can be turned into productive assets. Cow dung or animal bones available today in quantities

too small to be used properly, can be used for scientific preparation of manure. The collection of these materials, their processing, etc., will generate some work; so also improvement in the supply position of manure in agriculture will help increase intensity of cultivation, raise productivity and generate more work in agriculture.

Pooling of land and the joint cultivation will increase the scale of operation and management and will, in the process make for fuller and better exploitation of resources as well as increase in the employment potential of the rural economy.

Pooling of the land resource for its scientific management might be possible under state farming or cooperative farming. The former, however, does not involve the worker in active decision making which is left to the bureaucrats, while the latter implies active participation of each working member. It is, therefore, suggested that cooperative form of organization should be aimed for reorganization of agricultural activity.

1. To begin with, the ceiling on land-holding will have to be revised downwards. The new ceilings may be fixed at 10 hectares per household for dry cultivation and three hectares per household for irrigated agriculture. The necessary legislation should be enacted and enforced through the village committees in which all the size classes of landholders including the landless get representation proportional to their numerical strength in the village. The land in excess of the ceiling limit should be distributed to all the landless agricultural labour families in the village who are desirous of working on land and are also willing to join the cooperative. This step is essential to ensure that all those who join the cooperative have some stake in land and that the members do not have very unequal holdings, so that the large landholders exercise control over decision-making.

2. The land in the village should be cultivated through cooperative organization. Supply of loans, fertilizers and

provision of other facilities and assistance through the governmental agencies should be restricted only to the cooperative farms. The families in the village could be suitably grouped into agricultural cooperative teams of eight to twelve families each for the purposes of day-to-day agricultural operations and livestock management.

In principle, there will not be any absentee member except in case of households in which no able-bodied person is available for work. Thus every cultivator will become a participating member and payment may be made to a member according to his contribution of labour. A token payment may be made for his contribution in terms of land and major agricultural implements, draught cattle, etc., conditional to a specified contribution in terms of work on the cooperative farm.

Targets for yield levels would be indicated in the plan for each sub-watershed in view of the land capabilities. The cooperative teams operating within the sub-watershed would be expected to reach the yield levels set for the crops which they would be cultivating. If the total production exceeds this norm, a bonus payment may be made to the members of the respective team. A part of the bonus payment may be used for investment in some agricultural or community asset and the other part may be distributed among the individual members.

Eighty per cent of the net income of the team is suggested to be distributed as wages; 12 per cent may be used for land development and other capital formation in agriculture. The balance may be used for payment of return to capital contributed by members, for meeting community needs, etc.

3. At the village level, a village cooperative representing the agricultural cooperative teams will act as the coordinating agency. It will maintain an agricultural implements unit; will be responsible for storage and distribution of agricultural

inputs and storage and marketing of agricultural produce; will organize a centre for local experimentation and verification and extend agronomic advice to the member cultivators. The village cooperative will also look after the management of the forest and pasture resources of the village. It will also be responsible for water management and maintenance of bunds, drain, etc. The village cooperative will see that the land-use plan prepared in the formulation of the plan for the watershed is adhered to.

The cooperative societies at the village level operate presently as service cooperatives and extend services like supply of seed, fertilizer and credit, etc. Their services are availed of by the credit-worthy farmers according to their respective asset positions. Similar services which will be extended by the village cooperative under the new organization will, however, reach the entire agricultural community in the village operating in the cooperative fold. The village level cooperative will, in addition, play a vital role in the production activity and management of the resources of the village community. It will also act as a base unit in the chain of cooperative processing and manufacturing units to be organized in the region.

The present experiments in the cooperative organization in the country have not so far shown encouraging results and have, by and large, failed to uplift the small man. The main reason for such performance is that the cooperative structure is designed from above, organized in standardized patterns and at the operative level wielded by the power elite in the rural areas. The cooperative organization has to be built from the grass-root level so that scientific management of the resources as a whole would be possible and the benefits of such management could reach all the participating members.

The supportive role of the state is important for establishment of cooperatives and promotion of village level planning. The state will have to help in the development of

irrigation facilities. Water is one of the important exogenous resources which will have to be planned to take care of appropriate locale and size of the reservoir, full economic rehabilitation of the displaced families either on alternative land or other specific job/occupation, and equitable distribution of water. The state will have to take the responsibility of irrigation works upto minor surface irrigation schemes and provide the necessary information base, surveys and design, etc., for planning of village level surface flows and the groundwater.

The other important input is the support for experimentation under local conditions to work out optimum land use pattern, choice of tree species, fruit trees, grasses, mixed farming, mixed cropping, crop rotation, research on new varieties and supply of good quality seed, combined use of fertilizer and organic manure, processing of primary produce, development of appropriate technologies for meeting the village needs both in production activities and consumption sphere.

II. Suggested Policy Measures

The state will have to take the responsibility to stabilize prices so that a stable and assured income is received by the cultivator. Public procurement of surpluses at support prices, buffer stock operations, agro-processing and public distribution of foodgrains and other food items are the necessary complement of market regulation and price support. Purchase prices of all the regulated commodities should be announced at the beginning of each year. Arrangements for purchase at support price and storage will have to be made at the regulated markets for the commodities coming under regulation in each market. Its distribution/processing will have to be arranged through fair price shops, cooperative shops or state processing agencies like Maharashtra Agricultural Food Corporation (MAFCO).

Subsidies, if necessary, on fertilizer, water, power should be restricted only to small farmer/medium farmer joining

a cooperative, so also concessional interest rate should be available only to these categories. The rural banking network has to be coordinated so as to meet effectively the short term and long term credit needs of the cooperative farming units.

The necessary land reform legislation and enforcement of ceiling in cooperation with village assembly and a periodic consolidation of holdings programmes are the basis on which the developmental programme can progress.

The State government keeps on adding new departments and special agencies as and when some problems crop up - like Command Area Development Authority, Land Development Corporation, etc. Most of these departments are provided with extremely inadequate funds for the actual work expected of them. In many cases the establishment itself is inadequate but even this inadequate establishment is not fully utilized for want of working funds. There is a need to reorganize the departmental set up to ensure full coordination in work.

The State governments must make all efforts to generate funds necessary for comprehensive development through innovative tax measures such as progressive Land Holding Tax, progressive professional tax, etc. The Government of Maharashtra collects about Rs.160 crore for EGS through professional tax, There is no progression after income of Rs.2000 per month. A progressive professional tax ranging from 1 to 3 per cent of income could yield over Rs.500 crore in Maharashtra State.

If annually Rs.500 crore are mobilized through professional tax for watershed development, and the resources made available for Western Ghat development and similar schemes are added, it will be possible for Maharashtra to meet the expenditure of about 1000 villages every year. The problem is thus not of funds, but of mobilizing the grass-root level initiative and creating appropriate support machinery on the part of the Government.

At the same time it is essential to critically examine the allocations being made for new large surface irrigation schemes like the Sardar Sarovar project. In the future allocation of funds for surface irrigation priority must be given to complete the on-going projects including development of the command area with proper drainage arrangements and proper rehabilitation of the displaced families, scientific water use plan for utilization of the impounded water resources. As to the new projects, it was noted above that the per hectare cost for Narmada Project is about Rs. 50,000. Within the same amount, it will be possible to give benefit of comprehensive watershed development to about 14,000 out of 18,000 villages in Gujarat. The issue is thus not of paucity of funds, but whether the funds are to be utilized to benefit a particular section, displacing others, or for the benefit of all.

Today there is a plethora of bureaucratic regulations for petty matters - a legacy of colonial rule, but there is no overall plan frame and regulation. This needs to be changed. We have to have a scientific plan and to implement the plan certain regulatory and incentive measures are essential.

The initiative for preparation and implementation of scientific land use plan has to come from the grass-root level. Those who are today suffering due to the present development planning strategy - the small peasant and landless labourers who are put to great hardship due to unemployment, inflation, scarcity of fuel, drinking water, etc., can take the lead. The unions of agricultural labourers, artisans and peasants in the villages, supported by the unions of workers, women's organization, consumer cooperatives, associations of teachers, scientific workers, doctors, writers, engineers will have to come together for lowering of ceiling on land, land redistribution, forming of cooperatives, linking up the cooperatives of artisans,

construction workers, consumers, agro-processors. They have to take lead in the village assembly to plan the resources scientifically, to enforce the necessary regulating measures, to make provision for the necessary infrastructure.

Collection and flow of information are important for the smooth functioning of cooperative network as it would promote flexibility in planning and to incorporate appropriate new technology.

In the choice of technology two considerations are important. First, the choice will have to be based on efficient and economic use of raw material, minimum harmful effect (waste, pollution, accident hazard to worker). Second, the technique should emphasize recycling and continuous processing and minimize exhaustion of resources. The knowledge of modern science and technology has to be applied judiciously in view of the resource endowment, production priorities and provision of employment with progressive upgradation of labour productivity.

Table 9.1 : A Mapping of Available Institutional Alternatives for Waste Land Development

Institutional framework of ownership/usufruct right on waste lands	Efficiency in development and use of land (1)	Tendency to over-exploit the land (2)	Investment of effort and resources to regenerate and develop productive potential (3)	Need for effective management and control at community level (4)
1. Ownership and usufruct right vested in forestry departments	Moderate	Moderate-high	Low moderate	Very high
2. Ownership and usufruct rights vested in Gram Panchayats	Low	High	Very low	High
3. Communal ownership without well defined rights and responsibilities of members	Low-moderate	Very high	Very low-nil	Low (if present state is to continue)
4. Communal ownership with well defined sanctions on over-use	Moderate	Moderate	Very low-nil	Low (assuming that community can pose sanctions very high)
5. Ownership and use rights vested in cooperative of members	Moderate-high	Moderate	High	Very high

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Table 9.1: (Continued)

Institutional framework of ownership/usufruct right on waste lands	Need for powerful local level leadership	Chances of the poor benefiting from the land	Replicability of model on a larger scale	Empirical basis for making the inferences
	(5)	(6)	(7)	(8)
1. Ownership and usufruct right vested in forestry departments	-	Low-moderate	High	Existing experience
2. Ownership and usufruct rights vested in Gram Panchayats	Very high	Low?	High(i.e. if present state is to continue)	Existing experience
3. Communal ownership without well defined rights and responsibilities of members	Low(if present state is to continue)	Moderate-high (but will decline as the output becomes more valuable)	High(prevaling situation in grazing lands all over the country)	Existing experience
4. Communal ownership with well defined sanctions on over-use	Moderate	High?	Very low	Experience in most Indian villages until 40 years ago and tribal settlements now
5. Ownership and use rights vested in cooperative of members	Moderate-high	High-very high	Moderate-high	Gambhira co-op. Mehsana experience

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Table 9.1 : (Continued)

Institutional framework of ownership/usufruct right on waste lands	Efficiency in development and use of land (1)	Tendency to over-exploit the land (2)	Investment of effort and resources to regenerate and develop productive potential (3)	Need for effective management and control at community level (4)
6. Communal ownership and use rights with rewards linked directly to quality of individual effort	High	Moderate	High	Very high
7. Ownership and use right to individual poor families with a powerful support system	Moderate-high	Moderate-high	Moderate	Very high
8. Land leased to individual poor families without support system	Moderate	Very high	Nil	Moderate
a) Short term(1-3 years)	High	High	Low	Moderate-high
b) Long term(15-30 years)				
9. Land leased to private parties through open auction	High	Very high	Nil	-
a) Short term(1-3 years)	High	High	Moderate-high	-
b) Long term (15-30 years)				

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Table 9.1 : (Continued)

Institutional framework of ownership/usufruct right on waste lands	Need for powerful local level leadership	Chances of the poor benefiting from the land	Replicability of model on a larger scale	Empirical basis for making the inferences
	(5)	(6)	(7)	(8)
6. Communal ownership and use rights with rewards linked direct to quality of individual effort	High	High-very high	Low-moderate	Gambhira co-op. Vadi project
7. Ownership and use right to individual poor families with a powerful support system	High	High	Low-moderate	Vadi project of BAIF; forestry project of Rangpur Ashram
8. Land leased to individual poor families without support system	-	Low-moderate	High	Experience with distribution of surplus land to poor
a) Short term(1-3 years)	-	Moderate	High	
b) Long term (15-30 years)	-			
9. Land leased to private parties through open auction	-	Very low	High	Durga Prasad's findings
a) Short term(1-3 years)	-	Very low	High	
b) Long term(15-30 years)	-			

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Source : Fodder Production - An Alternative for Marginal and Waste Land Development. National Waste Lands Development Board, Government of India.

CHAPTER X

RECOMMENDATIONS FOR CONSERVATION, DEVELOPMENT AND MANAGEMENT OF LAND RESOURCES

The study covered three large States of India viz. Maharashtra, Rajasthan and Gujarat, and Goa, Diu, Daman and Dadra and Nagar Haveli. The geographical area of the region is 850,000 sq.km and the population was 1652 lakh in 1991 (Table 10.1). The main crops of this region are jowar, bajri, wheat, pulses, cotton, groundnut and other oilseeds. Growth in irrigated area and spread of improved and high yielding varieties together with chemical fertilizers had been the important measures taken for the development of agriculture. It may however be noted that there are considerable year to year fluctuations even in irrigated agriculture (Table 10.2). For example in Gujarat, the yield of irrigated kharif groundnut was 2094 kg/Ha in 1988-89 while it was 446 kg/ha in 1985-86. There are large year to year fluctuations in rainfed agriculture in the case of all the crops, and the levels of productivity are low. This is the case despite the development efforts of the last forty years. In the case of other land uses, viz. forest, pasture, desert development even the efforts have been meagre and the situation, in fact, is alarming. In western India, where arid and semi-arid tracts cover a considerable portion of the geographical area special attention needs to be given to pasture and forest development. An integrated approach to land and water use is essential, but is lacking today.

