

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

**SULABHA BRAHME
KUMUD PORE**

**GOKHALE INSTITUTE OF POLITICS AND ECONOMICS
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INTRODUCTION

Western 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 1981 Census was 1323 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 was 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 from about 1960 could be obtained on a uniform basis. Detailed information about the plan schemes in the sphere of irrigation, agriculture, animal husbandry, fishery, etc., was sought from the relevant government departments and other offices. Despite repeated visits and persistent efforts, it was not possible to get information on such vital matters as the number and the status of oustees of completed major and medium irrigation projects. Neither the irrigation department nor the planning department have information on the displaced families - a result of a major change in the land use. Other major changes in the land use that have taken place during the last four decades are the loss of village pastures, deterioration of village woodlots and tree groves, 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 through the concerned departments. However systematic information on these aspects is not maintained. Records of forest department are particularly inadequate and information scanty. It was not possible to bridge these gaps through field studies as this would have involved massive data compilation at village level. Lack of adequate data base proved to be one of the handicaps in the present study. Even to obtain the minimum required information, repeated visits and extended correspondence were involved. Much time was lost in the process of data collection from the official sources which made it impossible to keep up the time schedule originally planned.

A few field studies were taken up to get an 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 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 custeers 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 terms of money. It is also 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 as the centre of all 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 incomes, 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 and problems of developments in agriculture and animal husbandry, in the three States viz., Maharashtra, Rajasthan and Gujarat, are reviewed in Chapters II, III and IV. In Chapter V we outline the alternative development approach in relation to land and water use, in the light of the experience generated so far in India. Approach to perspective land use planning is discussed in Chapter VI. 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 VI. Chapters VII, VIII and IX, present the perspective land use plans for Rajasthan, Gujarat and Goa respectively. Chapter X deals with the special problems

relating to development of animal husbandry and fishery. Organizational imperatives and policy implications to implement the alternative land and water use plan are discussed in Chapter XI. Chapter XII presents conclusion and main recommendations of the study.

It is hoped that the alternative planning strategy and the organizational restructuring necessary to effect the new strategy will receive serious attention of the planners, scientists, technicians, peasants and other 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.

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 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.

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 "T and V Packages" are difficult to work with. 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 over-exploited leading to resource depletion. In the process the traditional users of these 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 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 with a convenient sea route from 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 1830 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, 1830, 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 supply soon after the rainy season, shortage of fuelwood, 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 satisfy cheaply their commercial demand for raw materials like cotton, indigo and timber. 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 saldari. The shortage of labour was thus wiped off. In 1898

the proportion of tenants and of labourers was 2.3 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. 32). 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 (1936) 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 personal 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 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 resource 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. 18 per cent is suited with moderate limitations. 19 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. Information on the irrigation potential created and utilized and the irrigated crop pattern for the latest normal year viz. 1985-86 is presented in Tables 1.2 and 1.3. 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, cooperative 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 through development planning 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 downgradation 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.

Table 1.2 : Jayakwadi Project : Irrigation Potential Created and Utilized

(Area in hectares)

Year	Potential Available	Irrigated Area	Irrigated area under		
			Sugarcane	L.S.Cotton	Kharif Crops
1979-80	57486	21415	1330	4196	2481
1980-81	73771	28090	2710	1338	1288
1981-82	90111	31538	5766	2146	9667
1982-83	106857	42873	6911	2212	16068
1983-84	122679	33046	5912	845	4292
1984-85	140114	36047	3901	1390	7018
1985-86	156642	34236	4901	3882	4066
1986-87	N.A.	13974	1383	488	4373
1987-88	N.A.	14309	2970	512	2007

Source : Records of the Command Area Development Authority, Aurangabad.

Table 1.3 : Jayakwadi Project: Irrigated Crop Pattern in 1985-86

Crop	Projected Crop Pattern (%)	Irrigated Area in 1985-86 (ha)	%	Unautho- rized Irrigated Area in 1985-86 (ha)	% Un- authorized in total irrigated area
Paddy	10.0	225	6.6		
Hybrid Jowar	12.0	1341	3.9		
Total Kharif	22.0	4066	11.9	963	23.7
Wheat	25.0	4022	11.7		
Jowar	15.0	9335	28.8		
Total Rabi	45.0	18994	55.5	5765	30.3
L.S. Cotton	25.0	3382	11.3		
Total Two Seasonal	28.0	4655	13.6	1689	36.3
Hot Weather	3.0	1132	3.3	472	41.7
Sugarcane	3.0	4901	14.3		
Banana	1.5	237	0.7		
Perennial	4.5	5389	15.7	3674	68.2
Total	102.5	34236	100.0	12563	36.7

Source : Records of the Command Area Development Authority,
Aurangabad.

CHAPTER II

AGRICULTURE AND ANIMAL HUSBANDRY : STATUS AND PROBLEMS IN MAHARASHTRA

1. Maharashtra - Through History

Civilisation flourished in the fertile Godavari basin from the third century B.C. to third century A.D. Satavahanas with their capital at Pratishthan - modern Paithan on the river Godavari about 45 kilometres west of Aurangabad city, ruled the Maharashtra region* together with parts of Andhra Pradesh and Madhya Pradesh. Maharashtri - a form of Prakrit was the language of the court. The Satavahanas were followed by Vakatakas, Chalukyas, Rashtrakutas and Yadavas. Marathi was the language of the people a few centuries before the Yadavas came to power in the 12th century A.D., but they were the first to give it patronage. The decline in the importance of the central Godavari basin began with the fall of the Yadavas in the 14th century A.D.

The second important subregion comprising the valleys of Purna, Wardha and Wainaganga formed the kingdom of Vidarbha ruled by the Vakatakas. The eastern portion of the Vidarbha region was under the rule of Gond kings after the fall of the Yadavas till the establishment of the rule by the Bhosales in mid-18th century.

The subregion Khandesh had no famous dynasties. Bhils - a numerous tribe penetrated into Maharashtra from Rajputana and a part of the Khandesh was ruled by the Bhil chieftains.

The invasions by the Khiljis in the early decades of the 14th century shattered the political and economic strength of the Yadavas. In 1325, the Tughlaqs of Delhi brought the Maharashtra

* Excavations at sites like Paithan, Nasik, Nevasa, Kolhapur, Prakash, Kaundinyapur, Tor, etc., yielded data on the material culture of the times and indicate flourishing trade and development of art and architecture. Rock-cut Buddhist caves at Karla, Kanheri, Junnar, etc., belong to this period.

region under their control. After the establishment of Mughal rule in the Deccan, sporadic revolts of the local chieftains continued. In 1646 Shivaji raised the flag of revolt giving expression to the simmering discontent of the peasantry. He established a Maratha kingdom and Maratha identity. He attempted to reform the land revenue system by introducing Rayatwari system of land tenure, under which the king was to receive the revenue directly from the cultivator. Soon after Shivaji's death in 1680 Peshwa, the Brahmin minister at Pune became the virtual ruler. Under the Peshwas the Shivaji's kingdom was expanded, but the administration was plagued with rapacity and corruption. When confronted with an organized and better equipped foreign force the faction-ridden Maratha empire collapsed in 1818.

The centre of power that shifted from the fertile Godavari basin to rugged Krishna basin in the 16th century again shifted, now to the port town of Bombay a small fishing village developed by the British as Western outpost to promote interests of the British capitalists. Subsequently the British laid the railway into the hinterland viz., Gujarat, Khandesh, Vidarbha to promote export of cotton. Because of the available infrastructural facilities cotton textile industry developed in Bombay in the later half of the 19th century.

With the establishment of British rule the court and army were disbanded resulting in a loss of vocation for a large number of military personnel and their retinue, civil service personnel, artisan and craftsmen. Subsequently with the growth of railways and flooding of the Indian market with cheap machine-made goods, a large number of transport workers and craftsmen, like spinners, weavers, potters, smiths, rice pounders, millers, etc., were thrown out of business. Consequently the proportion of workers dependent on land for their livelihood increased from about 55 per cent around 1850 to 70 per cent around 1880. The rigid land revenue system and the fall in grain prices, led to increase in the

dependence of peasants on money lender and consequent loss of mortgaged land. The tripple burden of land revenue, land rent and high interest rate crushed the peasantry. They were left with no cushion to face a famine year and died by the thousands when crops failed.

With the development of railways, roads, posts and other communication network the chain of merchant-cum-financiers from Bombay reached upto villages. Construction of major irrigation works between 1875-1920 in districts of Poona, Satara and Ahmednagar supported commercialization of agriculture in irrigated pockets. The peasant was drawn into market but his agriculture basically remained subsistence oriented.

On attaining independence the princely states of Sangli, Miraj, etc., were merged into Bombay Presidency. During state re-organization in 1956 the five Marathi-speaking districts of the erstwhile Hyderabad State were joined to the bilingual Bombay State. In 1960, Maharashtra State was formed with four main regions viz., Konkan, Western Maharashtra, Marathwada and Vidarbha.

2. Administrative Divisions

The Maharashtra State has a total area of 307762 square kilometres extending over 800 kms., from east to west and about 720 kms., from north to south with a long coast-line of 720 kms., in the west. The State is divided for administrative purpose into four divisions viz., the Bombay division which includes the Greater Bombay City District, four coastal districts or the Konkan area, two Khandesh districts viz., Dhule and Jalgaon and the Nashik district; Pune division or the Western Maharashtra which includes the Ghat area and the region to the east of the ghats; the Aurangabad division or the Marathwada region that includes six districts and the Nagpur division or the Vidarbha region which covers nine districts located in the eastern part of the State. There are 235 talukas in the State with 39354 inhabited villages

and 307 towns. The total population of the State was 628 lakh according to the 1981 Census of which 65 per cent was living in the rural areas (Table 2.1).

3. 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. The west of Sahyadri marks the highest elevation with peaks attaining the heights of 1650 m., 1567 m., and 1424 m., above MSL near Kalsubai, Salher and Harischandragarh respectively. 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 interdigitating 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 rectilineal 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 plateaus with eroded pediment followed by depositional pediment merging to flood plains of the Godavari, Bhima and Krishna rivers. Tapti basin is an asymmetri-

cal valley bounded by Satpudas and Ajanta ranges in the north and south respectively. The valley lies in the extreme northern part of the State. It has a gentle southern slope abruptly rising in the north in Satpuda hills. The rocky and rugged topography of Satpuda hill ranges with elevation ranging from 300 to 1200 m. above MSL limits the northern border of Maharashtra State.

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.

4. 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, gneisses, etc., flanked by metamorphosed precambrian sedimentaries, Dharwarian schists with sporadic exposures of rocks of Gondwana system Cuddappaha and Vindhya.

5. 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 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. However, in Vidarbha September rains are dependable. In Pune, heavy rains occur approximately from June 25th to August 8th, whereas in the semi-arid zone, the heaviest rainfall occurs in late September. Further east, in and around Solapur, rainfall occurs in late September, and early October resulting from the retreating south-west monsoon. The eastern part of Vidarbha gets heavier rains and

is more prolonged than in the western part and also it is distributed evenly more or less during the entire monsoon season. A few showers from retreating north-east monsoon associated with cyclonic storms are also received in these parts during winter season in the months of January and February.

The isohyet map of the State shows wide variations in rainfall from humid to rain-shadow semi-arid climate (Table 2.2). 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, quite unevenly spread over the different regions of the State (Tables 2.3 and 2.4).

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 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.

6. 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 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 (Table 2.5). The singularly uniform mineralogical 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 mineralogical make up, base exchange capacity, etc., remain the same all over the State,

differences are observed from place to place in such intrinsic 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 physiochemical 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.

7. Land Use

Of the total geographical area of 307583 sq.km. for which

land utilization statistics is available, 13408 thousand hectares or 60 per cent area was under cultivation in 1983-84. Permanent pasture and grazing lands formed about 5 per cent of the total area (Table 2.6).

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 1983-84 was 20788 thousand hectares, the intensity of cropping being as low as 113. Even by

1937-38 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.

3. 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 2.7). 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 oil seeds. In the assured rainfall region jowar and cotton are the major crops grown and these are grown under dry conditions.

There are large variations in the average yields of various crops between different regions of the State (Table 2.8). For example, in the case of rice, the yields, averaged over a period of 1964-65 to 1973-74, showed variation from about 300 kg. per hectare in some talukas from the Marathwada region to over 1500 kg. per hectare in some talukas from the Konkan area. The average yield of rice in the heavy rainfall areas of Konkan was about 1300 kg. per hectare while it was around 580 kg. per hectare in the other areas of the State. In the case of kharif jowar, variation from about 400 kg. per hectare in the Marathwada region to 1200 kg. in parts of Jalgaon district was noted. The average yield of kharif jowar was relatively higher in the Transition zone viz., 736 kg. per hectare as compared to the average yield noted in the other areas of the State viz. 535 kg. per hectare. In the case of bajra, the

inter-regional variations were less pronounced, the values of mean yield largely falling within the range of 200 kg. to 450 kg. per hectare. In the case of rabi crops, the average yields in the scarcity zone were considerably below the averages noted in the other areas. The respective figures of average yields in the scarcity zone and in the other areas of the State were 305 kg. and 430 kg. per hectare in the case of rabi jowar and 215 kg. and 340 kg. per hectare in the case of wheat (Dandekar, 1976, pp.92-102).

The year-to-year fluctuations in the yields of different crops are also quite substantial (Table 2.9). For example in the case of kharif jowar the coefficient of variation was about 50 in half the number of observations. The year-to-year fluctuations were relatively less pronounced in the case of wheat, a crop grown mainly in the areas with black retentive soils and assured rainfall as compared to kharif jowar which is grown in the scarcity tract as well as in the assured rainfall region of the State.

9. 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 scarcity areas as an integral part of the development plans and its implementation in a phased manner. The Committee suggested that high priority be accorded to major and medium irrigation schemes that would benefit the scarcity areas. 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 hydrogeological 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 a well digging programme.

It was noted in a survey carried out in 1967 in Ahmednagar district to study the utilization of long term finance for new wells that of the total loans disbursed for the construction of wells only 33 per cent proved to be productive. About 19 per cent of the investment was wasted due to the failure to strike water, 23 per cent of the investment did not prove fruitful as the work remained incomplete mainly due to the inadequacy of financial resources and 20 per cent of the loan amount was used for other purposes (Kadam, 1968, p. 123). The Land Development Bank, which financed about 3000 wells per year in Ahmednagar district, found that 20 per cent of the wells were completely dry and in 60 per cent of the wells the yield was poor (Lal, 1972, p. 110). On this evidence, the probability of a viable well can, at best, be put around 30 per cent. 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 uncertain.

In 1960, the Maharashtra State Irrigation Commission was appointed by the Government to give comprehensive consideration to the problems of irrigation in the State. The Irrigation Commission estimated that excluding the Konkan districts for which master plan was not completed, the total area in the State which could be brought under irrigation was about 33.8 lakh hectares. This estimate was based on investigations carried out for harnessing 75 per cent dependable flows (MSIC, 1962, pp. 31-57) (Table 2.10).

10. Surface Irrigation

The area irrigated from surface sources which was 2.1 per cent in 1950 was expected to increase to about 5.4 per cent when the schemes started in the First and Second Plans were implemented. These were expected to be completed by 1965 which meant that during the period from 1951 to 1965 on an average 0.2 per cent of the cultivated area would be added to the area under irrigation. If the work was to proceed at this rate, the Commission feared, it will take 83 years after 1965 to achieve full exploitation of the surface water resources. The Commission pointed out, "We consider that it is both imperative and practicable to achieve the stage of full exploitation of the resources by 1980". It was also recommended that the programme of exploiting surface resources should not be considered independently of the schemes intended to conserve and utilize underground water resources which included schemes of construction of wells, contour bunding and terracing. The total cost of the schemes for conservation and utilization of water resources during the period 1961-1980 was estimated, the total cost came to Rs. 1395 crore (Table 2.11).

The report emphasized, "In our opinion it is absolutely necessary to complete the work of fully exploiting the irrigation potential of the State by 1980. ... We have noted that the provision for all the works mentioned above in the Third Five Year Plan is only Rs. 105 crore which ... is wholly inadequate in relation

to the enormous leeway we have to make up. ... The Plan provisions in each of the three Five Year Plan periods between 1965-1980 would have to be of the order of Rs. 300 to Rs. 500 crores if the irrigation development programme outlined by us is to be completed by 1980" (MSIC, 1962, p. 57). With the completion of the programme it was expected that nearly 32 per cent of the cultivated land could be brought under irrigation. It was recommended that the water resources available should be stretched as far as possible to disperse the benefits of irrigation over as large an area in the State as feasible. It was also suggested that a combination of flow irrigation and lift irrigation should be made as far as possible. The recommendations of the Commission were accepted by the Government of Maharashtra in 1964.

The various expert committees and commissions appointed during the last 75 years stressed over and over again the urgent need to harness the irrigation potential in the State at a fast rate and to ensure proper utilization of the impounded water resources. The Government was in principle all along in agreement with the recommendations. However, there always was a wide gap in the proposals made by the expert bodies and the execution of the various schemes. There has also been considerable delay in the anticipated date of completion of a project and the actual year of completion.

A variety of reasons are reported to be responsible for the delays in commencing the work on a project. Clearance of the projects by the Central Water and Power Commission or the Planning Commission is reported to be a major hurdle. The inter-State river water disputes had hampered the clearance of some projects.

As regards the ongoing works delays were reportedly experienced due to the problems in land acquisition, the difficult supply situation with respect to steel and cement, inadequate number of heavy earth moving equipment, road rollers, problems of servicing

the heavy machinery, site problems leading to alterations and modifications in the design, cost escalation and shortage of funds, etc.

Even when the headworks are completed and the water impounded in the reservoir there is often a lag in the construction of irrigation canals. So also the completion of field channels, the land shaping and land levelling works and the drainage arrangements take considerable time. This in effect leads to a delay in the actual utilization of the water, even though the potential is created. The shift to irrigated agriculture from dry agriculture is fraught with many problems. Suitable cropping pattern has to be involved so that area under double cropping could be increased. The technical knowhow relating to the adoption of appropriate cropping pattern, seed varieties, application of fertilizers and pesticides to get full benefits of the irrigated agriculture has to reach the farmer. It is equally important to provide for adequate and timely finance to meet the increased input needs and also to ensure the supply of necessary inputs. The farmers' ability to incur higher initial expenditure and accept the risks and uncertainty involved has also to be strengthened. The cultivation of irrigated crops calls for adequate arrangements for marketing, storage and transportation of the marketable surplus. In areas of assured rainfall, there is a reluctance to shift to irrigated agriculture. The returns from irrigated agriculture have to be lucrative enough to promote a change over. All these factors have to be taken into account in promoting extension of irrigated agriculture, particularly in areas where surface irrigation is being newly introduced. Otherwise the area brought under irrigation falls considerably short of the irrigation potential created. It must also be noted that in many projects, more area is put under sugarcane crop than envisaged in the crop pattern given in the project report; consequently the water impounded gets utilized in the upper reaches and does not actually service the total irrigable command. The area irrigated

in such cases is considerably less than the area anticipated to be irrigated by the project. For example, the Pravara canals were designed to cover a culturable area of about 63500 hectares while the area actually irrigated was only 24300 hectares. Similarly the Nira left bank canal irrigation is spread over some 29500 hectares in the upper reaches of the canal, leaving the remaining area at the tail end with little benefit of irrigation (MSIC, 1962, p. 47).

Information about the irrigation potential created and the actual irrigated area is presented in Table 2.12. By 1974, full utilization of the irrigation potential created was noted only in the case of the Vir dam project completed in 1966-67. For the Ghod project the percentage utilization was 50. In the case of Purna and Girna projects where the irrigable command lay in the assured rainfall region, the extent of utilization was 35 per cent and 23 per cent respectively. For the ongoing major irrigation projects where part of the irrigation potential was already created the percentage utilization was noted to be 36 in 1974.

The situation has not improved in the subsequent period. According to official statistics the irrigation potential created by surface sources by 1986-87 was 2385.6 lakh hectares and the recorded utilization was only 807 lakh hectares or 34 per cent of the potential created was utilized.

The ultimate irrigation potential of major, medium and minor irrigation projects in the State is estimated at 60 lakh hectares as per revised estimate. By 1986-87 only about 12 per cent of the ultimate irrigable area by surface sources had come under irrigation whereas the Irrigation Commission of 1962 had considered it feasible to achieve full exploitation of the surface water resources by 1980!

11. Well Irrigation

Well has been ubiquitous source of irrigation in use since ancient times. The underground water resource potential varies considerably between the various tracts of the State. There are

also considerable variations in the extent of groundwater resources exploited so far in the different regions of the State. There were substantial additions to the number of irrigation wells in the State during the last 25 year period. The additions were particularly numerous in the Marathwada region, Western Maharashtra and Khandesh districts (Table 2.13). The average area irrigated by a well was about 1.3 hectares in 1971-72 in these regions while in the Konkan and Vidarbha region, nearly all the wells have less than one hectare of land under irrigation, the average area irrigated per well being around 0.5 hectare. For the State as a whole the average area irrigated per well works to about one hectare.

There are considerable inter-district variations in the number of irrigation wells not in use, this number being particularly high in the districts of Nagpur, Wardha, Akola. A variety of reasons like inadequate water supply or failure of a well due to bad siting, non-completion of work, inadequate area under well, non-use of well in a season because of adequate rainfall, problems of litigation, etc., were noted in the study of unused wells conducted in Wardha district (IWDP, 1962, pp. 15-21). About 56 per cent of the total irrigated area in the State is under well irrigation (Table 2.14). Except for rice where tank is the major source of irrigation, and only 9 per cent of the irrigated area under rice receives well irrigation, the percentage of well irrigated area is around 60 per cent for the other major irrigated crops like rabi jowar, wheat and sugarcane. In the case of horticultural crops, vegetables, chillies and spices well irrigation is the main source of irrigation.

The potential for further utilization of the groundwater resources has been worked out by the Groundwater Surveys and Development Agency on the basis of the normal rainfall, putting average re-charge at nine per cent of the total precipitation, adjustments being made for increase in the recharge due to surface irrigation,

return from well irrigation, bunding, etc. The current annual withdrawal of the water for irrigation and for domestic purposes has been estimated and the balance which is not tapped is worked out. Assuming that about 50 per cent of the balance will be tapped and an annual average draft of 12 acre feet will be made per irrigation well, the number of new irrigation wells has been worked out. The number of additional wells came to 5 lakh as per the estimate made in 1971. The number of irrigation wells in use increased from 7.1 lakh in 1971-72 to 8.2 lakh by 1979-80. The GSDA made third assessment in 1979 and arrived at an estimation of 18.5 lakh additional wells feasible in the State (Table 2.15). It may be noted that the GSDA does not give any explanation for such a dramatic upward revision by about 14.5 lakh wells. Further it has been reported that the water level in the wells is declining particularly from 1972 in districts like Aurangabad, Solapur, Latur, Osmanabad, Dhule. A study of 100 wells from different parts of the State made in 1977, 1978, 1979, 1980 and 1981 shows progressive deterioration in groundwater availability, as shown below:

	1977	1978	1979	1980	1981
No. of wells with less than 1 metre water in the well out of 100 wells studied	40	48	61	62	78
of which dry wells	21	28	39	42	51

These were the years of normal rainfall. It is necessary to take a serious note of this problem while taking decision about intensification of the programme of groundwater exploitation.

12. Irrigation in Various Regions of the State

On the eve of planning in 1950-51 the extent of irrigated area was very small in Konkan and Marathwada (2.0 and 2.5 per cent of the sown area respectively). The corresponding percentage was 1.2 in Vidarbha excluding Chandrapur and Bhandara districts. Well

was the main source of irrigation in Marathwada and Vidarbha. Only in Chandrapur and Bhandara districts the extent of irrigation was 22 per cent, tanks being the major source of irrigation. In Khandesh and in Nashik districts about 4 per cent of the cropped area received irrigation. In Western Maharashtra, which has an extensive belt of scarcity-prone areas, canal irrigation received attention in the late 19th and early 20th century and irrigated area covered about 9 per cent of the cultivated area in 1950-51. Irrigation is provided both through the surface and the groundwater resources.

In the thirty year period between 1951 and 1981 the area under irrigation increased by 170 per cent for the State as a whole. The increase was very small in Konkan and Chandrapur-Bhandara districts - the high rainfall regions of paddy cultivation. In Marathwada a beginning of surface irrigation was made and major projects like Purna and Jayakwadi Stage-I were completed and a number of medium and minor projects were also commissioned.

Well continues to be the major source of increase in the extension of irrigated area, accounting for about 68 per cent of the increase in the irrigated area between 1951 and 1981. This was largely due to the increase in the number of dug wells (Table 2.16). Nearly 3.5 lakh wells were added during the period 1956-1981. The increase in the number of energized wells also helped increase the area under irrigation to a certain extent. Extension of canal irrigation accounted for about 20 per cent of the increase in the irrigated area. The major increase was in Western Maharashtra, Marathwada and Khandesh-Nashik. Increase through lift irrigation was notable mainly in Kolhapur, Satara, and Sangli districts. The irrigated area formed about 18 per cent of total cultivated area in Western Maharashtra, 15 per cent in Khandesh, 11 per cent in Marathwada and it continued to be negligible in Konkan and Vidarbha.

13. Crop Pattern in Irrigated Agriculture

In 1951, about 60 per cent of the area receiving irrigation in the State was under foodgrains (Table 2.17). Rice was the major irrigated crop in Konkan and Chandrapur-Bhandara districts, wheat in Khandesh and jowar in Western Maharashtra. Among the other crops, chillies and spices accounted for about 10 per cent of the irrigated area in Khandesh and Vidarbha, and sugarcane covered 14 per cent of the irrigated area in Western Maharashtra. The irrigated area under oilseeds and cotton was negligible (about one per cent) and it was less than half a per cent in the case of fruits and vegetables.

In the following decade, certain changes were observed in the irrigated crop pattern in the State. By 1967-69 the share of sugarcane increased to about 12 per cent and that of fruit and vegetables to 5 per cent. The area under irrigated cotton increased from less than half a per cent to about 8.6 per cent in Vidarbha and 5.8 per cent in Khandesh. About 60 per cent of the irrigated area remained under foodgrains.

By 1981, the percentage of area under sugarcane increased to about 15 per cent and that under fruit and vegetables to 9 per cent. In Western Maharashtra sugarcane accounted for as much as 25 per cent of the irrigated area and consumed over 75 per cent of the water utilized for irrigation.

The extent of area under irrigated cultivation varies considerably between different crops. The sugarcane crop is fully irrigated. About 27 per cent of the rice crop receives irrigation. The percentage of irrigated wheat increased from 15 per cent in early 'fifties to 52 per cent by 1981. The area irrigated is quite small in the case of jowar (7 per cent), pulses (3.9 per cent), oilseeds (5.4 per cent). Cultivation of irrigated cotton has increased in Western Maharashtra where about 80 per cent of the area under cotton receives irrigation. The corresponding

proportion is 4 per cent in Marathwada and less than 2 per cent in Vidarbha, the major cotton growing tract of the State.

The area under different irrigated crops does not present a full picture of the utilization of irrigation water. The water requirements of different crops are highly divergent, varying from 7.8 acre-inches for kharif jowar for two supplementary waterings to 176.8 acre-inches in the case of sugarcane which needs 34 waterings during a one-year period (MSIC, 1962, pp. 348-349). If the utilization of water is taken into account it was observed that about 45 per cent of the irrigation water was utilized for sugarcane cultivation and 30 per cent for rice cultivation in the early 'fifties. Another 15 per cent was used for wheat, jowar and pulses. Crops like fruits and vegetables, cotton, oilseeds each claimed less than one per cent of the total water used for irrigation.

By eighties, it is noted that of the additional water resources made available nearly 70 per cent was devoted for the cultivation of sugarcane and horticultural crops, about 10 per cent for cotton, groundnut and other cash crops and only 20 per cent for the cultivation of foodgrains, mainly wheat. As a result, the share of cereals and pulses in the total irrigated crops, declined from about 46 per cent in 1951 to 33 per cent in 1981, while that of sugarcane and horticultural crops, increased from 47 per cent to about 60 per cent in the same period. The additional water resources impounded are, thus, being mainly utilized for voracious water consuming crops notably sugarcane.

The use of irrigation water was examined at the taluka level for the three scarcity-prone districts viz. Ahmednagar, Solapur and Pune. It is observed that in areas where the source of increase in the irrigation is mainly through wells which have a relatively dependable water supply as these are located in the canal command areas, the major increase is in the cultivation of sugarcane. There is little or no increase in the irrigated area

under foodgrains. Talukas like Indapur, Baramati from Pune district and Shrirampur, Rahuri from Ahmednagar district, or Pandharpur from Solapur district are cases in point. In case the increase in irrigation is primarily due to the extension of canal irrigation increase in the area under sugarcane as well as the area under foodgrains is noted because of the restrictions on the cropping pattern in the canal command area. For example, in talukas like Shirur and Daund from Pune district, Kopergaon and Shrigonda from Ahmednagar district, some increase in the area under cereals is noted. For the three districts together area under irrigated foodgrains increased from 2.0 lakh to 4.0 lakh hectares between 1950-51 and 1980-81 and that under sugarcane recorded an increase from 0.32 lakh hectares to 1.4 lakh hectares. If the water utilized is considered the share of foodgrains declined from 35 per cent to 25 per cent, and that of sugarcane increased from about 40 per cent to nearly 60 per cent.

The emphasis on the protective purpose of the irrigation projects laid at the turn of the last century by the British for avoiding the loss of land revenue income and the famine expenditure shifted during the 'thirties to the consideration of the return on the capital invested in the irrigation projects. Cultivation of sugarcane was encouraged to improve the income from irrigation charges. After 1950 the distinction between the protective and productive purposes receded in importance. With the success of co-operative sugar factories the cultivation of sugarcane became very attractive as it provided stable and larger income compared to the income from other irrigated crops. The sugarcane crop became the choice crop in the use of irrigation water. Since the water requirement of sugarcane are very large, even though the area under sugarcane is small (so also the number of cultivators who can grow sugarcane) the impounded water resources used for sugarcane cultivation are substantial. This in effect meant that the use of

irrigation water got restricted to a limited area. The need of spreading the water impounded over as large an area as possible, particularly for providing protection to the food and fodder crops in the drought-prone areas did not receive proper attention in the utilization of the water resources tapped during the last two decades. The lapses in the irrigation development like the slow pace of harnessing the available water resources of the State and the lack of rational policy in the utilization of the water resources were brought to the forefront again by the acute scarcity conditions experienced in the Maharashtra State during the drought of 1972.

14. Spread of New Technology

Surface irrigation, flood control and support to lift and well irrigation through extension of credit on easy terms were the priority items in plan expenditure on agriculture. The other agricultural programmes included contour bunding and land development, consolidation of fragmented holdings, supply of improved and hybrid seeds and fertilizers, electrification, support to cooperative credit and cooperative sugar industry. The physical achievements in regard to these would be clear from the data presented in Tables 2.19 to 2.23. The area under improved/high yielding varieties increased rapidly from 1967 and according to official statistics now the entire area under jowar, paddy and wheat is under hybrid and high yielding varieties. The consumption of fertilizer recorded increase from 1970-71. It increased from 12.5 kg/Ha in 1970-71 to 34.7 kg/Ha by 1977-78. Compared to other States the consumption of fertilizers is quite low in Maharashtra, mainly because the irrigated area is only 12 per cent in the State. In Punjab where 92 per cent area receives irrigation the per hectare application of fertilizers is as high as 176 kg. In the absence of irrigation the farmers are reluctant to incur expenditure for purchase of fertilizer as there is always an element of uncertainty and risk in the final output under rainfed agriculture.

Electrification made rapid progress during the last two decades and now about 90 per cent of the villages in Maharashtra are electrified. This supported the spread of electric pump sets; the number increased by leaps and bounds particularly during the eighties. In 1982 there were 12 lakh electric pump sets which means full mechanization of water lifting has been achieved in the State.

The spread of purchased inputs like improved seeds, fertilizer, electricity and water had been possible because of rapid increase in the supply of credit viz. long term loans given through Land Development Bank and Commercial Banks and short term loans through the cooperative network. The amount of advances through cooperative societies increased from Rs. 175 crore in 1960-61 to Rs. 6882 crore in 1987-88, an increase by 4.5 times in real terms.

Increase in the yield is noted due to various developmental schemes (Table 2.24). The average yield under irrigated conditions is not however much higher in the case of crops like rice, kharif jowar and wheat and the yields in Maharashtra are considerably lower as compared to the yield levels attained in the other States of India.

15. Sugar Factories in Maharashtra

The construction of Godavari and Pravara canals at the beginning of the present century opened up the opportunity for irrigated agriculture in the scarcity tract of the Ahmednagar district. However, the local peasantry had neither the knowledge nor the resources to shift to irrigated agriculture. The beginning of sugarcane farming was made by immigrant agriculturists - mainly from the Mali caste from the neighbouring districts. Sugarcane farming made a considerable progress in the boom following World War I but the break in gur prices in the later 'twenties brought this process to an end. Because of this conjuncture of circumstances Government found that the canal water was not being fully

used. Following the recommendations of the Deccan Canals Financial Improvement Committee (1931) Government decided to grant special concessions for the establishment of sugar factories. This coincided with the grant of protection to the sugar industry. The Government arranged to make available on long leases to the private sugar factories tracts of land for sugarcane farms taken on low rentals from the local peasantry. Between the years 1931 and 1936 six new sugar factories were established in the canal command area. (In 1930 there was only one sugar factory in the area.) The gur prices also picked up after 1935 and there was an increase in the area under sugarcane. A move towards the establishment of sugar factory in cooperative sector was made in a conference of irrigators at Shrirampur (Ahmednagar district) in December 1945. The conference adopted a resolution in favour of sponsoring establishment of a cooperative sugar factory.

In the Loni area (tāluka Shrirampur) Shri Vikhe Patil a local cultivator took the lead in the matter and in cooperation with Dr. Gadgil - a well known economist and an ardent and active cooperator who saw in it an answer to the peasant problem, promoted the venture. The Society was registered at the end of 1948. Dr. Gadgil was the Chairman of the Pravara cooperative sugar factory from 1949 to 1960. The Government agreed to subscribe Rs. 6 lakhs to share capital and the Industrial Finance Corporation agreed to sanction a loan of Rs. 20 lakhs. The Bombay Provincial Cooperative Bank was the chief source of supply of working capital. The Karkhana - a joint venture of the cultivators and the State Government started production of sugar in the year 1950-51. The share capital of the factory increased from Rs. 6 lakhs in 1950-51 to Rs. 120 lakhs by 1960-61. The irrigation facility in the command area was developed with the support extended by the factory. In the period 1950-51 to 1960-61 the number of wells recorded an increase from 288 to 1531 and the number of pumps from 32 to 1005.

During the period 1950-51 to 1974-75 the sugarcane crushed by the factory went up from 33 thousand tons to about 530 thousand tons.

The Pravara venture encouraged the State Government to launch a scheme of cooperative sugar factories. The Planning Commission had indicated its preference to processing plants owned and managed by the cooperative societies. In 1954, Government of Bombay issued a Press Note indicating 12 areas in the Deccan canal tract suitable for the establishment of cooperative sugar factories. The total capital requirement was Rs. 65 lakhs of which Rs. 15 lakh was share capital, to be subscribed by the farmers, Rs. 10 lakh share capital to be contributed by the State Government and Rs. 40 lakh loan to be advanced as loan by the IFC. Provision for medium term loan to the extent of 75 per cent* of the value of the share to be subscribed by the farmer was made by the Reserve Bank of India.

In the period 1955-60, 13 new sugar factories were established in the cooperative sector located in the canal irrigated areas of Ahmednagar, Nashik, Pune, Satara district and canal and lift irrigated areas of the Kolhapur district. During the 'sixties 15 new factories were added. Attempts to establish cooperative sugar factories outside the canal irrigated areas were made during this period. However, the uncertainty in the groundwater resources made the extension of sugarcane area difficult and the viability of the factory uncertain. The sugarcane yield is also lower in these tracts.

Sugarcane is one of the most profitable and attractive crops if grown for a cooperative sugar factory that gives assured price and takes the responsibility of cutting and transporting the cane. There is a scramble for securing licence for a cooperative factory and the number of factories have grown from about 20 in 1961 to 91 in 1986. About 100 villages in the hinterland of the factory

* This proportion was increased to 90 per cent in 1972.

derive benefits from sugarcane cultivation; most of the members are large and medium sized cultivators who can afford to put upto one hectare under sugarcane. The influential land-owners exercise control over the Board of Directors of these factories and these 'Sugar barans' wield considerable economic and political power in the district.

The benefits of large investments in irrigation and sugar factories are confined to limited irrigated tracts mainly in Western Maharashtra. Sugarcane accounts for less than 2 per cent of the total cropped area in the State.

The benefits of irrigation in Maharashtra are thus enjoyed mainly by one single crop, viz., sugarcane. The cultivation of sugarcane in the State is concentrated in some 24 talukas of the State, that includes eight talukas from Kolhapur district, five talukas from Ahmednagar district, three each from Nashik and Sangli districts, two each from Pune and Satara districts and one from Solapur district. These 24 talukas together account for 9.0 per cent of the gross cropped area in the State but claim as much as 55 per cent of the area under sugarcane in the State. High concentration of irrigation facility, mechanical lifts and tractors is noted in these talukas (Table 2.27).

Even within this group of districts a high concentration is noted in 6 talukas which together account for only 1.6 per cent of the gross cropped area of the State. Karveer, Hatkanangale, and Shirol talukas from Kolhapur district which do not fall within the drought-prone zone and three talukas viz., Shrirampur, Kopergaon and Rahuri from Ahmednagar district that were provided with protective irrigation facility in the early decades of this century together account for 18 per cent of the sugarcane area in the State. In 1932 about 17 per cent of the tractors in the State were located in these six talukas. Thus, the investment in irrigation and other agricultural development is largely concentrated in a

limited area of the State and the benefits of the investments made during the Plan period are mainly enjoyed by the sugarcane farmers. The agricultural situation has not changed significantly during the last two decades over the vast stretches of the rural Maharashtra.

16. Agricultural Production

An upward trend in the agricultural production and particularly some stabilization of agricultural production would be expected as a result of the sizable investment made for agricultural development. If the data relating to net income from agriculture and allied activities and trends in the production of major crops are examined, the first noteworthy fact is the violent year to year fluctuations in the production of different crops and the large year to year variations in the total agricultural income (Table 2.29). The net agricultural income reached a peak of Rs. 664.2 crore (at 1960-61 prices) in the year 1960-61. The net agricultural income at 1960-61 prices was around Rs. 620 crore in the years 1963-64, 1964-65; around Rs. 600 crore in 1958-59, 1962-63, 1968-69; it was as low as Rs. 500 crore in the drought year 1965-66 and an all time record low income of Rs. 393 crore was noted in 1972-73. After 1974-75 the agricultural income recorded some increase and a peak was reached in 1983-84 when the income at constant prices was Rs. 908 crore or about 37 per cent higher than the 1960-61 level. It dropped to Rs. 670 crore in 1986-87 - a scarcity year. The instability in agriculture thus persists and only a small increase in the income is experienced over a period of three decades. If the per capita income is considered (only for years of normal rainfall) some decline in the income in relation to 1960-61 level is noted as will be seen from the following figures.

Year	Per capita agricultural income for agricultural population at 1960-61 prices
1955-56	195
1960-61	260
1969-70	198
1981-82	242
1987-88	236

During the 'fifties some increase in the production was noted in the case of all the major crops except pulses. The growth in the production was partly due to the increase in the area under cultivation. The marked growth in the production of sugarcane from about 6 lakh tonnes in 1951-52 to about 16 lakh tonnes (in terms of gur) in 1969-70 was largely because of the expansion in the area under sugarcane from about 91 thousand hectares in 1951-52 to 200 thousand hectares in 1969-70. In the case of wheat also the increase in the area cultivated was an important contributory factor. Increase in the productivity was noted in areas where there was a significant shift from non-irrigated to irrigated wheat cultivation. For all the crops taken together the annual compound growth rate for the period 1952-53 to 1961-62 worked out to 3.13 per cent for production, the corresponding growth rate for the area sown came to 0.48 per cent. In the following period viz., 1961-73, wide fluctuations in the production were noted for all the crops barring sugarcane. The production was considerably below the normal in the years 1965-66, 1970-71, 1971-72 and nearly half the normal in the year 1972-73. A secular trend could not be fitted because of the wide year to year fluctuations in the production. The general trend, however, was downward for the period 1961-62 to 1971-72 for all the crops except bajra and sugarcane. In the case of sugarcane the increase is again due to the expansion of the area under sugarcane. In the case of wheat the introduction of improved and high yielding varieties, extension of irrigation and fertilizer application seem to be the important factors resulting in some increase in the per hectare yield (Rajpurohit, 1972, pp. 57-59). The performance of jowar, the major cereal crop that accounts for about 55 per cent of the cereal production in the State has been quite poor despite the introduction and spread of the high yielding varieties of jowar. During the period 1956-57 to 1969-70 negligible increase in the level of jowar production and productivity was

recorded. During the early phase of green revolution i.e. the period 1964-65 to 1969-70 the annual compound growth rate was negative (-0.4 per cent for productivity and -1.64 per cent in the case of production). In the case of hybrid jowar, the year to year variability in the yields did not appear to be significantly lower as compared to the fluctuations noted in the case of local varieties. Even if the average yields of hybrid jowar are higher, it demands higher initial expenditure, the returns on which remain uncertain. The relatively poor yield of fodder, also acts as a deterrent to the acceptance of the hybrid variety. In addition, the water requirement for prophylactic measure makes it difficult to take to the cultivation of hybrid jowar in the dry tracts. If hybrid jowar is to be sown in the rabi season, it is necessary to give a few waterings; since only about 8 per cent of the rabi jowar receives irrigation the spread of hybrid variety is necessarily limited. In some areas, hybrid jowar could not compete with the local varieties even on the irrigated lands because of the high susceptibility to pests and diseases (Muranjan, II, 1972, pp. 46-49).

If all the crops are taken together, some decline, both in the productivity and in the total production is noted for the State as a whole during the 'sixties. The annual compound growth rate for the period 1961-1970 (omitting the drought year 1965-66) came 0.05 for area under crops, it was -0.07 for agricultural production and -0.12 in the case of productivity (Khare, 1979, p. 269). In the early 'seventies there was a marked decline in the production for three successive years viz., 1970-71, 1971-72, 1972-73, when drought conditions occurred in different parts of the State.

During the period 1974-75 to 1987-88 some decline is noted in the area under wheat and production of wheat. It was reported that in the 'seventies the area under irrigated wheat increased particularly in the Marathwada districts however due to the problem of pest infestation there was a decline after 1981. Some increase

in the area under jowar and tur is recorded while the trend of decline in the area under groundnut continued.

The annual compound growth rate of productivity between 1973-74 and 1983-84 was 2.7 per cent, 1.7 per cent and 1.4 per cent respectively for jowar, for wheat and for rice. The annual compound growth rate for area, production and productivity for the period 1960-61 to 1983-84 is given in Table 2.30. In the case of sugarcane there has been a considerable growth in the area and production but not in productivity. In the case of cereals the growth in productivity was around 2 per cent while it was negligible for pulses, cotton and oilseeds. The coefficient of variability in production is quite high for all crops except sugarcane. With the meagre development of irrigation and in the absence of scientific approach to utilization of water resources, the agriculture in Maharashtra remains largely at the mercy of the vagaries of monsoon.

17. Distribution of Benefits

So far we have examined technical achievements at the aggregate level. It is equally important to examine the distribution of benefits of development among various agrarian classes.