I. Approach to Land-use Planning

We have suggested a radically different approach than the approach presently adopted in land and water use because the present approach, though it has given higher production in the short run, has led to a number of adverse consequences. (i) Irrigation without drainage arrangements has led to emergence of problems of waterlogging and salinity turning pockets of rich

black soils, unfit for cultivation. (ii) Over-exploitation of groundwater for irrigation is leading to shortage of even drinking water during summer months. (iii) Use of chemical fertilizers without combining it with organic manure is leading to deterioration of soil quality, and exhaustion of micronutrients. (iv) Shift from mixed cropping that helps maintain soil nutrient balance to mono-cropping is resulting in higher drain on soil nutrients making for greater need of artificial fertilizers. (v) Establishment of milk collection network in rural areas and subsidy for milch animals without augmenting the fodder resources is taxing the fodder resources, adversely affecting the quality of cattle. (vi) Exploitation of forest resources for commercial use (pulp, coal making, timber) at a fast rate and loss of extensive forest areas due to construction of dams, township, roads, etc., are resulting in an increase in the rate of soil erosion, siltation of reservoirs, rivers, flash floods, shortage of water supply after rainy season due to reduction in infiltration rate, shortage of fuelwood for the weaker sections and the loss of means of survival to tribals and other forest dwellers.

It is unfortunate that we have borrowed the technique of development of forestry, agriculture, livestock from temperate countries without giving any thought to the distinct features of tropical ecology. The soil characteristics, the rainfall pattern, the wind pattern, the pollination pattern are different in temperate and tropical zones. It is particularly important to remember that the soils in the tropics are poor in organic matter because organic matter decomposes quickly under the impact of high temperature and humidity that induces high microbial activity. Because of the long dry spell in the tropics, soils become parched and tend to get eroded with heavy rains. In the humid tropics, nature has provided earthworms and termites and ferns and algae in great abundance as builders of the top soil, and soil fertility. The use of chemical fertilizers and pesticides in tropics means

decimation of soil building species. Unlike temperate countries where pollination is mostly windblown, in tropical countries the main agency is insects. The use of pesticides that kills beneficial insects is therefore more harmful in the tropics. In wet tropics, chemical fertilizers get washed down the canals and rivers more quickly and hence poisoning of surface and groundwater level is much higher. The pesticides break down into components and find an easy entry into the biological systems. Hence the accumulation of pesticides components is much greater in the animal and human bodies in the tropics, increasing the risk of cancer.

The process of decomposition is slow presumably owing to the absence of termites and other important decomposers, and lower temperatures in the temperate zone. Consequently about half of the organic carbon in the northern coniferous forest gets deposited in the soil and half in the wood, while in the tropical rain forest only about 15 per cent is deposited in the soil. Similarly about 58 per cent of the nitrogen in the tropical rain forest gets set down in the vegetation while in the British Pine wood forest the corresponding figure is less than 10 per cent. This difference in the tropical and temperate forest eco-system has far reaching implications. If a tropical rain forest is cut down and the timber removed, most of the nutrients get removed. This explains why cultivation fails in tropical areas cleared of trees. The situation is further aggravated because inorganic cycling tends to occur rapidly and heavy rainfall results in soil erosion and leaching of nutrients (Owen, 1980, pp. 168-169).

The green revolution technology, crossbred animals, single species forest plantations have been transferred to India for immediate gains in productivity; however the long term consequences under tropical conditions must be given a serious consideration. Secondly, it must be recognized that the petrochemical based technology is not sustainable in the long run because it is resulting in depletion and deterioration of the natural resource

base, and it is based on non-renewable resources.

It is therefore essential to rely more on the renewable resources. For this it is necessary to deepen our understanding of how the biochemical systems exchange matters with their surroundings all the time, the process of recycling between land surface, water surface and the atmosphere; the process of recycling between soil, plant and animal life, the hydrological cycle and energy flows. Holistic understanding of nature will give us clues to simple, inexpensive but efficient techniques, beneficial in the long run. Holistic approach will show the way to nitrogen fixation through biological agents, soil enrichment by composting waste products, higher productivity through inter-cropping and crop rotation, pest control through diversity, maximization of food basket through multivarietal crops and multi-pronged culture - viz. forestry, agriculture, horticulture, animal husbandry, poultry, fishery, all interwoven and supporting one another. The variagated needs of human society can be satisfied taking advantage of the rich tropical diversity, and the bioproductivity can be maximized through judicious use of processes of recycling and symbiosis.

A switch from chemical to ecological farming may give lower yield in the initial years i.e. till the damage done to soils is repaired. It also means greater care, labour and skills. However, it is sustainable in the long run, as it is based on the conservational use of the natural resources and not on their exploitative use.

Improvement in production levels can be achieved through integrated approach to resource use rather than competitive approach. The basic elements of the new approach are: (i) All the land and water resources are to be treated as social resources and their use has to be planned on a scientific basis. (ii) The land and water use is to be planned on the basis of watershed planning, with uplying portion being reserved for erosion control using graded bunds with suitable grasses and trees planted down stream.

of bunds and low lying areas to be treated with chains of small surface storages and shelter belts, tree rows and grasses appropriately planted to promote water infiltration, control wind erosion and provide humus. The water thus stored in small detention storages, farm ponds, drainage trenches, or underground is to be used for protective irrigation or supplemental irrigation depending upon the rainfall performance in the particular year.

The water can be lifted through traditional devices or movable pumps and can be delivered using movable PVC pipes. Such measures to conserve as much water in situ as possible and reduce the runoff to the minimum will help augment the local water resources and thus (i) stabilize the water supply for drinking water and domestic use, (ii) improve moisture regime and stabilize crop production, (iii) augment the supply of fodder, fuelwood, timber, fruit, etc., (iv) make for diversification in production including certain crops like cassava, palms amenable to agro-processing thus promoting diversification in work.

The work can be executed largely using the local raw materials and local skills and the inputs from outside the local economy would be minimum. Major inputs from outside have to be put in the initial stages for preparing scientific plans for the watershed which have to be formulated on the basis of a survey of local resources. Various alternative paths will have to be charted and the final decisions made in consultation with the local population. The energy inputs could also come largely from local resources using mainly biogas and alcohol/methanol for lifting water, for cooking and water heating. The use of non-renewable resource - kerosene and diesel can be reduced through proper planning of biomass and animal waste which could be used for biogas production. Since watershed planning involves construction of small dams, nala training, gully plugging and plantation of grass/trees, etc., proper maintenance of bandharas and other

structures, desiltation of tanks and proper care of grassland, trees, etc., are essential to get the benefits on a sustained basis.

The watershed plan will decide the land use pattern which will be related to land capability and water availability. Attempt will have to be made to stretch the irrigation water over as much area of land as possible, so that in the year of deficit rainfall most fields could be serviced with protective irrigation, while the extra water available in the year of good rainfall could be used for supplemental irrigation. The land put to grass and tree cover would not only help in water retention, moisture retention but also in enriching the soil through leaf litter and micro-organic processes. This would help improve the water-holding capacity of the land and provide micronutrients. In addition, combination of cereals and pulses or nitrogen fixing trees/shrubs would help improve the soil fertility. The shortfall in NPK, if any, could be made up by artificial fertilizer application. The use of chemical fertilizer can thus be minimized.

In the selection of crops the aim would be to have a diversified cropping pattern to include production of cereals and fodder as by-product, pulses, oilseed, vegetables, fruit and nut, fuel-wood and small timber, fodder and grass for animals adequate to feed the draught cattle and provide milk and meat for local consumption and some cash crops. The cash crop would have to be selected on the basis of agro-climatic conditions. The broad crop pattern could be worked out for the watershed and the specific crops, varieties, etc., could be selected by the individuals, cooperatives on the basis of their specific needs and the local conditions.

Proper distribution of benefits from watershed planning and enlistment of cooperation of the villagers in the scheme are the two crucial organizational questions on which hinges

the success of watershed planning. Watershed planning can yield good results only on the basis of cooperative endeavour and not under a competitive or domineering set up. To be effective, the various members involved in the cooperative endeavour cannot be very unequal. Inequality leads to domination by the powerful group and democratic functioning becomes impossible. Therefore the first step is lowering of the ceiling on land and effective redistribution of surplus land i.e. reduce the present grave inequality in land ownership. Secondly, the cultivators should be encouraged to form a cooperative team for cultivation of land through special incentives like subsidy and concessions. If the plan is violated by an individual cultivator provision for fines and forfeiture will have to be made. The claims to benefit from the scheme must be made conditional to observance of certain regulations e.g. not to let loose the livestock, not to cut trees in common lands, etc. Even if the land distribution remains unequal sharing of water resources for irrigation must be made on equitable basis. Part of the grass, fuelwood, timber, etc., available from the non-crops lands in the watershed could be taken as headloads for personal use by the families in the cooperative team and the rest sold in the village. The small land owning families who lose their land in watershed planning as the land is not fit for cultivation but suitable for afforestation, etc., must be fully compensated through provision living wage to work on common lands and a claim in the produce of the land redeveloped.

The experience during the eighties indicates that the cost of watershed planning comes to about Rs.7000 to Rs.12000 per hectare. If the organizational set up gets established the funds for watershed planning can be easily provided through plan funds. The Maharashtra Government spent Rs.796 crore during the Sixth Plan on EGS that seldom creates durable productive assets. These funds could be used for watershed

planning. The progress initially would be slow. However, once the benefits are demonstrated in a few watersheds the demand will spread. It will be necessary to enlist the cooperation of the scientists from universities and research laboratories to help prepare scientific watershed plans and to carry out the necessary survey work. It is most important that the watershed plan is prepared scientifically and is implemented in toto including the structural components, the vegetative components and the requisite bans. The plan has to be comprehensive and integrated. Haphazard and half-hearted measures would lead only to waste of effort, and the problem will remain unresolved.

II. Suggested Land Use in Different Zones

The Western India is divided for the purpose of land-use planning in five major zones: (i) The coastal region. (ii) The Western Ghats and the Aravalis. (iii) The Desert. (iii) The semi-arid region. (v) The assured rainfall region.

(i) In the coastal region, special treatment of the shore is **necessary** to check ingress of saline water and extensive plantation of mangroves is a major protective measure that needs to be taken up on a massive scale. Cultivation has to be restricted mainly to the valleys and coastal plains. Horticultural development of the uplands and reforestation of hill slopes would make for water and soil conservation and provide valuable fruit and timber resources. Diverse energy sources like tidal, wind and gas pipe line from Bombay and Gujarat can be used with advantage in the coastal belt.

(ii) The Western Ghats are crucial in the regulation of the hydrology of the Deccan rivers and have to be fully protected from urban and other encroachment and treated as fully protected region to safeguard the hydrological cycle, and the lakes. The Aravalis help restrain the march of the desert and hence have to be fully protected. Conservation and reforestation measures must be taken and provision of work and adequate income must

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be made for the local population who will be required to discontinue shifting cultivation and free grazing, in the Western Ghats and the Aravalis. These ranges, on proper protection and revegetation would prove very rich laboratories for study and research of flora and fauna, for mountaineering and trekking and healthy recreation and also supply of medicinal herbs, fruits, nuts, honey, bamboos, fuelwood, grass, etc. The forest resources should be exploited not through clear felling but mainly as a source of the above products gathered annually on a sustained basis. The Western Ghats and Aravalis should not be used for tree plantation and clear felling, as this would lead to soil erosion, floods, etc.

(iii) The Desert cannot be put to agricultural use except for irrigated pockets and urgent steps for stabilization of desert have to be taken. The desert tract has to be systematically put under silvi-pastoral treatment with appropriate restrictions on free grazing. Conservation and storage of water at a number of points so as to make possible the use of these extensive grazing lands is equally important. In silvi-pastoral development and in erecting wind shelters and in tree planting schemes preference must be given to locally useful and well-adopted species like khejri. The augmentation of grass and tree resources and conservation of water resources will provide a basis for livestock development which could be brought about mainly through selective breeding of the indigenous breeds and their proper care (feed, water and health) and not through exotic breeds - that can hardly withstand the harsh desert conditions.

(iv) Semi-arid-region - Part of the semi-arid-region is well developed through the provision of irrigation facilities. Crop specialization and dairy business have been developed in the irrigated tracts. Economy and rationalization in the

water use needs to be introduced in the irrigated tracts so as to stretch the available water resources over as large an area as possible and also to optimize the return per unit of water rather than per unit of land. The rainfed tracts need to be developed through conservation of water in situ and adopting appropriate cropping pattern. Certain tracts with shallow soils are suited for silvi-pastoral development and there is a potential for livestock rearing once the grass-fodder resources are augmented.