Certain reform measures e.g. abolition of Jagir, Inam and Watan rights, elimination of absentee land ownership and ceiling on land holding were taken with a view to secure fruits of agricultural development to the tiller. The abolition of landlord system did not bring about any changes in the organization of agricultural production as lands were never operated in Maharashtra as large units but had been traditionally parcelled out to small tenant farmers. As tenancies were terminated a large number of small tenants become landless. The ceiling law proved ineffective because family lands were often parcelled in the name of several individual members. Subsequently the amount of surplus land was meagre and that too generally of a very poor quality.

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 63.6 lakh in 1980-81. During this period the number of landholders with land below one hectare increased from 1241900 to 1925900 (Table 2.31). Considerable increase in the number of landless labourers is also noted, their number increased from 45 lakh in 1961 to 65 lakh in 1981.

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.

18. Animal Husbandry

The cattle population in the State did not increase from 1951 to 1978, however between 1978-1982 growth is recorded particularly in the number of cows (Table 2.32). 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 (Table 2.33). The proportion of cow-milk is nearly 50 per cent in the total production, while in the milk collected the corresponding proportion is 75 per cent. 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 undernourishment 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 schemes. 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. The shepherds from Pune-Satara districts migrate to Rayagad district and those from Solapur and Marathwada migrate to Yavatmal district after the rainy season in search of grazing grounds. 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. Large flocks of 500 to 1000 are formed pooling the flocks prior to migration. 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.

Rough estimation of income for a unit of 50 sheep can be made on the basis of information obtained from primary and secondary sources. At 70 per cent lambing 35 lambs are born out of which 32 may survive. If 15 are disposed of at Rs.300 each income of Rs. 4500 will be obtained. Ten old ewes may yield about Rs. 2000 after disposal. The folding at Rs. 40 per 50 sheep for 40 foldings give an income of Rs. 1600 and Rs. 700 can be obtained from the sale of manure collected during stationary period. Twenty-

five kilograms of wool will fetch Rs. 250. The total gross income works out to Rs. 9050 for 50 sheep.

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.

Annual income estimates for a unit of 4 goats may be made for illustrative purpose. At 160 per cent kidding rate (60 per cent twins) 6 kids are born out of which 5 (say 2 male + 3 female) may survive. If the two male kids are sold at Rs. 500 each, income of Rs. 1000 will be obtained. Disposal of two old ewes will bring Rs. 600. Income from manure collected during night-time would come to around Rs. 400. Sale of milk (300 litres) would fetch Rs. 900. Goat-skin of the dead kid is sold at Rs. 30. Gross cash income for a unit of 4 goats works out to be around Rs. 2930. Besides the cash income the family would be getting some milk (about $\frac{1}{2}$ litre a day) for home consumption and gross asset position would improve by three ewes worth around Rs. 1800 at the end of the year. Out of these, two would replace the older ewes disposed and net addition would be one ewe.

To examine the relative importance of various animals gross return from animal husbandry is examined (Table 2.34). 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 Chapter X.

Table 2.1 : Districtwise Area, Population and Workers in Maharashtra (1981)

Sr. No.	District	Area in sq.km.			Population '000			Percentage of urban population to total (9)	Population per sq.km. Rural (10)
		Total (3)	Rural (4)	Urban (5)	Total (6)	Rural (7)	Urban (8)		
1.	Greater Bombay	603	-	603	8243	-	8243	100.00	-
2.	Thane	9558	9326	232	3352	1866	1486	44.34	200
3.	Raigad	7148	7015	133	1487	1277	210	14.12	132
4.	Ratnagiri	13054	12940	114	2111	1940	171	8.10	150
5.	Nashik	15530	15186	344	2992	2054	928	31.02	136
6.	Dhule	13150	13048	102	2050	1650	400	19.52	126
7.	Jalgaon	11755	11495	270	2618	1960	658	25.14	171
8.	Ahmednagar	17048	16871	177	2708	2357	351	12.97	140
9.	Pune	15642	15021	621	4164	2193	1971	47.33	146
10.	Satara	10484	10130	354	2039	1773	266	13.04	175
11.	Sangli	8572	8272	300	1831	1437	394	21.52	174
12.	Solapur	15017	14678	339	2610	1843	767	29.40	126
13.	Kolhapur	8047	7855	192	2506	1884	622	24.82	240
14.	Aurangabad	16305	16165	140	2434	1896	538	22.09	117
15.	Parbhani	12561	12339	222	1829	1487	343	18.74	120
16.	Beed	11085	10850	235	1486	1256	230	15.46	116
17.	Nanded	10502	10291	211	1749	1421	328	18.74	138
18.	Osmanabad	14210	13894	316	2231	1887	343	15.39	136
19.	Buldhana	9661	9603	58	1509	1230	279	18.49	128
20.	Akola	10575	10426	149	1827	1372	455	24.89	132
21.	Amravati	12212	12052	160	1861	1317	544	29.25	109
22.	Yavatmal	13584	13516	68	1737	1475	262	15.09	109
23.	Wardha	6310	6280	30	927	695	232	24.98	111
24.	Nagpur	9931	9600	331	2589	1120	1469	56.75	117
25.	Bhandara	9213	9140	73	1838	1597	241	13.10	175
26.	Chandrapur	25923	25809	114	2056	1794	262	12.73	70
Maharashtra State		307690	301802	5888	62784	40791	21993	35.03	135

(continued)

Table 2.1 : (continued)

Sr. No.	District	No. of Talukas	No. of Villages Inhabited	No. of Towns	Average Size of Villages (Persons)	Sex Ratio	Total Workers (in 000)	Percentage of Agricultural Labourers to Total Workers	Percentage of Cultivators to Total Workers
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
1.	Greater Bombay	3	-	1	-	772	2864	0.16	0.16
2.	Thane	13	1746	34	1068	833	1277	13.10	28.37
3.	Raigad	14	1827	16	699	1046	556	14.18	52.12
4.	Ratnagiri	15	2038	13	953	1238	718	8.29	65.84
5.	Nashik	13	1742	19	1185	937	1270	30.03	38.68
6.	Dhule	10	1516	7	1088	966	785	41.64	36.44
7.	Jalgaon	13	1475	15	1329	950	1040	41.30	34.17
8.	Ahmednagar	13	1503	8	1568	959	1139	28.24	47.54
9.	Pune	14	1753	26	1251	937	1428	13.22	33.91
10.	Satara	11	1417	10	1251	1061	706	19.78	50.14
11.	Sangli	8	708	8	2030	967	623	22.49	48.37
12.	Solapur	11	1104	10	1669	942	984	29.65	34.57
13.	Kolhaour	12	1200	12	1570	967	917	16.59	51.19
14.	Aurangabad	12	1959	10	968	947	922	31.09	45.17
15.	Parbhani	8	1615	12	920	968	805	39.84	39.66
16.	Beed	7	1256	7	1000	966	601	31.14	47.90
17.	Nanded	8	1425	11	998	960	712	34.52	38.96
18.	Osmanabad	11	1527	13	1236	958	862	37.90	42.70
19.	Buldhana	5	1273	9	966	957	707	43.80	40.05
20.	Akola	6	1546	9	838	948	777	50.76	28.82
21.	Amravati	6	1598	12	776	936	752	52.57	24.43
22.	Yavatmal	5	1751	8	843	958	802	53.40	30.37
23.	Wardha	3	1015	6	685	948	399	47.99	28.96
24.	Nagour	5	1558	16	675	924	914	26.56	21.10
25.	Bhandara	3	1624	7	983	997	838	27.16	45.35
26.	Chandrapur	6	2978	8	602	966	880	29.68	46.98
Maharashtra State		235	39354	307	1037	937	24277	26.79	34.84

Source: Statistical Abstract of Maharashtra State, 1982-83, 1983-84, Bombay, 1988.
(Hereinafter referred to as Statistical Abstract, 1988.)

Table 2.2 : Districtwise Annual Rainfall in Maharashtra

Rain gauge Centre	Annual rainfall (in mm)			
	Normal	1983-84	1984-85	1985-86
Bombay (Colaba)*	1804.8	3420.5	2219.3	2423.7
Thane (Dahanu)*	1909.1	2636.2	1302.3	1693.4
Raigad (Alibag)*	1959.8	4055.5	2203.6	2554.6
Ratnagiri*	2617.1	3924.3	2500.5	3365.4
Nashik (Ozar)*	632.7	559.2	558.6	362.3
Dhule (Nandurbar)*	637.2	N.A.	N.A.	N.A.
Jalgaon*	786.6	871.8	515.0	534.8
Ahmednagar*	621.9	815.4	497.5	418.6
Pune*	661.3	790.5	861.2	629.5
Solapur*	677.7	896.0	653.5	468.6
Satara	1025.1	807.4	1076.8	709.2
Sangli (Miraj)*	568.5	481.8	N.A.	472.5
Kolhapur*	1070.1	1060.7	848.7	805.7
Aurangabad*	725.8	1033.1	374.8	579.2
Parbhani*	853.8	1449.1	746.8	774.0
Beed	785.6	968.5	602.4	483.5
Nanded	982.2	1637.4	459.1	493.1
Osmanabad	809.0	1064.4	430.5	597.1
Buldhana*	892.6	988.7	569.4	553.9
Akola*	800.5	921.4	546.2	791.3
Amravati*	876.5	1020.0	699.7	805.3
Yavatmal*	1096.1	1242.4	691.7	983.3
Wardha*	1134.4	1119.4	784.6	967.8
Nagpur (A.P.)*	1242.2	1277.0	756.9	1352.8
Bhandara (Gondia)*	1471.0	1575.6	1012.3	1144.7
Chandrapur*	1267.4	1238.4	771.9	1117.0

* Observatory Stations. N.A. = Data is not yet received.

Source: Districtwise General Statistical Information of Agriculture Department, 1986-87 (hereinafter referred to as Epitome of Agriculture in Maharashtra).

Table 2.3 : Classification of Districts and Tahsils in Maharashtra State According to the Agro-Climatic Zones

Agro-climatic zone	Districts with Tahsils
I. Very high rainfall (2,500 to 3,000 mm) tract with lateritic soils	1. Ratnagiri - All Tahsils 2. Kolhapur - Chandgad
II. Very high rainfall (2,500 to 3,000 mm) with non-lateritic soils	1. Greater Bombay 2. Thane - All Tahsils 3. Kulaba - All Tahsils 4. Nashik - Igatpuri
III. Ghat zone (3,000 to 5,000 mm and above)	1. Satara - Mahabaleshwar 2. Kolhapur - Bavda, Radhanagari
IV. Transition - A (1,250-3,000 mm) with red to reddish brown soils	1. Nashik - Surgana, Peint 2. Pune - Khed, Maval, Mulshi, Velhe, Bhore 3. Satara - Jaoli, Patan 4. Kolhapur - Shahuwadi, Panhala, Karveer, Kagal, Bhudergad, Ajra, Gadhinglaj
V. Transition - B (700 to 1,250 mm) with greyish black soils	1. Nashik - Kalwan, Dindori, Sinnar 2. Dhule - Akrani, Akkalkuwa, Taloda, Nandurbar, Navapur 3. Ahmednagar - Akola 4. Pune - Junnar, Ambegaon, Pune City 5. Satara - Wai, Satara, Karad 6. Sangli - Shirala 7. Kolhapur - Hatkanangale, Shirol
VI. Scarcity zone with kharif-cum-rabi-cropping (500 to 700 mm)	1. Nashik - Baglan, Malegaon, Chandor, Nandgaon, Nashik, Niphad, Yeola 2. Dhule - Shahada, Sindkheda, Sakri, Dhule 3. Jalgaon - Amalner 4. Ahmednagar - All Tahsils except Akola 5. Pune - Sirur, Haveli, Daund, Purandhar, Baramati, Indapur 6. Satara - Khandala, Phaltan, Koregaon, Khatav, Man. 7. Sangli - All Tahsils except Shirala 8. Solapur - Karmala, Barshi, Madha, Malshiras, Pandharpur, Mohol, Sangola, Mangalwedha 9. Aurangabad - Vaijapur, Gangapur, Paithan

(continued)

Table 2.3 : (continued)

Agro-climatic zone	Districts with Tahsils	
	10. Beed	- Manjalegaon, Patoda, Ashti
	11. Osmanabad	- Parenda, Bhoom, Kallam
VII. Assured rainfall (700 to 900 mm) zone with mainly kharif cropping	1. Dhule	- Shirpur
	2. Jalgaon	- All Tahsils except Amalner
	3. Solapur	- South Solapur, North Solapur, Akkalkot
	4. Aurangabad	- All Tahsils except Vaijapur, Gangapur, Paithan
	5. Parbhani	- Partur, Jintur, Pathri, Gangakhed
	6. Beed	- Gevrai, Beed, Kaij, Ambejogai
	7. Nanded	- Mukhed, Degloor
	8. Osmanabad	- Ahmedpur, Osmanabad, Latur, Tuljapur, Udgir, AUSA, Omerga, Nilanga
	9. Buldhana	- All Tahsils
	10. Akola	- All Tahsils except Washim
	11. Amravati	- Melghat, Achalpur, Daryapur, Amravati
VIII. Moderate to moderately-high rainfall (900 to 1,250 mm) zone with soils formed from trap rock	1. Parbhani	- Hingoli, Kalamnuri, Parbhani, Basmath
	2. Nanded	- Kinwat, Hadgaon, Nanded, Bhokar, Kandhar, Billoli
	3. Akola	- Washim
	4. Amravati	- Morshi, Chandur
	5. Yavatmal	- All Tahsils
	6. Wardha	- All Tahsils
	7. Nagpur	- Katol, Saoner, Ramtek, Nagpur
	8. Chandrapur	- Warora, Rajur
IX. High rainfall (1,250 to 1,700 mm) zone with soils formed from mixed rocks	1. Nagpur	- Umrer
	2. Bhandara	- All Tahsils
	3. Chandrapur	- Brahmapuri, Gadchiroli, Chanda, Sironcha

Source : Report of the Study Committee on Employment Conditions of Agricultural Labour in Maharashtra State, 1973, pp. 117-118.

Table 2.4 : Distribution of the Geographical Area in Maharashtra by Agro-Climatic Zones

Agro-climatic zone	Region				
	Konkan*	Khandesh Nashik	Western Maha-rashtra	Marath-wada	Vidarbha
(Per cent area under different zones)					
I. Very high rainfall - lateritic soils	44.3	-	1.4	-	-
II. Very high rainfall - non-lateritic soils	55.7	2.3	-	-	-
III. Ghat	-	-	2.4	-	-
IV. Transition - A	-	4.0	15.4	-	-
V. Transition - B	-	17.9	11.3	-	-
VI. Scarcity	-	39.7	69.5	18.5	-
VII. Assured rainfall	-	29.6	-	59.8	19.9
VIII. Moderate to moderately high rainfall	-	6.5	-	21.7	43.3
IX. High rainfall	-	-	-	-	36.8
Total	100.0	100.0	100.0	100.0	100.0
Sq.km.	29791	40496	74810	64525	97537

* Excludes Greater Bombay.

Source : Computed on the basis of data in Table 2.3.

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Table 2.5 : Districtwise Distribution of Cultivable Land in Maharashtra State by Soil Type

(Area in lakh hectares)

Sr. District No.	Total Cultivable land	Soil Type								
		Coarse shallow soils	Medium black soils	Deep Black soils	Laterite and Lateritic soils	Reddish brown soils of hills slopes	Coastal alluvium	Coastal saline	Yellowish brown soils	Yellowish brown soils of plains
1. Thane	3.16	0.90	1.52	-	-	0.29	0.45	-	-	-
2. Raigad	3.39	0.91	1.43	0.80	0.25	-	-	-	-	-
3. Ratnagiri	6.41	-	-	-	4.51	0.02	1.69	0.19	-	-
4. Nashik	9.82	3.06	2.91	0.60	0.39	0.86	-	-	-	-
5. Dhule	5.75	3.62	1.04	0.73	-	-	-	-	-	-
6. Jalgaon	7.24	2.48	3.26	1.50	-	-	-	-	-	-
7. Pune	10.97	2.27	2.06	0.36	1.19	4.59	-	-	-	-
8. Ahmednagar	12.90	4.87	5.29	1.66	-	1.08	-	-	-	-
9. Solapur	12.36	3.11	6.02	3.23	-	-	-	-	-	-
10. Kolhapur	4.70	0.84	0.84	0.22	1.26	1.54	-	-	-	-
11. Satara	7.62	2.84	1.11	0.53	0.71	2.43	-	-	-	-
12. Sangli	7.39	2.50	3.21	1.68	-	-	-	-	-	-
13. Aurangabad	14.19	5.31	6.46	2.42	-	-	-	-	-	-
14. Parbhani	11.29	1.18	6.56	3.55	-	-	-	-	-	-
15. Beed	9.83	2.35	5.35	2.13	-	-	-	-	-	-
16. Nanded	8.27	2.00	4.01	2.26	-	-	-	-	-	-
17. Osmanabad	13.42	1.53	10.11	1.78	-	-	-	-	-	-
18. Amravati	7.63	1.84	4.58	1.21	-	-	-	-	-	-
19. Akola	8.27	0.71	6.12	1.44	-	-	-	-	-	-
20. Buldhana	7.32	3.50	2.69	1.13	-	-	-	-	-	-
21. Yavatmal	8.65	5.73	0.91	2.01	-	-	-	-	-	-
22. Nagpur	5.66	1.11	1.34	0.34	-	-	-	-	0.33	2.54
23. Wardha	6.93	2.51	2.64	1.78	-	-	-	-	-	-
24. Bhandara	4.13	-	-	0.15	-	-	-	-	2.20	1.78
25. Chandrapur	6.53	0.65	0.78	1.32	0.84	-	-	-	1.44	1.50
Total	203.83	55.82	80.60	33.33	9.15	10.81	2.14	0.19	3.97	5.82

Source: Epitome of Agriculture in Maharashtra, 1986-87.

Table 2.6 : Classification of Area in Each District of Maharashtra State, 1983-84

(Area in '00 hectares)

Sr. No.	District	Total Area	Forest	Barren and uncultivated land	Land put to non-agricultural uses	Culturable waste	Permanent pastures and grazing land	Land under trees crops and groves	Current fallow	Other fallows	Net sown area	Double cropped area	Gross sown area
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Greater Bombay	380	15	73	190	9	6	-	3	18	66	2	68
2.	Thane	9337	3675	817	651	397	875	64	162	73	2623	186	2809
3.	Raigad	6869	1613	1284	371	381	327	324	200	420	1949	392	2341
4.	Ratnagiri)	12733	308	3426	310	2953	172	388	476	1193	3562	350	3912
5.	Sindhudurg)												
	Total Konkan Div.	29374	5611	5600	1522	3740	1380	776	841	1704	8200	930	9130
6.	Nashik	15633	3345	1783	47	197	237	6	325	312	9381	747	10128
7.	Dhule	14380	5516	601	198	59	488	10	13	128	7367	584	7951
8.	Jalgaon	11640	1644	806	98	62	613	7	103	79	3228	1780	10008
	Total Nashik Div.	41653	10505	3190	343	318	1338	23	441	519	24976	3111	28087
9.	Ahmednagar	17020	1784	1463	84	130	405	-	484	328	12342	1295	13637
10.	Pune	15620	1844	1616	438	349	968	-	191	174	10040	1532	11572
11.	Solapur	15010	325	688	38	374	652	45	782	841	11265	1045	12310
	Total Pune Div.	47650	3953	3767	560	853	2025	45	1457	1343	33647	3872	37519

(continued)

Table 2.6 : (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
12. Satara		10582	1474	1101	281	395	919	1	306	420	5685	1763	7448
13. Sangli		8610	479	437	289	75	182	112	350	610	6076	605	6681
14. Kolhapur		8179	1468	419	340	680	418	59	306	369	4120	372	4492
Total Kolhapur Div.		27371	3421	1957	910	1150	1519	172	962	1399	15881	2740	18621
15. Aurangabad)		16272	319	247	661	193	683	131	361	207	12970	1318	14288
16. Jalna)													
17. Parbhani		12503	379	158	460	437	420	35	351	159	10104	1567	11671
18. Beed		11169	212	170	288	437	394	15	1391	381	7881	1073	8954
19. Nanded		10331	800	173	379	298	671	50	377	110	7473	672	8145
20. Osmanabad)		14027	13	156	254	642	385	73	532	394	11578	2016	13594
21. Latur)													
Total Aurangabad Div.		64302	2223	904	2042	2007	2553	304	3012	1251	50006	6646	56652
22. Buldhana		9671	1200	256	324	90	441	11	211	265	6873	1128	8001
23. Akola		10560	688	271	415	67	637	19	54	128	8281	716	8997
24. Amravati		12217	3238	182	409	75	616	81	222	189	7205	793	7998
25. Yavatmal		13519	2482	417	400	234	733	111	263	340	8539	364	8903
Total Amravati Div.		45967	7608	1126	1548	466	2427	222	750	922	30898	3001	33899
26. Wardha		6289	675	70	406	122	441	73	93	106	4303	341	4644
27. Nagour		9864	1853	146	716	119	1033	27	263	131	5571	655	6226
28. Bhandara		9279	2666	179	877	193	1375	75	110	79	3725	1566	5291
29. Chandrapur)		25834	14534	346	1217	619	1627	132	309	176	6874	932	7806
30. Gadchiroli)													
Total Nagour Div.		51266	19728	741	3216	1053	4476	307	780	492	20473	3494	23967
Total Maharashtra State		307583	53049	17235	10141	9587	15718	1849	8243	7630	184081	23794	207875
Percentage to total area		100.00	17.25	5.62	3.30	3.11	5.11	0.60	2.68	2.48	59.85		

Source : Epitome of Agriculture in Maharashtra, 1986-87.

Table 2.7 : Percentage Area Under Principal Crops to Total Cropped Area in each District of Maharashtra State(1981-82)

District	Paddy	Wheat	Kharif Jowar	Rabi Jowar	Bajri	Ragi	Gram	Tur	Sugar-cane	Cotton	Ground-nut (Kh.)	Ground-nut (Summer)	Sesamum (K+R)	Safflower	Linseed
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Konkan Division</u>															
1. Bombay	15.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Thane	51.1	-	0.1	-	-	8.0	0.4	1.0	-	-	0.1	-	0.1	-	-
3. Raigad	66.4	-	-	-	-	9.5	0.3	0.9	-	-	-	-	0.5	-	-
4. Ratnagiri	31.1	-	-	-	-	12.8	-	0.1	0.0	-	-	0.1	1.0	-	-
5. Sindhudurg	52.3	-	0.0	-	-	7.5	-	0.2	0.2	-	0.5	-	0.7	-	-
Total Konkan Div.	49.1	-	0.0	-	-	10.4	0.2	0.6	0.0	-	0.1	-	0.6	-	-
<u>Nashik Division</u>															
6. Nashik.	4.4	9.4	4.7	5.9	35.8	4.9	2.2	0.5	3.0	0.3	5.6	0.1	0.0	0.1	0.0
7. Dhule	3.5	5.6	15.2	10.9	16.9	1.4	1.2	1.5	1.5	7.9	11.2	0.5	1.2	-	-
8. Jalgaon	1.0	5.2	21.5	5.1	11.0	-	1.2	1.2	0.8	20.8	6.7	0.7	1.0	0.4	0.0
9. Ahmednagar	0.6	4.6	1.6	44.1	22.9	0.4	1.5	1.1	5.6	0.6	1.0	0.1	0.1	4.4	0.1
Total Nashik Div.	2.1	6.1	9.6	19.6	22.0	1.6	1.6	1.1	3.1	6.7	5.4	0.3	0.5	1.6	0.0
<u>Pune Division</u>															
10. Pune	4.5	3.2	3.1	38.8	15.4	1.1	2.2	0.6	2.2	0.5	2.3	0.2	0.4	2.5	0.0
11. Satara	5.3	3.2	14.2	21.2	16.9	1.8	1.8	1.0	4.1	0.3	8.8	0.1	0.0	0.8	0.0
12. Sangli	2.8	5.1	20.4	14.9	16.6	0.1	2.5	2.2	4.9	0.4	6.6	-	0.1	1.3	0.0
13. Solapur	0.4	2.6	1.1	60.0	5.6	-	2.6	5.1	2.0	1.1	1.5	0.6	0.2	4.7	0.2
14. Kolhapur	22.7	3.5	9.2	1.0	0.2	9.1	2.0	1.1	12.6	0.1	10.3	-	-	-	-
Total Pune Div.	5.1	3.3	7.7	34.4	11.3	1.6	2.3	2.3	4.0	0.7	4.6	0.2	0.2	2.4	0.1

(continued)

Table 2.7 : (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
<u>Aurangabad Division</u>															
15. Aurangabad	0.6	6.1	7.1	29.5	17.0	-	3.0	3.7	2.6	6.8	1.8	0.1	0.3	6.3	1.5
16. Jalna	0.5	5.9	10.1	20.7	5.9	-	1.9	3.7	1.2	13.7	1.2	0.0	0.3	9.1	1.6
17. Parbhani	2.3	5.7	19.9	17.4	0.9	-	3.0	4.0	0.5	21.1	1.0	0.5	0.3	5.6	2.5
18. Beed	0.2	5.2	15.3	30.2	14.7	-	4.2	3.9	0.7	3.9	1.4	0.2	0.4	5.2	3.6
19. Nanded	4.2	5.1	32.2	6.3	0.3	-	2.0	4.7	0.9	27.1	2.2	0.2	0.8	0.3	0.8
20. Osmanabad	2.1	5.5	17.3	30.1	0.6	-	5.8	3.9	2.1	0.0	2.7	0.3	0.8	5.1	2.0
21. Latur	3.1	4.0	31.4	5.6	2.0	-	4.1	8.0	1.1	4.6	4.8	0.0	1.0	2.0	1.6
Total Aurangabad Div.	1.9	5.4	13.7	20.3	6.3	-	3.4	5.0	1.3	12.4	2.0	0.2	0.6	5.0	2.0
<u>Amravati Division</u>															
22. Buldhana	0.4	5.9	33.0	0.3	1.3	0.0	1.7	4.4	0.3	29.7	3.0	0.1	0.2	5.8	0.2
23. Akola	1.0	4.5	31.2	-	0.6	-	1.3	4.4	0.1	39.6	2.2	0.1	0.4	1.5	0.4
24. Amravati	1.7	5.9	23.3	-	0.9	-	1.5	5.9	0.0	46.7	3.3	0.1	0.5	0.0	0.8
25. Yavatmal	1.5	2.4	31.4	-	1.4	-	0.5	5.8	0.2	45.3	2.7	0.4	0.8	0.0	0.7
Total Amravati Div.	1.1	4.6	30.0	0.1	1.1	0.0	1.2	5.1	0.2	40.3	2.8	0.2	0.5	1.8	0.5
<u>Nagpur Division</u>															
26. Wardha	1.6	7.8	39.1	0.4	0.2	-	1.0	5.4	0.0	43.1	1.0	0.3	1.6	-	2.5
27. Nagpur	7.4	12.1	27.4	3.4	0.0	-	2.1	5.2	0.0	13.9	2.1	0.1	2.5	-	5.9
28. Bhandara	59.4	5.5	0.3	5.6	-	-	2.0	1.6	0.2	-	0.1	-	0.2	0.0	7.9
29. Chandrapur	23.9	7.5	6.6	26.1	-	-	1.8	1.8	0.0	7.8	0.0	0.0	4.3	-	5.8
30. Gadchiroli	61.1	1.7	-	13.9	-	-	1.7	0.2	0.0	-	-	0.0	2.3	-	2.2
Total Nagpur Div.	26.5	7.7	14.6	10.8	0.1	-	1.7	3.2	0.1	14.0	0.7	0.1	2.4	0.0	5.3
Total Maharashtra State	7.3	5.0	15.2	17.8	8.7	1.1	2.1	3.3	1.8	13.0	3.2	0.2	0.6	2.5	1.2

Source : Epitome of Agriculture in Maharashtra, 1986-87.

Table 2.8 : Distribution of the 342 Observations on Crop Yield by Value of Mean Yield Averaged Over the Period 1964-65 to 1972-73 for Different Regions of Maharashtra

Average Yield Kg/Ha.	Rice						Jowar-Kharif						Bajri						Jowar-Rabi						Wheat					
	Region	A	B	C	D	E	To- tal	A	B	C	D	E	To- tal	A	B	C	D	E	To- tal	A	B	C	D	E	To- tal	A	B	C	D	E
	<u>No. of Observations</u>																													
Upto 200	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	-	-	5	-	1	7	-	-	8	-	-	1	-	-	1
200.1 - 300	-	2	-	1	-	3	-	2	-	1	1	4	-	8	8	11	-	27	-	2	8	1	-	11	-	1	-	6	6	13
300.1 - 400	-	2	-	6	1	9	-	2	-	6	4	12	-	9	1	3	-	13	-	1	4	8	4	17	-	2	-	6	15	23
400.1 - 500	-	-	-	4	2	6	-	2	1	11	15	29	-	5	5	-	-	10	-	1	3	9	3	16	-	1	-	-	5	6
500.1 - 600	-	1	1	3	5	10	-	-	3	5	13	21	-	-	-	-	-	-	-	5	2	1	2	10	-	-	-	-	1	1
600.1 - 700	-	1	4	-	4	9	-	2	1	-	5	8	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	-
700.1 - 800	-	-	5	-	2	7	-	-	1	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
800.1 - 1000	3	2	8	-	3	16	-	-	4	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1000.1 - 1200	8	-	2	-	-	10	-	1	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1200.1 - 2000	21	-	-	-	-	21	-	3	1	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	32	3	20	14	17	91	-	12	13	23	39	87	-	23	18	14	-	55	-	13	24	19	9	65	-	4	1	12	27	44

Note : A - Konkan Region. B - Nashik, Dhule, Jalgaon Districts. C - Western Maharashtra.
D - Marathwada Region. E - Vidarbha Region.

Source: Crop Insurance in India, pp. 92-102.

Table 2.9 : Distribution of the 342 observations on Crop Yield by Value of Coefficient of Variation for Maharashtra

Value of coefficient of variation	Crop				
	Rice	Jowar Kharif	Bajri	Jowar Rabi	Wheat
Percentage Distribution of Observations					
20.1 - 30%	26.3	5.8	7.3	7.7	15.9
30.1 - 40%	20.9	9.2	5.5	18.5	31.8
40.1 - 50%	18.7	26.4	30.9	20.0	36.3
50.1 - 60%	13.2	25.3	29.1	32.3	11.4
60.1 - 70%	7.7	16.1	12.7	13.8	2.3
70.1 - 80%	12.1	6.9	9.1	7.7	2.3
80.1 - 90%	-	4.5	1.8	-	-
Above 90%	1.1	5.8	3.6	-	-
Total	100.0	100.0	100.0	100.0	100.0
	= 91	= 87	= 55	= 65	= 44

Source : Crop Insurance in India, pp. 92-102.

Table 2.10 : Estimates of Irrigation Potential by Surface Sources in Maharashtra Prepared by Maharashtra State Irrigation Commission.

Name of the basin	Surface water resources* TMcft	Water resources used up to 1951 TMcft	Irrigated area ('000 hectares)	Utilization proposed under Schemes in I,II,III plans			Total culturable area ('000 hectares)	Irrigable command ('000 hectares)	Per cent irrigable
				Irrigation TMcft	Power TMcft	Irrigable Area ('000 hectares)			
Krishna	769	15.0	32.4	57.2	80.1	113.3	1615	415	25.7
Bhima	310	48.5	101.2	104.2	-	279.2	3941	753	19.1
Godavari	403	30.0	60.7	152.8	-	323.8	5965	958	16.0
Wainganga	720	40.0	202.3	68.2	12.5	210.4	4613	1220	26.4
Tapi	229	14.0	28.3	81.7	-	242.8	3352	523	15.6
West flowing rivers	1500	13.0	4.0	7.0	8.0	20.2	1745	270 ^b	15.4
Total	3931[@]	160.5^a	428.9	471.1	100.6	1189.7	21231⁺	4139⁺	20.4

Notes: * Estimated water resources at 75 per cent dependability.

@ In the case of West flowing rivers, because of the ruggedness of terrain and the steep gradient substantial part of the water available cannot be harnessed. It is estimated that about 14 per cent of the total flow or 210 Tmcft can be utilized. The total utilizable surface water resources for the State come to 2640 Tmcft.

a The total water resources used including those for power generation (viz. 40.8 Tmcft in Bhima basin) came to 201.3 Tmcft.

b Of this 110 thousand hectares comes from Krishna by diversion of some of its water westwards.

+ Narmada basin which has 50,000 hectares culturable area and 4000 hectares irrigable command is not included.

Source : Maharashtra State Irrigation Commission, Report, 1962, p. 38.

Table 2.11 : Irrigation Development Programme (Maharashtra)

Item	Estimated Cost Rs. Crore
Flow Irrigation works including wells in the culturable commands	1130
Wells outside command areas	50
Contour bunding	130
Terracing	25
Other Items	60
Total	1395

Source : Maharashtra State Irrigation Commission, Report,
1962, p. 57.

Table 2.12 : Irrigation Potential Created and Utilized in Different Regions of Maharashtra

(Area in '000 hectares)

Region	Major and Medium Projects					Anticipated potential*		Ultimate potential feasible	
	Completed Projects			Continuing projects: ultimate potential	Proposed project: ultimate potential	Total for completed, continuing & proposed projects	by 1974		between 1974-1979
	Ultimate potential	Potential created by 1971-72	Utilization in 1971-72						
Konkan	-	-	-	54.27	16.26	70.53	14.27	59.94	230.25
Khandesh and Nashik District	120.09	91.05	37.33	106.60	102.68	329.37	201.73	172.36	512.62
Western Maharashtra	174.21	117.21	66.82	601.49	112.74	883.44	479.36	397.90	1259.08
Marathwada	151.40	133.80	64.57	271.85	261.27	684.54	265.31	301.45	925.33
Vidarbha except Bhandara and Chandrapur districts	75.81	58.96	7.16	98.37	134.09	358.27	120.04	200.91	772.06
Chandrapur and Bhandara Districts	89.60	24.11	5.90	101.59	109.70	300.89	191.41	50.99	804.71
State	611.11	430.13	181.78	1234.17	786.74	2632.02	1272.20	1183.55	4504.05

* Major, medium and minor projects.

Source : Draft Out-line of the Fifth Five Year Plan (1974-79), 1973, pp. 108-109, 164-177.

Table 2.13 : Irrigation Wells in Different Districts of Maharashtra

District	No. of irrigation wells in use			Percentage of wells not in use to total irrigation wells 1981-82	Area irrigated per well (in ha.) (1981-82)	No. of oil engines (1981-82)	No. of electric pump-sets (1981-82)
	1956-57	1971-72	1981-82				
1. Bombay	386	386	386	11.87	2.33	-	-
2. Thane	6239	5904	7997	12.21	0.28	611	1814
3. Raigad	3684	3975	4773	9.01	0.59	594	1846
4. Ratnagiri	11798	12931	10792	18.35	0.45	497	1484
Total Konkan Div.	22107	23196	23948	14.51	0.45	1702	5144
5. Nashik	47338	68691	74674	4.81	1.16	8499	37416
6. Dhule	8694	22914	27076	14.57	1.54	8996	11612
7. Jalgaon	34689	42370	51052	13.57	1.78	6010	31462
Total Nashik Div.	90721	133975	152802	9.69	1.43	23505	80490
8. Ahmednagar	53532	72605	87362	10.20	1.65	11934	25631
9. Pune	38733	56003	61369	6.72	1.38	9086	15210
10. Satara	28083	37665	40378	8.37	1.96	9574	8970
11. Sangli	27747	41828	44720	9.18	1.18	12813	17163
12. Solapur	45858	53384	45803	7.68	3.18	9409	14623
13. Kolhapur	9309	14746	15766	12.07	1.22	12519	55966
Total Pune Div.	203262	276231	295398	8.83	1.78	65335	137563
14. Aurangabad	26009	68506	79234	5.80	1.29	7420	37328
15. Parbhani	10547	22406	26743	9.62	0.99	2994	7092
16. Beed	26084	30602	31776	5.59	2.63	2237	6446
17. Nanded	5688*	10846	12426	7.46	1.22	1007	8617
18. Osmanabad	14714	32654	45791	9.61	1.81	10351	15987
Total Aurangabad Div.	80234	165014	195970	7.32	1.59	24009	75470
19. Buldhana	12693	21162	27853	25.49	0.79	2776	14944
20. Akola	2372	8160	13873	23.18	1.05	1656	12420
21. Amravati	10109	19955	30788	21.01	1.05	1555	36768
22. Yavatmal	3588	9313	16398	22.04	0.79	1557	12440
23. Wardha	5725	9748	16343	38.28	0.96	2110	12724
24. Nagpur	18746	26453	27935	31.38	0.92	2120	19201
25. Bhandara	8410	10489	11042	18.10	0.55	1626	4269
26. Chandrapur	6399	8099	9674	21.30	0.36	1905	2437
Total Nagpur Div.	68542	113379	153906	26.15	0.86	15305	115203
Maharashtra State	464866	711795	822024	12.65	1.46	129856	413870

* Refers to year 1957-58.

Source : Statistical Abstract.

Table 2.14 : Irrigated Area in Different Districts of Maharashtra

(Area in '00 hectares)

District	Net irrigated area				Total	Gross irrigated area	Gross irrigated area as % of gross cropped area
	by well		by surface irrigation	1981-82			
	1956-57	1971-72					
1. Bombay	5	2	9	-	9	9	13.8
2. Thane	36	43	22	8	30	43	1.6
3. Raigad	15	22	28	70	98	112	5.2
4. Ratnagiri	52	42	49	104	153	170	4.6
Total Konkan Div.	108	109	108	182	290	334	3.8
5. Nashik	222	577	865	247	1112	1520	16.0
6. Dhule	172	395	416	231	647	902	11.8
7. Jalgaon	245	596	911	135	1046	1490	15.7
Total Nashik Div.	639	1568	2192	613	2805	3912	14.7
8. Ahmednagar	697	1098	1438	691	2129	2805	30.6
9. Pune	367	471	849	792	1641	1952	16.7
10. Satara	288	384	790	486	1276	1403	20.9
11. Sangli	295	415	527	219	746	992	15.1
12. Solapur	728	845	1458	305	1763	1836	15.0
13. Kolhapur	106	119	193	450	643	789	17.6
Total Pune Div.	2481	3332	5255	2943	8198	9777	17.7
14. Aurangabad	372	681	1025	272	1297	2043	13.1
15. Parbhani	171	143	265	299	564	766	7.7
16. Beed	223	305	835	237	1072	1227	13.8
17. Nanded	48*	82	152	221	373	464	5.9
18. Osmanabad	315	695	830	229	1059	1276	10.4
Total Aurangabad Div.	1143	1906	3107	1258	4365	5776	10.6
19. Buldhana	67	151	220	73	298	419	5.2
20. Akola	27	71	146	40	186	251	2.9
21. Amravati	51	150	323	8	331	459	6.2
22. Yavatmal	21	65	130	66	196	295	3.3
23. Wardha	41	80	157	25	182	250	5.7
24. Nagpur	127	210	257	221	478	606	9.3
25. Bhandara	26	44	61	1318	1379	1609	33.5
26. Chandrapur	11	21	35	1096	1131	1235	17.0
Total Nagpur Div.	371	792	1329	2852	4181	5124	9.3
Maharashtra State	4742	7707	11991	7848	19839	24923	12.5

* Refers to year 1957-58.

Source : Statistical Abstract.

Table 2.15 : Districtwise Groundwater Potentials of Maharashtra as per III Assessment - 1979

District	Total No. of water-sheds	No. of watersheds with groundwater development potential considered to be			Net groundwater recharge in MCM	Net groundwater withdrawal in MCM	Net groundwater balance in MCM	Total No. of additional irrigation wells feasible (1979)	Estimated No. of wells feasible (1971)
		Good	Fair	Poor					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Thane	34	34	-	-	1176.056	37.603	1138.448	75884	30937
Raigad	17	17	-	-	910.841	11.781	899.060	59930	23793
Ratnagiri	30	30	-	-	1223.840	53.310	1170.530	78035	37196
Nashik	80	59	10	11	1787.970	659.220	1129.200	75260	14641
Dhule	65	52	4	9	1263.650	385.020	910.950	60710	14201
Jalgaon	66	48	8	10	1238.580	592.610	715.400	47670	11075
Ahmednagar	80	46	15	19	1424.035	867.112	635.334	42328	13034
Pune	72	65	6	1	1678.391	455.392	1222.999	81503	19553
Satara	48	47	1	-	1412.588	283.862	1128.826	75235	12851
Sangli	38	20	4	14	785.320	552.439	288.133	19200	4294
Solapur	66	58	6	2	1345.989	541.419	804.570	53619	8619
Kolhapur	42	39	1	2	1208.204	276.054	932.150	62131	17533
Aurangabad	82	77	1	4	1505.160	497.810	1018.890	67946	12369
Parbhani	55	54	1	-	1451.700	251.240	1199.860	80013	19472
Beed	49	45	3	1	927.648	231.941	695.707	46372	14483
Nanded	49	49	-	-	1442.110	145.220	1296.890	86436	21219
Osmanabad	71	70	-	1	1321.710	370.640	950.950	63421	14174

(continued)

Table 2.15 : (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Buldhana	57	56	1	-	1051.120	225.280	825.840	55044	11608
Akola	65	65	-	-	1173.690	140.220	1033.470	68879	14915
Amravati	63	61	1	1	1092.430	245.230	863.220	56995	20751
Yavatmal	64	64	-	-	1574.920	94.510	1480.410	98678	32396
Wardha	39	35	3	1	668.210	171.740	496.470	33085	15160
Nagpur	54	50	3	1	1819.950	281.310	1538.740	102563	21172
Bhandara	54	54	-	-	1923.370	57.870	1865.500	124560	28717
Chandrapur	141	141	-	-	3588.400	42.260	3546.140	236423	74101
Total	1481	1336	68	77	34995.982	7441.098	27777.687	1851920	508264

Source : A Glimpse into Groundwater Resources of Maharashtra and Its Developmental Programmes.
D.G.S.D.A., Pune, 1983.

Table 2.16 : Progress of Irrigation in Maharashtra

Year	No. of wells for irrigation purposes	Well irrigated area in '00 hectares	Net irrigated area in '00 hectares	Index of irrigated area (1956-57=100)		Intensity of cropping*	Per cent area irrigated@
				By well	Net irrigated		
1950-51	N.A.	3900	7868	82.24	86.05	114.3	5.4
1955-56	N.A.	4600	8808	97.01	96.34	115.4	5.4
1956-57	464866	4742	9143	100.00	100.00	115.0	5.6
1957-58	479258	4782	9386	100.84	102.66	115.5	5.8
1958-59	491618	5214	9649	109.95	105.53	114.2	5.9
1959-60	518369	5554	10178	117.12	111.32	115.1	6.2
1960-61	542417	5953	10722	125.54	117.27	113.8	6.5
1961-62	557377	6108	10812	128.81	118.25	114.1	6.5
1962-63	571634	6315	11257	133.17	123.12	113.5	6.7
1963-64	584122	6506	11502	137.20	125.80	114.2	6.8
1964-65	603672	6826	11906	143.95	130.22	114.6	7.1
1965-66	610678	7107	12063	149.87	131.94	115.1	7.3
1966-67	626757	6982	12172	147.24	133.13	115.1	7.4
1967-68	642469	7210	12751	152.05	139.46	115.8	7.7
1968-69	664514	7964	13745	167.95	150.33	113.3	8.0
1969-70	680545	8211	14312	173.15	156.54	113.4	8.4
1970-71	693643	7679	13469	161.94	147.31	116.6	8.5
1971-72	711795	7707	13672	162.53	149.54	118.6	9.0
1972-73	733016	7133	12762	150.42	139.58	114.5	8.6
1973-74	753293	8399	14717	177.12	160.96	120.1	9.1
1974-75	764312	9358	16121	197.34	176.32	119.9	9.9
1975-76	778713	10842	13015	228.64	197.04	120.5	11.0
1976-77	785186	10919	13332	230.26	200.50	122.3	11.3
1977-78	804264	10822	13915	228.22	206.88	124.6	11.8
1978-79	816694	10967	19266	231.27	210.72	124.8	12.1
1979-80	825354	11408	19636	240.57	214.77	123.8	12.2
1980-81	825540	10553	18349	222.54	200.69	131.6	12.2
1981-82	822024	11991	19339	252.87	216.99	125.6	12.5
1982-83	N.A.	N.A.	N.A.	-	-	-	12.5
1983-84	N.A.	11620	20750	245.04	226.95	131.7	13.2
1984-85	N.A.	10570	18760	222.90	205.18	134.2	12.3
1985-86	N.A.	10630	18810	224.17	205.73	130.8	12.1
1986-87	N.A.	9920	13040	209.19	197.31	129.9	11.8
1987-88	N.A.	10210	18290	215.31	200.04	130.2	11.8

* Gross irrigated area/Net irrigated area x 100

@ Gross irrigated area/Gross cropped area x 100

Source : Season and Crop Reports, Maharashtra State.

Table 2.17 : Crop Pattern in Irrigated Agriculture for Different Regions of Maharashtra (1951-53, 1967-69 and 1981-82)

Region	1951-53						
	Konkan	Khandesh and Nashik District	Western Maharashtra	Marathwada	Vidarbha except Bhandara and Chandrapur Districts	Bhandara and Chandrapur Districts	Maharashtra State
Per cent area irrigated to gross cropped area	1.98	4.02	8.67	2.54	1.20	22.02	5.34
Gross irrigated area in '00 hectares	160	996	4512	1098	436	2088	9290
Percentage of irrigated area under:							
Total Food crops	60.17	86.10	88.86	92.61	98.84	99.98	91.48
Total cereals	26.67	43.48	54.39	55.60	30.57	96.33	61.20
Rice	23.13	7.36	4.37	2.54	20.78	96.15	26.20
Wheat	-	33.45	9.24	18.01	8.07	0.06	10.59
Jowar	-	1.24	32.69	28.08	1.34	-	19.39
Bajri	-	0.35	6.26	2.88	-	-	3.42
Total Pulses	3.03	5.53	6.08	10.08	1.90	-	4.88
Sugarcane	1.26	8.74	14.25	8.17	3.15	0.87	9.19
Fruits and vegetables	0.25	0.51	0.88	-	-	-	0.48
Chillies and Spices	3.29	9.84	3.04	2.27	10.81	-	3.36
Oilseeds	4.55	1.42	1.67	0.04	0.09	-	1.05
Cotton	-	0.12	1.48	1.01	0.28	-	0.86

(continued)

Table 2.17 : (continued)

Region	1967-69						
	Konkan	Khandesh and Nashik District	Western Maha- rashtra	Marath- wada	Vidarbha except Bhandara and Chandrapur Districts	Bhandara and Chandrapur Districts	Maharashtra State
Per cent area irrigated to gross cropped area	2.74	9.23	11.75	5.40	2.28	19.87	7.85
Gross irrigated area in '00 hectares	254	2377	6478	2728	925	2403	15165
Percentage of irrigated area under:							
Total Food crops	72.19	87.63	90.13	92.72	91.01	99.97	91.52
Total cereals	30.23	46.07	53.71	59.52	45.09	96.51	59.43
Rice	27.50	5.92	4.50	3.65	15.64	95.43	20.04
Wheat	-	36.01	10.25	18.30	25.92	0.99	15.05
Jowar	-	0.54	31.83	33.31	2.91	0.05	19.87
Bajri	-	2.91	5.10	1.88	0.18	-	2.98
Total pulses	2.99	5.15	4.53	5.35	2.33	0.02	3.90
Sugarcane	1.54	5.93	20.53	10.59	2.84	0.30	11.86
Fruits and Vegetables	14.63	10.74	3.80	4.25	13.37	0.81	5.25
Chillies and Spices	7.03	7.55	3.86	7.78	12.40	1.49	5.34
Oilseeds	24.90	1.46	1.74	0.67	0.15	0.03	1.52
Cotton	-	5.84	4.70	4.35	8.55	-	4.22

(continued)

Table 2.17' : (continued)

Region	1981-82						
	Konkan	Khandesh and Nashik District	Western Maha- rashtra	Marath- wada	Vidarbha except Bhandara and Chandrapur Districts	Bhandara and Chandrapur Districts	Maharashtra State
Per cent area irrigated to gross cropped area	3.84	14.68	17.71	10.59	5.32	23.52	12.45
Gross irrigated area in '00 hectares	334	3912	9777	5776	2280	2844	24923
Percentage of irrigated area Under:							
Total Food crops	70.93	82.67	91.02	91.29	86.97	99.86	90.17
Total cereals	42.25	38.91	54.69	65.15	54.46	96.03	59.19
Rice	39.22	5.47	3.96	7.03	8.55	93.14	15.98
Wheat	-	27.84	14.19	29.98	45.70	2.78	20.91
Jowar	-	4.06	30.41	27.02	0.22	0.11	18.86
Bajri	-	1.00	3.92	1.90	-	-	2.13
Total pulses	4.19	6.52	2.61	6.60	3.90	0.07	4.31
Sugarcane	1.00	11.99	24.86	12.00	2.59	0.35	14.70
Fruits and Vegetables	16.47	21.75	5.74	3.62	20.17	1.44	7.19
Chillies and Spices	8.98	3.50	2.31	4.06	5.66	1.97	3.24
Oilseeds	24.85	6.88	2.75	3.58	3.77	0.03	3.83
Cotton	-	8.72	2.90	4.87	8.82	-	4.42

Source : Season and Crop Reports, Maharashtra State.

Table 2.18 : Growth in Area Under Irrigated Foodgrains and Sugarcane in Pune, Ahmednagar and Solapur Districts

District	Year	Net irrigated area	Area under irrigated foodgrains	Area under sugarcane	Increase in irrigated foodgrains area	Increase in sugarcane area	(Area in hectares)		
							Index 1950-51=100		
							Net irrigated area	Area under irrigated foodgrains	Area under sugarcane
Pune	1982-83	172583	123683	28436	53118	10664	209	173	430
	1969-70	102668	70565	17772	- 903	11155	124	99	269
	1950-51	82635	71468	6617			100	100	100
Ahmednagar	1982-83	215731	160917	82157	67019	30134	254	273	465
	1969-70	147112	93898	52023	34976	34341	173	159	294
	1950-51	84820	58922	17682			100	100	100
Solapur	1982-83	138598	97626	24236	6031	9937	143	135	324
	1969-70	113823	91595	14299	19440	6813	117	127	191
	1950-51	97245	72155	7436			100	100	100

Table 2.19 : Bunded Area in Maharashtra

Period	Area (in '000 hectares)
First Plan	195.2
Second Plan	527.2
Third Plan	1916.5
1966-69	1716.8
1969-74	2793.1
1974-79	822.8
1979-80	209.4
1980-81	178.7
1981-82	144.0
1982-83	117.0
1983-84	126.0

Source : Statistical Abstract, 1988.

Table 2.20 : Area Under Hybrid and High Yielding Varieties in Maharashtra

Year	Rice			Kharif Jowar			Bajri		
	1	2	3	1	2	3	1	2	3
1966-67	13.54	0.66	4.9	26.36	0.11	0.4	20.13	0.11	0.5
1974-75	13.57	3.63	26.7	26.06	4.33	16.6	18.44	6.24	33.8
1977-78	14.99	8.91	59.4	32.11	17.14	53.4	17.59	2.26	12.8
1980-81	15.04	9.41	62.6	29.98	17.60	58.7	17.09	6.10	35.7
1981-82	15.16	9.60	63.3	30.48	18.53	60.8	17.44	6.69	38.9
1982-83	14.87	9.22	62.0	28.71	19.03	66.3	13.90	7.43	53.5
1983-84	15.21	10.32	67.9	29.51	19.13	64.8	18.13	11.18	61.7
1984-85	15.20	10.12	66.8	28.70	20.30	70.7	17.61	9.21	52.3

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Note: Col. 1 = Total area under crop (in lakh hectares)

(continued)

Col. 2 = Area under hybrid, high yielding varieties (in lakh hectares)

Col. 3 = Area under hybrid, high yielding varieties to total area under crop.

Table 2.20 : (continued)

Year	Wheat			Rabi Jowar			Cotton		
	1	2	3	1	2	3	1	2	3
1966-67	8.40	0.08	0.9	34.45	0.03	0.1	-	-	-
1974-75	9.48	4.03	42.5	34.17	0.25	0.7	23.07*	3.13*	13.6*
1977-78	12.15	9.91	81.6	34.29	0.63	1.8	23.14	2.45	10.6
1980-81	10.79	8.14	75.4	34.40	1.66	4.8	26.67	3.96	14.8
1981-82	11.28	8.77	77.7	35.29	1.22	3.5	27.10	4.74	17.5
1982-83	10.23	7.93	77.5	37.75	3.31	8.8	26.55	5.39	20.3
1983-84	11.83	10.98	92.8	35.89	12.87	35.9	26.85	5.51	20.5
1984-85	9.89	7.28	73.6	36.92	10.37	28.1	26.84	6.08	22.6

* 1975-76.

Source : Epitome of Agriculture in Maharashtra.

Table 2.21 : Consumption of Fertilizers in Maharashtra

Year	Total consumption in '00 tonnes	Fertilizer per hectare in kg
1975-76	2573	13.2
1980-81	4232	21.4
1982-83	5056	25.4
1986-87	6566	33.0
1987-88	6980	34.7

Source: i) Epitome of Agriculture in Maharashtra.
ii) Mid-term Appraisal, Seventh Five Year Plan, 1985-90,
Maharashtra State, 1988.

Table 2.22 : Electricity Supply in Maharashtra

Year	Total consumption (Million KWH)	Irrigation and dewatering (Million KWH)
1960-61	2720	15
1965-66	4717	90
1970-71	7650	356
1975-76	9490	803
1980-81	14034	1723
1984-85	19108	3375
1985-86	20979	3671
1986-87	22325	4059
1987-88	23848	4459

Source : Statistical Abstract, 1988.

Table 2.23 : Cooperative Credit in Maharashtra

	Advances (Rs. crores)	Outstanding loans (Rs. crores)
1960-61	175	87
1965-66	432	234
1970-71	751	478
1975-76	1909	716
1980-81	3200	1137
1984-85	5243	2008
1985-86	5823	2477
1986-87	6543	2781
1987-88	6882	2641

Source : Statistical Abstract.

Table 2.24 : Average Yield Under Irrigated and Dry Cropping in Maharashtra

Year	Rice			Kharif Jowar			Bajri			Wheat		
	1	2	3	1	2	3	1	2	3	1	2	3
1961-62	20.2	1145	N.A.	0.4	594	N.A.	2.0	256	N.A.	15.5	466	N.A.
1975-76	27.0	1615	1819	1.5	817	N.A.	3.5	310	619	41.9	1026	1504
1980-81	27.4	1570	1706	1.3	943	1605	3.0	445	1059	53.5	863	1249
1981-82	27.0	1607	1555	1.3	1074	1615	3.3	447	842	54.3	876	1168
1982-83	26.2	1311	1272	0.9	1136	1200	3.0	320	571	52.6	786	1076
1983-84	24.5	1617	1790	1.1	1049	1485	2.8	501	1120	54.9	965	1289
1984-85	21.7	1274	1121	1.1	1034	1485	2.8	322	755	55.9	866	1111

Note: Col. 1 = Irrigated area to total area under crop (%).

Col. 2 = Average yield in kg. per hectare.

Col. 3 = Average yield in kg. per hectare for irrigated crops.

(continued)

Table 2.24 : (continued)

Year	Rabi Jowar			Cotton			Gram		
	1	2	3	1	2	3	1	2	3
1961-62	7.3	409	N.A.	1.6	63	N.A.	8.9	326	N.A.
1975-76	11.8	369	903	2.9	58	203	15.2	404	676
1980-81	9.8	465	1009	5.6	81	304	19.8	350	506
1981-82	9.9	458	926	5.2	92	172	22.8	384	533
1982-83	9.1	368	884	4.5	104	170	22.2	339	443
1983-84	9.8	441	958	3.9	52	108	22.8	428	602
1984-85	10.1	497	1107	3.7	93	175	23.4	397	546

Source : Epitome of Agriculture in Maharashtra.

Table 2.25 : Number of Cooperative Sugar Factories in Maharashtra

District/ Region	Year of commencement				Total facto- ries in 1986	No. of Appli- cations
	Upto 1960 No. of	1961- 1970 cooperative	1970- 1978 sugar	Total factories		
Ahmednagar	5	3	4	12	13	2
Pune	1	2	1	4	6	-
Satara	2	1	2	5	6	3
Sangli	1	-	2	3	7	2
Solapur	-	2	2	4	6	5
Kolhapur	3	2	3	8	11	4
Nashik	2	1	2	5	6	1
Dhule	-	1	1	2	4	2
Jalgaon	-	-	3	3	3	3
Marathwada	-	3	8	11	22	3
Vidarbha	-	-	2	2	7	1
Total	14	15	30	59	91	26

Source : Records of the Maharashtra Rajya Sahakari Sakhar Karkhana Sangh (M.R.S.S.K.S.), Pune.

Table 2.26 : Growth of Sugar Cooperatives in Maharashtra

	Year	1961	1971	1981
Number of factories		20	69	78
Factories in production		14	30	67
Membership (000)		37.0	188.1	437.6
Sugarcane crushed (lakh tonnes)		22.78	68.28	169.53

Source : Records of M.R.S.S.K.S.

Table 2.27 : Districtwise Distribution of Sugar Factories in Maharashtra (1986-87)

District	Cooperative factories			Private factories		1986-87 crushing capacity (in 000 tonnes)
	No.	Crushing capa- city (Daily in tonnes)	% share	No.	Crushing capa- city (Daily in tonnes)	
Nashik	6	10000	6.6	1	1220	1716
Jalgaon	3	3750	2.5	-	-	674
Dhule	4	7250	4.7	-	-	1330
Ahmednagar	13	24700	16.2	-	-	4090
Pune	6	9066	5.9	1	1750	1979
Satara	6	13000	8.5	1	1300	2614
Sangli	7	13250	8.7	-	-	2366
Solapur	6	9500	6.2	2	2316	2183
Kolhapur	11	27700	18.1	-	-	4653
Aurangabad	7	8016	5.2	-	-	933
Parbhani	3	3750	2.5	-	-	470
Beed	4	5000	3.3	-	-	569
Nanded	3	2500	1.6	-	-	352
Osmanabad	5	6250	4.1	-	-	619
Vidarbha	7	8750	5.7	-	-	816
STATE	91	152482	100.0	5	6586	25364

Source: Records of M.R.S.S.K.S.

Table 2.28 : The Share of Selected Districts and Talukas in the State in Gross Cropped Area, Gross Irrigated Area, Area Under Sugarcane and in Oil Engines, Electric Pumpssets and Tractors

District	Per cent share in the State in													
	Gross cropped area				Gross irrigated area				Area under sugarcane					
	1956-57		1984-85		1968-69		1984-85		1956-57		1968-69		1984-85	
	D	S.T.	D	S.T.	D	S.T.	D	S.T.	D	S.T.	D	S.T.	D	S.T.
Kolhapur ¹	2.1	1.6	2.1	1.5	3.3	2.9	2.3	2.0	21.8	19.0	20.0	17.7	13.9	12.0
Ahmednagar ²	6.8	2.4	5.9	1.9	11.1	6.4	10.0	6.1	26.2	24.7	23.5	21.5	17.7	15.1
Sangli ³	3.4	1.2	3.0	1.1	4.2	2.1	4.0	2.4	3.9	2.8	9.4	7.7	9.6	8.3
Pune ⁴	5.6	1.1	-	-	8.0	4.2	-	-	8.3	6.2	8.6	6.4	-	-
Nashik ⁵	5.1	1.6	4.5	1.4	6.6	3.3	7.6	2.6	7.8	4.5	6.4	4.5	7.7	7.7
Satara ⁶	3.8	0.9	3.2	0.8	6.8	3.0	5.8	2.5	5.5	4.7	6.3	4.9	-	5.6
Solapur ⁷	6.8	0.6	-	-	9.0	2.3	-	-	7.7	5.5	6.4	3.5	-	-
Total	33.6	9.4	-	-	49.0	24.2	-	-	81.2	67.4	80.6	66.2	-	-

D = District. S.T. = Selected Talukas.

(continued)

Table 2.28 : (continued)

District	Per cent share in the State in							
	No. of oil engines and electric pumpsets				No. of tractors			
	1968-69		1982		1968-69		1982	
	D	S.P.	D	S.T.	D	S.P.	D	S.P.
Kolhapur ¹	5.5	3.0	4.8	3.9	15.4	15.1	10.8	10.2
Ahmednagar ²	13.7	9.8	13.1	7.9	16.8	15.2	14.7	11.9
Sangli ³	7.6	5.2	4.6	2.7	7.6	6.4	5.3	4.1
Pune ⁴	5.6	2.1	6.4	2.2	7.4	4.7	4.9	2.4
Nashik ⁵	9.6	4.6	7.1	3.6	8.0	5.0	15.2	9.0
Satara ⁶	3.7	1.6	4.6	2.2	5.0	3.9	4.4	2.4
Solapur ⁷	6.7	1.2	9.3	1.5	3.3	2.1	3.2	1.5
Total	52.4	27.5	49.9	24.0	63.5	52.4	58.5	41.5

Note: The selected talukas from the respective districts are as follows:

- 1 - Karveer, Hatkanangala, Radhanagari, Panhala, Shirol, Kagal, Gadhinglaj, Bhudergad.
- 2 - Shrirampur, Kopergaon, Rahuri, Sangamner, Newase.
- 3 - Tasgaon, Walwa, Miraj.
- 4 - Baramati, Indapur.
- 5 - Niphad, Malegaon, Baglan.
- 6 - Phaltan, Karad.
- 7 - Malshiras.

Table 2.29 : Net State Domestic Product Originating from
Agriculture, Animal Husbandry, Forestry and Logging
and Fishing

(Rs. Crore)

Year	Net State domestic product from agriculture etc., at current prices	Per cent share in State income	Net State domestic product from agriculture etc., at 1960-61 prices
1955-56	331.6	33.1	448.1
1956-57	440.7	38.1	523.3
1957-58	457.3	37.5	528.0
1958-59	546.0	40.2	604.6
1959-60	521.9	38.8	557.5
1960-61	664.2	41.6	664.2
1961-62	613.4	37.5	598.7
1962-63	655.6	36.2	606.6
1963-64	749.4	36.8	618.8
1964-65	841.4	37.1	617.6
1965-66	771.1	32.7	498.2
1966-67	929.1	33.7	542.0
1967-68	1083.4	34.6	592.8
1968-69	1086.9	32.7	600.5
1969-70	1160.0	31.6	592.6
1970-71	1109.0	28.6	562.6
1971-72	1083.1	26.4	525.7
1972-73	984.7	22.7	392.7
1973-74	1890.5	32.8	642.3
1974-75	2505.4	34.0	757.3
1975-76	2434.4	31.7	779.8
1976-77	2528.4	29.5	764.3
1977-78	2902.7	30.2	847.8
1978-79	3002.3	28.2	836.5
1979-80	3451.1	28.4	849.0
1980-81	4026.0	28.8	804.5
1981-82	4383.4	28.0	847.1
1982-83	4505.7	26.4	850.3
1983-84	5548.9	28.1	907.7
1984-85	5728.4	26.6	861.8
1985-86	5890.7	24.0	817.8
1986-87	5519.7	20.7	669.8
1987-88	7764.7	24.2	898.3

Source : Statistical Abstract.

Table 2.30 : Annual Percentage Compound Growth Rates of Area, Production and Productivity for Major Crops in Maharashtra

Region	Rice		Wheat		Jowar		Bajri		Gram	
	1960-84	1973-84	1960-84	1973-84	1960-84	1973-84	1960-84	1973-84	1960-84	1973-84
Maharashtra State										
Area	0.68	1.02	1.37	0.33	0.40	0.89	-0.38	-1.50	1.28	2.18
Production	2.95	2.45	5.44	2.04	2.43	3.60	1.62	-0.17	2.20	3.25
Productivity	2.26	1.42	4.04	1.70	2.03	2.70	2.01	1.40	0.91	1.13
Region I: Konkan										
Area	0.46	0.88	2.28	96.13	-4.29	80.74	-	-	2.35	6.67
Production	2.38	2.64	2.61	93.82	3.31	78.24	-	-	3.67	7.10
Productivity	1.91	0.72	0.33	0.17	4.42	0.35	-	-	0.87	0.32
Region II: Khandesh-Nashik										
Area	0.29	1.22	1.41	-0.51	1.31	4.55	-0.11	-0.18	2.05	3.04
Production	3.47	1.76	4.73	-0.12	3.91	6.85	1.65	-0.48	3.77	3.29
Productivity	3.18	0.55	3.25	0.43	2.57	2.20	1.73	-0.28	1.66	0.23
Region III: Western Maharashtra										
Area	0.10	1.75	4.49	3.73	0.05	0.71	-1.33	-2.06	2.15	5.31
Production	4.62	4.58	8.84	5.12	1.06	1.08	0.29	-1.52	3.14	7.81
Productivity	4.51	2.78	4.16	1.33	0.99	0.39	1.67	0.63	0.94	2.43
Region IV: Marathwada										
Area	1.48	2.78	0.97	-0.01	0.81	1.29	1.19	-2.16	0.49	0.61
Production	4.70	4.08	5.12	2.06	2.32	4.26	3.33	2.57	1.35	1.21
Productivity	3.18	1.24	4.10	2.04	1.51	2.86	2.61	4.94	0.82	0.65
Region V: Vidarbha										
Area	0.96	0.60	0.17	-1.02	0.16	-0.35	1.10	-5.81	1.49	0.89
Production	2.45	0.75	4.16	1.08	3.58	4.47	3.90	-3.22	1.77	1.04
Productivity	1.49	0.16	3.97	2.20	3.42	4.83	2.74	2.77	0.25	0.17

(continued)

Table 2.30 : (continued)

Region	Tur		Sugarcane		Cotton		Groundnut	
	1960-84	1973-84	1960-84	1973-84	1960-84	1973-84	1960-84	1973-84
Maharashtra State								
Area	1.29	1.97	4.63	4.77	-0.23	1.67	-1.77	-0.73
Production	1.22	3.14	5.16	4.77	0.28	1.97	-0.55	1.82
Productivity	-0.07	1.13	0.52	0.78	0.51	0.01	0.91	1.13
Region I: Konkan								
Area	0.43	2.49	-	-	-	-	8.19	17.62
Production	1.69	3.06	-	-	-	-	9.10	23.94
Productivity	1.22	0.56	-	-	-	-	0.84	0.21
Region II: Khandesh-Nashik								
Area	0.64	1.97	6.81	4.80	-2.04	1.81	-0.45	0.29
Production	1.89	2.39	8.70	3.81	-1.23	2.07	0.32	-0.66
Productivity	1.25	0.38	1.77	-0.94	0.83	0.30	0.77	-0.91
Region III: Western Maharashtra								
Area	-0.47	-4.47	4.23	4.47	-4.84	-1.32	-0.91	1.83
Production	-1.48	-3.09	4.41	4.69	-2.71	-2.40	0.03	6.26
Productivity	-1.02	1.36	0.18	0.22	2.23	-1.11	0.93	4.35
Region IV: Marathwada								
Area	1.54	1.46	5.22	6.92	-0.75	2.54	-4.70	-4.66
Production	3.46	4.40	7.18	6.37	0.65	4.62	-4.17	-1.06
Productivity	1.89	2.94	1.87	-0.04	1.37	2.04	0.55	3.70
Region V: Vidarbha								
Area	1.71	4.67	2.78	1.43	0.44	1.37	-1.00	-2.55
Production	0.83	3.93	6.66	1.53	0.78	1.04	1.66	-2.76
Productivity	-0.88	-0.75	3.78	0.06	0.33	-0.28	2.69	-0.21

Source : Computed on the basis of data from Statistical Abstract.

Table 2.31(A) : Distribution of Holdings by Size Class in Maharashtra (1980-81)

	Average size of operational holdings in ha.	Percentage distribution of holdings by size class of operational holdings (in hectares)									Total number of holdings ('00)
		Upto 1	1-2	2-4	4-5	5-10	10-20	20-50	50 and above	Total	
Greater Bombay	0.68	80.55	13.00	5.27	0.27	0.55	0.27	0.09	-	100.00	11
Thane	2.31	46.96	20.76	16.91	4.12	7.85	2.92	0.53	0.05	100.00	1818
Raigad	1.70	56.12	20.34	14.12	2.70	4.96	1.42	0.30	0.04	100.00	2172
Ratnagiri	2.69	43.74	17.29	18.31	5.24	10.47	3.57	0.83	0.05	100.00	2804
Sindhudurg	2.26	56.92	14.61	14.04	3.50	7.36	2.77	0.76	0.24	100.00	1780
Nashik	3.62	21.28	19.32	27.51	8.87	17.32	5.04	0.64	0.02	100.00	2905
Dhule	3.68	15.22	24.07	27.37	8.55	20.95	3.56	0.27	0.01	100.00	2070
Jalgaon	3.16	20.20	26.34	27.08	7.93	14.94	3.31	0.20	-	100.00	2757
Ahmednagar	3.31	3.73	12.67	24.84	11.21	21.36	14.09	1.50	0.05	100.00	3817
Pune	3.13	30.90	21.29	23.53	6.38	12.49	4.54	0.81	0.06	100.00	3652
Satara	1.99	47.15	22.31	18.47	3.94	6.33	1.53	0.25	0.02	100.00	3883
Sangli	2.54	39.30	21.98	20.58	4.93	9.51	3.16	0.53	0.01	100.00	2840
Solapur	4.63	15.65	17.70	26.09	8.64	21.51	8.90	1.45	0.05	100.00	2687
Kolhapur	1.55	56.90	20.24	14.85	2.77	4.15	0.91	0.15	0.03	100.00	3389
Aurangabad	3.74	15.56	21.18	30.26	8.70	13.54	5.40	0.35	0.01	100.00	2051
Jalna	4.16	12.26	20.92	28.88	9.20	21.38	6.96	0.39	0.01	100.00	1699
Parbhani	3.80	12.60	21.74	30.47	9.70	20.67	4.47	0.34	0.01	100.00	2446
Beed	3.64	17.46	21.63	28.76	8.50	17.55	5.24	0.51	0.02	100.00	2638
Nanded	3.38	17.97	23.30	29.75	8.54	16.75	3.47	0.22	-	100.00	2333
Osmanabad	4.71	11.94	19.49	25.47	9.43	23.25	9.29	1.09	0.04	100.00	1403

(continued)

Table 2.31(A) : (continued)

	Average size of operational holdings in ha.	Percentage distribution of holdings by size class of operational holdings (in hectares)								Total number of holdings ('00)	
		Upto 1	1-2	2-4	4-5	5-10	10-20	20-50	50 and above		
Latur	4.40	10.14	20.66	28.69	9.41	22.14	8.21	0.74	0.01	100.00	1514
Buldhana	3.19	20.76	26.84	27.87	7.09	12.79	4.19	0.45	0.01	100.00	2357
Akola	3.45	16.05	28.55	29.36	6.31	14.12	5.12	0.48	0.01	100.00	2451
Amravati	2.99	21.64	30.29	26.81	6.16	11.27	3.49	0.33	0.01	100.00	2588
Yavatmal	4.14	6.72	24.38	33.31	9.55	18.81	6.56	0.66	0.01	100.00	2311
Wardha	4.04	9.81	28.18	29.77	8.70	17.92	5.12	0.48	0.02	100.00	1220
Nagour	3.52	15.38	26.04	28.86	8.50	16.27	4.44	0.49	0.02	100.00	1819
Bhandara	1.66	49.84	25.17	16.17	2.95	4.77	0.98	0.11	0.01	100.00	2588
Chandrapur	2.99	28.58	22.05	24.77	7.19	13.47	3.57	0.36	0.01	100.00	1756
Gadchiroli	2.40	30.54	27.53	25.60	5.49	8.64	1.99	0.20	0.01	100.00	879
Maharashtra State	3.11	28.06	22.45	24.57	6.70	13.58	4.11	0.50	0.03	100.00	68625

Source : Statistical Abstract, 1988.

Table 2.31(B) : Distribution of Land Held by Size Class in Maharashtra (1980-81)

	Percentage distribution of land held by size class of operational holdings (in hectares)								Total area operated ('00 ha)	Net area sown per agricultural worker (hectare)	
	Upto 1	1-2	2-4	4-5	5-10	10-20	20-50	50 and above			Total
Greater Bombay	37.80	26.81	20.65	1.74	4.42	5.50	3.08	-	100.00	7	2.7
Thane	9.01	13.52	20.69	7.96	23.33	16.84	6.28	2.37	100.00	4201	1.6
Raigad	14.71	17.15	22.74	7.23	19.81	11.26	4.80	2.30	100.00	3701	2.5
Ratnagiri	6.34	9.69	20.35	8.53	26.75	18.30	8.51	1.53	100.00	7542	6.0
Sindhudurg	8.74	9.53	17.36	6.90	22.52	16.71	9.54	8.70	100.00	4017	
Nashik	2.96	8.29	22.23	11.06	32.71	17.81	4.33	0.61	100.00	10509	2.9
Dhule	2.64	9.84	21.18	10.32	39.98	13.84	1.91	0.29	100.00	7623	2.3
Jalgaon	3.78	12.67	24.84	11.21	31.86	14.09	1.50	0.05	100.00	8726	1.9
Ahmednagar	24.60	21.76	28.44	7.05	13.22	4.26	0.63	0.04	100.00	12634	3.8
Pune	4.85	9.79	21.41	9.03	27.52	18.82	6.82	1.76	100.00	11419	5.1
Satara	10.33	16.97	26.27	8.84	21.93	10.66	3.31	1.69	100.00	7734	4.6
Sangli	7.17	12.68	23.00	8.54	25.66	16.97	5.35	0.63	100.00	7203	4.3
Solapur	1.81	5.86	16.34	8.35	32.40	20.28	7.96	1.00	100.00	12442	3.8
Kolhapur	15.92	19.05	26.64	8.00	17.95	7.68	2.55	2.21	100.00	5227	3.0
Aurangabad	2.69	9.01	23.21	10.48	33.82	18.33	2.20	0.26	100.00	7661	4.1
Jalna	1.86	8.53	20.63	10.01	35.37	21.36	2.19	0.05	100.00	7063	
Parbhani	2.19	8.90	22.94	11.26	36.60	15.85	2.14	0.12	100.00	9292	3.1
Beed	2.74	8.85	22.59	10.33	33.26	18.29	3.50	0.44	100.00	9600	4.2
Nanded	3.30	10.38	25.05	11.43	33.99	14.22	1.57	0.06	100.00	7880	2.8
Osmanabad	1.53	6.33	16.45	8.84	34.03	25.79	5.94	0.59	100.00	6603	3.5

(continued)

Table 2.31(B) : (continued)

	Percentage distribution of land held by size class of operational holdings (in hectares)								Total area operated ('00 ha)	Net area sown per agricultural worker (hectare)	
	Upto 1	1-2	2-4	4-5	5-10	10-20	20-50	50 and above			
Latur	1.52	6.95	18.71	9.56	35.01	24.23	3.95	0.07	100.00	6665	
Buldhana	4.44	12.61	24.44	9.97	27.43	17.50	3.44	0.17	100.00	7523	2.2
Akola	3.16	13.09	23.86	8.26	28.50	19.54	3.31	0.26	100.00	8464	2.1
Amravati	5.00	15.49	25.83	9.25	26.13	15.19	2.81	0.30	100.00	7742	1.8
Yavatmal	1.27	9.10	23.16	10.39	31.41	20.45	3.94	0.28	100.00	9558	2.0
Wardha	1.92	10.73	22.45	10.36	33.17	17.69	3.19	0.49	100.00	4527	2.1
Nagpur	2.72	11.07	23.58	10.83	31.46	16.32	3.53	0.49	100.00	6412	2.2
Bhandara	14.40	22.10	26.85	7.93	19.23	7.60	1.75	0.14	100.00	4290	1.6
Chandrapur	5.70	10.78	23.27	10.72	30.76	15.36	3.04	0.37	100.00	5243	2.6
Gadchiroli	6.72	16.70	28.94	10.11	24.22	10.71	2.71	0.43	100.00	2103	
Maharashtra State	4.56	10.03	22.55	9.62	29.93	17.42	4.10	0.89	100.00	213616	2.8

Source : Statistical Abstract, 1988.

Table 2.32 : Distribution and Growth of Livestock in Maharashtra

(in '000)

	Adult Cattle			Cattle young stock	Adult Buffaloes			Buffaloes young stock	Sheep	Goat
	Bullocks	Cows in milk	Total cows		He-Buffaloes	Buffaloes in milk	Total She-Buffaloes			
(A) Distribution (1983)										
<u>Region</u>										
Konkan	312	208	516	306	131	162	260	124	19	419
Khandesh and Nashik	969	274	693	540	32	152	298	168	356	1052
Western Maharashtra	1278	485	1122	819	71	523	895	464	1658	2371
Marathwada	1533	480	1117	941	20	215	423	298	450	1649
Vidarbha	2095	656	1799	1509	97	210	431	259	188	2214
STATE	6687	2103	5247	4115	351	1262	2307	1313	2671	7705
(B) Growth										
<u>Year</u>										
1961	6490	1631	4644	4194	353	827	1639	1095	2093	5181
1966	6550	1607	4534	3645	340	855	1735	967	2205	5121
1972	6134	1673	4587	3912	308	955	1871	1122	2128	5911
1978	6329	1858	4781	4108	325	1275	2148	1425	2636	7563
1982	6687	2103	5247	4115	351	1262	2307	1313	2671	7705
		(126)	(210)	(202)						

(Figures in brackets refer to cross-bred cows.)

Source : Statistical Abstract.

Table 2.33 : Milk Production in Maharashtra

Year	Milk production in '000 tonnes	Average procurement in '000 tonnes	% cows milk in total procurement
1970-71	1062	80	N.A.
1971-72	1072	N.A.	N.A.
1972-73	1083	N.A.	N.A.
1973-74	1003	N.A.	N.A.
1974-75	1211	N.A.	N.A.
1975-76	1211	231	29
1976-77	1220	292	35
1977-78	1344	290	43
1978-79	1414	324	51
1979-80	1500	350	60
1980-81	1620	390	64
1981-82	1772	390	67
1982-83	1857	423	69
1983-84	2020	514	70
1984-85	2110	636	72
1985-86	2466	752	71

Source : Dairying in India, 1988.

Table 2.34 : Gross Value of Animal Products, 1986-87

Category of animal	Type of Product (Value in Rs. Crores)					Total	%
	Milk	Meat	Manure	Hides and skins	Other products		
Cow	411	53	400	3	2	869	41
Buffalo	604	30	126	2	2	764	36
Goat	58	126	39	10	1	234	11
Sheep	-	69	13	4	6	92	4.3
Pig	-	9	-	-	-	9	0.4
Poultry (eggs and meat)	-	161	-	-	-	161	7.5
Total	1073	448	578	19	11	2129	100.0
%	50	21	27	0.9	0.5	100.0	

Source : Records of Department of Animal Husbandry, Pune.

CHAPTER III

AGRICULTURE AND ANIMAL HUSBANDRY: STATUS AND PROBLEMS IN 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 Rangmahal culture, flourished in the early centuries A.D. Evidence suggests that the gradual decline in the soil after the Rangmahal 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 reorganized State of Rajasthan has 26 administrative districts subdivided into 197 tahsils. 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 1981 was only 34 million or 100 persons per sq.km. while the density for the country as a whole was over twice as much (208). There are large inter-district variations in the density, the density being as low as 6 persons per sq.km in Jaisalmer district - the desolute desert district (Table 3.1). In 1981, about 79 per cent of the population was living in rural areas distributed over 34968 villages (Table 3.2).

1. 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-easternly 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 (Table 3.3).

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 districts.

2. 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 (Table 3.4). 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 scarp-land 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.

3. 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, Bhilwara, 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.

4. 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 (Table 3.5).

5. 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 (Table 3.6). 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 (Table 3.7). 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 (Table 3.8). Thus, there is no surplus available during the year of normal rainfall for either runoff or addition to water-table.

In case of Kota, Udaipur, Jhalwar, Ajmer, Jaipur, the normal rainfall is more than evapotranspiration. Even though precise information on infiltration rates is not available, considering the broad classification of soils and the rainfall intensity, it is expected that in Ajmer, Jaipur, Kota, there is accretion to water-table or surface runoff possibility while in Udaipur, Kota and Jhalwar even during September, the amount of precipitation is more than evapotranspiration thus there is both runoff and recharge of water-table. In districts of Bharatpur, Bhilwara, Bundi, Chittorgarh, Sawai Madhopur and Tonk the amount of water likely to be available for addition to water-table during the months of July and August is likely to be more than in Jaipur region. Whenever the moisture available in the soil in any day is less than the PET value the actual evapotranspiration decreases depending upon the deficit and will even cease if the moisture level in the top layer is below the wilting point. During the years of above normal rainfall there will be recharge of water-table and increased runoff. During the year of sub-normal rainfall, the crops may suffer but there will be no effect on groundwater-table level which will decrease only if water is pumped out and used for irrigation.

6. 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 (Table 3.9).

7. Irrigation

The scope for flow irrigation is limited in Rajasthan because of the paucity of local precipitation and absence of streams 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 (Table 3.10). 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 3276 thousand hectares by 1983-84 (Table 3.11). The expansion is due to extension of canal irrigation and well irrigation. In 1952-53 canal irrigation was restricted only to Gang canal. Substantial additions 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 1997000 by 1982-83; 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 is 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 (Table 3.12). The western arid districts have less than 5 per cent of the area under irrigation except Ganganagar district which received 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.

As noted earlier 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-rexploited particularly in Jaipur and Alwar districts and care has to be taken to limit further expansion (Table 3.13). 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.

8. 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 to forest cover (Table 3.15). 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 1983-84 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 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 fuelwood, 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 percent 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. The coefficient of variation for bajra was noted to be as high as 77 in Bikaner for the period 1951-52 to 1965-66. 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 36 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. Comparative statistics for Ganganagar and Bikaner for two periods (1960-61 to 1970-71 and 1970-71 to 1983-84) are presented in Table 3.16. It will be noted that for the new crops taken in Ganganagar district, particularly wheat, the yield is markedly high and the variability low. However, irrigated agriculture in arid zone brings with it, its own problems which would be discussed in a subsequent section. Moreover, as noted above in Rajasthan the potential for bringing in larger areas from the arid zone under irrigation is nearly absent. Even when the known potential is fully exploited major part of the region will remain without irrigation. Under such circumstances the challenging problem is whether to continue with cultivation particularly in Zone I and

Zone II of the arid region, when it does not provide survival 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 (Tables 3.17 and 3.18). 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, corriandar and other spices and cotton has increased.

9. 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 ^{over} 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 (Table 3.19). However there are large year-to-year fluctuations in production depending upon the rainfall distribution (Table 3.20). The coefficient of variation in production for the period 1960-1985 was 27 per cent for jowar, while it was 43 per cent for wheat and 46 per cent bajra and for gram it was 35 per cent. Production of bajra was obviously more variable in the arid zone, where the coefficient of variation was noted to be 66 per cent.

Trend in production for the period 1960-61 to 1982-83 was examined for the major crops grown in different regions. Except for wheat where an increasing trend is noted from 1974, (though there is some decline in the years 1979, 1980) in all the other crops the growth is not continuous. Even though there are year to year fluctuations the level of production reached in the eighties is higher than that achieved by the sixties in the case of all the crops except barley and pulses.

Production of cereals increased from 32.64 lakh tonnes in 1956-57 to 33.98 lakh tonnes in 1983-84 and that of pulses from 15.86 to 16.54 lakh tonnes.

The increase in the production is partly due to the increase in the area under cultivation and partly due to the increase in productivity. This has been stimulated mainly through propagation of hybrid and high yielding varieties and use of chemical fertilizers.

10. Modernization

High Yielding Varieties: High yielding varieties of cereals have made progress in the State mainly under the conditions of assured irrigation. In 1975-76, about 72 per cent of the irrigated wheat was sown to high yielding varieties and the ratio of HYV in the case of irrigated paddy was 81 per cent in 1977-1978. Among millets, bajra shows a definite increase in the area under improved varieties. Yet only 11 per cent of the area under bajra was under hybrid varieties in 1978-79. This is largely confined to north-eastern Rajasthan where rainfall is relatively higher and more dependable as compared to Western Rajasthan, the main bajra growing tract of the State (Table 3.21). There are thus agro-climatic limitations to the spread of high yielding varieties which do not show any advantage under very low and uncertain rainfall conditions.

Fertilizers: The use of fertilizer is extensive mainly in the canal irrigated regions viz. Ganganagar district and south-east Rajasthan. These two regions accounted for 52 per cent of the fertilizer consumption during the triennium ending 1978-79. Per hectare consumption of fertilizers was 68 kg. in south-east Rajasthan whereas for the State as a whole the consumption was only 7.60 kg. per cropped hectare.

Mechanization: The use of pumpsets is extremely uneven in the State depending upon the number of wells and tubewells in use for irrigation. The number of electric pumpsets increased from 477 in 1961 to 205909 in 1983, the number is high in Jaipur, Chittorgarh, Sikar and Alwar districts. Oil engines are still in use in considerable number (226370) their number being high in Alwar, Jaipur, Sawai Madhopur and Bharatpur districts (Table 3.22).

Tractors: The number of tractors increased from 3154 in 1961 to 54686 by 1983. About 30 per cent of these are concentrated in Ganganagar district. The use of tractors in the total power used in agriculture is negligible in Rajasthan.

11. Productivity

Modernization of agriculture or the spread of green revolution is largely restricted to the irrigated pockets where gains in yield are significant. Due to the uneven development of irrigation in the State and large variations in the annual precipitation there are marked variations between districts in the yield levels attained. Ganganagar district leads in most of the crops, followed by north-eastern Rajasthan. Productivity is the lowest in the arid zone and particularly in the districts of Barmer and Bikaner (Table 3.23). There are large variations in the per hectare value of produce between different districts, because of the variability in production and the variations in the cropping pattern, the arid region taking only the low-value crops. The gross value of output was around Rs. 350 in Jaisalmer-Barmer and over Rs. 2200 in Alwar, Bharatpur, Sawai Madhopur and Dungarpur in 1983-84 (Table 3.24).

The relative contribution of yield and cropping pattern to growth in the value of agricultural productivity is examined for the following seven sub-regions of Rajasthan.