(v) Assured rainfall region - Unlike the other zones, particularly the first three zones where the land suitable for agriculture forms a small portion of the total geographical area, in this zone, agriculture will be the main land use. Measures will have to be taken for proper utilization of the rich lands and available water resources in this zone. Instead of conventional contour bunding, trenching would help moisture conservation and supplemental irrigation in black soils. In alluvial soils grass cover would be of considerable help in water conservation. This zone has the potential to attain high yields in the case of cereals, pulses, oilseeds, cotton, vegetables if judicious crop rotation, mixture of organic and chemical fertilizers, integrated pest management measures, etc., are adopted. The land unsuited for cultivation, particularly the undulating hilly areas must be put under tree and grass cover to provide protection to agricultural lands and to provide fuelwood, fodder, etc. In this region sizable area in the eastern-most part of Maharashtra viz. Bhandara and Chandrapur Districts have extensive forest cover rich in teak, bamboo and other trees suited for paper making or rayon making. The forest resources are at present not being exploited on a sustainable basis. Conservation and augmentation of these resources and their exploitation from a long term view must be planned. The area under forest should not be diverted to agricultural use but must be maintained under

forests through regenerative approach. If the forests are not indiscriminately exploited by the industry but properly managed, the forest wealth can be enriched. For this it is important to mobilize the cooperation of the tribals in the management of the forests and they should also get a share in the fruit. At present, the tribal problem is treated by the Government almost as a law and order problem in Chandrapur. A new approach as being tried in West Bengal should be adopted which will make for (i) better management and development of the forests, (ii) involvement of the tribals in forest management that will help conservation of forest resources which will provide a basis for bringing about improvement in the incomes and level of living of the tribals.

III. Urban Land Use

In Western India there is one megalapolis - viz. Bombay, three metropolitan cities viz. Ahmedabad, Nagpur, Pune (above 1 million population) and 47 cities (Table 10.3). The land use in urban areas is controlled through zoning regulations. However, the lands being almost entirely under private ownership and as the prices of urban lands have been skyrocketting particularly since 1976 (with the passing of Urban Land Ceiling Act pressure on available lands increased pushing up the land prices) it is beyond the means of local governments to purchase new lands for civic amenities and for low income group housing and slum improvement. There is a pressure for dereservation and for increase in density (FSI). This is resulting in excessive congestion and overcrowding particularly in the older parts of the cities. There is no space to widen the roads while the number of vehicles is increasing daily. The accident rate is on the increase and air pollution is going beyond the permissible limits in the metropolitan cities. With the increase in the FSI and high-rise buildings, the water supply and drainage systems are under stress. There is no relation between the

work place and residence and the number of commuters is mounting. This is putting great strain on the people as well as the transport system. More than one-third population in the metropolitan cities is living in slum and on pavements, lacking basic amenities of sanitation. Their plight particularly in the rainy season is beyond description. Slums pose a great health hazard. Problems of garbage collection and disposal and sewage treatment have assumed serious proportions in cities. To rationalize urban land use following measures are essential:

(i) Initiate watershed planning and other developmental measures together with the provision of living wages in rural areas so that work opportunities are diversified, productivity increases, incomes increase and level of living improves so that the rural people are not pushed to cities in the hope of securing work and means for survival.

(ii) Do not give new licences to large industry in and around (within 20 km) metropolitan cities and make it compulsory to large industry to reserve certain portion of their land for housing.

(iii) Measures should be taken to bring about a link between work place and residence through establishing Bureau for exchange of housing, offices, etc.

(iv) Encouragement should be given to development of housing estates with facilities of shopping, primary school, playgrounds and open spaces and essential services. These estates should have their solar water heating system, biogas digesters for supply of gas to the estate and rainwater collectors for watering trees.

(v) Overcrowded central city business core should be closed to vehicular traffic and turned into pedestrian precincts.

(vi) Public transport should be greatly augmented and improved so that private vehicles would not remain so essential.

(vii) Highway diversions must be provided and necessary lands reserved so that the highway traffic does not pass through towns and cities.

(viii) Sewage treatment plants and garbage depots should be suitably located so that the waste water and the compost could be used in the farms nearby.

(ix) Slum areas have to be earmarked for slum improvement and must be provided with safe water supply and sanitary facilities. Slums will have to be relocated if these cannot be given protection from flooding, etc., or pose a health hazard.

(x) Green belts, open spaces, hills and hill slopes, river beds and banks, sea beaches must be strictly reserved as breathing spaces, open to public at large and privatization of these lands or use of these lands for building construction should be strictly prohibited.

IV. Infrastructural Development

Development of irrigation, electricity supply, transport and communication links are of vital importance for achieving optimum utilization of land resources. These facilities are unevenly provided in different parts of the country. Since extension of these facilities using the current technology, is energy intensive and capital intensive the infrastructural facilities remain inadequate particularly in hilly and sparsely populated areas. Technologies are now developed to use combination of renewable bio-mass resources together with cement, steel, petrochemicals i.e. non-renewable resources in infrastructural development. These are cost-effective and help decrease dependency on imports (Datye, 1994). The waste lands and banks of streams, rivers, etc., if properly developed, can provide quick growing biomass material within a period of three to five years. Adequate supply of biomass-wood, bamboo, fibres will make it possible to change over to new technologies.

Land use planning and infrastructural planning, thus needs to be integrated. At the same time, care needs to be taken to see that accessibility created due to infrastructural development does not result in commercial over-exploitation of the local resources or else the rural poor lose even their meagre means of survival as is experienced today. The market forces, given the present highly skew resource ownership, make for unequal exchange, right from the village upto global economy. The more "developed" the village, the greater the impact of consumerist demonstration effects of the urban and the global milieu and frittering away of incomes on useless (Cocacola) and harmful products (drugs). The more "developed" the village, the less access to community resources for free collection of food, fuel and fodder for the rural poor and hence greater insecurity of food. The provision of infrastructure without consideration of local needs, and control by the ruling elite results in distribution of benefits in the favour of the rich at the cost of the labouring poor. Unless the local land and water resources are treated as a collective resource for the benefit of the entire village community the drain of resources, highly inequitous distribution of benefits and environmental decay would continue. Hence a new strategy emphasizing cooperative endeavour and participatory planning with the provision of appropriate science and technological inputs is essential.

The pricing structure of infrastructural services needs to be rational else it leads to the waste of valuable resources. The case of electricity supply to agriculture in Maharashtra State illustrates how national resources are being wasted due to irrational pricing policy. In Maharashtra, well irrigation and use of electric pump sets was promoted by the government through a massive programme of Rural Electrification and provision of loans for lift irrigation. Electricity,

in the initial years (1962) was provided at 12 paise per unit. Subsequently electric meters were made optional and the farmers could opt for a charge on the basis of the Horse Power of the motor and use any amount of electricity at a fixed charge. As a result the per unit charge for electricity, on an average, has remained about the same in 1992, as in 1962.

As there is no relation between the charge and the use of electricity, the farmers are not concerned with the efficiency of the motor and economy in the use of electricity and water. The efficiency is as low as 30 to 35 per cent and the consumption of electricity is increasing by leaps and bounds. It was 6404 million units (MU) in 1990-91 and 8177 million units in 1991-92. Consequently a subsidy amounting to about Rs.660 crores was involved, encouraging misuse and overuse of electricity and water. Supply of electricity by meter alone can promote rational use of electricity. The amount so saved can go a long way to develop watersheds that would augment the supply of groundwater.

V. Problem of Housing

Housing is beyond the reach of nearly half the urban population because of speculation in land prices. Now that the NRIs are entering the Indian market the prices are soaring higher and higher. In Bombay the prices of flats are reaching Rs.10,000 to Rs.30,000 per sq.ft. Unless non-Indians are prohibited purchase of immovable property in India and Government enters the housing activity on a massive scale using appropriate technological mix (ANAE, 1994) pakka housing would turn a luxury available only to the rich.

In the case of rural housing traditional construction methods need to be improved. Because of the defective methods of construction over 16000 houses from Latur and Osmanabad districts of Maharashtra collapsed in the Killari

earthquake on 30-9-1993 and about 1.5 lakh houses were damaged. Here again a judicious combination of cement, steel and timber grown locally will make it possible to address economically and effectively the question of repair and rebuilding of houses in rural areas (ANAE, 1994).

VI. Financing the Development

The developmental programmes were being financed so far, partly through domestic savings and partly through domestic and foreign borrowings. Over the period, the burden of accumulated debt has mounted so much that it is proving a drain. In an attempt to meet this critical situation the government is resorting to huge foreign borrowings, disinvestment through the sale of the shares of profitable public sector enterprises, closure of loss making enterprises and invitation to multinational companies. This will result in added debt burden, capture of vital fields of economy (oil, power, steel) by the multinationals, and greater drain through the activities of the multinationals, drain of natural resources of the country as well as drain of profits. This anti-development policy must be reversed immediately.

In India capital accumulation is possible through judicious use of country's natural resources. For this, the control over land by landlords and land speculators must first be eliminated and land brought under the control of the tillers. The land and water resources so released must be conserved, managed cooperatively by the tillers and utilized for optimum biomass growth. Biomass growth of about 30 kg. can be achieved through the use of 1 hectare mm water i.e. about 18 tonnes per hectare per year with rainfall of 1000 mm. Higher yields could be achieved through planned water application. It is possible after a three year period of initial growth, to obtain a net gain of about 5 to 10 tonnes from wastelands and degraded forest lands.

The main effort involved in revegetation is the protection to the wasteland through cooperative action of the village community so that natural regeneration is possible. The water conservation and soil conservation measures are mainly labour intensive. The enrichment of the biomass base will make it possible to provide locally the required food and fodder as well as the material for housing, energy generation and industrial use. Through the use of solar and biomass cogeneration and use of hydro-power and pumped storage, the local level energy needs could be largely met. Wide range of products can be obtained through bioderived inputs using solar energy and process heat in small-scale production units. The feed stock of chemical industry today is hydrocarbons derived mainly from coal or petroleum. In the alternative strategy, this will be replaced by biomass derived carbohydrates i.e. starch, cellulose or sugar or resins, latex. The intermediates produced from sugar and starch by fermentation and enzymic reactions can be refined and further processed by using solar heat energy. Technologies are known for converting starches and sugary juices into a wide range of chemical intermediates like butanol, styrene, acetone, ethanol (Datey, 1994). A wide range of chemical intermediates can be produced from a number of wasteland species such as jatropha, jojoba, neem, etc. The industrial and agricultural activity can thus be integrated through biomass development strategy and the present uncontrolled and harmful growth of metropolitan cities can be curbed. Self-reliant and equitable growth, reaching the fruits of development to all the toiling people can be achieved through this path.

VII. Redefining Land Use "Efficiency"

A concept of regenerative and self-reliant system that would meet the essential needs of the entire community suggests that "efficiency" in land use be evaluated in terms

of how it contributes to the health of the land ecosystem and to the health of the people, maintaining a carefully balanced priority for urban and rural sectors. Efficiency will be measured along the lines of productivity within the regenerative capacity of a given biotic community over a long time horizon and not over a short-term and at the cost of sustainability as is done today. Implied in the goal of self-reliant agriculture is the ending of profit-seeking international agricultural commodity trade (Freudenberger, 1988). The regenerative system would be based on optimizing the bio-diversity, discarding the present-day emphasis on mono-cropping and mono-culture. It would mean replacement of a petro-chemical based agriculture by a solar-biological and skill intensive agriculture (Dahlberg, 1984). It would solve the problem of toxicity, pollution and exhaustion of natural resources. Regenerative agriculture holds out a great promise for enabling society to relate to the land as trustees of a common heritage.

Regenerative land use would support 'good life' in the sense of fresh food, fresh air, fresh water, participative work and culture and not the life style of the West fashionable today - a life style that converts fresh food into frozen food or bottled food adding harmful chemicals, involving tremendous energy and capital costs and tremendous waste, a life style that pollutes the air, pollutes the land and pollutes rivers, streams and oceans, corrupts mind, a life style, that turns people against people. "Good life" is well within our reach as India is endowed with ample sunshine, fertile lands and rich water resources, provided we stop aping the West and shift from market-friendly (i.e. private profit-friendly) approach to nature-friendly and people-friendly development strategy.

Table 10.1 : Statewise Area, Population and Workers in Western Zone of India

	State/Union-Territory						Total
	Maha-rashtra	Raja-sthan	Gujarat	Goa	Daman and Diu	Dadra and Nagar Haveli	
Area (sq. kms.)	307690	342239	196024	3702	112	491	850258
Total Population 1991 (000)	78748	43881	41174	1169	101	139	165211
Density	256	128	210	316	906	282	194
Urban Population (000)	30496	10040	14164	479	48	12	55239
% Urban Population to Total	38.73	22.88	34.40	40.98	47.52	8.63	33.44
Total Main Workers (000)	30887	13862	14110	382	32	61	59334
Cultivators (000)	10134	8204	4722	56	3	36	23155
Agricultural Labourers (000)	8311	1404	3242	35	1	6	12999
Household Industries Workers (000)	947	393	307	13	1	1	1662
Others (000)	11494	3860	5839	278	27	18	21516
% of Workers in Agriculture	59.72	69.31	56.44	23.82	12.50	68.85	60.93
Total Reporting Area 1988-89 (000 ha)	30758	34248	18825 [@]	361	10 [*]	48	84250
Net Sown Area 1988-89 (000 ha)	18019	16123	9402 [@]	141	3 [*]	24	43712
% Net Sown to Total Area	58.58	47.08	49.94	39.06	30.00	50.00	51.88

@ Relates to year 1985-86.

* Relates to 1986-87.

Source : Census 1991 and Fertilizer Statistics 1991-92.