- | | |
|----|---|
| 1 | Ganganagar |
| 2A | Barmer, Bikaner, Churu, Jaisalmer |
| 2B | Jalore, Jhunjhunu, Jodhpur, Nagaur, Sikar |
| 3A | Ajmer, Pali, Sirohi, Tonk |
| 3B | Alwar, Bharatpur, Jaipur, Sawai Madhopur |
| 4 | Banswara, Bhilwara, Chittorgarh, Dungarpur, Udaipur |
| 5 | Bundi, Jhalwar, Kota |

The mean productivity in the seven sub-regions at 1953-57 agricultural price level varied between Rs. 81 and Rs. 238 during 1953-57. The total change in the value of agricultural productivity

at constant price level of 1953-57 was between 42.38 and 16.46 during 1962-66 (Table 3.25). For the period 1953-57 to 1962-66 in all regions except sub-region 3B and 2A the pure yield effect was negative. Despite a negative contribution of this component sub-region 4 showed increase in the value of productivity because of the positive cropping pattern effect and its interaction effect. The contribution of cropping pattern has been positive in other relatively developed agricultural regions viz. 1, 3B, 5. Between 1962-63 and 1972-76 the increase in the value of the crop output per hectare at the 1962-66 level of agricultural prices was more than 75 in regions 1, 3B and 5. This increase was dominated by pure yield effect, its contribution varying between 64 and 83 per cent.

Cropping pattern during this period favoured cereal crops, wheat being the largest gainer. The growth in wheat area is mainly due to expansion in irrigated areas. Bulk of the technological change has occurred in the rabi crop under irrigation leading to greater stability in foodgrains production in the rabi season.

Region 3B has a steady growth rate of about 4.6 per cent during both the sub-periods while for other regions the performance is better in the later period. The maximum growth of 11.3 per cent is recorded in Ganganagar district during 1966-79 as against 2.6 per cent during 1953-65. The other canal irrigated region viz. sub-region 5 improved its growth performance from 2 per cent to 6.1 per cent. The growth rate of agricultural production for the seven regions are given below.

<u>Region</u>	<u>1953-65</u>	<u>1966-79</u>	<u>1953-79</u>
1	2.6	11.3	9.3
2A	N.A.	N.A.	N.A.
2B	1.5	4.0	3.4
3A	3.1	4.4	3.9
3B	4.6	4.6	5.6
4	3.2	5.1	5.6
5	2.0	6.1	6.4
State	2.7	5.3	4.8

The gross agricultural production in the State has grown at the rate of 5.3 per cent during 1966-79 as against 2.7 per cent during 1953-65. In the earlier period the growth was mainly due to expansion in area, while in the second period crop productivity mainly accounted for the output growth.

12. Irrigated Farming in Ganganagar District

Parts of Ganganagar district from the arid zone received benefit of irrigation as early as 1927. As a component of Sutlej valley project about 3 lakh hectares of Ganganagar district (major portion of Ganganagar, Karanpur, Padampur, Raisingharh and part of Anupgarh tahsils) came under canal irrigation-perennial and seasonal — (three months i.e. kharif and first watering of rabi). With the completion of Bhakra dam perennial irrigation was received in parts of Hanumangarh, Tibi, Sadulshar, Sangaria, Suratgarh, Nohar, Bhadra and Ganganagar from 1954. This covers about 2464 sq.km. area.

The work on Rajasthan Canal project commenced in 1958. The water is taken at Harike barrage just below the confluence of the Beas and Sutlej rivers. On completion the length of the Rajasthan Main Canal would be 650 kms. Out of the total command area of 11500 sq.km., 5400 sq.km. is included in stage I. The total number of villages to receive benefit from stage I is 361 and stage II is 149. In 1974-75 2900 sq.km. potential was created and by 1983-84 full potential of stage I was completed; and that from stage II began to be added from 1981-82 (Table 3.26). The area under irrigated crops is shown in Table 3.27 for the period 1974-1986-87 and the productivity is shown in Table 3.28. It will be noted that cotton is the major kharif crop and wheat, gram and mustard in the Rabi season. The yields have increased substantially, however year to year fluctuations are considerable due to problem of timely availability of canal water. Even though Ganganagar has turned from a desert to a leading grain producing district of Rajasthan, intensive and unscientific use of water have developed some alarming

problems which if not controlled early, may lead to the encroachment of deserts towards further east.

Irrigation by canals started in 1927. Due to sandy terrain and seepage losses from main canal, distributories and field channels the groundwater level is rising at the rate of 0.43 to 0.83 m. per year.* In Ghaggar flood area water-table has risen by 6-9 metres within past 20 years. Further the seepage problems along the canal irrigated areas have caused water-logged areas in Suratgarh, Tibi, Hanumangarh and Anupgarh areas. This has increased salinity hazards. The cultivation of sand dunes and marginal lands in Bhadra, Nohar and Suratgarh tahsils has led to shifting of sands in the adjacent Churu district. The district has recently shown a considerable increase of desert sand, sand drifts and new sand dunes are developing around Churu and Taranagar tahsils.

The water-table has considerably increased and reached within 1 metre around Suratgarh, Borpai and Rangamahar areas. This has threatened the prehistoric excavations site at Rangamahar, Kalibangh, Hanumangarh and dry beds of Saraswati.

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 water-logging the problem of mosquito breeding has become serious. There is a danger of increase in the water-logged area because about 30 per cent of the command area in stage I is hard pan area i.e. having hard pan within 10 m depth, and in stage II 34 per cent of the gross command is hard pan area 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

* Rise in water-level has been computed on the basis of observations of 53 wells recorded by Dr. Hoon during 1952 and recorded by the Department of Irrigation, Bikaner during 1972-75.

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 water-logging. 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 ground-water 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 water-logging, 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.

13. 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. In 1960-61 around 45 per cent of the net domestic product was contributed by agriculture and 11 per cent by animal husbandry (Table 3.29). The percentage share of agriculture and animal husbandry fluctuated between 50 and 62 depending upon the rainfall in the particular year, the proportion was 52 per cent in a drought year (1968) and was nearly 61 per cent in a

good rainfall year (1970). In 1984-85 the share of primary sector was about 50 per cent, the contribution of animal husbandry being around 12 per cent.

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.

14. Livestock Economy

The animal husbandry sector is quite important in the economy of Rajasthan. The sector contributes to 12-15 per cent of the State Domestic Product. 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 Churu the number is 82, in Jhunjhunu 74, while the number of working bullocks per 1000 hectares is only 4 in Churu and 14 in Jhunjhunu. In Ganganagar district the number of tractors is also 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 (Table 3.30). In this region marginal farmers (below 1 ha) formed about 50 per cent of the total landholders and small farmers (1 to 2 ha) about 24 per cent while for the State as a whole the corresponding proportions were 29 per cent and 20 per cent respectively in 1980-81 (Table 3.31). The average cultivated area per pair of bullocks comes to less than 3.5 hectares in the southern hilly region.

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 about 189 cows per 1000 rural population in Rajasthan the number being 242 in the southern region. In Maharashtra the number of cows per 1000 rural population works to 128.

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. Because of the inter-regional variations in the breeds reared the number of productive animals and the yield per animal varies between regions it being the highest in the arid zone and the lowest in the humid hilly southern region (Table 3.32).

The bullock population for the State as a whole has remained around 40 lakh from 1961, only in 1933 it declined to 36.47 lakh (Table 3.33). 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 1963 and 1969, again 1971 and 1972 were drought years. Consequently there was a decline in the cattle population in Bikaner, Jodhpur, Nagaur, Pali, Jalore and Sirohi districts between the years 1966 and 1972.

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. 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.

The estimated annual milk production in 1985-86 was 39 lakh tonnes, half being contributed by cows and half by buffaloes. Seasonal variations are not large, the share of lean summer season being 28.6 per cent in the annual total (Table 3.34). The important milk producing districts are Jaipur, Alwar, Ganganagar, Bikaner, Jodhpur. The milk production has increased gradually from about 23 lakh tonnes in 1970-71 to 39 lakh tonnes by 1985-86, with the increase in the number of milch animals particularly buffaloes and some increase in the milk yield (Table 3.35).

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 current year 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. In Bikaner district the supply exceeded the capacity of the Uttar Rajasthan Milk Union to handle milk. With highly erratic power supply the milk powder processing unit also had to function below its capacity. The prices of 'khoya' and 'ghee' have 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 X.

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). Between 1966-1972 sheep population declined in several districts viz. Gangapur, Bikaner, Jaisalmer, Barmer, Pali, Jalore, Alwar, Jaipur, Bharatpur, etc. Even goat population recorded a decline in Jaisalmer, Sikar, Pali, Tonk and Bharatpur. In a drought year, the pastoralists from Western Rajasthan have to migrate and incidence of death is particularly high during migration.

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. About 37 per cent of the sheep is concentrated in the five extreme arid districts suited primarily for sheep and goat rearing, and these contribute 43 per cent of the State's wool production (Table 3.36). The wool produced in Rajasthan is predominantly of medium quality. There is only one breed viz. Shekhawati or Chokla that produces fine grade wool (Table 3.37). It supplies excellent carpet wool and medium quality apparel wool. This breed is restricted only to Churu and Sikar districts. 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.

The distribution of sheep in different regions of the State is more or less commensurate with their share in the total geographical area except for the humid south where the number of sheep is much less and it is relatively higher in the semi-arid region - well suited for sheep rearing. In the case of goats their number is relatively less in the extreme western districts and higher in the semi-arid and sub-humid districts.

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, Jamnapari and Barbari (Table 3.38). Jumnapuri is a heavy animal and can adapt 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 goats have long black hair which is used to make coarse blankets. 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.

As noted above 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. The use of tobas is regulated by custom. 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 X.

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 (Table 3.39). 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 (Table 3.40). 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 IX.

Table 3.1 : Districtwise Area, Population and Workers in Rajasthan

District	Area (sq. km.)	Density of popu- lation per sq. km. (1981)	Live- stock densi- ty per sq.km. (1983)	Population '000 (1981)			% urban in total
				Total	Rural	Urban	
1. Ganganagar	20634	97	106	2030	1612	418	20.6
2. Bikaner	27244	31	176	849	514	335	39.5
3. Jaisalmer	38401	6	42	243	210	33	13.6
4. Barmer	28387	40	112	1119	1021	98	8.8
5. Jodhpur	22850	73	117	1668	1088	580	34.8
6. Churu	16830	69	126	1180	835	345	29.3
7. Jhunjhunu	5928	202	198	1211	960	251	20.7
8. Sikar	7732	172	207	1377	1098	279	20.3
9. Nagaur	17718	91	172	1628	1391	237	14.6
10. Jalore	10640	82	139	903	830	73	8.1
11. Pali	12387	106	162	1275	1040	235	18.4
12. Alwar	8380	221	197	1771	1575	196	11.1
13. Jaipur	14068	244	221	3421	2170	1251	36.6
14. Ajmer	8481	180	234	1440	824	616	42.8
15. Dholpur	3010	195	151	-	-	-	15.2
16. Bharatpur	5090	260	195	1884	1562	322	18.0
17. S. Madhopur	10527	140	170	1536	1330	206	13.4
18. Tonk	7194	112	206	784	640	144	16.4
19. Bhilwara	10455	131	257	1311	1122	189	14.4
20. Sirohi	5136	108	148	542	445	97	17.9
21. Udaipur	17279	139	229	2357	2002	355	15.1
22. Dungarpur	3770	171	293	683	639	44	6.4
23. Banswara	5037	177	203	868	813	55	6.2
24. Bundi	5550	98	174	587	487	100	17.0
25. Chittorgarh	10856	112	170	1232	1070	162	13.1
26. Kota	12436	130	120	1560	1062	498	31.9
27. Jhalawar	6219	131	161	785	693	92	11.7
State	342239	100	145	34244	27033	7211	21.1

(continued)

Table 3.1 (continued) :

District	Main workers '000 (1981)					
	Total		Cultivators		Agril. Labourers	
	Male	Female	Male	Female	Male	Female
1. Ganganagar	571	27	330	15	83	5
2. Bikaner	225	23	117	15	6	1
3. Jaisalmer	74	4	43	2	2	-
4. Barmer	311	45	242	37	8	2
5. Jodhpur	432	78	244	57	16	8
6. Churu	292	56	205	50	9	2
7. Jhunjhunu	260	43	149	36	13	2
8. Sikar	306	33	184	25	13	2
9. Nagaur	415	125	282	105	20	11
10. Jalore	237	29	167	17	21	9
11. Pali	329	80	171	40	36	29
12. Alwar	437	36	291	25	21	4
13. Jaipur	862	142	396	96	28	11
14. Ajmer	386	130	161	81	19	18
15. Dholpur	-	-	-	-	-	-
16. Bharatpur	490	23	340	12	27	4
17. S. Madhopur	400	44	278	31	17	7
18. Tonk	212	53	130	34	11	9
19. Bhilwara	385	120	253	92	17	13
20. Sirohi	137	23	62	6	2	10
21. Udaipur	618	92	408	55	24	16
22. Dungarpur	161	25	123	11	6	9
23. Banswara	220	28	172	15	7	8
24. Bundi	167	33	99	19	13	7
25. Chittorgarh	354	112	240	85	19	14
26. Kota	413	61	176	18	49	20
27. Jhalawar	218	65	144	40	23	19
State	8912	1530	5407	1019	510	240

Source : Statistical Abstract, Rajasthan, 1984.

Table 3.2 : Classification of Villages in Rajasthan by Population size (1981)

Total population	No. of villages
Below 200	7861
200 - 499	10425
500 - 999	8537
1000 - 1999	5468
2000 - 4999	2335
5000 - 9999	321
10000 and above	21
Total	39968

Source : Statistical Abstract, Rajasthan, 1984.

Table 3.3 : Catchments and the areas of important rivers of Rajasthan

Catchment	Area (km ²)	Percentage of total area
The Jamuna (Ganges) catchment	5,125.49	1.5
The Chambal catchment (72,032.05 km ² or 20.9%)		
The Kul catchment	2,943.90	0.8
The Kalisindh and Parwan catchment	11,444.72	3.3
The Chambal catchment	18,446.45	5.4
The Bansi catchment	33,760.05	9.8
The Morel catchment	5,436.93	1.6
The Mahi catchment	16,551.18	4.8
The Luni catchment (34,866.40 km ² or 10.3%)		
The Sagi catchment	3,327.46	1.0
The Jawai catchment	8,856.88	2.6
The Sukri and Bandi catchments	22,672.04	6.7
The Sabarmati catchment	3,288.68	1.0
The Banas catchment	2,837.81	0.9
Zone of Inland drainage (3,85,587.21 km ² or 60.2%)		
The Kanti basin	4,667.80	1.4
The Sota and Sabila basins	5,793.88	1.7
The Barah basin	3,516.50	1.9
The Banganga basin	6,742.57	2.0
The Misfit streams	1,57,272.42	4.0
The Misfit streams of the Luni basin	27,594.04	8.1

Source : Groundwater Atlas of Rajasthan, 1982-83.

Table 3.4 : Districtwise Annual Rainfall in Rajasthan for selected years

District	Annual rainfall in mm				
	Normal	1958	1959	1968	1969
Ganganagar	254	61	304	85	103
Bikaner	264	72	531	46	114
Jaisalmer	164	151	232	83	25
Barmer	278	100	304	37	64
Jodhpur	319	158	427	168	104
Churu	326	105	287	226	171
Jhunjhunu	445	172	457	307	430
Sikar	466	223	414	541	391
Nagaur	389	263	324	286	178
Jalore	422	226	637	100	98
Pali	490	116	576	168	101
Alwar	612	373	583	484	1064
Jaipur	548	238	997	408	388
Ajmer	527	739	811	466	263
Bharatpur	672	526	544	441	588
S. Madhopur	689	554	1287	832	603
Tonk	614	423	864	344	644
Bhilwara	699	441	865	427	584
Sirohi	638	193	828	325	451
Udaipur	625	294	860	562	467
Dungarpur	762	494	1045	790	454
Banswara	922	540	1447	942	878
Bundi	764	672	758	536	566
Chittorgarh	852	470	1097	802	916
Kota	886	468	824	609	771
Jhalawar	1005	591	745	368	1242
State	586	334	702	399	448

(continued)

Table 3.4 : (continued)

District	1974	1975	1983	1984	Coefficient of variation
Ganganagar	109	234	674	402	57
Bikaner	347	336	548	117	51
Jaisalmer	31	412	267	133	68
Barmer	50	501	301	257	62
Jodhpur	194	694	554	221	58
Churu	285	549	419	244	39
Jhunjhunu	237	586	490	293	32
Sikar	625	903	862	307	33
Nagaur	295	1223	617	179	47
Jalore	133	721	886	246	57
Pali	172	775	380	269	49
Alwar	578	884	900	552	38
Jaipur	555	1127	681	85	40
Ajmer	470	1160	1054	656	43
Bharatpur	631	710	886	396	34
S. Madhopur	857	1179	642	295	28
Tonk	799	700	775	422	45
Bhilwara	641	839	900	634	31
Sirohi	354	977	782	425	52
Udaipur	442	599	813	549	52
Dungarpur	452	909	913	787	33
Banswara	855	1084	805	1451	32
Bundi	813	775	757	951	24
Chittorgarh	750	1246	804	650	32
Kota	1057	951	517	527	37
Jhalawar	903	992	802	765	34
State	488	810	695	458	

Source : (i) Statistical Abstract, Rajasthan
(ii) Census of India, 1961, Vol. XIV, Rajasthan
Part X-B, Census Atlas (1969).

Table 3.5 : Agroclimatic Regions of Rajasthan

Macro-region	Micro-region		District	Annual Rainfall Range (mm)	Total Area '000 Ha.	Cropped Area '000 Ha.
	Season	Cropping pattern				
I. Arid	i) Kharif	Mono	Barmer, Jodhpur, Jaisalmer and Bikaner	100-300	11488	2870
	ii) Irrigated Kharif and Rabi	Double	Ganganagar	100-300	2072	1280
II. Transitional (between arid and semi-arid)	i) Kharif	Mono	Churu, Jhunjhunu, Sikar and Nagaur	300-500	4818	2052
	ii) Irrigated Kharif and Rabi	Double	Pali and Jalore	300-500	2515	1218
III. Semi-arid	i) Kharif	Mono	Alwar and Jaipur	450-600	22376	1428
	ii) Kharif and Rabi	Double	Bharatpur and Sawai Madhopur	500-750	1864	1064
	iii) Kharif and Rabi	Multiple	Ajmer, Tonk and Bhilwara	450-650	2609	1157
IV. Sub-humid	i) Kharif and Rabi	Double	Chittorgarh, Bundi and parts of Udaipur and Sirohi	500-750	3239	1016
V. Humid	i) Kharif	Mono	Dungarpur, Banswara and parts of Sirohi and Udaipur	750 and above	1513	543
	ii) Irrigated Kharif and Rabi	Double	Kota and Jhalawar	750 and above	1872	839

Source : Agricultural Atlas of Rajasthan, ICAR, 1972.

Table 3.6 : Depth of Water Table in Rajasthan

Water table in metres	A r e a
Upto 10	Eastern plains comprising Alwar, Bharatpur, Sawai-Madhopur, Jaipur, parts of Ajmer, Bhilwara, North Eastern part of Bundi, Kota in Hadoli plateau
10 to 20	Aravali foothills, Luni Basin in South west plains in north-east
Greater than 40	Western sandy plains, Bikaner, Barmer, Jaisalmer, Jodhpur

Source : Impact of Medium Irrigation Projects on Environment, Rajasthan, 1980.

Table 3.7 : Extent of Saline Water Tract in Western Rajasthan

District	Total area (km ²)	Area having saline water	
		(km ²)	Per cent
Ganganagar	20384	19343	94.89
Bikaner	27102	21800	80.44
Jaisalmer	38475	26678	69.84
Barmer	29031	22031	75.89
Jodhpur	22213	6000	27.01
Churu	16261	13338	82.02
Jhunjhunu	5648	208	3.63
Sikar	7658	330	4.31
Nagaur	17592	5292	30.09
Jalore	10428	7262	69.64
Pali	11808	2400	20.33

Source : Groundwater Atlas of Rajasthan, CAZRI 1982-83.

Table 3.8 : Monthly Rainfall and P.E.T. Values for Selected Centres in Rajasthan

Months	Ganganagar		Bikaner		Jaisalmer		Barmer		Jodhpur		Sikar	
	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.
January	14.6	43.0	5.6	53.3	2.1	70.6	4.7	81.0	7.3	83.7	8.6	51.9
February	9.4	65.6	7.3	75.3	1.2	91.6	3.9	100.5	5.1	101.3	3.1	73.8
March	13.6	115.3	6.2	131.4	2.6	153.2	3.4	159.7	1.9	156.3	4.9	126.8
April	5.6	164.6	4.6	172.4	1.5	203.5	2.8	206.7	2.2	192.3	3.1	166.6
May	11.6	217.3	7.5	236.8	5.2	281.0	9.2	259.4	6.4	264.7	17.3	215.1
June	35.5	247.9	27.0	258.3	6.8	317.4	21.5	239.4	30.9	260.3	44.4	214.1
July	68.7	236.3	86.8	228.2	89.5	247.6	87.4	178.1	121.8	184.0	155.2	155.9
August	76.8	193.7	104.5	196.6	85.8	210.7	139.1	152.3	145.5	145.2	126.0	133.0
September	49.5	161.4	44.6	177.7	13.9	192.0	33.1	163.6	47.4	155.1	43.1	134.4
October	2.8	115.6	5.7	124.7	1.3	147.0	2.0	147.1	6.8	134.1	26.7	113.9
November	1.6	60.7	2.6	68.3	4.9	83.9	1.6	92.2	3.3	87.7	5.8	68.4
December	6.6	40.4	2.3	48.8	2.2	64.1	1.6	77.1	1.5	76.5	2.7	48.7
Annual	296.3	1662.2	304.7	1772.4	217.0	2063.2	310.3	1857.7	380.1	1843.0	440.9	1503.2

(continued)

Table 3.8 : (continued)

Months	Jaipur		Ajmer		Udaipur		Kota		Jhalawar	
	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.	N.R.	P.E.T.
January	14.0	75.6	11.7	55.2	9.0	59.3	8.8	61.6	13.7	66.9
February	8.4	98.2	6.1	76.2	4.4	78.5	3.9	80.3	3.7	86.9
March	8.6	152.7	5.9	130.0	3.5	125.3	5.0	131.4	4.2	135.4
April	4.2	196.4	3.0	174.0	2.6	158.9	4.9	166.9	4.0	171.8
May	10.0	257.4	9.3	243.0	4.6	204.4	7.4	225.0	5.7	229.9
June	54.0	242.6	66.5	229.3	87.0	178.7	78.5	210.3	111.2	213.5
July	193.2	161.7	187.4	155.8	197.3	119.5	308.6	138.6	356.6	140.8
August	239.0	126.4	174.6	128.3	206.7	102.3	267.9	130.6	326.7	125.8
September	89.8	144.8	71.0	142.1	120.4	115.3	132.2	133.3	163.5	129.6
October	19.3	137.2	16.5	113.9	16.1	112.3	15.2	122.4	18.2	118.2
November	3.4	84.7	3.7	66.4	5.9	70.9	6.2	75.4	10.2	75.0
December	4.2	67.0	1.7	50.6	2.5	55.2	2.9	58.3	5.8	60.7
Annual	648.1	1745.2	573.9	1566.3	660.0	1331.2	709.3	1524.7	1023.5	1555.9

Note : N.R. = Normal Rainfall in mm. P.E.T. = Potential Evapotranspiration.

Source : Meteorological Department, Pune.

Table 3.9 : Vegetation of Rajasthan

Region	Annual precipitation	Vegetation type
1) West and north west sandy dry belt	200 mm	Xerophyte plants : Calligonum polygonoides, Lasuirus indicus, Panicum turgidum, Prosopis cineraria, Zizyphus nummularia, Capparis dicitua
2) Lower Luni basin, Sambhar lake and salty marshes	200 to 400 mm	Halophytic plants : Hatoxylon salicornicum, Sueda fructicosa, grasses : Sporobolus marginatus, Elusine compressa Marshy Plants: Typha angustata, Phragmites karka
3) Eastern part around Bharatpur, Alwar flood plains	600 to 800 mm	Anogeissus pendula, Boswellia serrata, Acacia nilotica
4) Foothill of Arvalis and south eastern uplands	800 to 1000 mm	Anogeissus pendula, Boswellia serrata, Acacia leucopholoea, Tectona grandis Grasses : Sehema, Dichanthium, Themeda

Source : Impact of Medium Irrigation Projects on Environment, Rajasthan, 1980

Table 3.10 : Major and medium irrigation projects in Rajasthan

Irrigation project	District to benefit	Ultimate potential ('000 Ha.)	1983-84 utilization ('000 Ha.)
1) Major Schemes :			
Gang	Ganganagar	308	295
Bhakra	Ganganagar	246	313
Chambal	Kota, Bundi	230	189
Rajasthan canal	Ganganagar, Bikaner	I-540	434
	Jaisalmer, Stage II	II-610	-
Jakham	Udaipur	21	-
Gurgaon Canal	Bharatpur	28	1
Mahi	Benswara mainly	31	13
2) Medium Schemes :			
	Udaipur, Chittor- garh, S. Madhopur, Kota, Pali, Bhilwara, Jhalwar, Jalore	N.A.	291

Source : Basic Statistics, Rajasthan, 1985.

Table 3.11 : Growth in Net Irrigated Area by Source in Rajasthan from 1951 to 1983

(in '000 ha.)

Year	Net cultivated area	Government canals	Tanks	Wells and Tube Wells	Others	Net irrigated area	Gross irrigated area
1951-52	9,313	224	82	684	17	1007	1171
1952-53	10,398	239	145	853	46	1283	1541
1953-54	10,871	240	110	792	17	1156	1384
1954-55	11,058	252	145	825	15	1237	1507
1955-56	11,454	284	178	872	16	1350	1593
1956-57	12,425	279	189	906	38	1412	1693
1957-58	12,103	315	222	901	8	1446	1773
1958-59	12,587	331	313	787	14	1445	1647
1959-60	13,215	422	255	985	13	1675	1675
1960-61	13,112	535	166	1015	37	1753	1753
1961-62	13,742	581	214	977	50	1822	1823
1962-63	13,821	643	121	1066	29	1859	1859
1963-64	13,497	610	120	1110	23	1863	1863
1964-65	14,452	614	295	1127	43	2079	2080
1965-66	14,132	487	203	1023	40	1753	2068
1966-67	14,597	553	186	1033	23	1795	2120
1967-68	15,096	604	252	998	9	1863	2141
1968-69	13,311	701	219	1118	11	2119	2545
1969-70	13,095	753	189	1096	21	2059	2419
1970-71	15,179	756	270	1087	23	2136	2453
1971-72	15,363	811	179	1151	32	2172	2440
1972-73	14,459	810	106	1313	31	2269	2682
1973-74	15,967	844	233	1262	38	2378	2679
1974-75	13,958	831	161	1514	31	2647	3143
1975-76	15,105	887	253	1377	30	2547	2934
1976-77	15,060	867	238	1486	17	2608	2976
1977-78	15,168	914	231	1550	70	2765	3167
1978-79	15,471	950	192	1730	23	2894	3551
1979-80	14,207	981	214	2090	22	3308	4084
1980-81	15,268	941	112	1874	56	2982	3749
1981-82	15,578	946	85	1827	45	2903	3722
1982-83	15,659	1025	143	1997	53	3218	4088
1983-84	16,234	1119	214	1906	37	3276	4014

Source : Statistical Abstract, Rajasthan.

Table 3.12 : Districtwise Progress in Irrigation in Rajasthan

District	1963-84					1956-57				
	Net irrigated area (000 Ha.)	Per cent area irrigated by			Gross cropped area (000 Ha)	Gross irrigated area (000 Ha)	% area irrigated	Gross cropped area (000 Ha)	Gross irrigated area (000 Ha)	% area irrigated
		Canals	Tanks	Wells and tube wells						
1	2	3	4	5	6	7	8	9	10	11
1. Ganganagar	709	99.88	-	0.12	1947	1019	52.34	1214	319	26.28
2. Bikaner	37	99.94	-	0.06	1003	56	5.58	399	-	-
3. Jaisalmer	Negl.	1.19	-	98.81	305	Negl.	0.0	91	-	-
4. Barmer	19	0.39	-	97.64	1573	33	2.10	1105	8	0.72
5. Jodhpur	59	10.25	0.03	89.61	1240	78	6.29	901	30	3.33
6. Churu	1	-	-	100.00	1348	1	0.07	980	-	-
Sub total	116	37.11	0.02	62.49	5469	168	3.07	3476	38	1.09
7. Jhunjhunu	56	-	0.46	99.54	512	65	12.70	513	11	2.14
8. Sikar	88	0.30	-	99.70	586	109	18.60	567	33	5.82
9. Nagaur	67	0.51	0.50	98.99	1253	89	7.10	1057	23	2.18
10. Jalore	143	6.42	0.03	93.40	772	170	22.02	585	43	7.35
11. Pali	175	0.91	23.41	73.49	718	210	29.24	478	139	29.08
Sub total	529	2.15	7.87	89.22	3341	643	16.74	3200	249	7.78
12. Alwar	182	3.25	-	96.67	710	192	27.04	622	60	9.65
13. Jaipur	358	6.34	0.86	92.78	974	405	41.58	796	180	22.61
14. Ajmer	108	4.45	19.16	76.02	471	139	29.51	396	118	29.80
15. Dholpur	56	27.80	0.19	56.49	173	57	32.95	-	-	-
16. Bharatpur	97	4.30	0.35	82.32	492	100	20.33	612	122	19.93
17. S. Madhopur	157	25.87	3.92	69.73	619	161	26.01	497	59	11.87
18. Tonk	90	28.41	7.43	63.75	497	96	19.32	371	54	14.56
19. Bhilwara	153	1.07	32.79	65.99	460	194	42.17	302	154	50.99
Sub total	1201	10.68	7.25	80.73	4396	1344	30.57	3596	747	20.77

Table 3.12 : (continued)

1	2	3	4	5	6	7	8	9	10	11
20. Sirohi	56	-	18.81	30.95	211	70	33.18	138	38	27.54
21. Udaipur	132	-	24.03	75.79	552	160	28.99	364	128	35.16
22. Dungarpur	16	0.87	30.04	63.40	192	22	11.46	143	8	5.59
23. Banswara	34	34.27	20.58	29.51	316	35	11.08	219	:	1.83
Sub total	238	4.90	22.72	69.63	1271	287	22.53	864	178	20.60
24. Bundi	118	70.34	3.03	26.52	323	148	45.82	193	25	12.95
25. Chittorgarh	122	1.05	16.53	81.80	527	130	24.67	348	86	24.71
26. Kota	137	73.98	3.34	22.05	707	213	30.14	532	30	5.64
27. Jhalawar	55	2.51	1.64	95.03	398	59	14.82	288	21	7.29
Sub total	482	46.51	6.41	46.56	1955	550	28.13	1361	162	11.90
State total	3275	34.16	6.53	58.18	18879	4011	21.25	13711	1693	12.35

Source : Statistical Abstract, Rajasthan.

Table 3.13 : Districtwise Groundwater Potential and Utilization in Rajasthan

District	Estimated exploitable ground-water potential in mcm	Total exploited ground-water in mcm (1972)	Exploited ground-water for irrigation in mcm (1972)	Area irrigated by well in ha. (1972)	Area irrigated by wells and tubewells in ha. (1983-84)
Ganganagar	175.50	23.50	2.53	639	884
Bikaner	31.10	9.06	1.24	248	21
Jaisalmer	143.20	5.50	2.36	264	83
Barmer	87.78	12.88	2.35	5807	18606
Jodhpur	228.50	130.26	94.52	23632	52579
Churu	80.00	26.07	1.20	252	1271
Jhunjhunu	222.94	93.11	67.28	15914	55506
Sikar	285.90	193.12	163.26	42801	88156
Nagaur	353.92	129.01	90.00	20000	66334
Jalore	460.96	292.88	266.23	59246	133705
Pali	290.23	212.36	183.36	61110	128731
Alwar	410.80	364.15	327.75	82000	175976
Jaipur	749.63	681.27	626.17	203194	332491
Ajmer	377.10	256.21	219.71	52452	82308
Bharatpur	495.00	237.43	210.11	66007	79676
S. Madhopur	576.72	342.92	308.95	59803	109725
Tonk	207.93	163.31	141.91	40021	57245
Bhilwara	360.48	270.35	260.71	87215	100549
Sirohi	133.51	96.49	74.87	27320	45694
Udaipur	549.90	344.46	301.50	662411	99981
Dungarpur	58.05	30.43	26.72	9247	10385
Banswara	80.40	36.56	27.98	6997	9934
Bundi	269.89	123.23	113.07	22046	31268
Chittorgarh	376.89	329.33	305.38	78835	99825
Kota	581.80	166.98	130.36	26072	41319
Jhalawar	471.20	170.38	154.55	30824	52063

Source : Groundwater Atlas of Rajasthan, CAZRI 1982-83.

Table 3.14 : Districtwise Land Utilization in Rajasthan, 1983-84

(00 Hectares)						
Region/District	Reporting area for the land utilization purposes	Forests	Not available for cultivation		Other uncultivated land	
			Land put to non-agricultural use	Barren and uncultivated land	Permanent pastures and other grazing land	Land under miscellaneous tree crops and groves
1	2	3	4	5	6	7
Ganganagar	20631	391	1221	22	236	607
<u>Region 1</u> : Northern irrigated	20631	391	1221	22	236	607
Bikaner	27406	631	1243	142	557	8
Jaisalmer	38404	182	626	3600	1006	20
Barmer	28174	164	663	1380	2082	-
Jodhpur	22564	51	754	1461	1230	5
<u>Region 2</u> : Western arid	133411	1087	4004	6596	5354	33
Jhunjhunu	5928	334	164	193	444	1
Sikar	7751	251	268	492	468	5
Nagaur	17644	144	805	590	759	2
Jalore	10564	180	342	856	509	8
Pali	12300	730	501	1505	939	14
<u>Region 3</u> : Midwestern transitional	54187	1639	2080	3636	3119	30
Alwar	7662	161	444	1250	253	14
Jaipur	14012	630	784	1150	1105	19
Ajmer	8329	351	404	1081	776	11
Dholpur	3010	112	190	726	204	7
Bharatpur	5074	259	258	327	94	4
S. Madhopur	10543	2350	432	1261	689	4
Tonk	7189	230	288	424	636	1
Bhilwara	10400	555	546	1788	1192	1
<u>Region 4</u> : Mideastern semiarid	66219	4648	3346	6007	4949	61

Table 3.14 : (continued)

1	2	3	4	5	6	7
Sirohi	5178	1458	249	869	337	1
Udaipur	19127	3682	2379	4514	1621	13
Dungarpur	3792	617	151	778	401	24
Banswara	5067	1024	86	814	318	1
<u>Region 5</u> : Southern	33164	6781	2865	6975	2677	39
Bundi	5810	1291	331	717	247	12
Chittorgarh	10393	1403	649	1411	808	4
Kota	12230	3270	449	1003	553	30
Jhalawar	6323	1114	249	431	517	11
<u>Region 6</u> : Southeastern	34746	7078	1678	3562	2125	57
Rajasthan State	342358	21624	15194	28798	18460	827

(continued)

Table 3.14 : (continued)

Region/District	Culturable waste	Fallow land		Net sown area	Gross cropped area
		Other Fallow	Current Fallow		
1	8	9	10	11	12
Ganganagar	823	370	813	16148	19465
<u>Region 1</u> : Northern irrigated	823	370	813	16148	19465
Bikaner	11575	2114	1301	9825	10027
Jaisalmer	28223	1328	369	3050	3051
Barmer	2901	2969	2471	15544	15734
Jodhpur	552	2977	3470	12064	12404
<u>Region 2</u> : Western arid	43556	10422	8751	53608	54697
Jhunjhunu	78	150	210	4354	5123
Sikar	141	429	612	5085	5857
Nagaur	117	895	2338	11994	12533
Jalore	262	812	858	6737	7717
Pali	436	908	938	6329	7183
<u>Region 3</u> : Midwestern transitional	1034	3194	4956	34499	38413
Alwar	156	201	247	4936	7099
Jaipur	799	810	1003	7712	9736
Ajmer	1006	467	446	3787	4712
Dholpur	137	113	128	1393	1731
Bharatpur	59	114	203	3756	4916
S. Madhopur	312	209	286	5000	6189
Tonk	590	172	342	4506	4968
Bhilwara	2224	471	399	3224	4598
<u>Region 4</u> : Mideastern semiarid	5283	2557	3054	34314	43949

(continued)

Table 3.14 : (continued)

Region/District	Culturable waste	Fallow land		Net sown area	Gross cropped area
		Other Fallow	Current Fallow		
1	8	9	10	11	12
Sirohi	114	254	184	1712	2112
Udaipur	2430	493	318	3677	5522
Dungarpur	240	185	108	1288	1916
Banswara	181	241	160	2242	3163
<u>Region 5</u> : Southern	2965	1173	770	8919	12713
Bundi	351	185	240	2436	3225
Chittorgarh	2138	216	190	3574	5270
Kota	582	306	284	5743	7068
Jhalawar	674	125	99	3103	3976
<u>Region 6</u> : Southeastern	3745	832	813	14856	19539
Rajasthan State	57406	18548	19157	162344	188776

Source : Statistical Abstract, Rajasthan, 1984.

Table 3.15 : Changes in Land Utilization Pattern in Rajasthan (1956-57, 1983-84)

Region	Land utilization as percentage to reporting area								
	Forests	Land put to non-agricultural use	Barren and uncultivated land	Permanent pastures and other grazing land	Land under miscellaneous tree crops and grooves	Cultural waste	Fallow other than current fallow	Current fallow	Net sown area
<u>1956-57</u>									
Northern	-	3.25	-	0.09	-	33.11	2.33	5.14	56.08
Western	0.42	2.62	15.12	1.53	0.18	32.28	13.79	8.21	25.84
Midwestern	2.68	3.02	8.30	4.56	0.06	2.37	10.41	12.63	55.97
Mideastern	7.65	4.03	11.59	6.96	0.07	15.78	6.83	3.52	43.58
Southern	13.40	3.59	30.81	9.60	0.28	12.62	7.39	2.45	19.86
Southeastern	8.69	3.63	19.85	4.56	0.15	21.19	4.65	1.31	35.97
State	4.21	3.19	14.37	4.04	0.13	21.44	9.69	6.58	36.35
<u>1983-84</u>									
Northern	1.90	5.92	0.11	1.14	2.94	3.99	1.79	3.94	78.27
Western	0.82	3.00	4.94	4.01	0.00	32.65	7.81	6.56	40.02
Midwestern	3.02	3.85	6.72	5.76	0.03	1.91	5.89	9.15	63.67
Mideastern	7.02	5.05	12.09	7.47	0.09	7.98	7.26	4.61	51.82
Southern	20.45	8.64	21.03	8.07	0.12	8.94	3.86	2.32	26.89
Southeastern	20.37	4.83	10.25	6.12	0.16	10.78	3.54	2.34	42.76
State	6.32	4.44	8.41	5.39	2.41	16.77	2.39	5.60	47.42

Source : Statistical Abstract, Rajasthan.

Table 3.16-A : Average Productivity and Coefficient of Variation for Main Crops in Ganganagar and Bikaner Districts

Period	Productivity					
	Wheat		Bajra		Kharif Pulses	
	Mean	C.V.	Mean	C.V.	Mean	C.V.
<u>Ganganagar District</u>						
1960-70	998	29.02	182	57.53	132	68.99
1971-83	1640	15.75	356	36.62	222	61.27
1960-83	1436	31.42	259	54.85	173	68.84
<u>Bikaner District</u>						
1960-70	1000	68.51	89	70.98	129	50.87
1971-83	1627	13.67	100	95.22	176	84.78
1960-83	1606	46.21	96	83.10	157	78.17

Note: Mean - Average Productivity (kg/ha). C.V.=Coefficient of variation of productivity.

Table 3.16-B : Coefficient of variation of production for main crops in Ganganagar and Bikaner districts.

Period	Coefficient of variation of production					
	Wheat	Bajra	Gram	Kharif Pulses	Cotton	Rape Mustard
<u>Ganganagar District</u>						
1960-70	37.79	80.57	43.63	67.95	24.23	73.70
1971-83	31.18	43.51	29.94	63.64	27.14	42.17
1960-83	59.33	60.37	40.37	66.19	58.89	82.12
<u>Bikaner District</u>						
1960-70	99.03	70.99	212.13	55.41	-	316.23
1971-83	68.93	99.42	120.19	86.67	-	59.00
1960-83	128.19	92.68	186.13	87.24	-	119.12

Source : Computed using data from Statistical Abstract, Rajasthan.

Table 3.17-A : Changes in Cropping Pattern in Rajasthan

(Area in '000 Ha.)

Crop	Region 1 Northern			Region 2 Western			Region 3 Midwestern			Region 4 Mideastern		
	1956- 57	1967- 68	1983- 84	1956- 57	1967- 68	1983- 84	1956- 57	1967- 68	1983- 84	1956- 57	1967- 68	1983- 84
Bajra	173	271	90	1844	2302	2474	1173	1468	1562	555	804	839
Jowar	25	11	4	50	33	18	187	155	135	307	435	400
Maize	1	1	1	-	-	-	20	25	36	169	235	223
Wheat	180	140	323	53	47	67	193	176	276	445	477	885
Barley	56	103	9	3	5	1	51	117	27	363	355	187
Rice	3	9	21	-	-	-	-	-	-	5	13	9
Small millets	-	-	-	-	1	-	9	12	2	3	1	1
Gram	351	393	546	22	43	190	172	83	151	712	599	567
Other pulses	107	68	49	807	1059	910	690	656	480	328	276	143
Sesamum	4	1	-	67	88	50	192	267	141	136	161	49
Rape and mustard	41	26	111	2	4	43	21	20	198	180	143	404
Linseed	-	-	-	-	-	-	-	-	-	15	18	42
Groundnut	-	-	2	-	-	5	1	13	9	32	155	105
Sugarcane	4	6	6	-	-	-	-	-	-	11	4	6
Cotton	71	118	310	1	-	5	10	11	18	56	47	50
Gross Cropped Area	1214	1608	1946	3476	4595	5469	3200	3706	3841	3596	4122	4395

(continued)

Table 3.17-4 : (continued)

Crop	Region 5 Southern			Region 6 Southeastern			State		
	1956- 57	1967- 68	1983- 84	1956- 57	1967- 68	1983- 84	1956- 57	1967- 68	1983- 84
Bajra	18	36	30	2	10	8	3765	4891	5004
Jowar	15	49	45	269	486	383	853	1169	985
Maize	213	329	377	98	156	256	501	746	893
Wheat	114	114	221	370	311	391	1355	1365	2165
Barley	69	47	52	34	24	15	586	651	291
Rice	78	61	101	7	12	30	93	95	160
Small millets	61	66	42	2	1	-	75	81	45
Gram	109	65	103	177	140	240	1543	1323	1796
Other pulses	20	41	97	23	42	110	1975	2142	1788
Sesamum	53	83	32	27	66	105	479	666	377
Rape and mustard	12	4	32	1	1	32	266	198	821
Linseed	1	1	1	136	47	46	152	66	90
Groundnut	7	25	11	28	88	52	68	281	183
Sugarcane	9	4	7	10	6	14	34	20	34
Cotton	25	32	21	60	48	12	223	256	416
Gross Cropped Area	864	1026	1271	1361	1600	1954	13711	16657	18878

Source : Statistical Abstract, Rajasthan.

Table 3.17-B : Cropping pattern in 1983-84
(Percentage of area under each crop to gross cropped area of the region)

C r o p	Region 1 Northern	Region 2 Western	Region 3 Midwestern	Region 4 Mideastern	Region 5 Southern	Region 6 Southeastern	State
Bajra	4.63	45.24	40.67	19.01	2.39	0.43	26.51
Jowar	0.21	0.33	3.51	9.10	3.55	19.58	5.22
Maize	0.04	-	0.94	5.07	29.66	13.10	4.73
Wheat	16.61	1.23	7.19	20.15	17.39	20.03	11.47
Barley	0.46	-	0.70	4.25	4.10	0.79	1.54
Rice	1.08	-	-	0.20	7.91	1.52	0.85
Small millets	-	-	0.05	0.01	3.32	0.01	0.24
Gram	28.04	3.47	3.93	12.91	8.10	12.26	9.52
Other pulses	2.59	16.64	12.50	4.04	8.22	6.53	9.80
Sesamum	-	0.91	3.67	1.12	2.54	5.35	2.00
Rape and Mustard	5.71	0.79	5.15	9.19	2.51	1.66	4.35
Linseed	-	-	-	0.96	0.08	2.33	0.47
Groundnut	0.12	0.09	0.23	2.39	0.83	2.66	0.97
Castor seed	-	-	0.03	0.05	0.38	-	0.05
Sugarcane	0.31	-	-	0.13	0.56	0.34	1.68
Chillies	0.06	-	0.07	0.27	0.34	0.37	0.17
Cotton	15.92	0.09	0.47	1.13	1.68	0.63	2.20

Source : Statistical Abstract, Rajasthan, 1984.

Table 3.18 : Districtwise Crop Pattern in 1956-57 and 1983-84
(Percentage of area under each crop to gross cropped area of the district)

District	Year	Bajra	Jowar	Maize	Wheat	Barley	Rice	Gram	Other pulses	Rape and mustard	Other oil-seeds	Sugar-cane	Cotton
1. Ganganagar	1983-84	4.63	0.21	0.04	16.61	0.46	1.08	28.04	2.54	5.71	0.12	0.31	15.92
	1956-57	14.25	2.06	0.08	14.83	4.61	0.25	28.91	8.81	3.38	0.33	0.33	5.85
2. Bikaner	1983-84	30.59	0.08	-	1.22	0.04	-	1.38	24.33	1.08	1.69	0.03	0.35
	1956-57	32.58	0.50	-	-	-	-	-	53.13	-	2.01	-	-
3. Jaisalmer	1983-84	46.40	1.43	-	1.04	0.03	-	0.07	0.06	0.09	0.43	-	-
	1956-57	76.92	4.40	-	4.40	-	-	-	-	-	-	-	-
4. Barmer	1983-84	62.40	0.11	-	0.74	0.01	-	0.06	5.52	0.16	0.55	-	-
	1956-57	72.13	0.45	-	1.90	0.09	-	0.27	6.97	-	1.27	-	-
5. Jodhpur	1983-84	46.12	0.87	-	3.17	0.03	-	1.04	17.05	2.28	2.26	-	0.12
	1956-57	58.49	4.22	-	3.00	0.22	-	0.67	13.43	0.11	4.66	-	0.11
6. Churu	1983-84	34.99	0.01	-	0.07	-	-	12.02	27.27	0.11	0.03	-	0.01
	1956-57	32.65	0.10	-	0.10	-	-	1.33	40.51	0.10	0.31	-	-
7. Jhunjhunu	1983-84	48.10	0.03	-	5.70	0.62	-	6.93	16.34	2.96	-	-	-
	1956-57	30.02	0.39	-	0.58	1.75	-	13.06	43.47	1.17	-	-	-
8. Sikar	1983-84	40.77	0.05	0.03	6.77	2.13	-	6.90	15.83	2.81	0.18	-	0.02
	1956-57	38.62	0.18	0.18	1.59	3.17	-	6.88	34.39	0.53	-	-	-
9. Nagaur	1983-84	47.77	3.12	0.04	3.35	0.50	-	2.12	17.83	3.16	4.48	-	0.10
	1956-57	42.57	8.04	0.09	2.93	1.14	-	2.46	22.42	0.38	7.66	-	0.09
10. Jalore	1983-84	45.20	0.30	0.03	6.98	0.22	-	1.22	6.03	7.94	2.93	-	0.16
	1956-57	44.44	1.37	0.34	10.77	0.34	-	3.08	3.42	0.34	5.64	-	0.17

(continued)

Table 3.18 : (continued)

District	Year	Bajra	Jowar	Maize	Wheat	Barley	Rice	Gram	Other pulses	Rape and mustard	Other oil-seeds	Sugar-cane	Cotton
11. Pali	1983-84	17.99	13.01	4.92	15.49	0.43	0.01	5.41	4.75	9.13	10.05	-	1.82
	1956-57	18.83	19.04	3.35	18.20	4.18	-	4.60	3.35	1.26	16.53	-	1.67
12. Alwar	1983-84	26.31	2.49	1.47	16.93	3.52	0.02	18.99	1.39	15.35	0.67	0.02	-
	1956-57	20.42	4.34	1.61	6.43	7.23	-	30.23	6.27	10.93	2.25	-	-
13. Jaipur	1983-84	24.97	3.26	1.71	21.59	6.03	-	12.27	9.16	4.63	4.31	0.04	0.02
	1956-57	22.36	11.43	3.39	7.29	12.81	-	14.95	22.49	0.75	3.52	0.13	0.25
14. Ajmer	1983-84	12.48	23.73	9.33	16.56	5.49	0.04	12.42	3.99	1.21	3.03	0.03	3.92
	1956-57	7.07	19.70	10.60	13.13	11.87	-	12.88	5.81	-	9.34	-	4.55
15. Dholpur	1983-84	35.33	0.73	-	18.00	1.57	0.77	10.90	3.70	18.18	1.70	0.50	-
	1956-57	-	-	-	-	-	-	-	-	-	-	-	-
16. Bharatpur	1983-84	23.58	3.06	0.01	19.49	2.89	0.45	15.63	3.38	21.63	1.00	0.09	0.01
	1956-57	26.10	7.84	0.16	11.27	4.90	0.16	22.88	5.55	16.18	3.59	0.49	-
17. S. Madhopur	1983-84	21.99	9.89	0.35	19.64	2.20	0.77	12.70	3.25	11.37	10.52	0.22	-
	1956-57	17.51	6.84	0.80	15.49	7.04	0.80	24.35	11.37	3.01	6.64	0.60	-
18. Tonk	1983-84	6.93	25.22	3.61	24.43	3.78	-	11.03	0.78	6.59	5.85	0.21	0.14
	1956-57	2.96	21.29	3.50	26.15	11.86	-	16.98	2.70	0.27	7.01	0.27	1.89
19. Bhilwara	1983-84	0.59	7.85	28.64	23.29	6.03	-	5.58	2.68	0.67	3.73	0.30	6.60
	1956-57	0.33	4.30	23.84	17.22	16.89	-	9.93	1.33	-	7.61	0.99	9.60
20. Sirohi	1983-84	13.30	3.21	13.36	14.05	1.34	-	2.88	11.39	10.09	9.07	-	1.31
	1956-57	12.32	2.90	5.80	17.39	2.90	-	5.07	5.07	2.90	12.32	-	0.72

(continued)

Table 3.18 : (continued)

District	Year	Bajra	Jowar	Maize	Wheat	Barley	Rice	Gram	Other pulses	Rape and mustard	Other oil-seeds	Sugar-cane	Cotton
21. Uadipur	1983-84	0.35	4.15	38.45	20.38	7.46	3.43	5.54	4.60	1.86	4.28	0.94	0.63
	1956-57	0.27	3.02	32.12	15.11	15.11	3.57	9.07	1.92	1.65	3.84	1.92	3.30
22. Dungarpur	1983-84	0.20	1.36	24.93	18.44	2.32	19.78	9.99	9.39	0.03	1.50	0.44	0.21
	1956-57	-	-	23.08	11.19	4.20	20.28	16.78	2.10	1.40	6.29	0.70	1.40
23. Banswara	1983-84	-	4.04	28.07	13.75	1.16	13.81	14.92	11.72	0.07	0.97	0.35	4.64
	1956-57	-	-	25.11	8.68	1.83	16.44	20.55	2.29	-	8.68	0.46	4.57
24. Bundi	1983-84	0.55	14.36	10.83	29.56	1.54	5.32	10.16	2.08	1.22	9.42	2.79	-
	1956-57	-	18.65	3.63	29.02	5.70	0.52	14.51	2.07	-	3.11	1.07	0.52
25. Chittorgarh	1983-84	0.02	8.53	24.45	18.89	0.92	0.53	11.49	10.79	1.40	10.28	0.58	0.82
	1956-57	-	10.92	17.82	25.57	3.44	0.86	10.06	2.59	-	12.07	1.15	7.47
26. Kota	1983-84	0.41	23.53	4.64	21.47	0.69	1.23	13.97	4.65	2.96	11.73	0.13	-
	1956-57	0.19	19.92	1.50	32.52	1.69	0.38	15.41	2.07	0.19	16.72	0.38	0.19
27. Jhalawar	1983-84	0.91	31.41	14.95	11.26	0.19	0.27	11.93	7.87	0.04	7.40	0.31	2.01
	1956-57	0.35	30.90	7.29	18.06	0.69	0.35	11.11	3.12	-	9.72	0.69	11.11
State	1983-84	26.50	5.22	4.73	11.47	1.54	0.85	9.52	9.80	4.35	2.69	0.18	2.20
	1956-57	27.46	6.22	3.65	9.88	4.27	0.68	11.25	14.63	1.94	5.10	0.25	1.63

Source : Computed on the basis of data in Statistical Abstract, Rajasthan.

Table 3.19 : Production and Requirements of Foodgrains in Rajasthan in 1983

(Figures in 00 tonnes)

	Production (1983-84)	Requirements ¹		Consumption ²
		(A)	(B)	
Cereals	83985	64230	80019	70224
Pulses	16590	6818	10047	7020
Total	100575	71048	90066	77244
Oil	3366	5023	2511	2200

1 = For estimated population of the state in 1983.

(A)= On the basis of nutritionally balanced diet which is beyond the means of a large section of population.

(B)= On the basis of adequate calorie diet with accent on cereal consumption which comes close to the diet of an average income family.

2 N3S 28th Round

Source : Computed on the basis of data from Statistical Abstract, Rajasthan.

Table 3.20 : Trend in Productivity of Main Crops in Rajasthan

Year	Rainfall (mm)	Productivity - kg./Ha.					
		Bajra	Jowar	Maize	Wheat	Gram	Rape and mustard
1956-57	679	145	252	657	987	772	431
1957-58	497	207	307	617	788	474	339
1958-59	334	245	310	932	886	728	268
1959-60	702	254	304	862	855	451	272
1960-61	451	161	286	998	946	667	367
1961-62	713	244	252	1226	981	617	403
1962-63	520	230	353	1095	873	501	412
1963-64	481	190	265	910	768	355	142
1964-65	574	262	343	1099	932	527	381
1965-66	363	193	284	866	812	371	323
1966-67	434	245	305	829	907	463	216
1967-68	600	291	366	1374	1043	793	331
1968-69	399	98	212	532	1013	515	454
1969-70	448	185	346	664	1015	606	451
1970-71	621	521	485	1226	1320	739	972
1971-72	665	267	274	984	1248	539	320
1972-73	401	165	312	825	1253	667	733
1973-74	779	382	350	410	1070	477	296
1974-75	488	100	385	624	1280	558	600
1975-76	810	303	265	1141	1300	767	504
1976-77	745	366	429	760	1279	767	439
1977-78	752	197	387	689	1424	799	462
1978-79	696	253	400	970	1444	909	647
1979-80	545	89	181	655	1303	544	427
1980-81	419	226	337	872	1464	697	685
1981-82 @	471	163	421	814	1660	650	704
1982-83 +	576	289	374	741	1830	751	731
1983-84 +	695	491	600	1376	1594	606	791

@ = Based on final forecast

+ = Based on Revised Final Estimates

Source : Statistical Abstract, Rajasthan.

Table 3.21 : Progress in Area under Improved Varieties

Year	Bajra	Jowar	Maize	Paddy	Wheat
<u>1975-76</u>					
1. Area Under High Yielding Variety (00 Ha.)	3144	59	201	385	8257
2. Total Area Under Crop (00 Ha.)	37167	7131	6864	1547	17622
3. Per Cent Area Under High Yielding Variety	8.46	0.83	2.93	24.89	46.86
<u>1980-81</u>					
1. Area Under High Yielding Variety (00 Ha.)	7855	176	280	469	8804
2. Total Area Under Crop (00 Ha.)	50317	10022	9004	1701	16350
3. Per Cent Area Under High Yielding Variety	15.61	1.76	3.11	27.57	53.85
<u>1983-84</u>					
1. Area Under High Yielding Variety (00 Ha.)	13970	315	291	429	14533
2. Total Area Under Crop (00 Ha.)	50036	9850	8930	1602	21647
3. Per Cent Area Under High Yielding Variety	27.92	3.20	3.26	26.78	67.14

Source : Statistical Abstract, Rajasthan

Table 3.22 : Districtwise Distribution of Tractors and Pump Sets in Rajasthan, 1983

District	Tractors	Oil engine operated pump sets	Electric pump sets
1. Ganganagar	14889	1751	1921
2. Bikaner	722	1	8
3. Jaisalmer	219	4	18
4. Barmer	1066	3256	1587
5. Jodhpur	4293	4524	4441
6. Churu	525	1	63
7. Jhunjhunu	364	2231	9935
8. Sikar	1020	2646	16688
9. Nagaur	3800	3570	6925
10. Jalore	1991	17324	8068
11. Pali	3725	9290	10708
12. Alwar	4689	38766	13843
13. Jaipur	4797	28386	41698
14. Ajmer	616	3947	6352
15. Dholpur	665	8435	683
16. Bharatpur	4517	23341	7159
17. S. Madhopur	1198	21822	9743
18. Tonk	496	6067	3520
19. Bhilwara	801	3214	9355
20. Sirohi	419	4159	5267
21. Udaipur	381	7806	11873
22. Dungarpur	26	3599	1356
23. Banswara	47	5842	2279
24. Bundi	965	3677	2172
25. Chittorgarh	799	11190	20172
26. Kota	1529	6218	4381
27. Jhalawar	127	5303	5189
State	54686	226370	205909

Source : Statistical Abstract, Rajasthan, 1984.

Table 3.23-A : Production of Major Crops in Rajasthan in 1956-57 and 1983-84

Crop	(000 tonnes)													
	Region 1		Region 2		Region 3		Region 4		Region 5		Region 6		State	
	1956-57	1983-84	1956-57	1983-84	1956-57	1983-84	1956-57	1983-84	1956-57	1983-84	1956-57	1983-84	1956-57	1983-84
1. Bajra	18	42	191	757	155	984	180	655	2	15	-	4	546	2457
2. Jowar	6	3	1	5	21	48	55	163	1	29	131	343	215	591
3. Maize	1	1	-	-	7	34	81	263	186	504	54	424	329	1229
4. Wheat	218	613	34	81	152	358	487	1496	119	331	326	573	1336	3452
5. Barley	52	5	3	2	89	39	440	291	94	76	43	19	721	432
6. Rice	2	59	-	-	1	-	2	11	78	106	4	41	87	217
7. Small millets	-	-	-	-	3	1	1	1	25	21	1	-	30	22
8. Gram	340	313	6	57	77	57	577	435	74	69	116	158	1190	1089
9. Other pulses	17	14	172	219	104	115	89	97	9	67	5	58	396	570
10. Sesamum	1	-	14	3	34	20	26	9	13	9	4	25	92	66
11. Rape and mustard	18	95	-	27	7	112	82	356	5	32	-	26	112	648
12. Groundnut	-	2	-	4	-	6	18	91	4	9	39	62	39	174
13. Other Oilseeds	-	-	-	-	-	1	3	25	-	1	45	20	45	47
14. Sugarcane	83	366	-	12	5	9	222	260	185	270	690	568	690	1485
15. Chillies	-	1	-	9	-	3	-	10	-	2	-	5	-	30
16. Cotton	75	473	1	7	6	27	51	47	8	18	166	7	166	579

Source : Statistical Abstract, Rajasthan.

Table 3.23-B : Yield of Major Crops in Rajasthan in 1956-57
(Yield in kg.per hectare)

Crops	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	State
Bajri	104	104	132	324	111	-	145
Jowar	240	20	112	179	67	487	252
Maize	1000	-	350	479	873	551	657
Wheat	1211	56	788	1094	1044	881	986
Barley	929	4000	1459	1212	1362	1265	1230
Rice	667	-	-	400	1000	571	935
Small Millets	-	-	333	333	410	500	400
Gram	969	273	448	810	679	655	771
Other Kharif Pulses	159	213	149	253	400	87	195
Tur	-	-	1000	267	1000	-	316
Other Rabi Pulses	-	-	-	667	-	375	417
Sesamum	250	209	177	191	245	148	192
Rape and Mustard	439	-	333	434	417	-	421
Linseed	-	-	-	200	-	309	296
Groundnut	-	-	-	563	571	607	574
Castorseed	-	-	-	-	-	-	-
Sugarcane	20750	-	-	20182	20556	19500	20294
Cotton	190	180	108	164	58	75	134

Table 3.23=C : Yield of Major Crops in Rajasthan in 1983-84

Crop	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	State
Bajri	471	306	630	780	491	491	491
Jowar	600	292	356	406	652	897	600
Maize	1376	1371	940	1192	1337	1655	1376
Wheat	1896	1195	1296	1690	1498	1463	1594
Barley	534	1480	1456	1557	1453	1249	1481
Rice	2825	1345	1365	1218	1055	1385	1358
Small Millets	500	333	301	1428	490	522	493
Gram	574	298	381	767	667	658	606
Other Kharif Pulses	268	241	239	524	647	437	298
Tur	481	462	187	528	601	273	503
Other Rabi Pulses	997	486	667	761	783	592	701
Sesamum	171	64	140	186	267	235	173
Rape and Mustard	858	630	566	882	1007	791	791
Linseed	476	505	510	581	335	437	504
Groundnut	948	949	643	863	818	1199	949
Castorseed	556	131	251	59	225	300	194
Sugarcane	60701	44178	44177	45242	37640	40024	44179
Chillies	986	4766	717	849	496	648	971
Cotton	259	237	257	161	145	98	237

Source : Statistical Abstract, Rajasthan.

Table 3.2 : Districtwise Gross Value of Agricultural Produce in Rajasthan

District	Gross value of agricultural produce 1983-84 (Rs.)		District Index *	Growth Index †
	Per Hec-tare	Per Agri-cultural worker		
Ganganagar	2600	11693	161	128
Bikaner	750	5428	47	240
Jaisalmer	650	4211	40	90
Barmer	444	2415	28	93
Jodhpur	765	2918	47	141
Churu	534	2706	33	167
Jhunjhunu	1303	3335	81	233
Sikar	965	2524	60	210
Nagaur	1008	3022	63	185
Jalore	1114	4017	69	140
Pali	1404	3652	87	112
Alwar	2609	5432	162	146
Jaipur	1710	3136	106	121
Ajmer	1286	2171	80	86
Dholpur	3400	-	211	-
Bharatpur	2669	3429	166	129
S. Madhopur	2993	5564	186	190
Tonk	1579	4264	98	108
Bhilwara	1946	2337	121	112
Sirohi	2164	5706	134	185
Udaipur	2217	2433	133	92
Dungarpur	2480	3196	154	115
Banswara	1937	3031	120	102
Bundi	2077	4862	129	105
Chittorgarh	2433	3582	151	154
Kota	2180	5860	135	135
Jhalawar	1639	2886	102	83
State	1612	4241	100	129

* District-level average per hectare gross value of agricultural produce with state average as 100.

† Gross value of agricultural produce in 1983-84 at constant prices with 1956-57 as 100.

Source : Computed using data from Statistical Abstract, Rajasthan.

Table 3.25 : Contribution of Yield and Cropping Pattern in the Growth of Agricultural Productivity

(Figs. in (Rs.))

Sub-Region	1953-57 to 1962-66				1962-66 to 1972-76			
	Yield	Cropping pattern	Inter-actions	Total	Yield	Cropping pattern	Inter-actions	Total
1	-51.61 (-121.2)	8.03 (19.0)	1.20 (2.2)	-42.38 (-100.0)	163.54 (83.3)	24.02 (12.2)	8.86 (4.5)	196.42 (100.0)
2A	7.19 (116.5)	-0.14 (-2.2)	-0.88 (-14.3)	6.17 (100.0)	0.50 (15.8)	3.62 (114.6)	-0.96 (-30.4)	3.16 (100.0)
2B	-1.94 (-65.3)	-2.22 (-74.7)	1.19 (40.0)	-2.97 (-100.0)	10.45 (31.8)	15.02 (45.7)	7.43 (22.5)	32.90 (100.0)
3A	-14.65 (-81.0)	-6.85 (-37.9)	3.41 (18.9)	-13.09 (-100.0)	8.84 (30.3)	14.86 (51.0)	5.44 (18.7)	29.14 (100.0)
3B	6.30 (38.3)	13.50 (82.0)	-3.34 (-20.3)	16.46 (100.0)	48.84 (64.4)	24.85 (32.8)	2.11 (2.8)	75.80 (100.0)
4	-17.85 (-1821.4)	7.68 (783.7)	9.19 (937.7)	-0.98 (-100.0)	13.72 (119.7)	-0.06 (-0.5)	-2.20 (-19.2)	11.46 (100.0)
5	-11.62 (-239.6)	11.85 (244.3)	-5.08 (-104.7)	-4.85 (-100.0)	94.58 (91.0)	20.12 (17.2)	2.09 (1.8)	116.79 (100.0)
All Rajasthan	-2.42 (-57.0)	-1.36 (-32.1)	-0.47 (-10.9)	-4.25 (-100.0)	38.70 (73.7)	12.00 (22.9)	1.80 (3.4)	52.50 (100.0)

Figures in bracket are percentages.

Note : Districts included in each sub-region are given on page 119.

Source : Rural Transformation in a Developing Economy, 1987, p. 123.

Table 3.26 : Irrigation potential utilization in Stage-I of Rajasthan Canal

Year	Area irrigated ('00 Ha.)						Grand Total
	Area irrigated upto km.74 of Rajasthan main canal			Area irrigated below km. 74 of Rajasthan main canal			
	Kharif	Rabi	Total	Kharif	Rabi	Total	
1951-62	0.7	13.8	14.5	-	-	-	14.5
1965-66	134.8	179.5	314.3	-	-	-	314.3
1970-71	678.4	1064.5	1742.9	-	-	-	1742.9
1975-76	1189.5	1662.2	2851.7	15.1	21.4	36.5	2888.2
1980-81	1525.2	1883.4	3408.6	67.9	124.3	192.2	3600.8
1981-82	1618.6	2133.1	3751.7	99.9	167.5	267.4	4019.1
1982-83	1714.3	2213.4	3932.7	130.9	237.0	367.9	4300.6
1983-84	1755.2	2223.5	3978.7	155.4	237.7	393.1	4371.8
1984-85	1756.7	2021.6	3778.3	165.4	213.8	379.2	4157.5
1985-86	1705.1	2465.3	4170.4	185.8	278.0	463.8	4634.2
1986-87	2020.1	2605.6	4626.7	257.8	347.9	605.7	5232.4

Source : Indira Nahar Project, CADA, Bikaner.

Table 3.27 : Area Under Principal Irrigated Crops under Rajasthan Canal

Crops	('00 Ha.)							
	1974- 75	1977- 78	1980- 81	1983- 84	1984- 85	1985- 86	1986- 87	1987- 88
<u>Kharif</u>								
Cotton	230.9	566.5	635.8	949.6	767.9	582.4	1037.5	1558.3
Pulses	15.2	3.2	35.2	12.4	15.6	22.2	13.6	12.0
Bajri	146.4	101.7	33.2	27.8	39.7	54.6	37.3	12.7
Groundnut	-	Neg.	3.3	48.8	140.6	290.3	315.0	491.7
Sugarcane	20.3	2.3	13.4	23.4	22.6	16.5	18.9	19.7
Paddy	65.6	76.3	68.8	72.0	103.0	90.7	103.9	78.9
Gauw	389.0	332.5	626.5	622.5	649.2	558.2	565.7	277.0
Vegetable	5.3	12.8	1.0	25.2	-	1.3	3.1	2.0
Fodder	28.2	29.5	45.3	61.7	77.8	82.1	76.8	55.8
Others	25.8	21.5	77.2	11.7	32.0	93.5	14.8	72.4
<u>Rabi</u>								
Wheat	499.7	754.1	644.2	1200.4	985.4	1129.9	1465.1	681.3
Gram	667.3	626.9	930.2	636.0	430.3	563.2	794.9	428.9
Mustard	329.4	322.3	286.1	466.9	654.9	805.0	543.7	460.9
Bajra and Barley	98.6	18.7	20.0	18.0	9.0	11.4	22.3	23.9
Pulses	1.3	4.5	2.7	4.3	6.8	2.6	3.2	1.6
Fodder	17.0	27.1	40.0	67.7	59.6	74.8	78.8	77.5
Vegetable	6.9	16.4	5.8	1.6	2.5	3.9	2.6	2.7
Others	34.1	9.5	45.7	53.2	74.4	57.8	43.8	24.6

Source : Indira Nahar Project, CADA, Bikaner.

Table 3.23 : Trend in Crop Productivity for Major Irrigated Crops under Rajasthan Canal

(productivity per ha. in quintal)					
Year	Cotton	Bajri	Paddy	Groundnut	Tur
<u>Kharif Crops</u>					
1974-75	8.91	-	27.50	-	-
1975-76	8.91	4.80	27.50	-	-
1976-77	8.90	7.26	29.87	-	-
1977-78	9.91	7.10	28.68	-	-
1978-79	11.34	5.12	33.52	-	-
1979-80	11.50	-	33.91	17.72	12.12
1980-81	10.41	-	20.12	16.00	10.00
1981-82	10.15	-	33.44	14.65	8.33
1982-83	11.30	-	37.63	15.10	-
1983-84	9.14	-	42.80	18.10	-
1984-85	13.33	-	40.35	18.14	-
1985-86	11.38	-	35.00	13.61	9.53
1986-87	12.74	-	-	15.93	-
<u>Rabi Crops</u>					
Year	Wheat	Gram	Mustard		
1974-75	12.71	7.36	6.22		
1975-76	14.32	9.27	3.71		
1976-77	15.96	9.72	6.81		
1977-78	16.56	10.38	6.86		
1978-79	18.40	10.60	8.10		
1979-80	18.25	8.48	6.77		
1980-81	18.25	8.20	6.20		
1981-82	19.50	7.00	8.50		
1982-83	23.80	6.55	9.71		
1983-84	13.77	6.50	10.50		
1984-85	13.32	6.15	10.45		
1985-86	20.00	8.00	12.00		
1986-87	20.39	5.64	8.35		

Source : Indira Nahar Project, CADA, Bikaner.

Table 3.29 : Net State Domestic Product of Rajasthan by
Industrial Origin at Current Prices
(Rs. in lakhs)

Year	Agriculture and allied activities *	Agriculture (including Animal Husbandry)	Total N.S.D.P.	Percentage share of agriculture etc. in total N.S.D.P.
1960-61	31444	30947	55941	55.3
1961-62	36627	36104	63114	57.2
1962-63	34189	33657	62149	54.2
1963-64	35452	34307	67815	53.7
1964-65	50798	50075	84765	59.1
1965-66	45774	44786	82533	54.3
1966-67	61716	60895	102354	59.5
1967-68	74307	73591	119050	61.8
1968-69	52063	51496	98093	52.5
1969-70	68916	68241	120386	56.7
1970-71	100845	100374	163737	61.3
1971-72	86890	86338	151744	56.9
1972-73	92214	91572	164489	55.7
1973-74	150896	150164	233858	62.9
1974-75	148367	147427	253526	58.2
1975-76	143139	142165	257630	55.2
1976-77	171708	170578	304728	56.0
1977-78	191809	190631	339988	56.1
1978-79	199905	198259	364346	54.4
1979-80	162464	160833	340120	47.3
1980-81	206922	204779	413299	49.5
1981-82	251765	249139	500056	49.8
1982-83	291096	288522	578565	49.9
1983-84	386849	384244	739791	51.9
1984-85	365132	362332	728616	49.7
1985-86 x	359556	356896	772904	46.2
1986-87 x	337734	384909	873035	44.1
1987-88 x	416680	414615	950219	43.6

* Includes Agriculture, animal husbandry, fishery, forestry and related activities.

x Provisional

N.S.D.P. = Net State Domestic Product.

Source : Publication of D.E.S., Rajasthan.

Table 3.30 : Regionwise Livestock Population in Rajasthan (1983)

Category	('00)						State
	Region 1 Northern	Region 2 Western	Region 3 Mid- Western	Region 4 Mid- Eastern	Region 5 Southern	Region 6 South- Eastern	
Bullocks	781	1445	3707	12240	10052	8245	36468
Cows in milk	1538	5049	3831	5339	2406	2941	21104
Total cows	2584	10679	7736	14303	7665	8019	50986
Per cent cows in milk	59.52	47.28	49.52	37.33	31.39	36.68	41.39
Cattle youngstock	2711	8338	7637	12308	8019	8191	47204
Per cent cows in total adult cattle	76.79	83.03	67.60	53.89	43.26	49.31	58.30
Buffaloes in milk	1206	964	2720	7277	1965	1763	15900
Total buffaloes (Females)	2051	1798	4433	14045	4794	3930	31151
Per cent buffaloes in milk	58.80	53.62	60.67	51.81	40.99	44.42	51.04
Buffalo youngstock	2088	1651	5002	11747	4037	3574	28099
Sheep	6128	49875	31732	31371	11077	4125	134308
Goat	4138	38204	32103	42206	22084	16060	154795
Camel	1165	3799	1425	741	241	138	7559
Net sown area (00 Ha.)	16148	53608	34499	34314	8919	14856	162344
Net sown area (Ha.) per pair of bullocks	41.35	74.19	18.61	5.61	1.77	3.60	8.90
Percentage share in net sown area	9.95	33.02	21.25	21.14	5.49	9.15	100.00
Percentage share in bullocks	2.14	3.96	10.17	33.56	27.56	22.61	100.00
Percentage share in camels	15.41	50.26	18.85	9.80	3.19	2.49	100.00

Source : Statistical Abstract, 1984.

Table 3.31 : Distribution of Land Holdings by Regions in Rajasthan

(Figures in per cent)

Size of Holding		Western		Southern		North-East		South-East	
		Holdings	Area	Holdings	Area	Holdings	Area	Holdings	Area
Marginal	1970-71	9.3	0.5	40.5	7.8	31.7	4.9	24.6	3.3
	1976-77	10.2	0.5	49.5	10.9	36.4	6.1	31.4	4.6
	1981-82	11.3	0.7	47.4	12.2	36.2	6.5	30.3	5.2
Small	1970-71	10.5	1.4	23.5	15.0	21.6	9.8	21.7	8.6
	1976-77	10.6	1.7	21.4	17.1	21.5	11.3	27.2	10.1
	1981-82	11.0	1.9	23.9	19.4	22.8	12.3	23.9	11.8
Semi-Medium	1970-71	16.9	4.5	20.6	26.6	22.5	20.4	24.1	18.7
	1976-77	17.8	5.5	18.0	28.3	21.1	22.2	22.6	21.0
	1981-82	18.0	5.9	18.9	29.9	21.4	23.1	24.0	22.5
Size of Holding		Western		Southern		North-East		South-East	
		Holdings	Area	Holdings	Area	Holdings	Area	Holdings	Area
Medium	1970-71	28.3	16.8	13.2	34.5	18.7	35.6	22.8	38.2
	1976-77	30.8	21.5	9.8	31.9	16.3	36.3	19.9	40.0
	1981-82	30.8	22.6	8.8	29.1	15.7	35.7	18.3	40.9
Large	1970-71	34.9	76.8	2.2	16.8	5.5	29.2	6.9	31.2
	1976-77	30.6	70.8	1.3	11.8	4.7	24.0	4.9	24.3
	1981-82	28.8	68.9	1.0	9.3	3.9	22.4	3.4	16.6
Coefficient of Concentration	1970-71	0.47		0.53		0.54		0.53	
	1976-77	0.47		0.54		0.54		0.49	
	1981-82	0.47		0.51		0.53		0.51	
Average Holding Size (ha)	1970-71	10.99		2.24		3.18		3.70	
	1976-77	9.44		1.78		2.71		3.52	
	1981-82	8.92		1.74		2.64		3.00	

Source : Agricultural Census, Rajasthan.

Table 3.32 : Productivity of Milch Animals in Rajasthan by region

Region	Per cent of animals in milk		Milk yield per animal per day (lts.)	
	Cows	Buffaloes	Cows	Buffaloes
Western	62	64	2.8	4.3
North-East	52	63	1.9	3.3
South	45	52	0.9	1.8
South-East	47	50	1.0	1.9
State	52	59	1.9	3.0

Source : N.S.S. Report No. 281/11.

Table 3.33 : Growth in Livestock Population in Rajasthan

Category	('00)				
	1961	1965	1972	1977	1983
Bullocks	40766	40918	40404	40085	36468
Cows in milk	27268	18253	20485	20565	21104
Total cows	48773	48001	46120	48620	50986
Per cent cows in milk	55.91	38.03	44.42	42.30	41.39
Cattle youngstock	46023	42315	39170	40258	47204
Per cent cows in total adult cattle	54.47	53.98	53.30	54.82	58.30
Buffaloes in milk	14043	10358	12074	13508	15900
Total buffaloes	20215	21444	24919	27849	31151
Per cent buffaloes in milk	69.47	48.30	48.45	48.51	51.04
Buffalo youngstock	20236	19241	19541	20968	28099
Sheep	83430	89062	85563	99380	134308
Goat	74011	103234	111624	123069	154795
Camel	6021	6535	7445	7520	7559

Source : Statistical Abstracts

Table 3.34 : Growth in Annual Milk production in Rajasthan

Year	Quantity in 000 tonnes
1970-71	2300
1971-72	2410
1972-73	2430
1973-74	2370
1974-75	2500
1975-76	2560
1976-77	2600
1977-78	3100
1978-79	3175
1979-80	3150
1980-81	3250
1981-82	3300
1982-83	3400
1983-84	3500
1984-85	3500
1985-86	3650

Source : Dairying in India, 1988

Table 3.35 : Milch Animals and Milk Production in 1972 and 1983

Year	Cows (in 000)		Buffaloes in 000)		Milk per day per animal in milk (kg)		Estimated milk produc- tion (lakh tonnes)	
	In milk	Total	In milk	Total	Cow	Buffaloe	Cow	Buffaloes
1972	2048	4612	1273	2492	1.95	2.93	14.6	13.6
1983	2110	5098	1590	3115	2.53	3.38	19.5	19.6

Source : Statistical Abstract, Animal Husbandry Department,
Rajasthan.

Table 3.35-A : Districtwise Sheep and Goat Population and Wool Quality in Rajasthan

District	Sheep population '00 (1983)	Sheep Breeds	Quality of wool	Goat population '00 (1983)
Ganganagar	6128	Nali	M	4138
Bikaner	10789	Nagra + Pungal	M	3956
Jaisalmer	8763	Jaisalmeri	M	4167
Barmer	11573	Marwari	M	13346
Jodhpur	11468	Marwari	M	8350
Churu	7282	Chokla + Nali	F	8386
Jhunjhunu	2360	Nali	F + M	5237
Sikar	4167	Chokla + Nali	F	7660
Nagaur	12262	Chokla	F + M	9762
Jalore	5335	Marwari	M	4009
Pali	7608	Marwari	M	5435
Sirohi	1902	Marwari	M	2505
Alwar	1525	Malpura	M	5840
Ajmer	7752	Malpura	C	5218
Jaipur	5215	Malpura	F + M	9925
Bharatpur	1011	Malpura	M	2250
Dholpur	153	-	-	1261
S. Madhopur	1696	Malpura	M	6280
Tonk	4490	Malpura	C	3912
Bhilwara	9527	Sonadi	M + C	7522
Udaipur	6626	Sonadi	M + C	13501
Chittorgarh	2066	Sonadi	C	5478
Bundi	1244	-	-	3644
Banswara	277	Sonadi	C	3057
Jhalawar	266	Sonadi	C	2833
Kota	548	Sonadi	C	4105
Dungarpur	2272	Sonadi	C	3020
Total	134305			154797

C = Coarse.

M = Medium.

F = Fine.

Table 3.36-B : Regional Distribution of Sheep and Goat Population

Region	Per cent share in sheep popula- tion (1972)	Per cent share in wool pro- duction (1972)	Per cent share in sheep popu- lation (1983)	Per cent share in wool pro- duction (1983)	Per cent share in goat popu- lation (1983)
1. Northern	3.3	6.2	4.6	9.1	2.6
2. Western	27.9	34.8	37.1	43.1	24.7
3. Midwestern	29.1	28.2	23.6	20.9	20.7
4. Mideastern	26.1	19.9	23.4	18.1	27.3
5. Southern	9.3	8.8	8.2	6.8	14.3
6. Southeastern	4.3	2.1	3.1	2.0	10.4

Source : (1) Sheep in Rajasthan, CAZRI, 1981.

(2) Statistical Abstract, Animal Husbandry Department, Rajasthan, 1987-88

Table 3.37 : Distribution of Sheep Breeds in Rajasthan

Breed	Location	Sheep characteristics	Quality of wool	Average produce per year (kg.) per sheep
Marwari	Barmer, Jalore, Sirohi, Pali, Ajmer, Jodhpur (excluding Phalodi tehsil), Parbatsar, Merta and part of Didwana and Nawa tehsils of Nagaur.	Black faced, stocky and medium built, adult males weighing on an average 45 kgs. This is a highly stabilised breed, capable of undertaking long journeys and possessing high resistance to diseases and worms.	M, C	1-2
Sonadi	E. Udaipur, Dungarpur, Banswara, Chittorgarh, E. Bhilwara, Bundi, Kota and Jhalawar	Appears light brown in colour, weighing more than 60 kgs; withstands heavy rainfall and can walk through hilly areas.	C	.75-1.0
Malpura	Alwar, Bharatpur, Sawai Madhopur, Tonk and Jaipur (excluding N.W. adjacent to Sikar and Nagaur).	Appears almost completely white; weighs about 30 kgs.	C	.75-1.0
Chokla	Sikar and Southern Churu, Jhunjhunu, Nagaur	Very light built, weighing about 26 kgs.	F, M	1-2
Nali	Ganganagar, Jhunjhunu, N. Churu	Light brown faced, weighing about 35 kgs.	M	1.5-3.0
Jaisalmeri	Jaisalmer tehsil.	Brown and black faced, weighing about 45 kgs.	M	2-3.5
Magra	Borders of Jaisalmer, Nagaur, Bikaner	Good built, weighing about 35 kgs.	M	1.5-2.0
Pungal	Bikaner tehsil	Well built, weighing about 30 kgs.	M, C	1.5-2.0

F = Fine. M = Medium. C = Coarse.

Source : Sheep in Rajasthan, CAZRI, 1981.

Table 3.38 : Lactation Yield and Length of Important Indigenous Goat Breeds

Breed	Main products	Lactation yield (kg.)	Lactation length (days)	Body weight (12 months) (kg.)
Jamunapari	M + Mt	202	191	20.2
Jhakrana	M + Mt	136	210	13.0
Barbari	M + Mt	107	150	16.8
Marwari	M + Mt	97	168	16.2
Sirohi	M + Mt	77	157	19.3

M = Milk

Mt = Mutton

Source : Animal productivity, 1989.

Table 3.39 : Yearwise Production of Fodder from Principal Crops in Rajasthan (in tonne)

Year	Rice (paddy)	Jowar	Bajra	Maize	Wheat	Gram	Kharif pulses	Total fodder
1956-57	0.87	6.45	21.84	4.93	26.74	3.57	1.17	65.57
1957-58	0.21	9.72	32.24	5.43	16.80	1.76	0.94	67.10
1958-59	0.87	10.23	39.24	8.11	20.92	3.40	3.08	83.85
1959-60	1.17	9.84	40.28	7.87	21.04	2.36	1.11	83.67
1960-61	0.65	6.12	29.36	9.73	20.20	2.75	0.81	69.62
1961-62	0.89	9.30	42.92	10.57	24.46	3.00	1.24	92.38
1962-63	1.00	12.54	38.24	11.55	20.78	2.29	1.17	87.57
1963-64	1.29	8.19	32.84	9.00	17.32	1.62	0.85	71.11
1964-65	0.98	12.30	50.84	11.70	22.05	2.16	1.22	101.26
1965-66	0.24	8.76	37.60	9.63	15.70	1.24	0.80	13.97
1966-67	0.22	10.38	49.12	9.21	17.44	1.55	0.77	83.69
1967-68	0.95	12.84	56.92	15.39	26.38	3.14	1.35	116.97
1968-69	0.57	6.03	17.92	6.34	23.50	1.54	0.44	56.34
1969-70	0.99	11.76	32.04	7.75	25.16	2.31	0.95	80.96
1970-71	1.35	17.19	107.04	13.95	39.02	3.58	1.70	183.83
1971-72	1.59	7.59	54.53	11.26	37.76	2.65	1.24	116.62
1972-73	0.80	9.23	34.55	9.92	35.07	2.41	0.52	92.50
1973-74	1.18	11.72	87.49	5.15	35.81	2.15	1.64	145.14
1974-75	1.00	9.38	16.98	7.08	36.39	2.39	0.43	73.65

Source : Perspective plan for Rajasthan, 1974-1989, Vol. II, NCAER, 1980.

Table 3.40 : Fodder production and requirement in Rajasthan (1983)

Region	Geographical area (00 Ha.)	Forest/pasture fallow/waste land (00 Ha.)	Estimated * fodder supply (00 tonnes)	Per cent share of crop residue	Total cattle units (00)	Fodder availability as per cent of need
1. Northern	20630	3240	24751	71.6	10658	116.0
2. Western	133409	69203	80687	39.9	34136	118.2
3. Mid-western	54186	13972	50972	56.1	33635	75.7
4. Mid-eastern	66218	20552	85266	69.1	59501	72.5
5. Southern	33164	14405	30133	63.9	31253	48.2
6. South-eastern	34745	14650	40686	68.3	26427	77.0
State	342352	136022	313495	53.6	195670	80.0

* Includes fodder from crop residue, fodder crops and forest, pasture and other lands in a normal year in dry weight.

Source : Computed using data from Statistical Abstract, Rajasthan.

CHAPTER IV

AGRICULTURE AND ANIMAL HUSBANDRY : STATUS AND PROBLEMS IN GUJARAT

Gujarat has a long and eventful history. The historical records have revealed that during the Maitraka period (470 A.D. to 643 A.D.) the territory north of Abu was known as Gurjara Desh. The name Gujarat was recognized from 10th century A.D. during the Solanki period when Mulraja, the first Chalukyan ruler laid the foundation of his kingdom with its capital at Anhilwad Patan.

During the British period, Gujarat belonged to the much bigger Bombay province which extended from Karachi to Karnataka. The area of Gujarat was divided into the British districts of Ahmedabad, Bharuch and Panch Mahals, Kheda and Surat and a large number of native states and estates.

With the reorganization of States after Independence, the demand for separate linguistic states led to the bifurcation of the bilingual Bombay State thus bringing into existence the present State of Gujarat with 17 districts from 1st May 1960. There have been some subsequent changes in the administrative boundaries of the districts due to integration, merger, reorganization and bifurcation. For purposes of administration, Gujarat State at present comprises of 19 districts sub-divided into 134 talukas having 18275 inhabited villages and 216 towns. According to 1981 Census, Gujarat has a total population of 34 million i.e. about 5.2 per cent population of the country and in respect of population ranks 10th among the States of India.

1. Geography

Gujarat State is situated on the West coast of India between $20^{\circ}-6'$ N to $24^{\circ}-42'$ N latitude and $68^{\circ}-10'$ E to $74^{\circ}-28'$ E longitude. It is bounded by the Arabian Sea in the West, by the State of Rajasthan in the North and North-East, by Madhya Pradesh

in the East and by Maharashtra in the South and South-East. The State has an international boundary and has a common border with Pakistan at the North-western fringe.