Table 10.2 : Irrigated and Unirrigated Yield of Principal Crops in Gujarat, Maharashtra and Rajasthan (1985-86 to 1988-89)

		(Kg.per hectare)							
State	Season	Irrigated				Unirrigated			
		1985-86	1986-87	1987-88	1988-89	1985-86	1986-87	1987-88	1988-89
I. Rice									
Gujarat		1570	2364	1741	2191	544	677	435	1837
Maharashtra	Kharif	1358	1170	968	1776	1422	1125	1310	1187
	Summer	1988	1676	1985	2077	-	-	-	-
Rajasthan	Kharif	2294	-	-	1929	97	-	-	1129
II. Wheat									
Gujarat		2290	2297	1870	2787	481	307	426	554
Maharashtra		990	1051	1113	1535	416	453	602	741
Rajasthan		2463	-	-	2361	1117	-	-	1257
III. Jowar									
Gujarat	Kharif	996	689	458	933	316	205	152	468
	Rabi	986	-	448	944	898	599	350	784
Maharashtra	Kharif	-	-	-	-	921	-	-	900
	Rabi	758	784	865	1021	295	228	523	452
IV. Bajra									
Gujarat	Kharif	1014	1227	825	1189	316	658	102	951
	Summer	1504	-	1439	1588	-	-	-	-
Maharashtra		557	721	950	788	238	254	486	449
Rajasthan	Kharif	543	-	-	915	151	-	-	453

Contd...

Table 10.2 : (Continued)

State	Season	Irrigated				Unirrigated			
		1985-86	1986-87	1987-88	1988-89	1985-86	1986-87	1987-88	1988-89
V. Maize									
Gujarat		361	1652	678	2340	359	1414	298	1308
Maharashtra	Kharif	1015	-	1984	-	454	-	832	-
	Rabi	1671	1541	1101	-	815	1439	235	-
Rajasthan		945	-	-	1739	535	-	-	1260
VI. Groundnut									
Gujarat	Kharif	446	1312	1390	2094	188	484	57	1510
	Summer	1444	2011	-	1229	-	-	-	-
Maharashtra		1272	-	-	967	673 K	616	888	-
Rajasthan		834	-	-	1289	475	-	-	1069
VII. Sugarcane									
Maharashtra		89350	86100	86500	81130	-	-	-	-
Rajasthan		38375	-	-	42789	-	-	-	-
VIII. Cotton (Lint)									
Gujarat		439	298	178	360	133	59	26	136
Maharashtra		164	122	189	-	115	52	94	-
Rajasthan		427	-	-	-	-	-	-	-

Note : K = Kharif

Source: Fertilizer Statistics 1991-92, The Fertilizer Association of India, New Delhi.

Table 10.3 : Distribution of Urban Population in Western Zone of India (1991)

State/Union territory	Population size of city/town								% share in urban population of western zone
	Above 10 lakh	1 to 10 lakh	50,000-99,999	20,000-49,999	10,000-19,999	5,000-9,999	Less than 5,000	All classes	
(Population in '000)									
Maharashtra									
No.	3	24	28	103	83	40	9	290	
Population	16718	7023	1978	3170	1261	313	33	30496	55.21
Rajasthan									
No.	-	14	20	71	87	22	1	215	
Population	-	5030	1373	2139	1313	183	2	10040	18.18
Gujarat									
No.	1	20	27	50	74	44	9	225	
Population	3298	6111	1804	1490	1089	343	29	14164	25.64
Goa									
No.	-	-	3	1	8	10	4	26	
Population	-	-	249	31	107	74	18	479	0.87
Daman & Diu									
No.	-	-	-	2	-	-	-	2	
Population	-	-	-	48	-	-	-	48	0.08
Dadra & Nagar Haveli									
No.	-	-	-	-	1	-	-	1	
Population	-	-	-	-	12	-	-	12	0.02
Total									
No.	4	58	78	227	253	116	23	759	
Population	20016	18164	5404	6678	3782	913	82	55239	100.00
Per cent:	36.24	32.88	9.78	12.45	6.85	1.65	0.15	100.00	

Sources: Census of India 1991. Series 1 India. Paper 2 of 1991. Rural Urban Distribution, pp. 22-23.

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National Income

12. VALUE ADDED FROM AGRICULTURE AND ALLIED ACTIVITIES

	At current prices		At 1993-94 prices	
	2002-03	1997-98	2002-03	1997-98
	Rs. crores			
Gross value of output	560,516	426,792	321,513	302,400
<i>Of which :</i>				
Agriculture	404,437	319,586	228,153	225,746
Livestock	156,080	107,206	93,361	76,654
Less inputs	118,072	83,125	64,732	61,731
<i>Of which :</i>				
Seed	9,417	7,923	5,722	5,954
Organic manures	7,367	5,090	3,782	3,512
Chemical fertilisers	20,271	14,703	13,861	13,187
Current repairs*	3,241	2,909	1,821	2,049
Feed of livestock	49,820	36,054	25,837	24,585
Irrigation charges	827	452	563	428
Market charges	5,118	4,133	2,979	2,922
Electricity	3,320	2,293	1,604	2,138
Pesticides and insecticides	1,439	807	913	607
Diesel oil	12,934	5,458	5,035	3,794
Gross value added:				
Agriculture & allied	442,444	343,667	256,781	240,669
Operation of Irrigation system	13,600	9,823	6,315	5,930
Total	456,044	353,490	263,096	246,599
Less Depreciation	25,634	17,814	14,563	12,371
Net value added	430,410	335,676	248,533	234,228

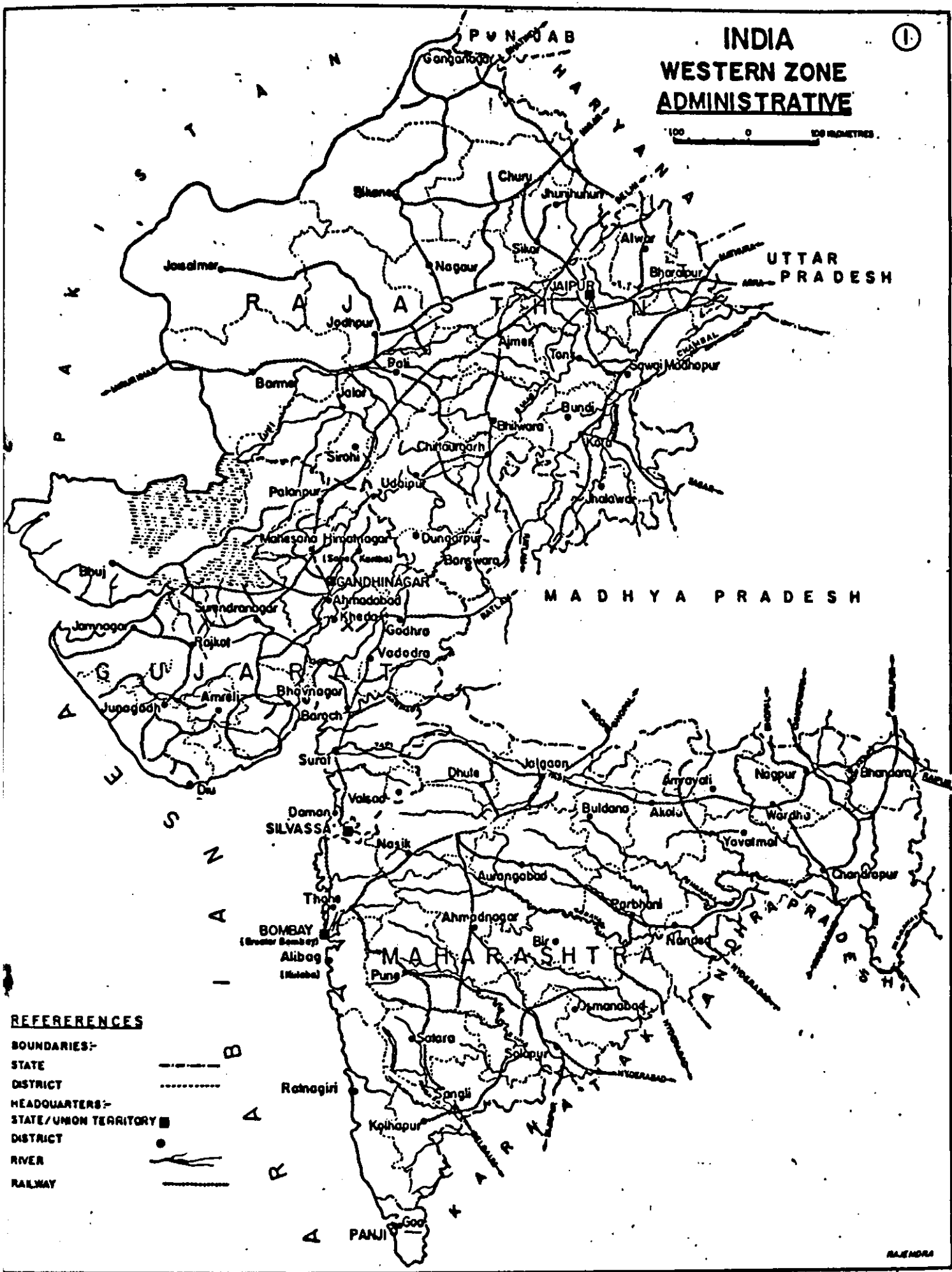
* Including maintenance of fixed assets & other operational costs.

National Income

13. VALUE OF OUTPUT FROM REGISTERED MANUFACTURING SECTOR*

	At current prices		At 1993-94 prices	
	2002-03	1997-98	2002-03	1997-98
	Rs. crores			
Food products	171,101	104,384	104,713	78,307
Beverages, tobacco etc.	38,252	15,737	18,723	10,457
Cotton textiles	51,180	44,268	32,249	29,972
Other textiles & products	73,343	50,496	59,116	47,316
Wood, furniture etc.	3,647	1,999	2,036	1,306
Paper & printing etc.	26,502	19,288	15,231	15,223
Leather & fur products	8,287	7,502	6,370	5,825
Chemicals etc.	198,077	121,537	113,903	88,648
Rubber, petroleum etc.	160,500	71,880	83,900	54,870
Non-metallic products	38,927	25,908	27,145	20,400
Basic metal industries	121,426	88,130	83,684	67,429
Metal products	21,529	18,733	17,546	15,889
Non-electrical machinery etc.	54,625	36,359	34,815	27,883
Electrical machinery	65,659	50,019	58,520	47,637
Transport equipments	82,157	49,957	55,699	39,090
Other manufacturing	43,083	21,904	29,091	17,113
Repairing services	28,120	11,585	21,883	10,004
Total	1,186,937	750,177	765,032	586,428

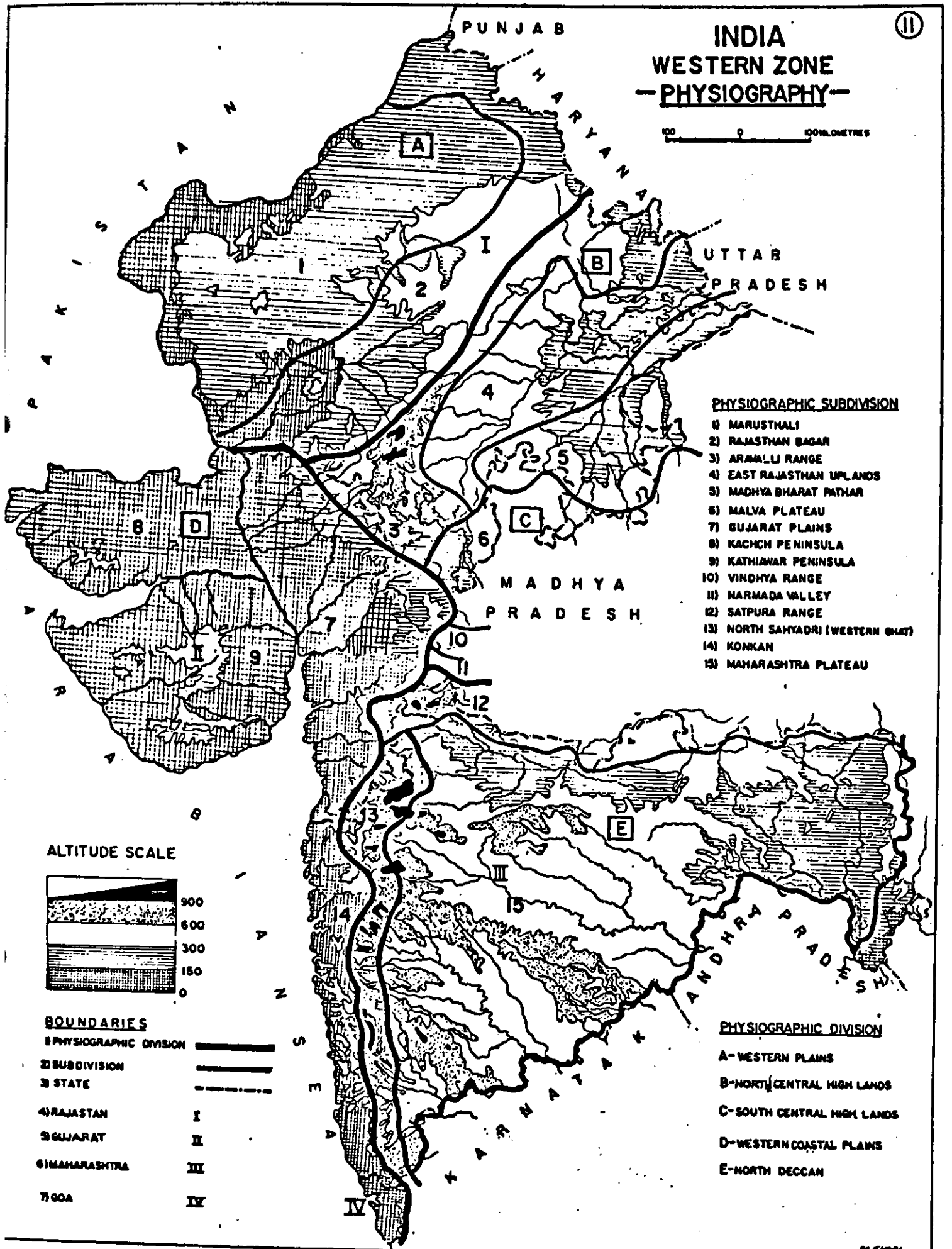
* Covers manufacturing & processing establishments registered under the Indian Factories Act, 1948.