The long coastline (over 1600 km.) with the exception of South Saurashtra is generally characterized by tidal flats and saline wastes. The West and the South coasts of Kachchh have a marshy zone with a width ranging from 10 to 13 kms. The whole Gujarat coast from the head of the Gulf of Khambhat to Valsad is irregular in outline, broken by the estuaries of the Mahi, the Tapi, the Narmada and Kim rivers. The saline marshes, locally known as 'Khar lands' are unsuitable for cultivation. The two Ranns, one north of Kachchh and the other between Kachchh and the mainland Gujarat are saline wastes.

Between the marshy coastal zone and the plateaus and the mountains in the interior, lie the plains of Gujarat drained principally by the rivers viz., Sabarmati, the Mahi, the Narmada, the Tapi and their tributaries. The plain is well demarcated by its confinement between the coastal marshes on the west and a rupture of slope on the east rising upto the mountains.

The eastern hill region consists of the out-liers of the Aravali system, the Vindhyas, the Satpudas and the Sahyadris. The highlands that encircle the State from the north, north-east and the east occupy parts of Sabarkantha, Panch Mahals, Vadodara, Bharuch, Surat and Dangs districts which constitute the forest area and the tribal region of the State.

2. Physiography

The physical features of the State indicate the following three distinct physiographic units based on relief, slope and land forms, geographical 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 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 Vindhya's, the Satpudas, and the Sahyadris. The northern region belongs to the Aravali system, while the southern section belongs to the Vindhya's, 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. The great Pavagadh peak is some 900 metres above the sea level.

(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.

Saurashtra can be physiographically divided into three parts.

1) Coastal Lands

2) The Inland Plain

3) North-eastern and South-western Highland region.

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. From 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.

Physiographically, the southern series differs considerably from the northern series. It begins in the west and the Gir hills

and stretches eastward in an irregular series of peaks and ridges and becomes dense with forests. The Goraknath peak (1117 metres) of Girnar is the highest point in the State.

(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.

3. Drainage Pattern

Although drainage pattern in Gujarat is influenced by both physio-climatic and geological factors, the surface expression of drainage in Gujarat is more by physio-climatic factors than the geological ones. Information on river basins of Gujarat is presented in Table 4.1.

Three distinct drainage areas can be delineated

(a) Gujarat Plain

(b) Saurashtra

(c) Kachchh

(a) Gujarat Plain: The Gujarat Plain can be sub-divided into two parts (i) the drainage of the north-western part that culminates in the Little Rann of Kachchh and (ii) the drainage of the Gulf of Khambat.

The rivers of the north-western Gujarat Plain viz., the

Banas, the Saraswati and the Rupen take their sources from the foothills of Aravalis and flow from north-east to south-west direction parallel to each other and discharge their waters in the Little Rann of Kachchh.

In the Central Gujarat, the rivers Sabarmati, the Meshwo and the Mahi debouch in the head of the Gulf of Khambhat.

To the South, the Narmada and the Tapi occupy structural troughs. These rivers originate much beyond the borders of Gujarat State. South of the Tapi, the Ambica and the Par are much like the streams of western coast adjoining the Western Ghats. They are short and turbulent and often dry in summer. Most of the rivers have formed very broad estuaries and as the strong currents in the Gulf of Khambhat wash away the silts, they do not have any significant deltaic formation.

(b) Saurashtra: Saurashtra is marked by a radial drainage pattern. The drainage pattern is controlled by the Rajkot hills (383 metres) and Girnar ranges (728 metres). A few rivers from the region flow towards north and debouch in the Gulf of Kachchh, the important among them being the Dami, the Machhu and the Bambhan. Southern coast of Saurashtra receives quite a few important streams like the Bhadar-Ozat, the Shetrunji, the Kalubhar, the Ghelo, the Bhadar and the Bhogawo.

(c) Kachchh: In Kachchh, the drainage development is still in transition. On the northern side of the Central highland, a meagre development of drainage network is marked. Streams are few and intermittent. The southern slopes of the central highland have a few streams flowing into the Gulf of Kachchh. The important streams are the Khasi and the Bhukhi. These are small and seasonal and also dry for most part of the year.

4. 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. The State can be broadly divided into five regions for this purpose.

- i) Sub-humid South Gujarat
- ii) Moderately humid Gujarat from the Narmada to Sabarmati
- iii) Humid and sultry Saurashtra coastal region facing South
- iv) Dry region of Central Gujarat north of Ahmedabad and Central Saurashtra
- v) Arid and semi-arid north Gujarat and Kachchh.

Districtwise normal rainfall and rainfall for the period 1930 to 1938 is presented in Table 4.2.

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.

From the point of reliability of the rainfall, Gujarat can be divided into five zones according to the coefficient of variability of annual rainfall. On the whole the reliability of rainfall is on the lower side, the coefficient of variability varying between less than 35 per cent to over 60 per cent.

i) Exceptionally low reliability of rainfall exists in north-western parts of Kachchh district and parts of coastal areas of Jamnagar and Junagadh districts. The coefficient of variability is over 60 per cent.

ii) Extremely low reliability of rainfall is experienced in south-eastern parts of Kachchh, entire Banaskantha district, northern strip of Mahesana, most of Jamnagar district and west-coastal strip of Junagadh district. The coefficient of variability is between 50 per cent and 60 per cent.

iii) Very low reliability of rainfall with a coefficient of variability ranging between 40 per cent and 50 per cent is experienced in most of Sabarkantha, Mahesana districts, entire Gandhinagar and northern half of Ahmedabad and Surendranagar districts, western half of Rajkot, eastern half of Junagadh and southern half of Bhavnagar districts.

iv) Reasonable degree of reliability of rainfall with a moderate coefficient of variability ranging between 35 per cent and 40 per cent is experienced in south-eastern part of Sabarkantha, most of Kheda, southern half of Ahmedabad and Surendranagar, eastern half of Rajkot, northern half of Bhavnagar, entire Amreli and Bharuch districts and western half of Vadodara district.

v) Assured rainfall with a low coefficient of variability of less than 35 per cent is experienced in Panch Mahals, Surat, Dangs and Valsad districts and eastern half of Vadodara district.

Correspondingly, areas with a high coefficient of variability of rainfall are in acute need of some irrigation facilities for stable agriculture. Drinking water problems are also acute in many parts of these regions.

5. 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 Mehsana 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 32 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.

6. 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 fluorite, lignite and bauxite have raised the States importance on the mineral map of the country.

7. 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. This is much below 33 per cent which is the proportion prescribed under the National Forest Policy. Of the total area under forest, 65 per cent is classified as reserved forests, 6 per cent under 'protected' forests and 29 per cent under unclassified forests.

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 wide variations in the climate and topography in the State have resulted in various types of forest growth. 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 type of forest growth ranges from pure desert condition in Kachchh and north-east Gujarat to moist deciduous forest in Dangs. The forests of the State can be classified into four main types:

- (i) Moist Deciduous
- (ii) Dry Mixed Deciduous
- (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

district 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, temburni, 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.

8. Demographic Characteristics

According to 1981 Census, with its 34 million population, Gujarat ranks tenth among the States of India in respect of population. The decennial growth rate of population between 1971 and 1981 was somewhat lower (27.21 per cent) than the previous decade (29.39 per cent) but was higher than the All India growth rate of 24.43 per cent. Average density of population in 1981 was 173 persons per sq.km. for the State as a whole as against the all India density of 221 persons per sq.km. The density varied from less than 20 for Kachchh and less than 60 for Dangs which are the sparsely populated districts to around 350 for thickly populated districts of Ahmedabad and Kheda.

Broad characteristics of population are presented in Table 4.3.

Level of literacy for Gujarat was higher at 43.30 per cent as compared to the average level of literacy for country as a whole (36.17 per cent). So also the number of women per 1000 males was higher for Gujarat at 942 as compared to 935 for country as a whole. There is a large variation in literacy levels both between men and women as between different districts of the State, highest being 65.47 per cent among males of Ahmedabad district and lowest being 11.36 per cent for females in Banaskantha district.

A large majority of the population of the State (68.90) lives in rural areas in 18114 inhabited villages of varying sizes. Banaskantha, Sabarkantha, Panch Mahals and Dangs are more or less wholly rural districts of the State while Ahmedabad, Surat, Rajkot, Vadodara and Jamnagar are relatively more urbanized districts in the State; Ahmedabad being the most urbanized district with 72 per cent of its population living in urban areas.

About a quarter of the inhabited villages are small villages with population of less than 500 persons. The medium size-group of villages accounted for 55.56 per cent of total inhabited villages and 46.04 per cent of the total rural population of the State in 1981. The average rural population per inhabited village comes to about 1296.

About half of the urban population of the State in 1981 is accounted by the eleven class I cities of population size of 100,000 and over, and the rest half is distributed among 244 towns in the State, one-third of which are concentrated in the size class with average population between 10,000 and 19,999. Thus although the sizes of both villages and towns are growing over years, Gujarat State is even today a State with large villages and small and medium towns.

Scheduled castes and scheduled tribes together account for over a fifth of the total population of Gujarat in 1981. Their proportions vary considerably between different districts. In Surendranagar, Kachchh, Banaskantha and Ahmedabad, scheduled caste population accounts for over 10 per cent of total population in the district. The six districts viz. Panch Mahals, Vadodara, Bharuch, Surat, Valsad and Dangs with the Aravali, Vindhya and Sahyadri ranges running through their eastern parts house most of the tribal population of the State. The proportion of tribal population to total population ranges between 25.35 per cent for Vadodara and 92.31 per cent for Dangs.

Economic characteristics of population of Gujarat are presented in Table 4.4.

Proportion of main workers to total population works out to be 32.23 per cent. However there is considerable difference in the rates of labour participation for men and women. The proportion of male main workers to male population is 52.19 per cent while the proportion of female main workers to female population is only 11.03 per cent. There is not much of inter-district variation in participation rates for both men and women.

More than 37 per cent of the main workers in Gujarat are cultivators and 22.65 per cent are agricultural labours. There is a large variation in between the districts ranging between 11.55 per cent for Ahmedabad district and around 60 per cent or more for Dangs, Panch Mahals and Banaskantha districts.

There is not much of inter-district variation in the proportion of agricultural labourers except that it is quite low for Panch Mahals, Ahmedabad and Jamnagar and relatively high for Vadodara and Bharuch.

There is also not much of inter-district variation in the proportion workers engaged in household industry which stands at around 2.5 per cent for the State as a whole. However, there is wide inter-district variation in the proportion of main workers engaged in activities other than three specified activities viz. cultivation, agricultural labour and household industry. The proportion of 'other workers' to main workers varies widely from 15-16 per cent in the tribal districts of Panch Mahals and Dangs to 72 per cent in the highly industrialized district of Ahmedabad.

Table 4.5 presents districtwise information on number of working factories and average daily employment in Gujarat for 1961 and 1981.

The number of working factories has become threefold in 1981 over 1961 and the increase in average daily employment is

about 85 per cent. Ahmedabad is, by far, the most industrialized district accounting for around 25-30 per cent of the working factories and 40-45 per cent of the average daily employment both in 1961 and in 1981. In 1931, Ahmedabad and Vadodara are the major industrial districts having 21.78 and 10.42 per cent of the main workers employed in factories.

Tables 4.6 and 4.7 present the economic characteristics of the scheduled caste and scheduled tribes population of Gujarat. The overall rate of participation for scheduled caste population is 31.43 per cent and for scheduled tribes it is 40.55 per cent. The proportion of agricultural labourers in the total main workers in the State is 22.65 per cent while it is 41.21 per cent for scheduled castes and 40.10 per cent for scheduled tribes. The proportion of cultivators in the total main workers in the State is 37.46 per cent while it was 15.99 per cent for scheduled castes and 45.94 per cent for scheduled tribes. The proportion of main workers in household industry is significantly higher for scheduled castes as compared to scheduled tribes and general population of the State.

9. State Domestic Product and Per Capita Income

State Domestic Product (SDP) and per capita SDP at 1970-71 prices for the period 1960-61 to 1987-88 is presented in Table 4.8.

Gujarat State had a total State Domestic Product of Rs.1406 crores in 1960-61 and it increased, in real terms, to Rs.3308 crores, in 1987-88 giving an average annual rate of growth of about 5.0 per cent over the period which is somewhat higher than the rate of growth of Net National Product over the same period. The per capita income in the State increased, at 1970-71 prices from Rs. 689 to Rs. 853 in 1987-88 giving an average annual rate of growth of 1.0 per cent. If we take out the last three years (1985-1988) as particularly bad years for the Gujarat economy because of the general drought conditions the rate of growth for

SDP and per capita income would work out to be 6.0 per cent and 1.6 per cent respectively.

Table 4.9 presents the information on State Domestic Product by Industry Groups at 1970-71 prices for the recent period.

The contribution of the primary sector is declining in real terms and if we take out the last three years which were agriculturally poor years for the State, primary sector currently contributes more than a third to the SDP and secondary sector contributes a little over a quarter. The contribution of services, particularly economic and financial services is steadily increasing. However, primary production is still the mainstay for the State economy.

10. 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.

There is increase in area under forest as well as in the proportion of total land under forest. 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 reduction in the permanent pastures and grazing lands which is also probably brought under the plough or have become waste lands. There is substantial increase in the cultivable wasteland indicating deterioration in the land resources of the State.

The forest area in Gujarat is concentrated in the hilly parts of the State. Junagadh in Saurashtra and the hilly parts on the north-eastern and eastern rim of the State starting from north and north-east with Sabarkantha; Panch Mahals down to eastern parts of Vadodara, Bharuch, Surat and Valsad districts and the whole of Dangs constitute the forest area of the State. Saurashtra districts have some land under permanent pasture but most of the mainland

districts have only a very small proportion of land under pastures.

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 is uncultivable and another 35 per cent as wasteland, is taken out, the proportion of net sown area is 62.54 per cent. As such there is little, if any, margin for extension of cultivation in the State.

From Table 4.9, it is clear that 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 in 1983-84. It is evident that 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.

Growth in population, difficulties in further extension of cultivation and dependence on agriculture for employment have their reflection on the average size of landholding in the State. Information on the average size of landholding in different districts in 1970-71 and 1976-77 is presented in Table 4.12.

The average size of holding in Gujarat was 4.11 hectares in 1971 and decreased to 3.71 hectares in 1976. The trend is experienced uniformly in all the districts although there are differences in the extent to which the average size of holding has decreased.

There is, correspondingly, a marked deterioration in the man-land ratio in the State. Columns 3 and 4 of Table 4.10 indicate man-land ratios (hectare per person) calculated on the basis of Reported Area in land-utilization and columns 5 and 6 indicate man-land ratios calculated on the basis of Reported land

exclusive of forest and barren and uncultivable wasteland. For Dangs, the ratios on the basis of Reported Land are more realistic as the net-sown area in Dangs is included in forest and thus gets excluded in the ratios presented in columns 5 and 6; for other districts ratios in columns 5 and 6 are more realistic. The man-land ratios have uniformly deteriorated in all the districts of the State.

The operational holdings in Gujarat are typically small in size. Information on distribution of operated holdings by different size classes for 1976-77 and 1980-81 is presented in Table 4.13.

About a quarter of total number of operational landholdings were of less than a hectare in size both in 1976-77 and in 1980-81. Sixty-eight per cent in 1976-77 and 70.8 per cent in 1980-81 were below four hectares. If we examine the proportion of land operated in small operational holdings, it is clear that over years more and more land is being parcelled into small operational holdings in the State.

11. 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.

Progress during the Five Year Plans: Highest priority was accorded to irrigation sector right from the inception of the plans. Planwise position in respect of major and medium schemes taken upto the end of Sixth Plan is presented in Table 4.14. The

physical achievements by way of creation of irrigation potential and levels of utilization in the various plan periods commencing from the First Five Year Plan are presented in Table 4.15.

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.

Low priority has been given to minor irrigation such as percolation tanks, nala-bunding and contour bunding, and around 10 to 15 per cent of total outlay on irrigation gets allotted to minor irrigation.

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; they were 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 BC ratio on paper. For example, in the case of Mahi Right Bank Canal (MRBC) out of a total command area of 1.86 lakh hectares, it is difficult to carry out any on-farm development in about 0.52 lakh hectares, yet the area is included in the command area (Ibid., p. 32).

Minor irrigation works often do not directly create irrigation potential (percolation tanks, etc.) to offset the costs.

However, 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, the normal levels of utilization being much below these levels. 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).

Unpredictability of rains is also a major reason for low utilization levels in the kharif season.

Construction of field channels is delayed because of paucity of funds with the farmers, problems of consolidation of holdings, land levelling, etc.

Groundwater Resources: The surface irrigation projects of major and medium categories in Gujarat (except Narmada) have either been completed or are in progress and almost all surface water resources (except Narmada) have already been tapped. At present, substantial quantity of groundwater is being extracted to support irrigation, industry and drinking water needs of the people.

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). An area of 1,09,304 sq.km. is covered by hard rock formations. Thus an area of 1,60,984 sq.km. i.e. 82 per cent of total geographical area or the entire State excluding the Rann area is such where groundwater potentials could be looked for and investigated.

The groundwater investigation in Gujarat started in 1918 in the alluvial tracts of the State. A detailed groundwater investigation was done in Mehesana 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.

On the basis of investigations done so far the State can be divided into three distinct hydrological groups.

- 1) Eastern Hilly Tract
- 2) Saurashtra and Kachchh
- 3) Alluvial Tract

The eastern hilly tract occupies the north-eastern, eastern and southern rims of the State. The area is highly undulating and major rainfall goes as runoff from the area. The groundwater accumulates only in secondary porosity like zone of weathering, joint planes, grades and fissures. The water levels in this tract range between four and ten metres below the ground level.

The western part of Gujarat is mainly occupied by Deccan trap rocks in Saurashtra, south Gujarat and Kachchh region. These rocks yield moderate quantities of groundwater through open wells. There is a wide variation in the groundwater yield factors of the trap rocks, since it largely depends on the degree of weathering and saturated thickness of the formation. The water level in this formation varies between 10 and 25 metres below the ground level.

The alluvial deposit extends from Banaskantha in the north to Valsad in the south. The deposits consisting of well sorted fine to coarse grain material, this formation yields large quantities of groundwater in wells and tubewells. The water levels in the alluvial deposits vary from five metres to 35 metres below ground level.

Generally it could be stated that the quality of groundwater from recharge areas drawn to the central alluvial zones is within suitable limits for irrigation but the quality of groundwater starts deteriorating west-ward i.e. towards discharge areas where the quality of water in upper aquifers is brackish and lower

aquifers yield better quality groundwater. In these areas tubewells are envisaged by tapping deep confined aquifers only

Under systematic micro-level groundwater investigation started since 1970 in Gujarat, an area of 1,20,000 sq.km. was covered till June 1985 and remaining 40,984 sq.km. is to be covered during Seventh Plan period to bring the status of coverage to 100 per cent.

Geophysical surveys have also been carried out in an area of 42,454 sq.km. including hard rock areas and coastal areas of Saurashtra and Kachchh for identification of suitable sites for drilling of tubewells and effects of sea water ingress respectively. Recently, efforts have been initiated for identifying areas of worthy of groundwater development in hard rock areas with the help of aerial photographs. Periodical reassessment of groundwater resources work has to be done continuously.

The total dynamic groundwater resources from the unconfined aquifers in Gujarat are estimated at 20,376.9 MCM/yr and the utilizable groundwater resources for irrigation are estimated at 17,320.4 mcm/yr (EGRIP, 1986, p. 70).

In addition, total groundwater resources of 2174.97 mcm/yr and utilizable groundwater resources (for irrigation) of 1848.72 MCM/yr are estimated from confined and semi-confined aquifers in alluvium and semi-consolidated rocks. The depth to which these resources are evaluated varied from 110 to 180 m (Ibid., p. 8).

In five talukas of Gujarat viz. Kodinac (Amreli), Mangrol (Junagarh), Mahesana, Sidhpur and Patan (Mahesana) the overall annual draft exceeds recharge and these talukas are over-exploited talukas. Groundwater development level is over 85 per cent (critical taluka) in Veraval in Junagarh district and in 13 talukas the level of groundwater development varies between 65 per cent and 85 per cent (semi-critical talukas); they are Kunkawav and Sefrabad in Amreli; Ranavav, Visavadar, Porbunder and Maliya in

Junagarh; Morbi, Lodhika Paddhari and Rajkot in Rajkot and Bhanvad in Jamnagar district (Ibid., p. 8).

Mahesana district has received the attention of hydrologists and hydrogeologists during the past three decades on account of continuous declines of water levels in the phreatic (unconfined) as well as confined/semi-confined aquifers. The decline in phreatic aquifer ranged from 1 to 21 metres during the period 1966 to 1981. The maximum decline was recorded from the area near Visnagar town. However, in the eastern part of Mahesana the water levels in phreatic aquifer have risen by 1 to 5 metres between 1981 and 1984 due to additional recharge from Dharoi canal system by way of canal seepage and recycled irrigation water as well as by almost 10 per cent reduction in groundwater draft by wells in the canal command area.

The overall level of development for the confined and semi-confined aquifers in alluvium and semi-consolidated rocks is around 85 per cent in Ahmedabad, Gandhinagar, Sabarkantha and Mahesana districts although locally it may be somewhat higher. In Surendranagar district, the level of development in the potential aquifers is around 72 per cent. In the districts of Vadodara, Bharuch, Banaskantha, Kheda and Kachchh the level of development of the potential confined aquifers is much less. In the remaining districts of Gujarat the groundwater potential available in the deeper aquifers is either very meagre or waters are too saline to be of any use.

Information on groundwater potential of Gujarat is presented in Table 4.16. 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.

	<u>Unconfined aquifer</u>	<u>Confined and Semi-confined aquifer</u>
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 pumpsets in 1984. According to the estimates of the Group, 3.51 lakh wells with pumpsets can be added to the existing number. (Ibid., p. 14).

The present rate of development is of the order of about 4,000 wells per year and at this rate it may take over 200 years to have full development of groundwater. The Group has, therefore, recommended that adequate subsidies towards capital cost are to be provided to the farmers.

The Group estimated the then average cost of construction of an open well with pumpset to be around Rs.25000 (if not higher) which can irrigate about 2 hectares on an average. Investment per hectare works out to be around 12.5 thousand which is beyond the means of most farmers. For flow irrigation scheme, the investment is Rs.25000 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 farmer getting the advantage of flow irrigation is thus heavily subsidized in setting up the facility and subsequent maintenance.

Besides, irrigation supplies from well are under the control and management of the farmer and are therefore likely to be more

prudently used. Evaporation losses and losses in transit are minimum. About 30 per cent of the groundwater applied for irrigation percolates back to the system and replenishes a part of water used (Ibid., Annexure 1).

Information on the net area irrigated by sources for the period 1960-61 to 1933-34 is presented in Table 4.17.

It is evident that the groundwater resource has all along been an important source for irrigation in Gujarat. Wells including tubewells irrigated about 83 per cent of the net irrigated area in 1960-61 and even today irrigate about 76 per cent of the net irrigated area.

12. Cropping Pattern

The prevalent cropping patterns in any locality are the cumulative results of past and present decisions by individuals, communities or governments and their agencies. These decisions are usually based on experience, tradition, expected profit, risk-bearing and resource raising capacity of the decision makers, social and political pressures, etc. Cropping patterns do, however, change over long period, economic viability usually indicating the short term responses and ecological viability lending sustainability to the cropping pattern so evolved. The possibility of conflict between short-term economic viability and long-term ecological sustainability and the domination of the former over the latter can lead to and has, in point of fact, led to secular deterioration of basic agricultural resource i.e. land in some parts of the country.

As seen earlier, about half of the land in Gujarat is brought under the plough.

Percentage shares of major crops in gross cropped area are presented in Table 4.18.

A little less than half of the gross cropped area is being 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 1930-33 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.

The changing relative importance of foodgrains, oilseeds and cotton in different districts of Gujarat can be seen from Tables 4.19 and 4.20.

Foodgrains production has been of very high importance for Banaskantha and Panch Mahals accounting for 77.4 per cent and 75.8 per cent of gross cropped area in 1961. Over the years, although cultivation of foodgrains is still very important for Banaskantha (73.3 per cent) introduction of new oilseeds crops like castor and rape and mustard has resulted in 22.5 per cent of area under cultivation allotted to oilseeds in 1936-37. For Panch Mahals, 89.4 per cent of gross cropped area in 1936-37 was under foodgrains. In fact, in 1936-37, all the districts except the five oilseeds producing districts and one cotton producing district (Surendranagar) of Saurashtra, foodgrains production occupies an important place ranging from 51.2 per cent for Vadodara to 96.7 per cent for not only the Dangs, but also as high as 91.7 per cent for Valsad,

89.4 per cent for Panch Mahals and between 70 and 80 per cent for Banaskantha, Bharuch and Surat.

Commercial Crops in Gujarat: Farmers in Gujarat started producing commercial crops from the 17th century. The main cash crop then was cotton. Besides cotton, tobacco and groundnut also began to be cultivated from the beginning of this century. The percentage of net cropped area under food and non-food crops was 72 and 28 respectively; by 1933-39 the percentage of area under food crops had fallen to 54 per cent (Choksey, 1968) and by 1960-61 it had fallen further to 47 per cent. In 1986-87 the percentage of area under food crops and non-food crops was 51.2 and 48.8 per cent respectively. The main groundnut producing districts in 1960-61 were Jamnagar (55 per cent gross cropped area under groundnut), Rajkot (49.4 per cent), Bhavnagar (38.0 per cent), Amreli (48.4 per cent), Junagadh (45.5 per cent) in Saurashtra and to a lesser extent Sabarkantha (26.8 per cent) and Panch Mahals (14.2 per cent) in the mainland Gujarat.

According to 1986-87 cropping pattern, the main oilseeds producing districts are Junagadh (76.3 per cent), Jamnagar (66.3 per cent), Amreli (66.5 per cent), Rajkot (56.5 per cent), Bhavnagar (40.8 per cent) in Saurashtra, to a lesser extent Gandhinagar (31.3 per cent), Mahesana (26.2 per cent), Banaskantha (22.5 per cent) and Sabarkantha (16.5 per cent) in the mainland Gujarat and Kachchh (25.8 per cent). Although groundnut is still the most important oilseed in the State and accounts for around 77.7 per cent of the area under oilseed, castor (8.9 per cent of area under oilseeds) and rape and mustard (7.7 per cent of area under oilseeds) are becoming significant oilseed crops in the State, particularly in the oilseed producing districts in the mainland Gujarat viz. Banaskantha, Sabarkantha and Mahesana as also in Kachchha. In Banaskantha, castor, rape and mustard account for around 95 per cent of area under oilseeds and the proportion in Sabarkantha and

Mahesana is 33.5 per cent and 98 per cent respectively.

Traditional cotton-growing districts are Bharuch (51.4 per cent of GCA under cotton), Surendranagar, Vadodara and Ahmedabad. Over the years, proportion of area under cotton has declined marginally from 18.5 per cent in 1960-61 to 16.9 per cent in 1986-87 for the State as a whole. The important cotton producing districts are Surendranagar (57.9 per cent of gross cropped area in the district), Baroda (40.0 per cent), Ahmedabad (35.7 per cent), Sabarkantha (24.8 per cent) and Bharuch (23.5 per cent) in main-land Gujarat and to a lesser extent Rajkot (21.8 per cent) and Bhavnagar (15.8 per cent) in Saurashtra. Kheda and Vadodara are the two main tobacco producing districts with 15.7 per cent and 5.7 per cent of gross cropped area under tobacco respectively. The proportion of land under tobacco has increased from 11.9 per cent in 1960-61 to 15.7 per cent in 1986-87 for Kheda and from 3.5 per cent to 5.7 per cent for Vadodara over the same period. Ahmedabad, Banaskantha, Mahesana and Panch Mahals have between 1000 and 3500 hectares of land under tobacco but this forms negligible proportion of the total gross cropped area in these districts.

Sugarcane is a cash crop relatively new in the State which was not significant in the 1960-61 cropping pattern. In 1986-87 also, it is confined to only two districts Surat (13.8 per cent of GCA) and Valsad (7.6 per cent of GCA) and only to a small extent Junagadh (1.6 per cent of GCA). For the State as a whole, sugarcane is not an important crop even today.

Foodgrains, however, still occupy an important position in the cropping pattern of many districts in the State. More than half (51.2 per cent) of the gross cropped area in the State was under foodgrains in 1986-87. Around 90 per cent or more of the gross cropped area was under foodgrains in the districts of Dangs (96.7 per cent), Valsad (91.7 per cent), Panch Mahals (89.4 per cent). Around three-fourths of the gross cropped area was under

foodgrains in the districts of Bharuch (73.4 per cent), Banaskantha (73.3 per cent), Kheda (72.3 per cent) and Surat (71.9 per cent). Districts having less than the State average proportion of gross cropped area under foodgrains included all the five districts of Saurashtra viz. Junagadh (17.5 per cent of gross cropped area under foodgrains), Rajkot (21.2 per cent), Amreli (27.6 per cent), Jamnagar (27.9 per cent) and Bhavnagar (43.2 per cent) and Surendranagar (35.0 per cent).

According to the latest figures available (1986-1987) Gujarat produces 26.5 per cent of groundnut production in the country and the proportion for cotton is 18.9 per cent. Thus production of commercial crops is important for Gujarat economy which is a deficit State as far as production of foodgrains is concerned. Gujarat has 5 per cent of India's population and produces 3.5 per cent of cereals produced in India and 3.3 per cent of pulses produced in India in 1986-87. The oilseeds crops and cotton crops in the State are also important from the point of national economy. Imports, particularly of edible oil are known to be closely associated with the performance of oilseeds crops in Gujarat and drought in Saurashtra resulting in failure of oilseeds crops has far-reaching repercussions not only on the agricultural incomes and agricultural employment in Gujarat but also for the general edible oil situation in the country as a whole.

13. Irrigated Agriculture

Growth in gross irrigated area during 1960-61 to 1983-84 is presented in Table 4.21. The gross irrigated area has increased from 7,33,800 hectares in 1960-61 to 27,97,400 hectares in 1983-84 i.e. by about 280 per cent and more or at an average annual rate of growth of over 12 per cent between 1960-61 and 1983-84.

The growth in net irrigated area by sources during the same period is presented earlier in Table 4.17. Total net

irrigated area has increased from 6,32,900 hectares in 1960-61 to 22,70,900 hectares in 1983-84 i.e. by 230 per cent and more and at an average annual rate of growth of 10.0 per cent. Intensity of cropping in irrigated land has increased from 107.5 in 1960-61 to 123.2 in 1983-84.

Well irrigation (including tubewells) has always been and still is the most important source of irrigation in Gujarat and more than 75 per cent of net irrigated area is under well irrigation. Although the proportion has somewhat declined from 83 per cent to 76.5 per cent between 1960-61 and 1983-84, net irrigated area from wells has increased from 5,67,700 hectares in 1960-61 to 17,37,000 hectares in 1983-84 i.e. by over 200 per cent during the period. Canal irrigation was very limited in 1960-61 and contributed less than 10 per cent to total irrigation in the State. It has increased over the period from 65,800 hectares to 4,89,200 hectares in 1983-84 i.e. was almost seven and a half times of what it was in 1960-61 and currently contributes a little over a fifth to the total irrigation in the State on the net area basis. Tanks are but a minor source of irrigation and contributed less than 2 per cent to total irrigation in 1983-84.

Irrigation is not uniformly available in all the districts of the State. Nor is the growth in irrigation facilities uniform for all the districts. The status of different districts on this account for the years 1960-61 and 1983-84 is presented in Table 4.22.

Kheda, Mahesana and Gandhinagar are better irrigated districts with more than 40 per cent of gross cropped area under irrigation while Surendranagar, Amreli, Kachchh, Panch Mahals, Bharuch, Dangs are moderately irrigated districts with less than 20 per cent of gross cropped area under irrigation.

The gross irrigated area has substantially grown in most of the districts mostly on the basis of an extensive programme of construction of irrigation wells including tubewells. Except for

Surat and Valsad, well irrigation is the major source of irrigation for all other districts. Surface irrigation has, however, contributed in substantially increasing land under irrigation for Kheda, Ahmedabad, Bhavnagar and of course, Surat and Valsad.

Irrigated Cropping Pattern: Cropping pattern for irrigated agriculture in Gujarat State as a whole is presented in Table 4.23.

Major food cereals were important and more than half the gross irrigated area was under rice, jowar, wheat and bajra together in 1965-66. Over the later years, however, the proportion of gross irrigated area under these crops together has reduced substantially. Wheat is the major user of irrigation all through, and by far is the largest among the cereal crops while proportion of jowar has declined to a negligible level over the period.

Cotton, groundnut, tobacco and sugarcane are the important cash crops grown under irrigation. The proportion of cotton had increased upto 1975-76, however it has declined in the eighties. Although irrigated groundnut as proportion of GIA increased over the period, groundnut, basically a kharif crop, is not mainly an irrigated crop. On the other hand, sugarcane is essentially an irrigated crop and tobacco is growingly cultivated under irrigated conditions.

Besides these traditional food and cash crops in Gujarat new irrigated crops introduced in recent years are rape and mustard in Junagadh, Banaskantha, Mahesana districts, castor in Banaskantha and Gandhinagar, condiments and spices in Jamnagar, Banaskantha, Mahesana, Gandhinagar districts, fruit and vegetables in Valsad, Surat, Gandhinagar, Junagadh and Bhavnagar districts.

It is to be noted that fodder crops assume an important place in Gujarat agriculture and more than 8 per cent of the gross cropped area and as much as 5 per cent of gross irrigated area is under fodder crops like lucern, jowar. Irrigated fodder cultivation is significant for all Saurashtra districts viz., Jamnagar (11.8

per cent), Rajkot (6.6 per cent), Bhavnagar (7 per cent), Amreli (6.5 per cent) and Kachchh (7.1 per cent) and Mahesana (5.9 per cent).

About 49 per cent of area under paddy and 80 per cent of area under wheat was irrigated in 1983-84. For gram the proportion was about a fifth. In commercial crops 29.34 per cent of area under cotton was irrigated and 73 per cent of area under tobacco was irrigated. The proportion was about the same at 12.50 per cent for groundnut and fodder crops. Sugarcane and chillies were grown under irrigated conditions only. So also, rape and mustard and castor were mostly cultivated under irrigated conditions. Irrigation was also important for growing vegetables, condiments and spices.

The relative importance of various crops in irrigated agriculture in different districts in 1960-61 and in 1983-84 can be gauged from Table 4.24.

In the groundnut growing districts of Saurashtra, particularly Junagadh, Bhavnagar and Jamnagar, irrigated groundnut cultivation has assumed increased importance and proportion of area under groundnut to gross irrigated area increased from less than two per cent in 1960-61 to about a quarter and more in 1983-84. In the district of Kachchh, groundnut which covered about a fifth of gross irrigated area in 1960-61, covered two-fifths of gross irrigated area in 1983-84.

Among the cotton growing districts, cotton has been assuming growing importance in irrigated agriculture in Surendranagar, Rajkot, Sabarkantha and Vadodara while there is substantial decline in the relative importance of cotton in Ahmedabad and Mahesana in mainland Gujarat. In Saurashtra, cotton has increased in importance in Bhavnagar and Amreli districts while it has decreased in importance in Jamnagar and Junagadh districts and also in Kachchh.

Rice has been an important irrigated crop and its importance has increased over the period for Ahmedabad, Kheda and Surat districts. While it has lost its importance as an irrigated crop in all the districts of Saurashtra which are groundnut growing districts and in Vadodara and Bharuch which are cotton growing districts of the State.

Wheat was an important irrigated crop in all districts of Gujarat except in the rice growing districts of Surat and Bharuch and the desert district of Kachchh in 1960-61. Its importance declined substantially over the period in Rajkot, Surendranagar, Bhavnagar, Sabarkantha and Vadodara districts where cotton became a more important irrigated crop and in Banaskantha and Mahesana where rape, mustard and castor became important irrigated rabi crops.

Sugarcane is an important crop only in Surat and Valsad districts and in Surat it covers two-fifths of the gross irrigated area.

Over the years there has been a lot of diversification in irrigated agriculture particularly in Jamnagar, Banaskantha, Mahesana, Gandhinagar, Valsad districts. Besides the new major entrants in oilseed crops like rape, mustard and castor, spices and condiments, fruit and vegetables, tobacco and fodder crops are now important commercial crops along with the traditional commercial crops of Gujarat viz., groundnut and cotton. (For districtwise relative importance of irrigated crops see Table 4.25.)

14. Production and Productivities in Agriculture

Information on area, production and yield per hectare of important food and non-food crops in Gujarat for the years 1960-61 to 1984-85 is presented in Table 4.26.

Over the twenty-five year period, production of cereals has increased from 1719100 tonnes in 1960-61 to 4701100 tonnes i.e. by 173 per cent. The main components of cereal production are jowar and bajra. The production of jowar has increased by 125 per cent.

and that of bajri has increased by 220 per cent over this period. Production of rice has gone up by 137 per cent and that of wheat has increased by 339 per cent. The contributions of jowar and bajri to total cereal production in 1960-61 were 12.3 per cent and 27.3 per cent respectively and those of rice and wheat were 16.9 per cent and 15.8 per cent respectively. In 1984-85, wheat contributed 28.2 per cent to cereal production and the contributions of jowar, and rice were 10.6 per cent, and 17.7 per cent respectively. Bajri is still the main cereal crop contributing about 32.6 per cent to total cereal production in 1984-85.

Production of pulses increased by over 228 per cent over the period. Production of cotton and groundnut has grown by 40 per cent and 29.5 per cent over this period. Production of tobacco increased by over 167 per cent over this period.

Thus there has been an impressive increase in agricultural production and the compound annual growth rate for the period 1960-61 to 1983-84 for production of foodgrains, oilseeds and cotton has been 3.4, 3.1 and 0.9 respectively. It must be, however, noted that production of all the important crops in Gujarat is fraught with frequent and large fluctuations particularly in rain-fed agriculture due to the vagaries of monsoon.

Growth in production is the combined result of changes in area under crop and changes in productivities.

Indices for area, production and yields per hectare of important crops in Gujarat for selected years are presented in Table 4.27. The year 1984-85 has been the latest normal year for most of the districts and crops for Gujarat, the later three years being drought years of varying but substantial intensity and spread.

There has been only a 15 per cent increase in 1984-85 in the area under rice as compared to the triennium ending 1969-70, however the increase in production was estimated to be about 97.56 per cent mainly attributed to rise in productivity of the order of 71 per cent.

Wheat, accounting for only around 4 per cent of gross sown area 1986-87 is becoming an important food crop over years. The increase in area has been around 30 per cent and increase in production by over 100 per cent mainly, again, due to increase in productivities during seventies and eighties to the tune of 64 per cent.

Jowar, on the other hand is losing ground in spite of more than 100 per cent increase in productivity. It appears that the total production is maintained due to increase in productivity and the land released is transferred to more paying crops. Similar is the case with bajri. The gains in productivity are utilized mainly for reduction in area under bajri and transfer of land to more paying crops. The total cereals picture, therefore, shows that the productivities have increased by about 94 per cent, production by around 60 per cent and the area under cereals has declined over years by about 20 per cent.

There have been substantial gains in area, production and productivity for pulses. Increase in the total production of pulses in Gujarat is to be attributed to both increase in productivity over 100 per cent and in area under pulses by about 75 per cent.

For foodgrains as a whole, for more or less the same area under foodgrains as in 1967-70, Gujarat State produced 74 per cent more in terms of foodgrains production mainly due to about 37 per cent increase in the productivities of foodgrains.

In commercial crops, there has been some increase in the area under groundnut and tobacco while area under cotton has slightly declined. Production of groundnut and cotton increased by 42 per cent and 33 per cent respectively with the gains in productivity of about 26 per cent and 63 per cent respectively. There was substantial gain in the production of tobacco (about 75 per cent) both due to increase in productivity (about 49 per cent) and in area (about 17 per cent).

Productivities of different crops are not uniform for different districts of Gujarat. Districtwise productivities of important crops in Gujarat are presented in Table 4.28.

Yields also differ considerably for crops grown under irrigated and unirrigated conditions. Yields per hectare for the year 1983-84 for some important crops grown under irrigated and unirrigated conditions in Gujarat are presented below.

S. No.	Crop	Yield per hectare in kg		Percentage of crop irrigated
		Irrigated	Unirrigated	
1	Rice	1934	1089	34.3
2	Wheat	2634	583	76.7
3	Groundnut	1525	772	9.3
4	Cotton	359	122	22.6

Irrigated rice gave especially better yields in the two rice-growing districts of Surat (2496 kg) and Valsad (2634 kg). Unirrigated yields in these two districts also compared favourably with average unirrigated yield and were at 1363 kg and 1527 kg respectively.

Irrigated wheat gave especially better yields in Kheda (3122 kg), Bhavnagar (3111 kg) and Junagadh (3291 kg) districts. Yield for unirrigated wheat was substantially high at 1164 kg for Gandhinagar district.

Kheda (1895 kg) (and Bhavnagar (1625 kg)) recorded a high yield for irrigated groundnut and Bhavnagar (551 kg) for irrigated cotton.

15. Main Problems of Agriculture in Gujarat

Large parts of Gujarat are situated on the periphery of south-west monsoon zone and receive nearly 90 per cent of precipitation from the south-west monsoon. Of the total land area of 176.3 lakh hectares, 32.4 lakh hectares or 18 per cent have rainfall below 37.5 cm., 93.8 lakh hectares between 37.5 and 75.0 cm.

and 45.6 lakh hectares between 75.0 and 125.0 cm. The desert and sandy areas in the Rann of Kachchh aggregating about 24 lakh hectares have annual rainfall of less than 25.0 cm. Apart from the failure of monsoon which is a frequent occurrence, the distribution of rainfall even in good years is not satisfactory over the entire monsoon period.

Information on the districtwise arid and semi-arid zones in Gujarat is given in Table 4.29.

Ninety per cent and more of the Kachchh district and half of Jamnagar district together covering nearly a quarter of the entire geographical area of Gujarat constitute the arid zone in the State. The semi-arid zone is quite extensive and covers 82 talukas of 12 districts extending over a third of the State.

Dependence of agriculture on low and ill-distributed rainfall results in widely fluctuating performance of agriculture in the State. This is reflected in the fluctuating contribution of agriculture and allied activities to the State Domestic Product ranging from 45 per cent in good years to less than 30 per cent in bad years.

The nature and extent of fluctuations can be assessed from Table 4.27 giving indices of area, production and yield for important crops for selected years as also from Tables 4.30 and 4.31 giving average area, production and yield per hectare of principal crops for the three latest drought years (1985-86, 1986-87 and 1987-88) as percentage of those in 1984-85 and the average rainfall in these years as percentage of normal rainfall in different districts of Gujarat.

The above Tables show that during the three years 1985, 1986 and 1987 which were drought years for Gujarat as a whole, the average rainfall was much below the normal rainfall for all districts except the Dangs. The overall deficit ranged from 23.13 per cent in Valsad to over 77 per cent in Kachchh and Rajkot; in

eight districts out of nineteen the deficit was more than 50 per cent. The sowing of Rabi crops like wheat and gram was drastically reduced and although the Kharif crops were sown around 80 per cent of the normal area under respective crops, the total production was drastically affected by shortage in rainfall and production of all the important food crops as well as commercial crops like cotton and groundnut was less than 50 per cent of production in normal year. The only exception was tobacco which is mostly an irrigated crop.

Stabilization of agriculture through stabilization of water availability in the State through proper water and soil conservation measures along with extension of irrigation is called for.

Irrigation in Gujarat has its own problems.

Waterlogging: Water management in irrigation implies an integrated process of diversion, conveyance, regulation, measurement, distribution and application of a rational amount of water at appropriate time and removal of excess water from farms. Water management at the farm level is largely done by the cultivators. However, efficiency in water management is affected by the operating rules of the irrigation system, the institutional framework in which the farmers operate and the complementary infrastructural facilities available.

Water loss is through evaporation, and percolation. Effect of lining of canals on water losses showing percentage of utilization of released water by crops under different systems is shown below.

Irrigation System	% water utilized by crops	% loss in conveyance
1. Entire system unlined	29	44
2. Only canal lined	34	35
3. Canals and distributaries lined	36	32
4. Entire system lined	46	12

Water losses also depend on irrigation method. Flooding causes high losses while furrow irrigation reduces the losses in transit and higher duties can be realized.

In Gujarat most of the ^{surface} irrigation is serviced through unlined distribution system. Normally percolation would not be so much objected to in alluvial soils as it benefits the wells near the irrigation canals. However in most of the command area of Ukai-Kakrapar Irrigation Scheme lying in Surat and Valsad districts the soils are deep black cotton soils and have flat terrain with unsatisfactory drainage conditions. Lower levels of utilization coupled with availability large quantities of water under major projects like Ukai-Kakrapar and Mahi-Kadana have created problems of rise in the sub-soil water levels resulting in waterlogging where drainage characteristics are unfavourable.

Command Area Development programme has been recently taken up in the Mahi Kadana and Ukai-Kakrapar command area. However it is too soon to evaluate the work done so far. For economic use and equitable distribution of water among all the beneficiaries Rotational system of supply of water (Warabandhi System) was also introduced during the eighties.

Salinity: The entire Saurashtra and Kachchh coastal area which is a fertile and productive tract is affected by salinity ingress from Bhavnagar to Una, Madhavpura to Malia, Malia to Lakhpat in a length of 1015 kms. Continuous heavy withdrawals of groundwater for purposes of irrigation and water supply of Saurashtra and Kachchh combined with decreased recharge due to poor rainfall conditions have created problems of salinity ingress and inundation. Salinity in the groundwater in the areas has assumed serious dimensions since 1971. Currently, an area of as much as 7 lakh hectares with a population of about 10 lakh is affected. The number of wells affected comes to about 40,000. The number of villages affected is 534. Large scale migration has

taken place deserting lands and villages. If timely and proper measures are not taken the entire Saurashtra-Kachchh coastal belt will in the long run turn into a barren and deserted area.

In fact the entire coastal area along the 1600 kms of coastline of Gujarat suffer from the problem of salinity ingress resulting in permanent damage to agricultural land and aggravating the problem of drinking water supply.

The lands lying along the Gulf of Khambhat are affected by tidal waters. The land remains submerged during the rainy season and for the rest of the year is affected by tidal waters. In Gujarat, around 11.27 lakh hectares of khar land in Valsad, Surat, Bharuch and Kheda districts have been affected adversely by coastal salinity. Kharland Development Board established in 1962, has so far protected only about 20,000 hectares of land and has disposed another 33000 hectares to salt industries. Cultivation is a near impossibility in this part of the State yet is at times undertaken for sheer survival.

Flood Areas: Agriculture is a game of uncertainty also in the flood-prone areas of the State. The Ghed area covering about 1452 sq.kms is situated in the north-west of Junagadh district where riverbed gradients in deltaic area are very flat. This area is very susceptible to floods which result in inundation and erosion of the surrounding cultivable lands. There are flood distress areas in other river basins extending over more than 9 lakh hectares of cultivable land affecting more than 40 lakh population. Flood control schemes so far have not received priority in the State plans. Some measures like construction of embankments, sluices, etc., for protection of the vulnerable downstream flood areas of major reservoirs are envisaged in the Seventh Plan.

Thus uncertainty looms large on the rainfed agriculture in Gujarat. Problems of waterlogging and salinity ingress due to overwithdrawal of well water along the coast and flooding due to

tidal ingress uncertain monsoon conditions result in hostile conditions for coastal agriculture. Besides, it shares all the problems of Indian agriculture like uneconomic holdings for a vast majority of cultivators which keep the mass of cultivators and agricultural labourers in the State poor.

16. 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.

Information on livestock population in 1961 and 1982 Gujarat along with percentage composition of livestock in 1982 is presented in Table 4.32.

Bovine population, sheep and goats together accounted for over 90 per cent of total livestock population both in 1961 and in 1982. 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, over the twenty year period.

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). There is a high association between bovine population and cropping intensity, extent of irrigation, percentage of area under food and fodder crops to total gross cropped area and density of population (Vyas and Choudhary, 1971, p. 389).

Information on the relative composition of livestock is presented in Table 4.33. In the adult cattle population working bullocks are an important component while cows are more important as breeders rather than milch animals. This is reflected in the proportion of cows and bullocks in the total cattle population. Cows are around 37-38 per cent and bullocks are around 62-63 per cent of total cattle population in the State. Number of cows per 100 bullocks has been usually around 60-64. The biological dynamics of cattle population shows that for a herd of healthy animals, this proportion is just about right for stable population of bullocks over a generation.

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, cows accounted for 51.9 per cent and buffaloes for 48.1 per cent of total adult female bovine population. These proportions have changed over the years. The proportion of cows has gradually declined to 43.2 per cent and that of buffaloes has

increased to 56.8 per cent. The tilt in favour of female buffaloes is clearly a result of the dairy development programme. Over the last twenty years, cows increased by around 5.7 per cent while female buffaloes increased by over 50 per cent.

Livestock Production: Estimates of output of livestock and poultry product and their value in Gujarat in 1980-81 are presented in Table 4.34. The value of service of the draught animals is not included in these estimates. There were about 30 lakh working bullocks in Gujarat in 1982. However their service is not actually monetized since bulk of it does not enter the market. Thus the contribution of livestock is grossly underestimated.

Of the marketed and marketable production of the livestock, milk is clearly the most important product contribution 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. Gujarat contributed 10.3 per cent to the total value of output of milk and milk products in 1980-81 in the country as a whole.

Meat and meat products constituted about 9.16 per cent of total value of livestock output in Gujarat. Hides and skins and wool and hair were minor products contributing about 2.62 per cent and 0.5 per cent respectively to the 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.

17. Dairy Development in Gujarat

Annual milk production in Gujarat for the period 1970-71 to 1985-86 is presented in Table 4.35.

Production of milk has increased steadily over the last 25 years from 19 lakh tonnes a year in 1970-71 to over 31 lakh tonnes a year in 1985-86. The current daily production of milk in Gujarat is estimated at around 88 lakh litres i.e. about 32 lakh tonnes a year.

Although the presence of cattle and buffaloes is more or less ubiquitous, milk production is not equally generally spread out in the State. The major pockets contributing nearly half the milk production in the State are Mahesana, Kheda, Banaskantha, Sabarkantha, and Junagadh districts (Table 4.36).

The cooperative movement in dairy development in Gujarat started with AMUL Dairy in Kheda district and has spread to the districts of Mahesana, Sabarkantha, Banaskantha, Vadodara and Surat. The Milk Marketing and Dairy Development Scheme known as the Operation Flood Programme was launched in Gujarat in 1970 and Gujarat Dairy Development Corporation was set up in 1973. Milk is collected through numerous village level dairy cooperative societies and processed and marketed centrally at a dairy plant at the district level.

Growth of milk societies and growth in their membership for the period 1960-61 to 1980-81 is presented in Table 4.37. There is more than twenty-fold increase in the number of societies and over seventeen-fold increase in the membership.

Physical achievement as in 1987-88 is presented in Table 4.38. The daily procurement is on an average 20 lakh kg and even in the peak month, it is about 28 lakh kg. Excess processing capacity exists in most of the districts particularly in Kachchh and Bharuch. Direct milk sale through the cooperatives is around 9 lakh litres which is about 10 per cent of the daily milk production of the State and about half the average daily milk procurement in the State. The cooperative sector procures about 23 per cent of daily production in the State. It means that over 75 per cent

of the milk production is today being handled outside the cooperative sector by small private dairies or by individuals.

18. 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, indscript 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.

There are a number of gaushalas engaged in cattle breeding work for the preservation of indigenous breeds of cattle.

In addition, there are a number of private cattle breeding farms as there is good demand for pedigree animals outside the

State as also from the Government for distribution of quality bulls to the village panchayats.

The other problem is that of fodder scarcity. Although fodder crops cover eight per cent of the gross cropped area and five per cent of the irrigated area in the State. The shortage of fodder is seen if we examine the density of cattle in the State. The norm of about 3 livestock units per hectare gross cropped area is far exceeded by the density of livestock population per hectare gross cropped area in the State. It stands at 5.77 livestock units. Besides the agricultural residuals, jowar and lucern are the major fodder crops in the State. Area under both jowar and lucern is growing over the years. However 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 1932 census, the sheep population of the State is about 23.57 lakh which is 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.3000 per year.

Income from sheep is mainly from sale of ram lambs (60-70 per cent); manure yields about 25 to 30 per cent and the rest i.e. about 5 to 10 per cent is obtained from wool. Wool production is hardly one kg 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). As substantial part of the milk is consumed in the family, improvement in the milk yield will help both the nutrition and the cash income of the family.

Livestock economy is complementary to the agricultural economy. Both are interdependent, agriculture depending on livestock for draught power and rural population for milk, milk products and meat and the livestock economy depending on agriculture for fodder and feed. Land use plan for a region has, therefore, to be developed taking into account the requirements of agricultural produce and livestock produce, bearing in mind this interdependence between the agricultural activity and livestock rearing.

Table 4.1 : River Basins of Gujarat State

Sr. No. (1)	Name of Basin (2)	Area (in sq.kms.) (3)	Rainfall (in cm.) (4)	Nature of River (5)
A. Gujarat Plain				
1.	Banas	2937	62.75	Ephemeral
2.	Saraswati	970	68.53	"
3.	Sabarmati	5936	96.52	"
4.	Mahi	2335	109.73	Perennial
5.	Dhadhar	1580	109.93	Ephemeral
6.	Narmada	4558	109.22	Perennial
7.	Ambica	1062	143.76	Ephemeral
8.	Purna	947	143.76	"
9.	Tapi	1395	133.35	Perennial
10.	Auranga	474	197.61	Ephemeral
B. Saurashtra Region				
1.	Bhogavo	2770	65.28	Ephemeral
2.	Sukh Bhadar	772	66.30	"
3.	Utavali	1353	66.30	"
4.	Kalubhar	500	76.20	"
5.	Shetrunji	2130	74.42	"
6.	Bhadar	2640	30.77	"
7.	Machchhu	904	67.56	"
8.	Melan	424	32.30	"
9.	Saraswati	3639	74.93	"
10.	Meghal	522	63.75	"
C. Kachchh Region				
1.	Khari	373	33.53	Ephemeral
2.	Rukmavati	275	44.20	"
3.	Kankawati	275	33.53	"
4.	Neran	200	33.53	"
5.	Tapar	225	38.36	"

Source: Statistical Atlas of Gujarat, Vol. I.

Table 4.2 : Districtwise Normal Rainfall and Annual Rainfall in Gujarat, 1980-1988

(in millimetres)

Sr. No.	District	Normal Rainfall	Year									Rainfall in drought** years as % of normal
			1980	1981	1982	1983	1984	1985	1986	1987	1988*	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1.	Jamnagar	466.1	1210.0	1369.0	834.0	855.0	665.0	203.0	189.0	36.0	482.0	30.93
2.	Rajkot	594.3	635.0	641.0	470.0	637.0	539.0	273.0	200.0	130.0	1017.0	22.93
3.	Surendranagar	487.0	483.5	641.0	532.0	453.0	498.0	423.0	303.0	81.0	443.0	55.57
4.	Bhavnagar	620.1	487.0	764.0	418.0	554.0	449.0	657.0	364.0	121.0	761.0	61.40
5.	Amreli	515.0	855.2	805.0	827.8	1087.6	293.5	311.0	454.5	112.6	1317.0	56.87
6.	Junagadh	843.7	1653.0	1337.0	1131.0	2538.0	1215.0	449.0	762.2	194.1	2178.0	55.50
7.	Kachchh	340.4	535.0	598.0	145.5	257.0	306.0	113.0	105.9	5.0	657.0	22.43
8.	Banaskantha	750.7	512.0	476.0	355.7	646.0	704.0	322.1	323.0	60.8	730.0	31.57
9.	Sabarkantha	794.2	821.8	829.0	465.0	997.0	925.0	521.0	292.0	163.0	973.0	41.20
10.	Mahesana	613.0	475.0	637.9	511.0	761.9	627.4	186.3	169.1	109.4	635.0	25.27
11.	Gandhinagar	N.A.	377.0	613.0	472.0	519.0	845.5	554.0	537.4	135.9	650.0	64.17
12.	Ahmedabad	782.8	732.8	1263.8	759.4	1090.1	762.8	802.8	452.1	251.3	723.0	64.17
13.	Kheda	769.5	943.0	1052.4	597.5	812.1	710.2	385.1	N.A.	433.0	1256.0	56.40
14.	Panchmahals	1026.5	955.0	1054.0	634.0	1040.0	818.0	407.0	437.5	471.0	906.0	42.70
15.	Vadodara	916.6	1003.9	842.5	662.0	1389.4	706.7	633.5	303.8	419.3	1068.0	49.30
16.	Bharuch	876.6	620.7	1131.0	501.0	1380.8	799.0	685.7	589.0	447.2	1147.0	65.46
17.	Surat	1071.1	1037.6	1240.1	1182.1	1966.9	1052.7	761.2	828.1	632.4	2298.0	69.13
18.	Valsad	1305.6	1963.3	1917.2	1523.2	3047.4	1323.0	1305.0	1441.6	1418.0	2269.0	76.37
19.	Dangs	1779.9	2779.6	3063.3	1664.5	2914.5	2742.8	2497.1	1356.0	1953.9	3172.0	118.27

* Upto October, 1988.

** Average of 1985, 1986 and 1987.

Source : Socio-Economic Review 1988-89 Gujarat.

Table 4.3 : Broad Demographic Characteristics of Gujarat, 1981

Sr. No.	District	Population ('000)	Rural Population as % to total population	Scheduled Castes as % of total population	Scheduled Tribes as % of total population	Literacy rates, 1981		
						Total	Male	Female
1.	Jamnagar	1393	62.53	7.29	0.31	40.52	50.24	30.29
2.	Rajkot	2093	58.72	6.55	0.13	48.78	58.14	38.90
3.	Surandranagar	1034	71.28	10.87	0.58	37.47	48.61	25.53
4.	Bhavnagar	1879	66.74	5.31	0.13	39.79	51.12	27.97
5.	Amreli	1079	79.61	8.62	0.07	42.08	51.91	32.01
6.	Junagadh	2101	69.54	8.41	0.51	41.63	52.58	30.15
7.	Kachchh	1050	73.90	10.65	6.02	35.42	44.14	26.68
8.	Banaskantha	1668	91.37	10.20	6.71	23.04	34.08	11.36
9.	Sabarkantha	1503	90.08	8.56	16.72	39.80	53.70	25.54
10.	Mahesana	2549	79.91	8.75	0.33	46.71	58.03	35.11
11.	Gandhinagar	239	78.55	7.33	0.58	51.48	63.17	38.84
12.	Ahmadabad	3876	28.25	11.27	0.34	56.08	65.47	45.54
13.	Kheda	3015	79.90	5.87	1.43	49.04	62.48	34.35
14.	Panchmahals	2322	88.89	3.80	41.76	28.10	40.79	14.86
15.	Vadodera	2558	62.82	6.01	25.35	48.34	58.46	37.29
16.	Bharuch	1296	81.34	4.61	44.54	44.66	55.51	33.17
17.	Surat	2493	57.24	3.68	41.64	46.73	54.99	37.79
18.	Valsad	1774	73.07	3.10	54.59	46.95	55.74	37.99
19.	Dangs	114	100.00	0.66	92.31	29.84	38.39	21.04
Gujarat State		34085	68.90	7.15	14.22	43.30	54.44	32.30

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.4 : Economic Characteristics of Population of Gujarat, 1981

Sr. No.	District	(Population in '000)										
		Population			Main workers as % of total population			Marginal workers as % of total population	Main workers as % of total main workers			
		Total	Male	Female	Total	Male	Female		Culti-vators	Agri-cultu-ral labour-ers	House-hold indus-try *	Other workers
1.	Jamnagar	1393.0	714.8	678.3	30.88	51.73	8.90	3.92	42.46	13.23	2.57	41.74
2.	Rajkot	2093.1	1074.8	1018.2	31.37	51.02	10.63	2.99	38.47	15.49	2.37	43.67
3.	Surendranagar	1034.2	534.7	499.4	32.50	51.63	12.02	5.27	35.49	25.77	4.38	34.36
4.	Bhavnagar	1879.3	959.7	919.6	32.37	51.66	12.24	3.35	37.40	24.21	3.33	35.06
5.	Amreli	1079.1	546.0	533.1	31.03	51.04	10.53	6.28	49.10	23.14	3.01	24.75
6.	Junagadh	2100.7	1074.6	1026.1	29.58	49.51	8.70	4.62	43.56	20.71	2.56	33.17
7.	Kachchh	1050.1	525.4	524.7	31.75	51.72	11.76	4.18	34.16	22.97	3.14	39.73
8.	Banaskantha	1667.9	857.3	810.6	30.31	52.58	6.75	5.57	58.16	18.57	2.50	20.77
9.	Sabarkantha	1502.3	760.4	741.9	30.38	50.79	9.46	8.94	52.32	21.78	2.37	23.53
10.	Mahesana	2548.8	1293.6	1255.2	29.11	49.19	8.42	7.20	38.39	25.69	2.52	33.40
11.	Gandhinagar	289.1	150.2	138.9	29.30	49.24	7.74	1.94	22.97	25.81	2.15	49.07
12.	Ahmadabad	3875.8	2050.0	1825.8	29.98	50.39	7.06	1.94	11.55	13.74	2.56	72.16
13.	Kheda	3015.0	1574.3	1440.7	30.70	52.12	7.30	4.68	40.39	26.94	2.07	30.60
14.	Panchmahals	2321.7	1185.4	1136.3	33.23	53.75	11.81	11.74	72.44	10.93	1.42	15.21
15.	Vadodara	2558.1	1335.3	1222.8	33.36	54.30	10.49	4.03	28.23	31.06	1.54	39.17
16.	Bharuch	1296.5	667.2	629.2	37.25	54.89	18.53	4.87	29.86	41.40	1.34	26.90
17.	Surat	2493.2	1295.7	1197.5	39.66	57.65	20.19	2.89	23.51	28.30	2.96	45.23
18.	Valsad	1774.1	895.3	878.8	36.38	53.50	18.93	6.70	36.13	24.95	2.05	36.82
19.	Dangs	113.7	57.7	56.0	39.79	56.29	22.78	10.83	63.09	17.90	2.03	16.98
	Gujarat	34085.8	17552.6	16533.1	32.23	52.19	11.03	5.04	37.46	22.65	2.43	37.46

* Manufacturing, Processing, Servicing and Repairs.

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.5 : Districtwise Number of Working Factories and Average Daily Employment in Gujarat, 1961 and 1981

Sr. No.	District	(Average Employment in '000)			
		1961		1981	
		No. of Factories	Average Daily Employment	No. of Factories	Average Daily Employment
1.	Jamnagar	152	11.1	529	18.9
2.	Rajkot	310	12.1	1149	37.3
3.	Surendranagar	109	11.5	382	18.8
4.	Bhavnagar	236	13.4	511	17.4
5.	Amreli	50	1.8	88	3.8
6.	Junagadh	152	8.9	383	22.9
7.	Kachchh	34	3.0	124	7.7
8.	Banaskantha	22	0.5	31	1.1
9.	Sabarkantha	58	4.9	88	8.5
10.	Mahesana	110	15.4	238	19.7
11.	Gandhinagar	-	-	43	3.4
12A.	Ahmadabad City	1006	170.2	1937	134.9
12B.	Rest of Ahmadabad	-	-	1489	68.2
13.	Kheda	323	20.4	635	39.8
14.	Panchmahals	61	5.2	162	8.1
15.	Vadodara	264	32.4	1318	88.9
16.	Bharuch	70	9.5	271	15.6
17.	Surat	382	40.0	1000	58.7
18.	Valsad	-	-	958	43.6
19.	Dangs	1	neg.	2	0.1
Gujarat		3840	360.6	11438	668.0

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.6 : Economic Characteristics of Scheduled Castes Population in Gujarat(1981 Census)

Sr. No.	District	Total Scheduled Castes Population ('000)	Total Scheduled Castes Main Workers('000)	% to total Schedule Caste Main Workers			
				Cultivators	Agricultural Labourers	Workers in Household Industries	Other Workers
1.	Jamnagar	101.6	34.6	15.80	42.03	3.76	38.41
2.	Rajkot	137.0	47.7	16.76	43.50	2.45	32.29
3.	Surendranagar	112.4	38.8	11.43	45.47	17.68	25.37
4.	Bhavnagar	99.7	33.0	8.25	50.68	9.85	31.22
5.	Amreli	93.0	30.5	20.78	61.23	4.31	13.68
6.	Junagadh	176.5	57.2	15.17	57.51	3.31	24.01
7.	Kachchh	111.9	37.5	19.35	44.05	6.65	29.45
8.	Banaskantha	170.1	49.4	36.28	38.96	5.72	19.04
9.	Sabarkantha	128.5	39.8	23.51	46.70	4.41	20.38
10.	Mahesana	223.0	63.2	9.92	53.97	5.22	30.88
11.	Gandhinagar	21.2	5.8	3.30	31.92	1.33	63.45
12.	Ahmadabad	436.9	126.6	4.44	22.73	3.52	69.31
13.	Kheda	177.1	55.6	17.60	50.01	2.76	29.63
14.	Panchmahals	88.2	27.9	47.50	18.47	11.64	22.59
15.	Vadodara	153.7	50.5	10.64	41.62	3.71	44.03
16.	Bharuch	59.7	21.3	14.73	47.92	2.64	34.66
17.	Surat	91.6	30.6	10.42	20.91	2.31	66.36
18.	Valsad	55.0	15.2	20.87	13.75	10.54	54.84
19.	Dangs	0.7	0.2	2.33	2.43	22.27	72.47
Gujarat State		2438.2	766.2	15.99	41.21	5.26	37.54

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.7 : Economic Characteristics of Scheduled Tribes Population in Gujarat, 1931

Sr. No.	District	Total Scheduled Tribes Population ('000)	Total Scheduled Tribes Main Workers ('000)	% to total Scheduled Tribes Main Workers			
				Cultivators	Agricultural Labourers	Workers in Household Industries	Other Workers
1.	Jamnagar	4.2	1.6	26.50	15.79	12.85	44.86
2.	Rajkot	3.8	1.3	0.38	16.40	-	83.22
3.	Surendranagar	5.9	2.5	14.21	67.54	0.16	18.09
4.	Bhavnagar	2.4	0.8	0.36	12.47	6.35	80.82
5.	Amreli	0.8	0.3	11.64	45.09	1.82	41.45
6.	Junagadh	10.7	3.7	15.23	29.41	2.33	53.03
7.	Kachchh	63.3	22.5	27.50	46.13	1.17	25.15
8.	Banaskantha	111.9	35.6	60.83	28.75	0.38	10.04
9.	Sabarkantha	251.1	70.9	72.50	18.54	0.36	8.60
10.	Mahesana	8.4	2.6	4.51	17.96	1.55	75.98
11.	Gandhinagar	1.7	0.7	0.27	29.51	0.13	70.09
12.	Ahmadabad	32.5	11.3	4.89	25.44	1.31	68.36
13.	Kheda	44.7	21.6	2.29	74.99	0.27	22.45
14.	Panchmahals	969.5	329.6	81.30	13.55	0.09	5.06
15.	Vadodara	648.3	251.9	38.66	53.23	0.26	7.85
16.	Bharuch	577.3	256.9	28.96	58.80	0.87	11.37
17.	Surat	1038.2	504.4	34.84	48.52	1.47	15.17
18.	Valsad	968.5	405.4	43.77	36.72	0.91	18.60
19.	Dangs	104.9	42.1	67.23	18.86	1.77	12.14
Gujarat State		4848.6	1966.1	45.94	40.10	0.83	13.13

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.3 : State Domestic Product and Per Capita SDP at 1970-71 Prices - Gujarat, 1960-61 to 1987-88

Year	Estimate at 1970-71 prices (Rs. crore)	Per Capita SDP at 1970-71 prices (Rs.)
1960-61	1406	689
1961-62	1546	739
1962-63	1534	717
1963-64	1637	743
1964-65	1780	788
1965-66	1652	715
1966-67	1694	715
1967-68	1854	760
1968-69	1726	690
1969-70	1900	742
1970-71	2139	829
1971-72	2256	832
1972-73	1800	650
1973-74	2202	775
1974-75	1898	652
1975-76	2439	818
1976-77	2597	851
1977-78	2745	877
1978-79	2924	914
1979-80	2795	852
1980-81	3057	904
1981-82	3419	991
1982-83	3277	931
1983-84 (P)	3617	1005
1984-85 (P)	3652	995
1985-86 (P)	3362	899
1986-87 (Q)	3567	936
1987-88 (Q)	3308	853

P = Provisional. Q = Quick Estimate.

Source: Statistical Atlas of Gujarat, Vol.II for years 1960-61 to 1979-80.
Socio-Economic Review, Gujarat, 1983-89 for years 1980-81 to 1987-88.

Table 4.9 : State Domestic Product by Industry Groups at Constant 1970-71 Prices - Gujarat

Sr. No.	Industry Group	Unit	Year								
			1970-71	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
							(P)	(P)	(P)	(Q)	(Q)
1.	Agriculture, forestry, logging, fishing, mining and quarrying	Rs.in Crores	1071 (48.9)	1193 (39.0)	1439 (42.1)	1165 (35.5)	1258 (34.8)	1322 (36.2)	892 (26.5)	941 (26.4)	506 (15.3)
2.	Manufacturing, construction, electricity, gas and water supply	"	456 (20.3)	769 (25.2)	796 (23.3)	373 (26.6)	1027 (28.4)	948 (26.0)	1025 (30.5)	1110 (31.1)	1198 (36.2)
3.	Transport, communication, trade, storage, hotels and restaurants	"	380 (17.4)	664 (21.7)	731 (21.4)	759 (23.2)	819 (22.6)	843 (23.1)	871 (25.9)	908 (25.5)	952 (28.8)
4.	Banking, insurance, real estate, ownership of dwellings and business services	"	116 (5.3)	192 (6.3)	201 (5.9)	215 (6.6)	232 (6.4)	246 (6.7)	264 (7.9)	285 (8.0)	309 (9.3)
5.	Public Administration and other services	"	166 (7.6)	239 (7.8)	252 (7.3)	265 (8.1)	281 (7.3)	293 (8.0)	310 (9.2)	323 (9.0)	343 (10.4)
6.	Total State domestic product	"	2189 (100.0)	3057 (100.0)	3419 (100.0)	3277 (100.0)	3617 (100.0)	3652 (100.0)	3362 (100.0)	3567 (100.0)	3308 (100.0)
7.	Per capita State domestic product	Rs.	829	904	991	931	1005	995	899	936	853

Source : Socio-Economic Review, Gujarat, 1988-89.

P - Provisional.
Q - Quick Estimates.

Table 4.10 : Land Utilization in Gujarat State, 1960-61 and 1983-84

	(In '00 Hectares)			
	1960-61	% of R.A.	1983-84	% of R.A.
1. Reporting area for land utilization purpose (R.A.)	18299		18325	
2. Forest	1143	6.2	1947	10.3
3. Barren and uncultivable waste	4739	25.9	2611	13.9
4. Land put to non-agricultural uses	406	2.2	1081	5.7
5. Cultivable waste	764	4.2	1963	10.4
6. Permanent Pastures and grazing land	1042	5.7	847	4.5
7. Land under tree crops	416	2.3	41	neg.
8. Current fallow	341	1.9	699	3.7
9. Other fallows	425	2.3	56	0.3
10. Net Area Sown	9397	51.3	9617	51.2
11. Gross Area Sown	9768	53.3	11150	59.2
Index of Intensity of Cropping		103.9		115.9

Source : Statistical Abstracts - Gujarat.

Table 4.11 : Land Utilization in the Districts of Gujarat
(1933-84)

Sr. No.	District	% land under forest	% land in non-agricultural use	% land under pastures	% land net sown	% land gross cropped	Index of cropping intensity
1.	Jamnagar	3.4	6.3	7.6	58.6	71.5	121.9
2.	Rajkot	3.2	6.1	7.7	63.7	75.7	118.9
3.	Surendranagar	4.4	4.0	4.3	62.5	64.0	102.5
4.	Bhavnagar	3.2	7.3	7.2	63.3	79.4	125.5
5.	Amreli	6.0	5.8	6.7	72.6	84.3	116.1
6.	Junagadh	13.7	4.8	10.7	56.9	70.9	124.6
7.	Kachchh	5.4	1.5	1.5	12.6	13.3	105.6
8.	Banaskantha	11.3	5.1	5.9	67.0	82.5	123.2
9.	Sabarkantha	17.2	5.6	4.7	59.9	69.0	115.2
10.	Mahesana	1.3	7.2	6.1	74.9	99.2	132.4
11.	Gandhinagar	-	14.8	10.4	75.4	88.4	120.1
12.	Ahmadabad	neg.	7.3	3.9	69.2	72.3	104.5
13.	Kheda	1.5	12.4	3.9	76.2	92.3	121.0
14.	Panchmahals	31.2	6.3	3.0	53.6	62.4	116.4
15.	Vadodara	10.6	8.5	4.3	69.4	71.8	103.5
16.	Bharuch	18.6	12.6	3.0	54.1	54.3	100.4
17.	Surat	18.2	7.7	3.1	51.8	55.1	106.3
18.	Valsad	24.2	7.1	1.5	57.3	63.1	110.1
19.	Dangs	98.5*	neg.	-	-	-	-
Gujarat		10.0	5.7	4.5	51.0	58.8	115.4

* Net sown area included under forest area.

Source : Statistical Abstract - Gujarat.

Table 4.12 : Districtwise Average Size of Landholding According to Agricultural Censuses 1970-71 and 1976-77 and Man-Land Ratio in 1971 and 1981

(landholding in ha.)

Sr. No.	District	Average size of holding		Man-Land Ratio*		Man-Land Ratio**	
		1970-71	1976-77	1971	1981	1971	1981
1.	Jamnagar	7.26	5.59	0.91	0.73	0.73	0.59
2.	Rajkot	7.11	5.34	0.69	0.53	0.59	0.46
3.	Surendranagar	8.44	7.19	1.24	1.01	1.02	0.84
4.	Bhavnagar	6.73	5.45	0.70	0.52	0.61	0.45
5.	Amreli	6.49	5.14	0.79	0.62	0.73	0.58
6.	Junagadh	5.51	4.17	0.64	0.50	0.50	0.40
7.	Kachchh	6.46	6.20	5.37	4.34	3.16	2.38
8.	Banaskantha	6.26	5.66	0.97	0.74	0.84	0.64
9.	Sabarkantha	2.91	2.68	0.61	0.49	0.51	0.39
10.	Mahesana	2.90	2.77	0.43	0.35	0.42	0.35
11.	Gandhinagar	2.36	2.13	0.33	0.23	0.32	0.22
12.	Ahmadabad	5.00	4.61	0.29	0.22	0.26	0.20
13.	Kheda	1.39	1.31	0.23	0.23	0.26	0.21
14.	Panchmahals	2.56	2.46	0.43	0.38	0.34	0.27
15.	Vadodara	3.04	2.75	0.39	0.30	0.35	0.27
16.	Bharuch	3.69	3.44	0.70	0.60	0.57	0.48
17.	Surat	2.98	2.78	0.43	0.31	0.30	0.23
18.	Valsad	1.90	1.75	0.36	0.29	0.26	0.21
19.	Dangs	5.13	5.16	1.33	1.52	0.51	0.02
State		4.11	3.71	0.70	0.55	0.54	0.42

* Hectares per person based on Geographical Area.

** Hectares per person based on Cultivable Area.

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.13 : Distribution of the Number and the Area of Operational Holdings by Different Size Class of Holdings in Gujarat in 1976-77 and 1980-81

(Nos. in '00; Area in '00 Hectares)

Size Class (Hectares)	No. of Operational Holdings				Area of Operational Holdings			
	1976-77		1980-81		1976-77		1980-81	
	No.	% to total	No.	% to total	No.	% to total	No.	% to total
1. Below 1	6556	25.0	7105	24.2	3238	3.3	3760	3.7
2. 1.0 - 1.99	5409	20.6	6345	21.7	7920	7.9	9296	9.2
3. 2.0 - 3.99	6517	24.8	7279	24.9	18708	18.6	20834	20.6
4. 4.0 - 9.99	6709	25.6	6856	23.4	41563	41.2	42091	41.7
5. 10 and above	1040	4.0	1716	5.8	29266	29.0	25061	24.8
Total	26231	100.0	29301	100.0	100745	100.0	101042	100.0

Source : Statistical Atlas of Gujarat, Vol. II.

Table 4.14 : Number of Major and Medium Schemes of Irrigation During Five Year Plans

Period	Spilled over from previous Plans		Newly Taken up		Total in progress		Completed	
	Major	Medium	Major	Medium	Major	Medium	Major	Medium
Pre-Plan	-	-	-	2	-	2	-	-
First Plan	-	2	3	30	3	32	-	2
Second Plan	3	30	5	19	8	49	-	16
Third Plan	8	33	-	-	8	33	1	222
Three Annual Plans	7	11	1	-	8	11	2	4
Fourth Plan	6	7	6	43	12	50	-	2
Fifth Plan	12	46*	4	13	16	59	-	13
Two Annual Plans	16	46	1	69	17	115	2	5
Sixth Plan	15	110	-	-	15	110	4	19

* Two schemes transferred to Drinking Water Schemes.

Source : Seventh Five Year Plan Gujarat 1985-1990.

Table 4.15 : Irrigation Potential Created and Utilized
(Major and Medium Irrigation Projects)

(Lakh hectares)				
Sr. No.	Plan	Irrigation Potential created during the Plan/Annual Plans	Irrigation Potential created (cumulative) at the end of Plan/Annual Plans	Utilization achieved
1.	First Plan (1951-56)	0.23	0.23	-
2.	Second Plan (1956-61)	2.25	2.48	0.66
3.	Third Plan (1961-66)	0.93	3.41	1.90
4.	Three Annual Plans (1966-69)	0.98	4.39	3.11
5.	Fourth Plan (1969-74)	1.83	6.22	4.01
6.	Fifth Plan (1974-78)	3.02	9.24	5.01
7.	Two Annual Plans (1978-80)	0.88	10.12*	5.29
8.	Sixth Plan (Estimated) (1980-85)	2.19	10.81	

* Reappraised in 1979-80 at 8.62 lakh hectares.

Source : Seventh Five Year Plan Gujarat 1985-1990.

Table 4.16 : Groundwater Potential of Gujarat

Sr. No.	Name of District	Total groundwater resources (MCM/Yr)	Provision for domestic and industrial uses (MCM/Yr)	Utilisable groundwater resources (MCM/Yr)	Gross draft (MCM/Yr)	Net draft (MCM/Yr)	Balance (MCM/Yr)	Level of groundwater development (%)
1.	Ahmedabad	1254.15	188.13	1066.02	352.13	246.49	819.53	23.12
2.	Amreli	822.69	123.41	699.29	571.64	400.15	299.14	57.22
3.	Banaskantha	1450.19	217.53	1232.64	582.29	407.60	825.04	33.07
4.	Baroda	1136.47	177.98	1008.50	209.07	146.35	862.15	14.51
5.	Bhavnagar	1329.76	199.46	1130.26	598.47	418.92	711.34	37.06
6.	Bharuch	840.16	126.03	714.13	99.22	69.46	644.67	9.73
7.	Bulsar	1143.18	171.48	971.70	194.63	136.24	835.46	14.02
8.	Dang	144.28	21.64	122.64	1.23	0.86	121.78	0.70
9.	Gandhinagar	122.84	18.43	104.41	45.40	31.78	72.63	30.44
10.	Jamnagar	993.55	149.03	844.50	535.33	374.74	469.76	44.37
11.	Junagadh	1251.11	187.67	1063.44	723.85	506.64	556.80	47.64
12.	Kheda	1602.58	240.39	1362.19	308.27	215.77	1146.42	15.84
13.	Kutch	802.93	120.42	682.51	281.58	197.10	485.41	28.88
14.	Panchmahal	1116.03	167.40	948.63	222.42	155.64	792.99	16.40
15.	Rajkot	1351.68	204.25	1157.42	913.26	639.27	518.15	55.23
16.	Sabarkantha	1263.69	189.32	1079.14	667.21	467.03	607.11	43.47
17.	Surat	1960.21	294.05	1666.16	232.04	162.41	1503.75	9.75
18.	Surendranagar	867.24	130.08	737.16	393.97	275.75	461.41	37.41
19.	Mehsana	864.30*	129.64	734.66	690.61	483.42	251.24	65.80
Total for Gujarat		20377.04	3056.34	17320.40	7622.62	5335.62	11984.78	30.81

* Excluding a leakage of 463.44 MCM from the unconfined aquifer during the non-monsoon period.

Source : Report of the Group on the Estimation of Groundwater Resource and Irrigation Potential from Groundwater in Gujarat State.

Table 4.17 : Net Area Irrigated by Sources in Gujarat State,
1960-61 to 1983-84

Year	(100 Hectares)						
	Canal		Wells including Tubewells		Tanks	Other	Total
	Ha.	%	Ha.	%			
1960-61	658	9.6	5677	83.1	128	356	6829
1961-62	1054	14.1	5903	78.7	181	363	7501
1962-63	961	14.4	5318	79.9	183	197	6659
1963-64	975	13.6	5711	79.8	183	288	7157
1964-65	1221	13.8	6997	79.2	326	293	8837
1965-66	1404	13.5	8625	82.8	296	87	10412
1966-67	1673	16.5	8064	79.3	325	105	10167
1967-68	1989	17.9	8661	78.2	339	92	11081
1968-69	1958	17.0	9173	79.8	275	93	11499
1969-70	2065	17.1	9617	79.6	297	106	12085
1970-71	2365	17.3	10831	79.0	372	141	13709
1971-72	2303	16.4	11165	79.3	402	203	14073
1972-73	1934	14.4	10933	81.5	355	192	13414
1973-74	2425	17.3	11192	79.9	254	145	14016
1974-75	2266	16.8	10909	80.8	198	126	13499
1975-76	2844	18.8	11900	78.6	252	148	15144
1976-77	3043	19.4	12227	78.0	321	80	15671
1977-78	3268	19.1	13458	78.5	330	93	17149
1978-79	3257	18.3	14109	79.2	349	97	17812
1979-80	3451	17.9	15395	79.7	394	86	19326
1980-81	3668	18.3	15884	79.3	409	65	20026
1981-82	4211	19.5	16896	78.4	399	48	21554
1982-83	4306	19.2	17634	78.7	412	50	22402
1983-84	4892	21.5	17370	76.5	407	40	22709

Source: Statistical Atlas of Gujarat for 1960-61 to 1979-80.

Statistical Abstract Gujarat for years 1980-81 to 1983-84.

Table 4.13 : Percentage Shares of Major Crops in Gross Cropped Area in Gujarat Average for 1962-65, 1970-73 and 1980-83

	1962-65	1970-73	1980-83
Rice	5.96	5.17	5.31
Wheat	4.56	5.75	7.34
Jowar	15.66	13.38	10.34
Maize	2.59	3.00	3.39
Bajra	15.42	19.91	15.39
Ragi	0.70	0.59	0.53
Barley	0.06	0.08	0.07
Cereals	44.95	47.37	42.37
Gram	1.15	0.54	1.13
Tur	0.97	0.93	2.48
Pulses	2.12	1.52	3.61
Foodgrains	47.08	49.39	45.97
Groundnut	23.04	19.92	23.37
Sesamum	1.25	1.31	1.19
Rape and Mustard	0.39	0.43	1.72
Castor	0.75	0.57	1.31
Oilseeds	25.42	22.23	28.09
Cotton	19.30	19.70	16.82
Sugarcane	0.29	0.42	0.93
Tobacco	0.90	0.93	1.26
Other	7.00	7.28	6.93
Total	100.00	100.00	100.00

Source : G.S. Bhalla and D.S. Tyagi, "Spatial Pattern of Agricultural Development in India," Economic and Political Weekly, June 24, 1989, p. A-48.