INDIA WESTERN ZONE — PHYSIOGRAPHY —

11

100 0 100 KILOMETRES



PHYSIOGRAPHIC SUBDIVISION

- 1) MARUSTHALI
- 2) RAJASTHAN BAGAR
- 3) ARMALI RANGE
- 4) EAST RAJASTHAN UPLANDS
- 5) MADHYA BHARAT PATHAR
- 6) MALVA PLATEAU
- 7) GUJARAT PLAINS
- 8) KACHCH PENINSULA
- 9) KATHIAWAR PENINSULA
- 10) VINDHYA RANGE
- 11) NARMADA VALLEY
- 12) SATPURA RANGE
- 13) NORTH SAHYADRI (WESTERN GHAT)
- 14) KONKAN
- 15) MAHARASHTRA PLATEAU

ALTITUDE SCALE



BOUNDARIES

- 1) PHYSIOGRAPHIC DIVISION ————
- 2) SUBDIVISION ————
- 3) STATE - - - - -
- 4) RAJASTHAN I
- 5) GUJARAT II
- 6) MAHARASHTRA III
- 7) GOA IV

PHYSIOGRAPHIC DIVISION

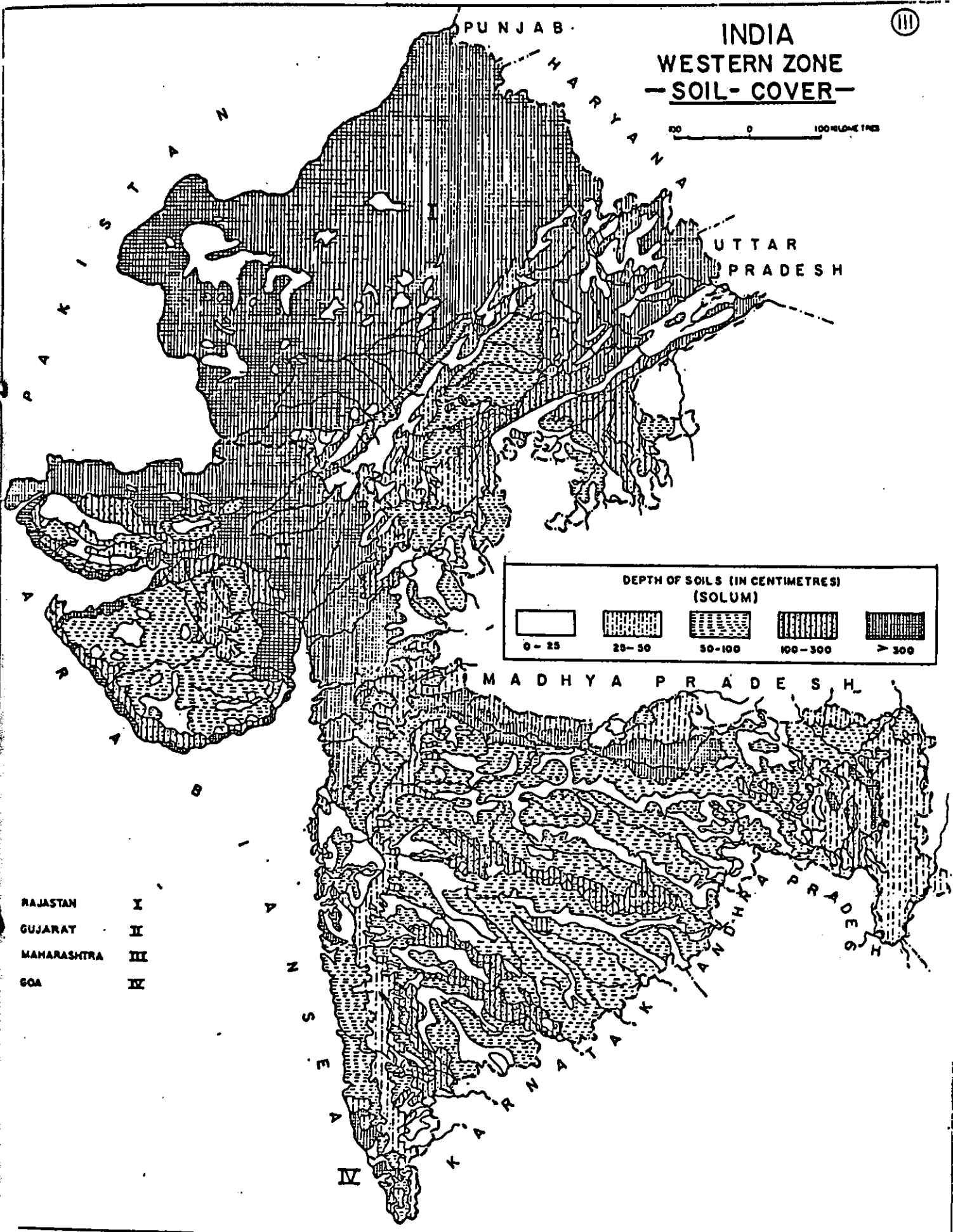
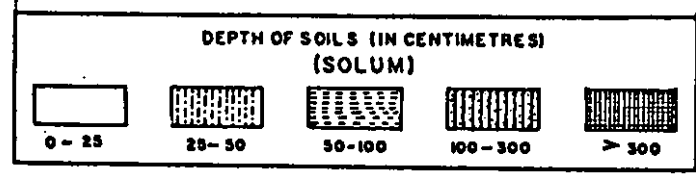
- A- WESTERN PLAINS
- B- NORTH CENTRAL HIGH LANDS
- C- SOUTH CENTRAL HIGH LANDS
- D- WESTERN COASTAL PLAINS
- E- NORTH DECCAN

RAJENDRA

INDIA
WESTERN ZONE
— SOIL-COVER —

III

0 100 KILOMETRES

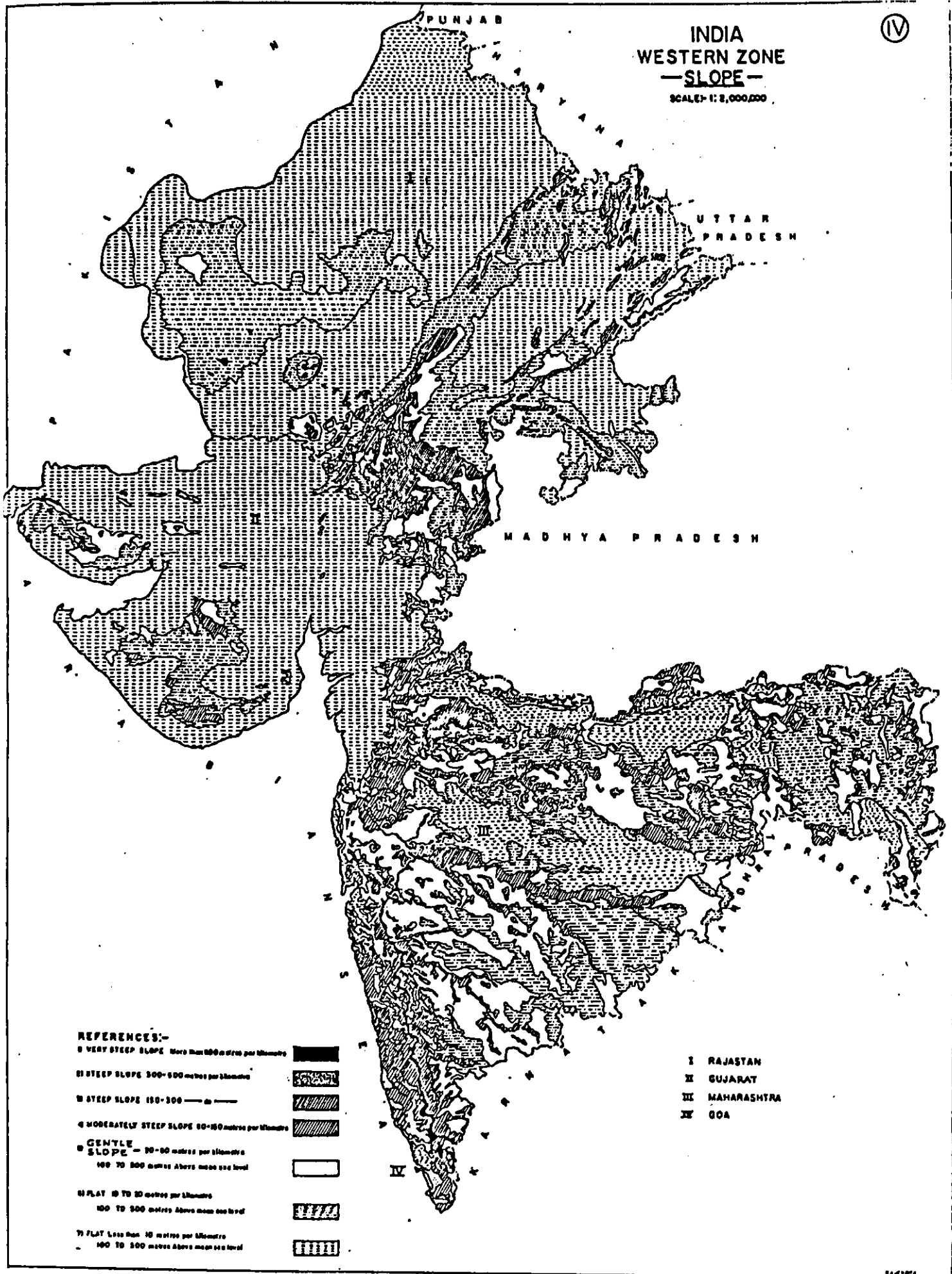


- RAJASTAN I
- GUJARAT II
- MAHARASHTRA III
- GOA IV

INDIA
WESTERN ZONE
—SLOPE—

SCALE: 1: 2,000,000

IV



REFERENCES:-

0 VERY STEEP SLOPE More than 600 metres per kilometre

1 STEEP SLOPE 300-600 metres per kilometre

2 STEEP SLOPE 150-300 ————

3 MODERATELY STEEP SLOPE 50-150 metres per kilometre

4 GENTLE SLOPE - 20-50 metres per kilometre

500 TO 500 metres Above mean sea level

6 FLAT 0 TO 20 metres per kilometre

100 TO 500 metres Above mean sea level

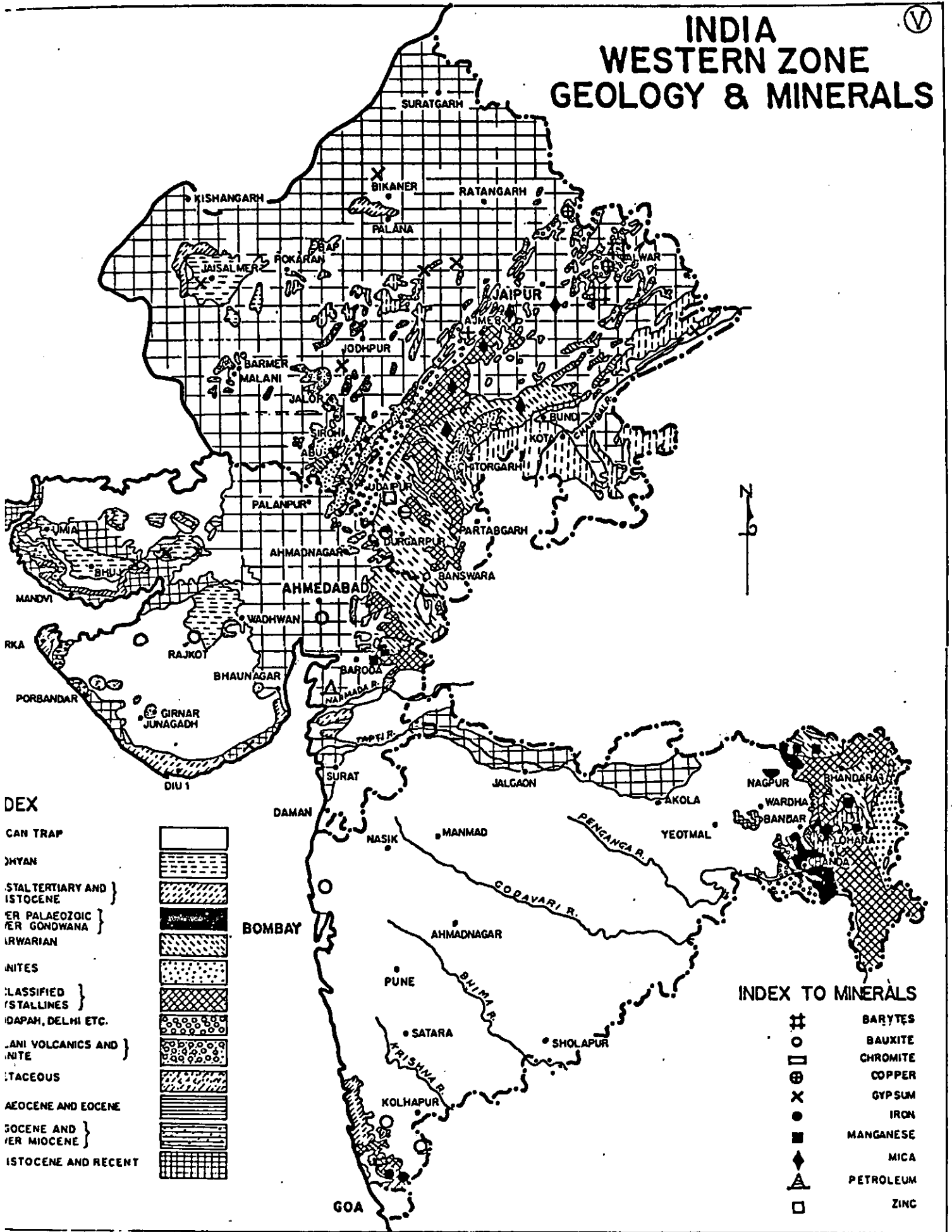
7 FLAT Less than 10 metres per kilometre

100 TO 500 metres Above mean sea level

- I RAJASTHAN
- II GUJARAT
- III MAHARASHTRA
- IV GOA

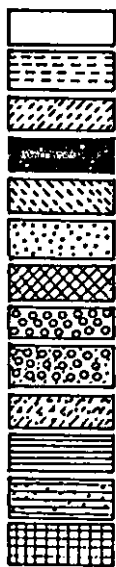
INDIA WESTERN ZONE GEOLOGY & MINERALS

Ⓟ



INDEX

- CAN TRAP
- DECCAN
- QUATERNARY
- PALEOGENE
- CRETACEOUS
- TRIASSIC
- PERMIAN
- DEVONIAN
- CARBONIFEROUS
- PERMIAN
- TRIASSIC
- CRETACEOUS
- PALEOGENE
- QUATERNARY

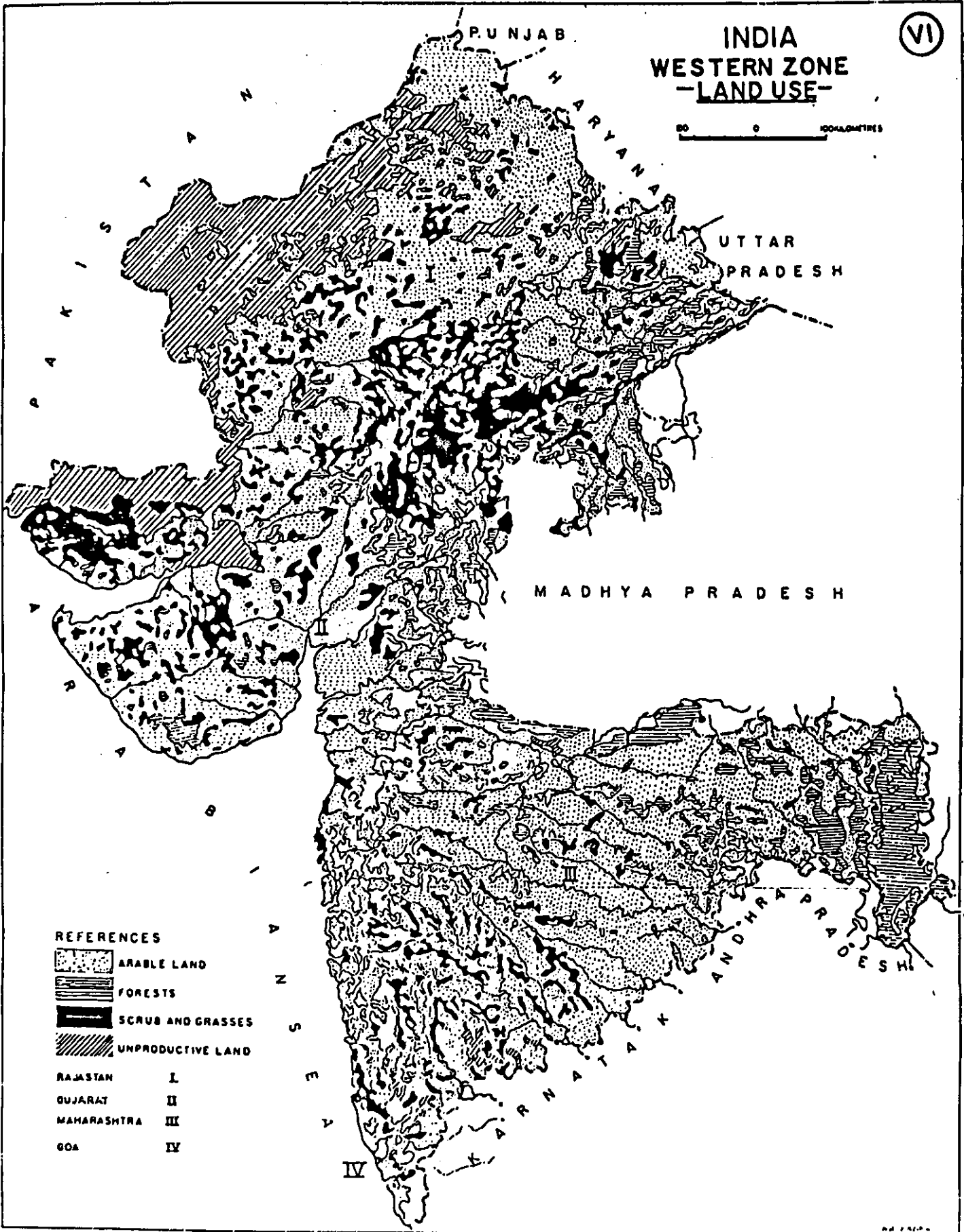


INDEX TO MINERALS

- ⊞ BARYTES
- BAUXITE
- CHROMITE
- ⊕ COPPER
- × GYPSUM
- IRON
- MANGANESE
- ◆ MICA
- △ PETROLEUM
- ZINC

INDIA WESTERN ZONE —LAND USE—

00 0 100 KILOMETRES

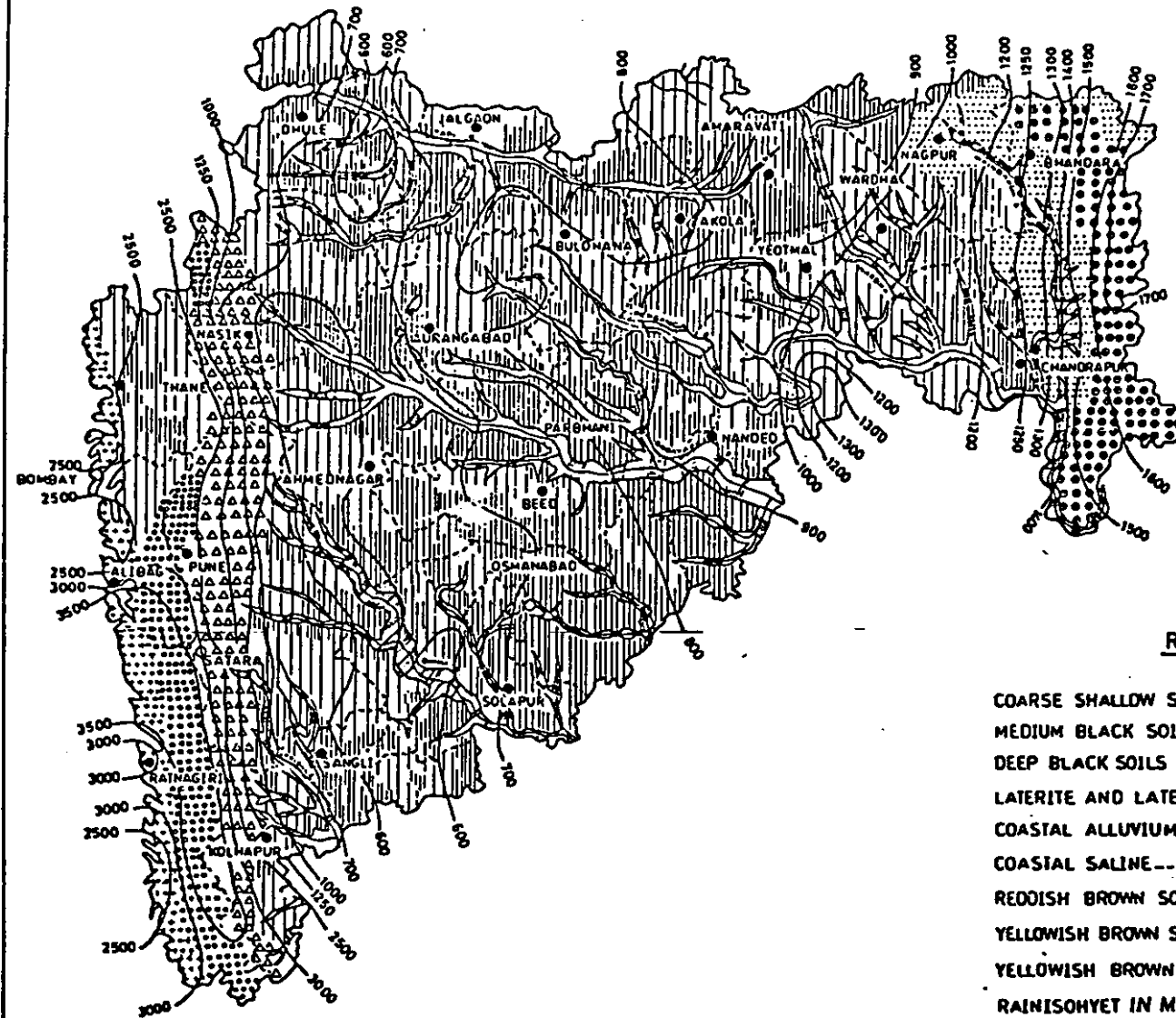


REFERENCES

-  ARABLE LAND
-  FORESTS
-  SCRUB AND GRASSES
-  UNPRODUCTIVE LAND

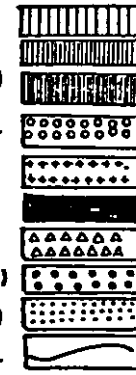
- RAJASTAN I
- GUJARAT II
- MAHARASHTRA III
- GOA IV

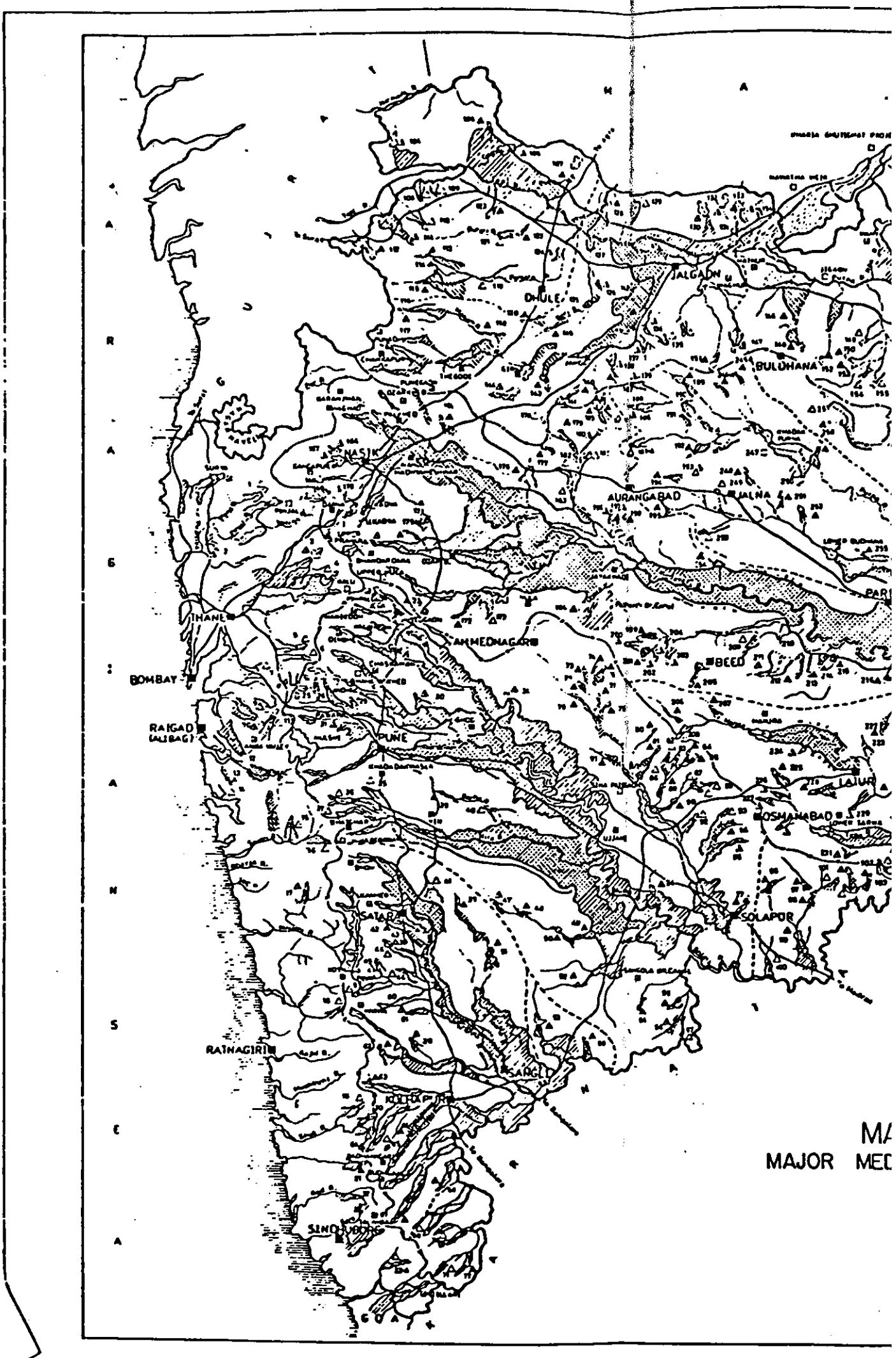
MAHARASHTRA SOILS AND ISOHYETS



REFERENCES

- COARSE SHALLOW SOILS (HIGH LEVEL).....
- MEDIUM BLACK SOILS (PLAINS).....
- DEEP BLACK SOILS (VALLEYS).....
- LATERITE AND LATERITIC SOILS.....
- COASTAL ALLUVIUM.....
- COASTAL SALINE.....
- REDDISH BROWN SOILS OF HILL SLOPES (TRAP).....
- YELLOWISH BROWN SOILS (MIXED ORIGIN)(ON HIGH LEVEL).....
- YELLOWISH BROWN SOILS OF PLAINS(MIXED ORIGIN).....
- RAINISOHYET IN MM.....

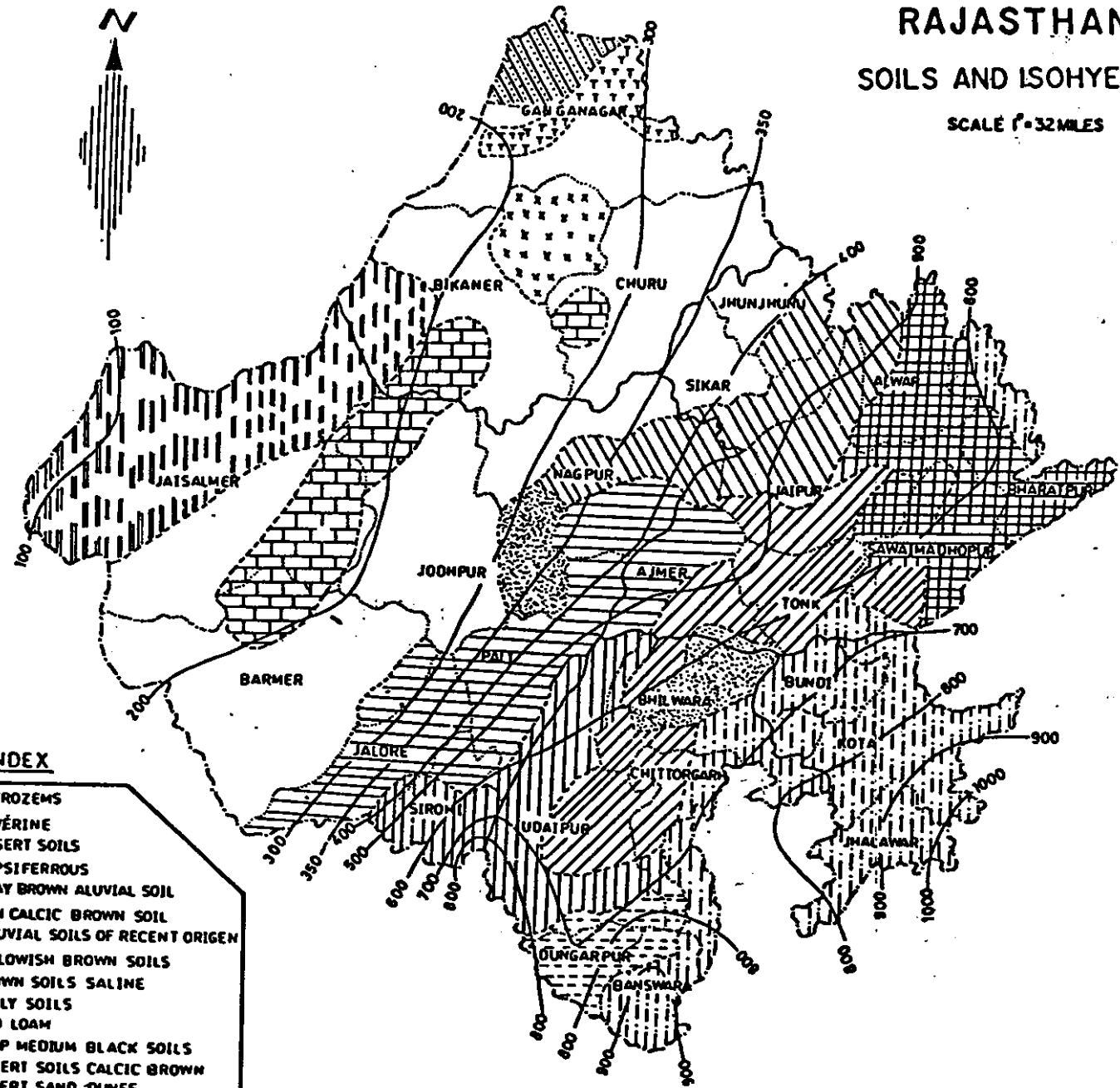



















M/
MAJOR MEC

RAJASTHAN SOILS AND ISOHYETS

SCALE 1"=32 MILES



INDEX

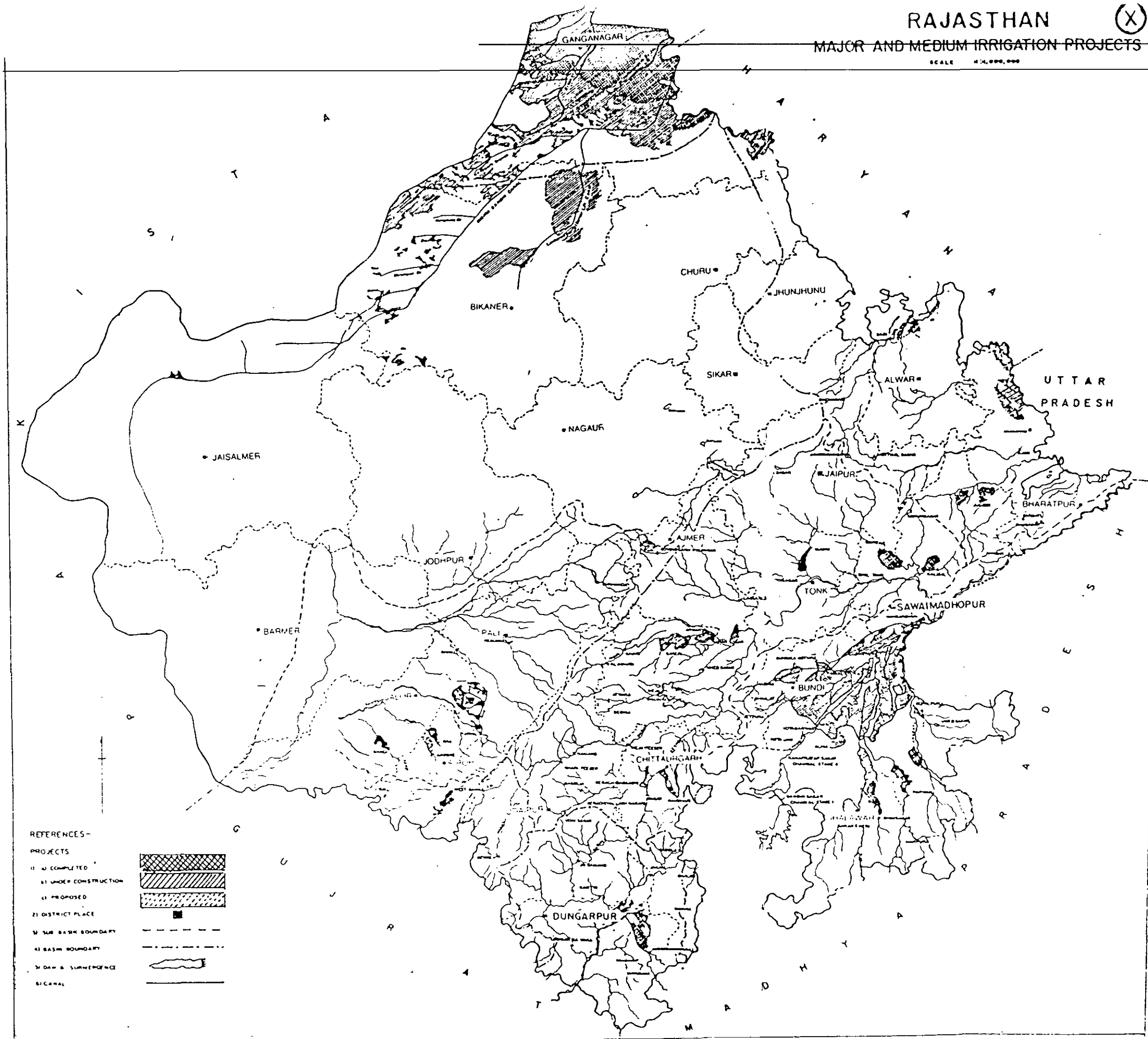
-  SEERZEMS
-  REVERINE
-  DESERT SOILS
-  GYPSIFEROUS
-  GRAY BROWN ALUVIAL SOIL
-  NON CALCIC BROWN SOIL
-  ALLUVIAL SOILS OF RECENT ORIGIN
-  YELLOWISH BROWN SOILS
-  BROWN SOILS SALINE
-  WILLY SOILS
-  RED LOAM
-  DEEP MEDIUM BLACK SOILS
-  DESERT SOILS CALCIC BROWN
-  DESERT SAND DUNES
-  RAINFALL CONTOURS IN MM.

RAJASTHAN

(X)

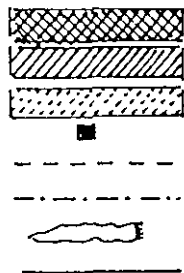
MAJOR AND MEDIUM IRRIGATION PROJECTS

SCALE 1:4,000,000



REFERENCES - PROJECTS

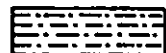
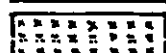
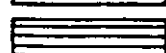







- 11 12 COMPLETED
- 13 UNDER CONSTRUCTION
- 14 PROPOSED
- 21 DISTRICT PLACE
- 31 SARB JAM BOUNDARY
- 41 BASM BOUNDARY
- 51 DAM & SURGE TANK
- 61 CANAL



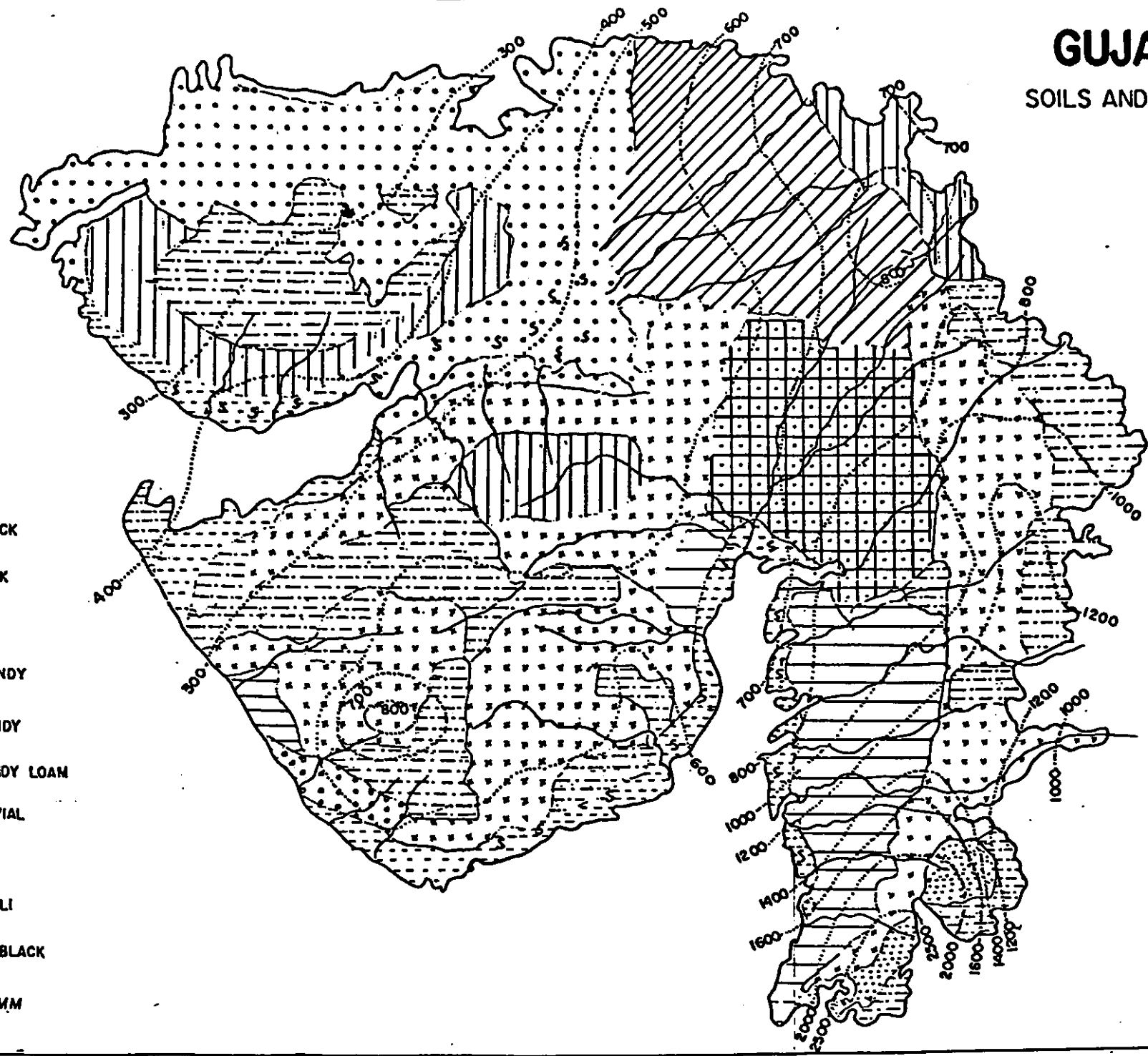
GUJARAT

SOILS AND ISOHYETS

REFERENCES

-  SHALLOW BLACK
-  MEDIUM BLACK
-  DEEP BLACK
-  RESIDUAL SANDY
-  ALLUVIAL SANDY
-  ALLUVIAL SANDY LOAM
-  COSTAL ALLUVIAL
-  DESERT
-  SALINE ALLKALI
-  MIXED RED & BLACK

 ISOHYETS IN MM

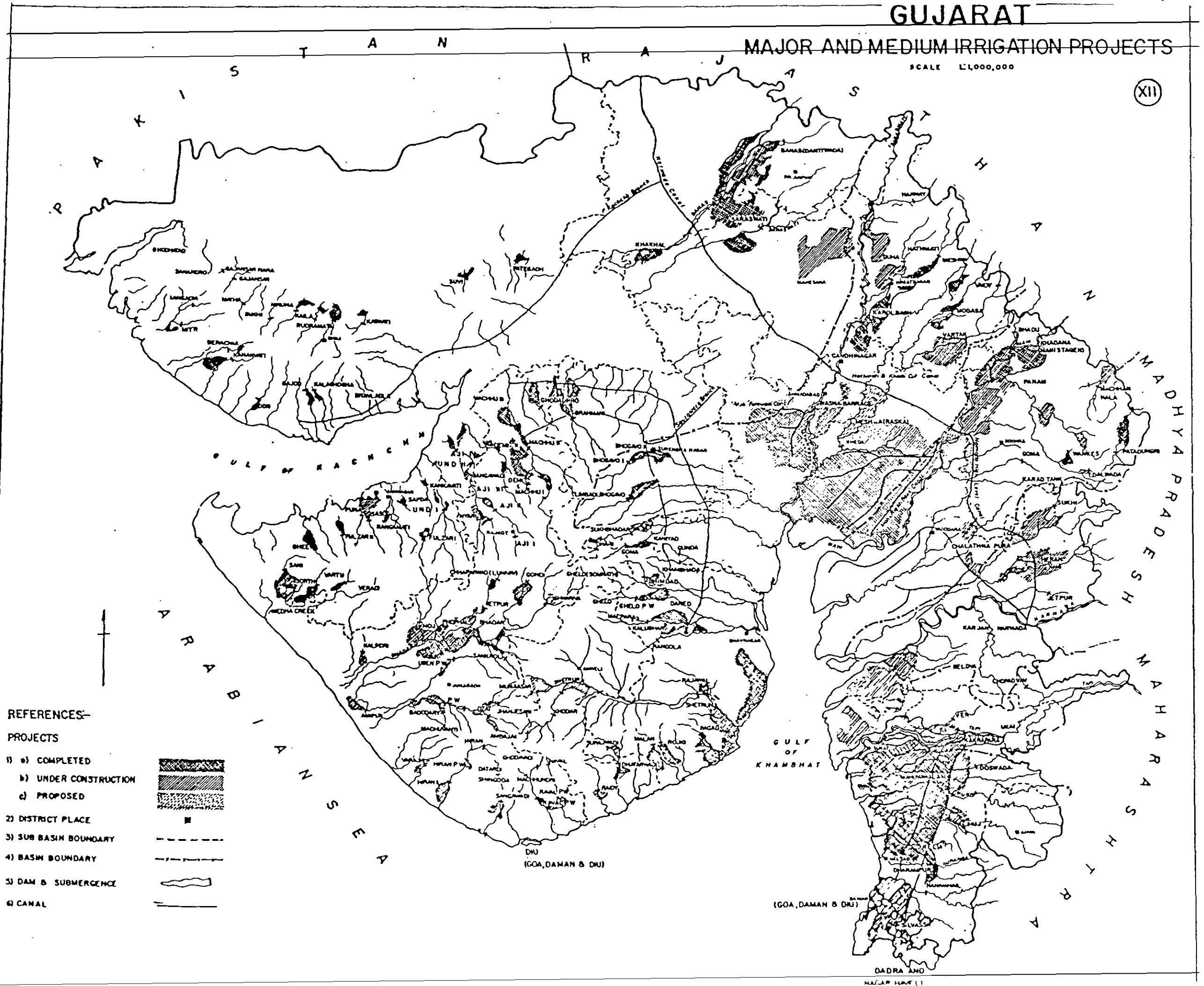


GUJARAT

MAJOR AND MEDIUM IRRIGATION PROJECTS

SCALE 1:4,000,000

(XII)



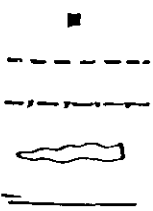
REFERENCES-

PROJECTS

- 1) a) COMPLETED
- b) UNDER CONSTRUCTION
- c) PROPOSED

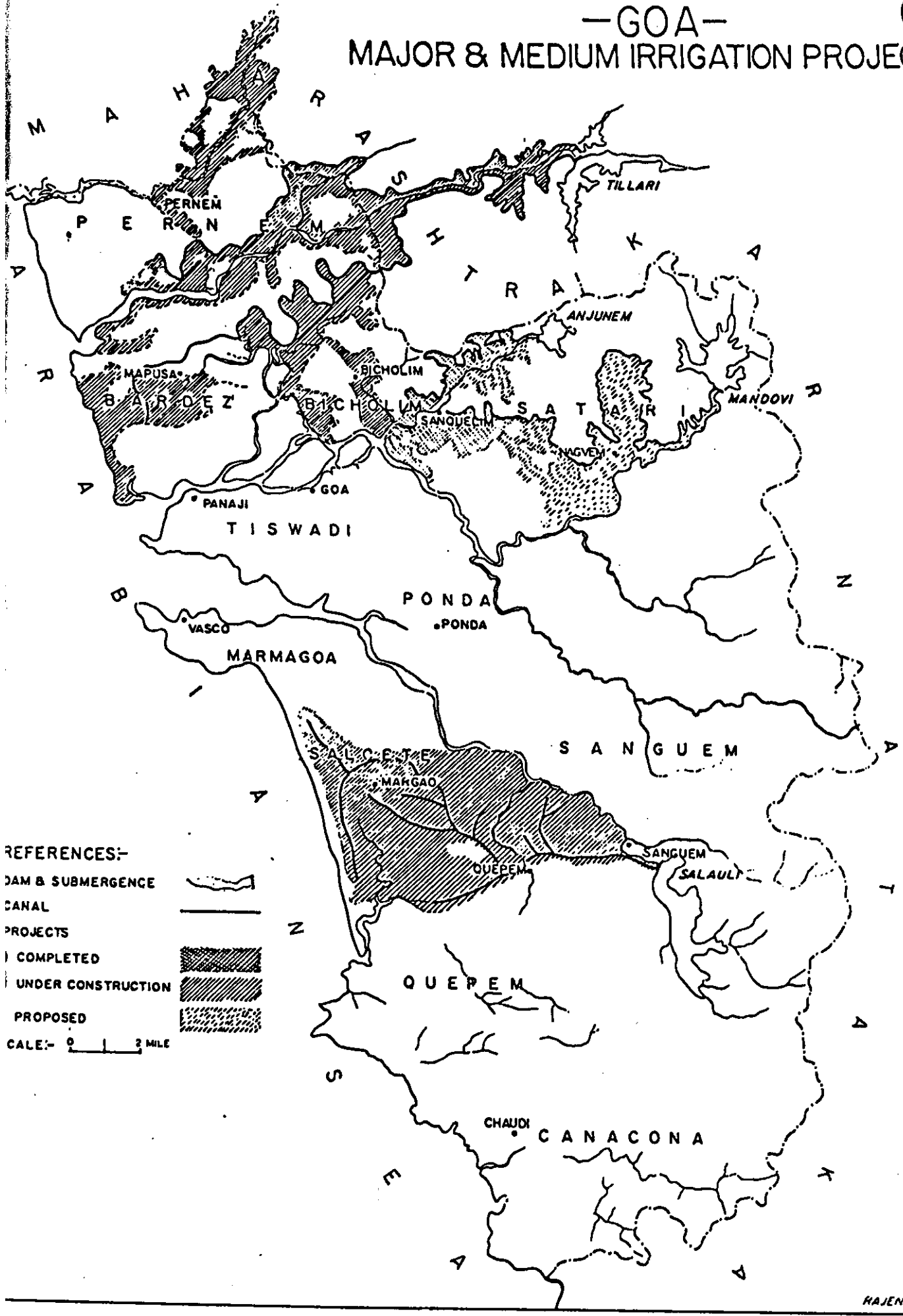


- 2) DISTRICT PLACE
- 3) SUB BASIN BOUNDARY
- 4) BASIN BOUNDARY
- 5) DAM & SUBMERGENCE
- 6) CANAL



DADRA AND
NAGAR HAVELI

-GOA- MAJOR & MEDIUM IRRIGATION PROJECTS



GLOSSARY OF PLANTS

<u>Marathi/Hindi Name</u>	<u>Botanical Name</u>
Adulsa	Adhetoda vasica
Ain	Terminalia tomentosa
Amba/Mango	Magnifera indica
Amoni	Rhus mysurensis
Ananas/Pineapple	Ananas sativus
Anjan	Memecylon umbellatum
Apta	Bauhinia racemosa
Arecanut palm	Areca catechu
Avla/Awala	Emblica officinalis
Babul	Acacia arabica
Bamboo	Dendrocalamus strictus
Behda	Terminalia bellerica
Bhabhar grass	Eulaliopsis binata
Bherlimad	Caryota urens
Bor/Ber	Zizyphus jujuba
Bordi	Zizyphus nummularia
Caju/Cashewnut	Anacardium occidentale
Char	Buchania lanzan
Chiku	Achras zapota
Chinch/Tamarind	Tamarindus indica
Dhaman	Cenchrus ciliaris
Dhawda	Anogeissus latifolia
Erand	Ricinus communis
Gaur	Cyamopsis tetragonoloba
Haldu/Hedu	Adina cordifolia
Hirda	Terminalia chebula
Jal	Salvadora oleoides
Jambhool	Syzygium cumini
Jhinjani	Mimosa hamata
Kadhilimb	Murraya koenigi
Kair	Capparis decidua
Karad	Dichanthium annulatum
Karanj/Karani	Pongamia pinnata
Karvand	Carissa congesta
Kasheed	Cassia siamea
Kawath/Woodapple	Feronia elephantum
Khair	Acacia catechu
Khejri	Prosopis cineraria
Kokam	Garcinia indica
Kuda	Holarrhena antidysenterica
Kulith	Dolichos biflorus
Lana	Haloxylon salicornieum
Limbara	Melia composita
Mahua	Madhuka indica
Munja	Secchrum munja
Mosambi	Citrus sinensis
Moth	Vigna aconitifolia

<u>Marathi/Hindi Name</u>	<u>Botanical Name</u>
Nachani/Ragi Neem/Kadulimb Nirgudi	Eleusine coracana Azadirachta indica Vitex negundo
Palas Pangara Papae Peroo/Guava Phog	Butea monosperma Erythrina variegata Carica papaya Psidium guajava Calligonum polygonoides
Ritha Rui	Sapindus emarginatus Calotropis procera
Saal Sarpagandha Sawa Sawar Shatawari Shewari Shikekai Shisam/Sissum Shivan Siris Sisoo Sitaphal/Custardapple Subabhul	Boswellia serrata Rauvolfia serpentina Panicum miliare Bombax malabaricum Asparagus racemosus Sesbania aegyptiaca Acacia rugata Dalbergia lalifolia Gmelina arborea Albizia lebbek Dalbergia sissoo Anona squamosa Leucaena leucocephala
Tendu	Diospyros embayopteris
Vari Vavding	Panicum miliaceum Embelia tsjeriam