Table 4.19 : Districtwise Crop Pattern Gujarat State, 1960-61 and 1986-87*

Sr. No.	District	Gross sown area	(Area in '00 Hectares)							
			Rice	Wheat	Jowar	Bajri	Total Cereals	Total pulses	Groundnut	Cotton
<u>1960-61</u>										
1.	Jamnagar	15730	(0.5)	(2.4)	2670 (13.7)	(13.7)	(35.1)	(0.6)	(55.9)	(4.8)
2.	Rajkot	17382	(0.9)	(3.1)	2110 (17.4)	(11.1)	(31.7)	(0.9)	(49.4)	(13.5)
3.	Surendranagar	16529	(0.01)	(2.6)	1860 (18.6)	(16.6)	(39.2)	(1.2)	(10.2)	46.0
4.	Bhavnagar	16250	(0.5)	(5.6)	1910 (19.1)	(19.4)	(44.7)	(1.2)	(38.0)	(4.5)
5.	Amreli	4930	(0.3)	(2.6)	1220 (14.9)	(19.4)	(37.8)	(1.1)	(48.4)	(1.7)
6.	Junagadh	6168	(2.0)	(2.5)	770 (11.6)	(15.2)	(31.4)	(0.7)	(45.5)	(10.7)
7.	Kachchh	5622		(1.4)	1110 (16.0)	(19.7)	(37.2)	19.6	(4.6)	(13.7)
8.	Banaskantha	7459	(0.2)	(3.9)	1110 (14.7)	(44.9)	(67.6)	(9.8)	(1.3)	(2.1)
9.	Sabarkantha	4693	(6.9)	(5.1)	510 (5.1)	(8.4)	(40.7)	(2.1)	(26.8)	(23.7)
10.	Mahesana	17283	(1.1)	(10.3)	1770 (17.9)	(26.2)	(53.8)	(6.1)	(4.9)	(11.4)
11.	Gandhinagar	-								
12.	Ahmadabad	18336	(4.2)	(10.7)	1210 (13.1)	(7.5)	(36.3)	(1.3)	(9.6)	(41.4)
13.	Kheda	5434	(13.0)	(5.0)	110 (1.4)	(16.4)	(48.0)	(5.3)	(9.0)	(12.8)
14.	Panchmahals	5232	23.6	(1.7)	110 (2.7)	(3.8)	(66.3)	(9.5)	(14.2)	(4.7)
15.	Vadodara	5537	(13.0)	(0.9)	110 (11.4)	(2.6)	(34.0)	(6.1)	(6.1)	(42.6)
16.	Bharuch	4537	(6.1)	(3.0)	110 (15.1)	(1.4)	(27.7)	(6.9)	(3.9)	(51.4)
17.	Surat	8000	(16.8)	(1.4)	110 (12.8)	(neg.)	(36.9)	(10.2)	(4.3)	(20.1)
18.	Valsad	-								
19.	Dangs	380	(18.2)	(neg.)	(neg.)	neg.	(57.8)	(14.6)		1
20.	State	297680	5.5	3.7	13.5	14.7	42.2	5.2	20.3	18.5

Note: *Gross sown area in 1960-61 was 97.68 lakh hectares, it was 111.5 lakh hectares in 1983-84. The final forecast of gross sown area was 95.0 lakh hectares in 1983-84, and in 1986-87 it was 80.0 lakh hectares because of drought conditions. (continued)

Table 4.19 : (continued)

Sr. No.	District	Gross sown area	Rice	Wheat	Jowar	Bajri	Total Cereals	Total Pulses	Groundnut	Cotton
<u>1986-87</u>										
1.	Jamnagar	5908	2(neg.)	44 (0.7)	702(11.9)	842(14.3)	(27.0)	370 (6.3)	3785(64.1)	299. (5.1)
2.	Rajkot	6655	4(neg.)	43 (0.6)	479 (7.2)	770(11.6)	(19.6)	103 (1.5)	3609(54.2)	1450(21.8)
3.	Surendranagar	5705	2(neg.)	85 (1.5)	1013(17.8)	716(12.6)	(31.8)	183 (3.2)	237(4.2)	3301(57.9)
4.	Bhavnagar	5291	7 (0.1)	77 (1.5)	676(12.8)	1384(26.2)	(40.8)	128 (2.4)	1908(36.1)	836(15.8)
5.	Amreli	4750	2(neg.)	115 (2.4)	441 (9.3)	719(15.1)	(27.3)	27 (0.6)	2927(61.6)	234 (4.9)
6.	Junagadh	5048	17 (0.3)	218 (4.3)	132 (2.6)	409 (8.1)	(15.7)	88 (1.7)	3833(75.9)	228 (4.5)
7.	Kachchh	4473	-	127 (2.8)	950(21.2)	805(18.0)	(42.1)	941(21.0)	831(18.6)	495(11.1)
8.	Banaskantha	7261	-	370 (5.1)	1066(14.7)	3072(42.3)	(64.0)	674 (9.3)	19 (0.3)	248 (3.4)
9.	Sabarkantha	4192	164 (3.9)	219 (5.2)	51 (1.2)	458(10.9)	(43.1)	630(15.0)	399 (9.5)	1039(24.3)
10.	Mahesana	4952	55 (1.1)	468 (9.5)	1015(20.5)	1099(22.2)	(54.5)	187 (3.8)	18 (0.4)	676(13.7)
11.	Gandhinagar	389	40(10.3)	60(15.4)	-	140(36.0)	(62.0)	13 (3.3)	-	5 (1.3)
12.	Ahmedabad	3669	356 (9.7)	359 (9.8)	455(12.4)	620(16.9)	(49.1)	162 (4.4)	4 (0.1)	1310(35.7)
13.	Kheda	4714	1089(23.1)	426 (9.0)	25 (0.5)	1230(26.1)	(63.6)	208 (4.4)	201 (4.3)	321 (6.8)
14.	Panchmahals	4705	925(19.7)	130 (3.8)	61 (1.3)	235 (5.0)	(77.4)	569(12.1)	139 (3.0)	278 (5.9)
15.	Vadodara	4809	570(11.9)	123 (2.6)	388 (8.1)	170 (3.5)	(32.3)	909(18.9)	102 (2.1)	1927(40.1)
16.	Bharuch	3431	204 (5.9)	126 (3.7)	584(17.0)	75 (2.2)	(31.0)	1452(42.3)	36 (1.0)	805(23.5)
17.	Surat	2825	597(21.1)	97 (3.4)	733(25.9)	-	(52.9)	538(19.0)	179(6.3)	210 (7.4)
18.	Valsad	1446	996(68.9)	14 (1.0)	44 (3.0)	-	(82.0)	141 (9.8)	5 (0.3)	-
19.	Dangs	428	81(18.9)	-	6 (1.4)	-	(80.4)	70(16.4)	13 (3.0)	-
20.	State	80651	5111 (6.3)	3151 (3.9)	8821(10.9)	12744(15.8)	(42.6)	7079 (8.8)	18245(22.6)	13662(16.9)

Figures in brackets indicate percentage to gross sown area in the respective district.

Source : Statistical Abstract - Gujarat for 1960-61
Director of Agriculture - Gujarat for 1986-87.

Table 4.20 : Ranking of Districts of Gujarat According to the Relative Importance of Selected Crops in Their Cropping Patterns in 1960-61 and 1986-87.

Sr. No.	District	1960-61				1986-87				
		Foodgrains	Cotton	Oilseeds	Tobacco	Foodgrains	Cotton	Oilseeds	Sugarcane	Tobacco
1.	Jamnagar	14	12	1	-	16	13	3	neg.	-
2.	Rajkot	16	8	2	-	18	6	4	neg.	-
3.	Surendranagar	10	2	8	-	15	1	neg.	neg.	-
4.	Bhavnagar	8	14	5	-	14	7	5	neg.	-
5.	Amreli	12	16	3	-	17	14	2	neg.	-
6.	Junagadh	17	11	4	neg.	19	15	1	3	-
7.	Kachchh	5	7	13	-	9	9	8	neg.	-
8.	Banaskantha	1	15	16	neg.	5	16	9	neg.	neg.
9.	Sabarkantha	9	5	6	neg.	11	4	10	neg.	-
10.	Mahesana	4	10	12	3	10	8	7	neg.	neg.
11.	Gandhinagar	-	-	-	-	8	-	6	-	-
12.	Ahmadabad	13	4	9	neg.	12	3	11	neg.	neg.
13.	Kheda	6	9	10	1	7	11	12	neg.	1
14.	Panchmahals	2	13	7	neg.	3	12	14	neg.	neg.
15.	Vadodara	11	3	11	2	13	2	15	neg.	2
16.	Bharuch	15	1	15	neg.	4	5	16	neg.	neg.
17.	Surat	7	6	14	neg.	6	10	13	1	-
18.	Valsad	N.A.	N.A.	N.A.	N.A.	2	-	neg.	2	-
19.	Dangs	3	-	-	-	1	-	neg.	-	-

Source : Statistical Abstract Gujarat for 1960-61, Director of Agriculture Gujarat for 1986-87.

Table 4.21 : Gross Cropped Area and Gross Irrigated Area in Gujarat, 1960-61 to 1983-84

(In '00 hectares)			
Year	Gross Cropped area	Gross Irrigated area	Percentage of gross irrigated area to gross cropped area
1960-61	97676	7338	7.51
1961-62	101271	7889	7.79
1962-63	99764	6972	6.99
1963-64	98867	7406	7.49
1964-65	101339	9134	9.01
1965-66	101831	10722	10.52
1966-67	101995	10573	10.37
1967-68	104204	11657	11.19
1968-69	101818	12409	12.19
1969-70	100447	13071	13.01
1970-71	105403	14939	14.17
1971-72	105276	15247	14.48
1972-73	103087	15212	14.83
1973-74	105415	15913	15.10
1974-75	88998	15232	17.12
1975-76	105494	17091	16.20
1976-77	104041	17741	17.05
1977-78	104385	19358	18.54
1978-79	104536	20204	19.32
1979-80	106550	22114	20.75
1980-81	107459	23344	21.72
1981-82	109541	25227	23.03
1982-83	109978	26143	23.77
1983-84	111497	27974	25.09

Source: Statistical Atlas of Gujarat, Vol. II for years 1960-61 to 1979-80.
Statistical Abstract Gujarat for years 1980-81 to 1983-84.

Table 4.22 : Irrigation in Different Districts of Gujarat
1960-61 and 1983-84

	% GCA under irriga- tion 1960-61	% of GCA under irriga- tion 1983-84	Gross irri- gated area 1983-84 ('00 ha)	% of GIA [@] Serviced by wells and tubewells
1. Jamnagar	5.24	24.05	1748	97.2
2. Rajkot	5.68	26.97	2276	80.5
3. Surendranagar	2.29	14.35	961	82.9
4. Bhavnagar	9.47	27.09	2107	66.5
5. Amreli	7.30	17.49	991	91.3
6. Junagadh	12.03	24.12	1807	96.0
7. Kachchh	17.25	10.86	814	80.2
8. Banaskantha	7.74	26.05	2652	91.5
9. Sabarkantha	9.78	31.98	1611	93.9
10. Mahesana	19.03	42.62	3812	97.0
11. Gandhinagar	11.45*	45.23	261	100.0
12. Ahmedabad	7.61	22.29	1374	64.1
13. Kheda	7.45	49.34	3138	69.5
14. Panchmahals	2.14	12.11	669	50.9
15. Vadodara	2.53	25.34	1416	92.7
16. Bharuch	1.08	9.58	406	70.5
17. Surat	2.46	29.78	1273	21.3
18. Valsad	3.23**	20.18	656	44.9
19. Dangs	neg.	0.38	2	100.0
Gujarat State	7.51	25.09	27974	67.6

* In 1964-65

** In 1962-63

@ In 1979-80

GCA = Gross cropped area.

Source : Statistical Abstract Gujarat.

Season and Crop Report, Gujarat, 1979-80.

Table 4.23 : Cropping Pattern for Irrigated Agriculture in Gujarat for Selected Years

Year	Percentage to gross irrigated area								
	Rice	Wheat	Jowar	Bajri	Cotton	Ground-nut	Tobacco	Sugar-cane.	Others
1960-61	9.06	29.74	4.40	5.32	14.34	2.98	2.09	3.52	28.55
1965-66	8.96	31.89	5.29	3.95	18.14	1.08	1.68	3.69	25.32
1970-71	11.04	27.70	2.56	4.64	23.78	1.46	2.52	2.60	23.70
1975-76	8.70	22.71	1.96	5.93	26.26	1.60	3.31	2.82	26.71
1980-81	8.57	20.30	1.44	6.03	19.00	7.94	3.42	4.21	29.09
1983-84	9.53	21.29	1.08	4.94	14.92	9.62	2.83	4.07	31.72

Source : Statistical Atlas of Gujarat for years 1960-61 to 1975-76.

Statistical Abstract of Gujarat for years 1980-81 to 1983-84.

Table 4.24 : Districtwise Cropping Pattern for Irrigated Agriculture in Gujarat, 1960-61 and 1983-84

District	(Per cent of gross irrigated area)					
	Rice		Wheat		Jowar	
	1960-61	1983-84	1960-61	1983-84	1960-61	1983-84
1. Jamnagar	9.20	0.17	29.7	23.74	2.6	0.28
2. Rajkot	15.75	0.31	53.94	37.57	-	-
3. Surendranagar	4.60	1.04	33.56	8.43	5.27	0.70
4. Bhavnagar	5.41	0.85	38.51	23.35	14.70	0.43
5. Amreli	11.67	0.71	36.11	47.63	9.17	0.71
6. Junagadh	16.87	1.33	19.32	39.90	10.61	2.05
7. Kacheh	-	-	8.14	17.69	4.74	0.51
8. Banaskantha	-	-	50.81	15.27	1.44	2.52
9. Sabarkantha	1.96	3.29	49.02	26.57	-	0.12
10. Mahesana	1.73	1.05	31.89	18.34	2.74	0.71
11. Gandhinagar	-	10.73	-	27.20	-	-
12. Ahmadabad	33.72	51.82	26.92	16.59	-	-
13. Kheda	13.77	33.52	14.07	12.68	1.73	0.06
14. Panchmahals	5.31	17.94	46.90	32.59	-	0.45
15. Vadodara	12.86	5.65	23.57	6.99	2.14	3.18
16. Bharuch	22.92	2.96	4.17	17.24	8.33	8.13
17. Surat	17.77	20.19	5.58	7.93	1.52	4.24
18. Valsad	-	37.04	-	5.79	-	-
19. Dangs	-	-	-	100.00	-	-
State	9.06	9.53	29.74	21.29	4.40	1.08

(continued)

Table 4.24 : (continued)

District	Bajri		Cotton		Groundnut	
	1960-61	1983-84	1960-61	1983-84	1960-61	1983-84
1. Jamnagar	3.63	0.91	16.50	2.44	-	28.48
2. Rajkot	-	1.19	6.44	23.81	-	11.29
3. Surendranagar	-	2.29	42.76	80.75	1.31	2.08
4. Bhavnagar	0.17	-	2.53	20.88	1.52	30.56
5. Amreli	-	-	-	13.32	1.11	10.80
6. Junagadh	11.16	1.49	17.82	3.76	0.14	23.41
7. Kachchh	23.81	15.36	30.21	3.44	20.93	40.66
8. Banaskantha	0.36	8.56	1.08	1.85	-	0.04
9. Sabarkantha	0.44	3.54	29.19	41.59	-	0.74
10. Mahesana	1.08	11.02	13.49	7.56	-	0.47
11. Gandhinagar	-	9.96	-	1.53	-	-
12. Ahmadabad	0.21	2.04	15.53	6.26	-	0.15
13. Kheda	10.12	9.78	-	1.91	-	9.27
14. Panchmahals	2.65	7.62	-	6.43	-	4.48
15. Vadodara	1.43	3.11	27.86	50.07	-	2.19
16. Bharuch	-	1.23	37.50	32.51	-	1.48
17. Surat	-	-	6.09	8.25	-	1.34
18. Valsad	-	-	-	-	-	0.30
19. Dangs	-	-	-	-	-	-
State	5.32	4.94	14.34	14.92	2.98	9.62

(continued)

Table 4.24 : (continued)

District	Tobacco		Sugarcane		Others	
	1960-61	1983-84	1960-61	1983-84	1960-61	1983-84
1. Jamnagar	-	-	6.27	2.17	32.01	41.76
2. Rajkot	-	-	8.83	5.93	15.04	19.90
3. Surendranagar	-	-	0.66	0.60	11.84	4.06
4. Bhavnagar	-	-	8.28	1.33	28.89	21.74
5. Amreli	-	-	13.61	8.48	28.33	18.37
6. Junagadh	-	-	4.49	8.19	19.59	19.87
7. Kachchh	-	-	0.21	0.37	11.96	21.99
8. Banaskantha	-	0.45	2.69	0.45	43.63	70.85
9. Sabarkantha	-	0.12	0.44	0.37	18.95	23.65
10. Mahesana	2.16	1.05	0.5	0.05	46.39	59.26
11. Gandhinagar	-	0.38	-	-	-	50.19
12. Ahmadabad	0.41	-	0.62	0.66	17.60	22.49
13. Kheda	23.21	17.21	-	0.29	32.10	15.26
14. Panchmahals	3.54	2.99	2.65	0.30	38.94	27.20
15. Vadodara	16.43	12.50	0.71	0.21	15.00	16.10
16. Bharuch	-	-	-	1.23	27.08	35.22
17. Surat	-	-	18.78	41.01	50.25	17.05
18. Valsad	-	-	-	19.21	-	37.65
19. Dangs	-	-	-	-	-	-
State	2.09	2.83	3.52	4.07	28.55	31.72

Source : Statistical Atlas of Gujarat for 1960-61.

Statistical Abstract of Gujarat for 1983-84.

Table 4.25 : Other Important Food Crops and Non-Food Crops in Irrigated Agriculture in Different Districts of Gujarat in 1979-80

Sr. No.	District	Total Irrigated area ('00 ha.)	% food crop	% non-food crop	Other important irrigated crops
1.	Jamnagar	1449	46.1	53.9	Chillies (1.2), Cumin (2.1), garlic (13.7), mustard (4.1), fodder crops (11.8)
2.	Rajkot	1632	46.8	53.2	Cumin (1.8), garlic (1.3), onion (1.5), mustard (1.0), fodder crops (6.6)
3.	Surendranagar	712	11.2	88.8	Fodder crops (3.4)
4.	Bhavnagar	1193	40.6	59.4	Chillies (2.3), cumin (2.4), fruits (2.8), onion (2.9), vegetables (5.0), fodder crops (7.0)
5.	Amreli	644	67.2	32.8	Chillies (1.9), cumin (2.0), fodder crops (6.5)
6.	Junagadh	1101	66.6	33.4	Chillies (1.2), cumin (1.0), banana (1.2), mango (2.4)
7.	Kachchh	718	44.1	55.9	Castor (1.3), fodder crops (7.1)
8.	Banaskantha	2222	59.0	41.0	Cumin (14.6), mustard (20.6), castor (5.3), Isabgul (6.2), fodder crops (4.0)
9.	Sabarkantha	1578	42.5	57.5	Castor (1.7), fodder crops (3.3)
10.	Mahesana	3413	50.2	49.8	Chillies (1.1), cumin (7.5), Rape (1.5), mustard (17.2), castor (8.9), Isabgul (3.9), fodder crops (5.9)
11.	Gandhinagar	241	56.0	44.0	Chillies (2.5), mustard (4.1), castor (14.5), fodder crops (10.8)
12.	Ahmadabad	995	81.8	18.2	Castor (3.2), fodder crops (3.0)

(continued)

Table 4.25 : (continued)

Sr. No.	District	Total Irrigated area ('00 ha.)	% food crop	% non-food crop	Other important irrigated crops
13.	Kheda	2434	64.0	36.0	Sauer lime (1.0), fodder crops (2.3)
14.	Panchmahals	411	81.3	18.7	Chillies (2.7)
15.	Vadodara	1131	35.8	64.2	Banana (2.8), fodder crops (2.7)
16.	Bharuch	440	40.5	59.5	Banana (5.7)
17.	Surat	1211	81.1	18.9	-
18.	Valsad	537	98.0	2.0	Chillies (3.0), banana (3.2), mango (20.5), chikku (4.3), Brinjal (3.4)
19.	Dangs	2	100.0	-	Chillies (50.0)
Gujarat State		22114	54.8	45.2	Cumin (3.2), garlic (1.0), spices and condiments (6.2), vegetables and fruits (2.8), mustard (5.2), castor (2.4), Isabgul (1.3), fodder crops (5.0)

Note : Figures in brackets indicate area under a crop as a percentage to gross irrigated area in the respective district.

Source : Season and Crop Report - Gujarat 1979-80.

Table 4.26 : Area, Production and Yield Per Hectare of Important Food and Non-Food Crops in Gujarat for the Years 1960-61 to 1984-85

(Area in hundred Hectares, Production in hundred M.Tonnes and yield per hectare in kg.)

Year	Rice			Wheat			Jowar			Bajri			Total Cereals		
	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.
1960-61	5332	2917	547	3577	2716	759	13150	2216	168	14349	4793	334	41206	17191	417
1961-62	5629	5120	910	4209	3776	897	13074	3212	246	14396	5415	376	42462	23532	554
1962-63	5446	4002	735	3617	2798	774	13151	4488	341	13902	5371	386	40877	21458	525
1963-64	5381	4990	927	4301	3628	844	15664	4281	273	14400	7743	538	44548	25085	563
1964-65	5487	4710	858	4441	4159	937	13085	4074	311	14831	8883	599	42625	26924	632
1965-66	5362	2553	476	5150	5537	1075	12921	3382	262	16516	7803	472	44842	22838	509
1966-67	5064	2988	590	4270	4576	1072	13882	3652	264	17757	8539	481	46123	22815	495
1967-68	5074	4633	913	5538	6870	1241	13427	4233	315	18670	12392	664	48210	33562	696
1968-69	4946	3692	747	4936	5902	1196	13588	3349	246	18507	7731	418	47429	23420	494
1969-70	4699	4399	936	4307	5951	1381	13479	3755	278	20205	13466	667	47976	32015	667
1970-71	5111	6306	1234	6473	9735	1504	13046	6014	461	21111	17991	868	50865	46428	913
1971-72	5161	5595	1084	5247	8082	1540	10957	4471	408	18111	15202	866	44461	39541	889
1972-73	4870	2562	526	3754	5554	1479	11117	2281	205	19098	8562	469	43717	22692	519
1973-74	4434	4722	1065	5378	8360	1554	12019	5295	441	21488	14872	723	48504	37057	764
1974-75	3966	2136	809	3662	6457	1763	10284	3212	312	15038	4460	313	38232	19523	510
1975-76	4639	5967	1286	6037	9825	1627	12363	6095	493	18452	12821	695	47347	42381	895
1976-77	4740	5649	1192	6014	8630	1435	11064	6432	581	14153	11314	799	41632	36165	869
1977-78	5124	7238	1413	5598	9619	1718	10981	5584	309	13829	9674	700	40941	35407	865
1978-79	5291	6128	1158	5523	10529	1906	10826	6234	576	14537	14482	996	41656	41791	1003
1979-80	5502	5162	938	6425	11631	1810	10970	6374	581	14322	13657	954	42628	39772	933
1980-81	5750	6810	1185	6170	12760	2069	10920	6870	629	15020	12270	817	43240	44380	1026
1981-82	6100	9200	1508	6760	13580	2009	11060	6600	597	15150	15050	995	44450	50150	1128
1982-83	5910	6150	1041	6380	14400	2255	11300	5440	481	14900	12080	811	43780	42450	970
1983-84	5403	7543	1396	7412	15260	2194	9496	5820	613	14366	16073	1119	41524	51840	1248
1984-85	5661	8382	1480	6369	13293	2087	8744	4997	571	13726	15353	1119	39182	47011	1200

(continued)

Table 4.26 : (continued)

Year	Total Pulses			Total Foodgrains			Groundnut			Cotton*			Tobacco		
	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.	Area	Prod.	Yield/ ha.
1960-61	5117	1692	331	46323	18883	408	19816	12137	612	18026	14764	139	926	648	700
1961-62	5841	2124	364	48303	25656	531	22652	14797	653	16986	13582	136	921	841	913
1962-63	4870	1852	380	45747	23310	510	23444	11669	498	17447	17178	165	822	858	1044
1963-64	4748	1920	404	49296	27005	548	18470	12666	686	17432	14043	137	822	771	938
1964-65	4753	1877	395	47378	28801	608	21431	16463	768	18455	16463	152	906	904	998
1965-66	4246	1326	312	49088	24164	492	20658	9447	457	17510	14905	145	824	758	920
1966-67	4265	1315	308	50389	24130	479	19571	9123	466	17263	14923	147	908	862	949
1967-68	5293	2044	386	53503	35606	665	19420	14087	725	16397	16044	166	944	1004	1064
1968-69	4372	1183	271	51801	24603	474	18746	8646	461	17005	15474	154	865	921	1065
1969-70	4468	1463	327	52444	33478	638	16569	10400	628	17377	17387	170	965	1054	1093
1970-71	4962	2013	406	55827	48441	868	17776	18686	1053	17450	19041	186	806	1033	1281
1971-72	4330	1697	351	49291	41238	837	19965	17449	879	22044	28880	223	879	1201	1366
1972-73	4208	1202	286	47925	23894	499	19487	3786	195	21477	17208	136	962	1180	1227
1973-74	5094	1864	366	53598	38921	726	17002	13412	789	19907	18373	157	810	1160	1430
1974-75	3567	1052	295	41849	20575	492	16136	4845	300	17459	16157	157	578	861	1487
1975-76	5945	2077	349	53292	44458	834	17745	21904	1234	18592	17584	161	907	1421	1569
1976-77	6139	3363	548	47771	39528	827	20766	20744	999	18556	17615	161	1245	2075	1665
1977-78	5903	2922	495	46844	38329	818	20515	18594	906	19696	20366	176	1256	1917	1527
1978-79	6685	3616	541	48341	45407	939	20855	16139	774	18222	21453	200	1217	2396	1967
1979-80	7133	3717	521	49761	43489	874	21081	18557	880	17166	17966	178	1254	1814	1447
1980-81	7940	5200	655	51180	49580	969	21790	16160	741	15660	17380	189	1310	1910	1460
1981-82	8610	5560	647	53060	55710	1050	21780	21760	999	15140	20400	229	1200	2630	2192
1982-83	9160	5640	616	52940	48090	908	21050	12850	610	15120	16290	138	1070	1300	1751
1983-84	8021	5587	697	49545	57427	1159	21496	18101	842	13990	14444	176	1083	1869	1688
1984-85	8286	5560	671	47468	52571	1107	20611	15923	763	13834	20683	254	1084	1735	1600

* Production in 100 bales of 170 kg each.

Source : Statistical Atlas of Gujarat for 1960-61 to 1979-80.
Statistical Abstract Gujarat for 1980-81 to 1984-85.

Table 4.27 : Indices of Area, Production, Yield of Important Crops in Gujarat State for Selected Years

(Triennium ending 69-70 = 100)

Year	Rice	Wheat	Jowar	Bajri	Total cereals	Total pulses	Total food-grains	Ground-nut	Cotton	Tobacco
<u>Area</u>										
1960-61	108.68	72.60	97.43	75.02	86.08	108.62	88.09	108.61	106.50	100.14
1970-71	104.17	131.38	96.66	110.37	106.25	105.33	106.18	97.43	103.09	87.17
1980-81	117.20	125.10	80.90	78.50	90.30	168.50	97.30	119.40	92.50	141.30
1984-85	115.40	129.30	64.80	71.80	81.80	175.91	90.30	113.00	81.70	117.20
1987-88	70.60	39.10	38.90	41.10	46.30	102.50	51.30	57.60	42.50	88.10
Average 85-86 - 87-88	91.66	63.56	56.83	58.80	64.47	137.77	71.00	85.30	68.70	107.47
<u>Production</u>										
1960-61	68.75	43.46	58.64	42.80	57.93	108.23	60.47	109.89	90.57	70.49
1970-71	148.63	155.76	159.13	160.66	155.96	128.76	155.11	169.19	116.80	129.00
1980-81	160.51	204.16	181.78	109.60	151.90	338.20	162.90	146.30	118.80	192.20
1984-85	197.56	212.80	132.22	137.10	162.50	362.30	174.20	142.40	133.80	174.70
1987-88	65.90	56.30	33.10	30.90	42.80	96.00	45.90	12.70	20.40	122.70
Average 85-86 - 87-88	92.73	95.90	63.97	59.77	74.53	157.27	79.53	56.77	74.47	125.27
<u>Yield</u>										
1960-61	63.21	59.64	60.07	57.29	67.37	100.91	68.88	101.21	85.10	65.18
1970-71	142.60	113.13	164.84	148.88	147.50	123.78	146.54	174.15	113.88	119.27
1980-81	136.90	162.60	224.90	140.10	165.80	199.90	163.60	122.55	120.90	135.90
1984-85	171.03	163.99	204.17	191.94	193.86	204.57	186.89	126.19	163.60	148.98
1987-88	93.10	143.40	85.10	75.50	88.90	90.30	85.30	22.00	48.00	139.20
Average 85-86 - 87-88	100.26	150.33	108.83	98.87	110.13	109.53	105.70	60.13	98.37	146.33

Table 4.28 : Districtwise Productivities of Important Crops in Gujarat in 1933-34

(Kg. per ha.)

Sr. No.	District	Rice	Wheat	Jowar	Bajri	Pulses	Groundnut	Cotton	Tobacco
1.	Jamnagar	1667	2364	107	792	675	546	195	-
2.	Rajkot	2000	2966	1028	877	716	542	148	-
3.	Surandranagar	1944	1837	133	531	548	1023	131	-
4.	Bhavnagar	2083	2610	673	1394	547	1267	280	-
5.	Amreli	2143	2819	465	1107	708	1011	165	-
6.	Junagadh	1957	3233	819	1018	1606	846	255	-
7.	Kachchh	-	2590	333	1144	772	860	92	-
8.	Banaskantha	1400	2134	1108	1076	392	1000	145	1000
9.	Sabarkantha	1366	1959	1074	789	568	1053	289	2000
10.	Mahesana	1080	2486	683	1416	670	1123	149	1714
11.	Gandhinagar	1280	2600	-	1149	733	1000	425	2000
12.	Ahmadabad	1673	771	164	934	754	1000	102	1727
13.	Kheda	1481	2573	1038	1292	637	1605	188	1705
14.	Panchmahals	996	2009	1000	1457	763	993	207	1762
15.	Vadodara	871	570	1147	1410	717	1005	267	1798
16.	Bharuch	944	703	839	1054	601	1000	145	1500
17.	Surat	1852	2420	1015	1400	686	1000	223	-
18.	Valsad	1747	2607	1083	-	674	1048	200	-
19.	Dangs	1091	-	1000	-	681	923	-	-

Source : Statistical Abstract - Gujarat.

Table 4.29 : Districtwise Abstract of Information on Arid and Semi-Arid Zones of Gujarat

District	Area (in Sq.kms.)	No. of taluka under Zone	Total Area (in Sq.kms.) Under Zone	% in District	% of Gujarat
<u>ARID ZONE</u>					
1. Jamnagar	14125.0	8	7814.3	55.32	
2. Kutch	45612.0	9	41076.5	90.49	
Total	59737.0	17	48890.8		24.94
<u>SEMI-ARID ZONE</u>					
1. Rajkot	11203.0	10	8242.0	73.56	
2. Surendranagar	10438.0	3	3556.1	33.90	
3. Bhavnagar	11155.0	12	9738.3	87.74	
4. Amreli	6760.0	10	6711.5	99.27	
5. Junagadh	10607.0	13	7051.9	66.48	
6. Banaskantha	12702.0	6	6124.2	48.21	
7. Sabarkantha	7390.0	5	3520.7	47.63	
8. Mehsana	9027.0	8	5608.3	62.12	
9. Gandhinagar	649.0	1	649.0	100.00	
10. Bharuch	9045.0	4	2844.6	31.44	
11. Panchmahals	8866.0	3	3104.2	35.01	
12. Ahmedabad	8707.0	7	8565.9	98.38	
Total		82	65766.7		33.56

Source : Agriculture Information Technical Bulletin No. 111.
Directorate of Agriculture, Gujarat.

Table 4.30 : Area, Production and Yield Per Hectare of Principal Crops in Gujarat (Average of three drought years 1935-36, 1986-87 and 1987-88 as percentage of 1984-85)

Sr. No.	Crop	Area	Production	Yield per hectare
1.	Rice	79.51	46.90	58.59
2.	Wheat	49.08	48.05	91.68
3.	Jowar	87.80	48.33	53.21
4.	Bajri	81.96	43.60	51.55
5.	Total Cereals	78.76	45.88	56.81
6.	Tur	95.95	63.75	67.10
7.	Gram	41.67	28.05	67.31
8.	Total Pulses	78.29	42.93	53.50
9.	Total Foodgrains	78.49	45.56	56.55
10.	Cotton	85.06	54.37	58.66
11.	Groundnut	75.53	39.86	47.66
12.	Tobacco	91.98	90.61	68.94

Table 4.31 : Average Rainfall in 1985, 1986 and 1987 as Percentage of Normal Rainfall in Different Districts of Gujarat

District	Rainfall in 1986, 1987, 1988 as % of normal rainfall	District	Rainfall in 1986, 1987, 1988 as % of normal rainfall
Jamnagar	30.93	Gandhinagar*	52.26
Rajkot	22.93	Ahmadabad	64.14
Surendranagar	55.57	Kheda**	56.40
Bhavnagar	61.40	Panchmahals	42.70
Amreli	56.87	Vadodara	49.30
Junagadh	55.50	Bharuch	65.13
Kachchh	22.43	Surat	69.13
Banaskantha	31.57	Valsad	76.87
Sabarkantha	41.20	Dangs	118.27
Mahesana	25.27		

* Based on Normal rainfall of Ahmadabad.

** Based on two years average 1985 and 1987.

Table 4.32 : Livestock Population in Gujarat 1961 and 1982

(in '000)

Category	1961		1982		% increase 1961-1982
	No.	% to total	No.	% to total	
1. Cattle					
a. Males over 3 years	3046	21.3	3055	15.3	0.3
b. Females over 3 years	1838	12.9	1942	9.7	5.7
c. Young stock	1673	11.7	1944	9.7	16.2
d. Crossbred cattle	-	-	53	0.2	-
Total Cattle	6557	45.9	6994	35.0	6.7
2. Buffaloes					
a. Males over 3 years	40	0.3	50	0.2	25.8
b. Females over 3 years	1702	11.9	2558	12.8	50.2
c. Young stock	1174	8.2	1835	9.2	56.3
Total Buffaloes	2916	20.4	4443	22.2	52.4
Total Bovine	9473	66.3	11437	62.0	20.7
3. Total Sheep	1481	10.4	2357	11.8	59.2
4. Total Goats	2223	15.6	3300	16.5	48.4
Total livestock (including others)	13454	100.0	18440	100.0	37.1

Source: Statistical Abstract of Gujarat.

Table 4.33 : Trends in Composition of Livestock Population in Gujarat

Category	1961	1966	1972	1977	1982
1. Cattle over 3 years of age	100	100	100	100	100
a. Cows	37.6	36.5	37.2	37.1	38.9
b. Bullocks	62.4	63.5	62.8	62.9	61.1
c. No. of cows per 100 bullocks	60.3	57.4	59.1	59.0	63.6
2. Buffaloes over 3 years of age	100	100	100	100	100
a. Female buffaloes	97.7	98.1	98.0	98.4	98.1
3. Female Bovines over 3 years of age	100	100	100	100	100
a. Cows	57.9	49.4	46.9	44.8	43.2
b. Buffaloes	48.1	50.6	53.1	55.2	56.8
4. Sheep and goats as per cent of total livestock:					
a. Sheep	10.4	11.5	11.4	11.0	11.8
b. Goats	15.6	19.3	21.3	21.4	16.5

Source : Statistical Abstract of Gujarat.

Table 4.34 : Estimate of Outout of Livestock and Poultry Product and Their Value in Gujarat, 1980-81

No.	Product	Unit	Estimated output	Estimated value (Lakh Rs.)	Estimated value as % of total value
1.	Milk (fluid)	00 tonnes	13751	24516	61.6
2.	Ghee	"	252	6585	16.6
3.	Beef	"	28	115	0.2
4.	Buffalo meat	"	119	489	1.2
5.	Goat meat	"	131	1311	3.4
6.	Sheep mutton	"	107	1083	2.8
7.	Pork	"	16	90	0.2
8.	Glands	"	58	88	0.2
9.	Heads and legs	"	58	86	0.2
10.	Fats	"	27	38	neg.
11.	Other Meat Products	"	-	351	0.9
12.	Cattle Hides	00 Nos.	5061	296	0.7
13.	Buffalo Hides	"	3515	248	0.6
14.	Goat Skins	"	19242	294	0.7
15.	Sheep Skins	"	13511	207	0.5
16.	Wool	00 Tonnes	15	195	0.5
17.	Goat Hair	"	1	6	neg.
18.	Camel Hair	"	1	neg.	neg.
19.	Dung fuel	"	16092	1625	4.2
20.	Other Dung	"	127400	634	1.7
21.	Bones	"	54	51	0.1
22.	Other Products	"	-	8	neg.
23.	Hen eggs	00 Nos.	1614268	661	1.8
24.	Duck eggs	"	22184	9	neg.
25.	Adult Fowls	"	9723	191	0.5
26.	Chickens	"	55699	501	1.4
27.	Adult ducks & drakes	"	259	5	neg.
28.	Ducklings	"	472	4	neg.
Total				39687	

Source: Statistical Atlas of Gujarat, Vol. II.

Table 4.35 : Annual Milk Production ('000 Tonnes) in Gujarat,
1970-71 to 1985-86

Year	Production	Year	Production
1970-71	1900	1978-79	2188
1971-72	2013	1979-80	2200
1972-73	2113	1980-81	2153
1973-74	1728	1981-82	2239
1974-75	1500	1982-83	2317
1975-76	1800	1983-84	2442
1976-77	1950	1984-85	2610
1977-78	2025	1985-86	3150

Source: Dairying in India - 1988.
XXII Dairy Industry Conference, August 1988, pp.169-171.

Table 4.36 : Milk Pockets in Gujarat

Sr. No.	District	Milk produced per day ('000 litres)
1.	Mahesana	1100
2.	Kheda	860
3.	Banaskantha	820
4.	Junagadh	640
5.	Sabarkantha	580
6.	Ahmadabad	530
7.	Rajkot	480
8.	Kachchh	470
9.	Vadodara	390
10.	Surat	340
State Total (including other districts)		8300

Table 4.37 : Milk Cooperative Societies and Their Membership in Gujarat, 1960-61 to 1980-81

Sr.No.	Year	(Membership in '000)	
		Numbers	Membership
1.	1960-61	315	55
2.	1961-62	377	68
3.	1962-63	437	76
4.	1963-64	505	104
5.	1964-65	742	128
6.	1965-66	961	147
7.	1966-67	1144	209
8.	1967-68	1290	240
9.	1968-69	1471	270
10.	1969-70	1552	285
11.	1970-71	1747	333
12.	1971-72	1972	373
13.	1972-73	2265	412
14.	1973-74	2452	451
15.	1974-75	2790	486
16.	1975-76	3018	530
17.	1976-77	3780	616
18.	1977-78	4538	700
19.	1978-79	5468	807
20.	1979-80	6202	865
21.	1980-81	6759	975

Source: Statistical Atlas of Gujarat, Vol. II.

Table 4.38 : Physical Achievements in Dairy Development in Gujarat State, 1987-88

Sr. No.	Name of District Union	No. of societies	Farmer members ('000)	Average Daily Milk Procurement		Processing capacity ('000 LPD)	Chilling capacity ('000 LPD)	Drying capacity MTD	Cattle Feed capacity MTD	Average Direct Milk Sale ('000 LPD)
				Yearly average ('000 kg/day)	Peak month average ('000 kg/day)					
1.	Kheda	888	423.00	584.13	794.94	800	40	65.00	450.00	76.50
2.	Mahesana	918	227.00	537.00	712.15	750	340	82.00	400.00	55.95
3.	Sabarkantha	1303	123.10	247.49	309.01	400	175	42.00	100.00	16.91
4.	Banaskantha	1116	78.92	99.51	134.45	350	90	12.50	100.00	20.70
5.	Vadodara	880	135.27	156.44	215.99	200	20	-	100.00	117.64
6.	Surat	717	108.25	180.05	240.02	200	90	1.50	100.00	185.69
7.	Panchmahal	660	72.52	47.16	66.98	100	-	10.00	-	27.40
8.	Valsad	230	20.14	40.70	62.40	30	-	-	-	36.02
9.	Bharuch	538	32.80	21.36	31.59	60	-	-	-	18.75
10.	Ahmadabad	423	29.21	39.74	55.08	320	40	-	100.00	267.53
11.	Bhavnagar	249	16.25	5.96	12.97	16	8	-	-	34.25
12.	Gandhinagar	69	7.14	11.13	15.15	39	-	-	-	16.57
13.	Junagadh	365	23.51	40.04	52.29	25	40	-	-	17.20
14.	Kachchh	165	5.18	2.35	3.54	20	4	-	-	10.52
15.	Rajkot	473	28.09	35.92	52.18	40	20	2.00	100.00	14.51
16.	Surendranagar	348	12.49	17.59	24.90	100	26	-	-	5.90
Total		9342	1342.87	2067.48	2783.64	3441	893	215.00	1450.00	921.00

Source : Dairying in India, 1988.

CHAPTER V

ALTERNATIVE APPROACH TO LAND AND WATER USE PLANNING

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. That is why 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, steel and glass buildings 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 sub-tropical 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 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 and the modern science 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 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 co-operative and adaptive approach. For instance, in Varud taluka of Amravati district (Maharashtra) it is profitable to grow oranges. The area under orchards grew, so also did 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 cover for soil and water conservation. If the land is forest clad it takes thousands of years to remove by 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 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 of the land (113 million hectares) has high slopes (30 per cent or more) and needs to be kept under forest. Protection of existing forest cover (today close forested area is about 36 million hectares) through ban on clear felling, encouragement of natural regeneration in heavy rainfall areas and plantation of degraded forests particularly in accessible areas 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 direct benefit from it. Suitable organizational forms essential for these programmes are discussed in Chapter XI.

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 eventually yield fodder, fuel, timber, agave fibre, fruit and nuts. The hilly areas will have thus to be permanently kept 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 be largely 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. Summer cracks on the bund sides 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.

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 annalatum 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.

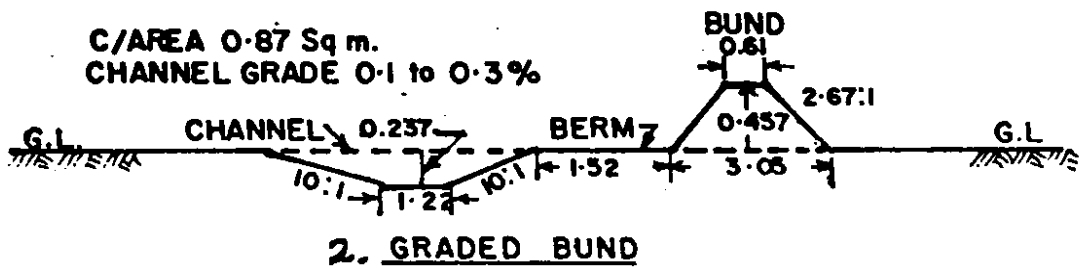
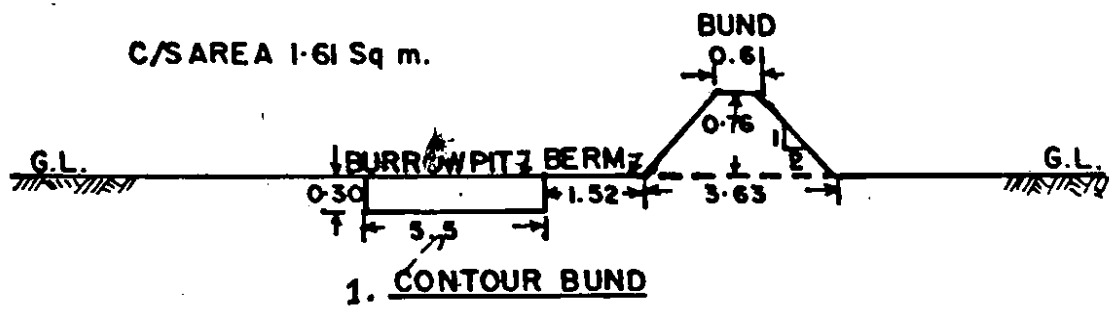
Due to the low intake rates of deep soils and their easy dispersibility, overland flow quickly transforms into channelized flow with the resultant rill erosion. Left unchecked this results in high rates of soil loss. To overcome this and to provide barrier against head extension, two rows on Agave americana 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 5.1.)

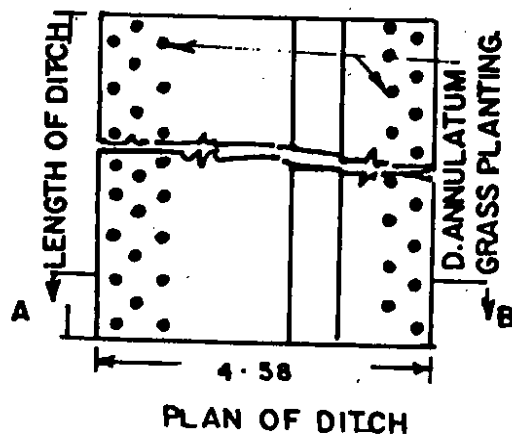
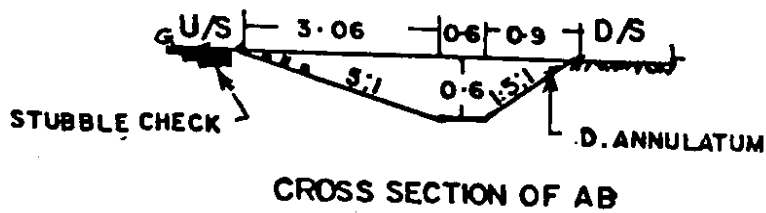
Conservation measure	Area occupied by structure	Cost of construction	
		per metre Rs.	per hectare Rs.
Contour bunding	5.7%	3.50	583
Graded bunding	4.8%	4.30	717
Conservation ditching	7.1%	5.15	858

Fig 5.1

SOIL & WATER CONSERVATION TECHNIQUES



3. CONSERVATION — DITCHING



ALL DIMENSIONS IN METRES

SKETCH NOT TO SCALE

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 has been 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

Sukhana 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 (Table 5.1). 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.

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 and the number of goats declined (Table 5.2). The watershed development measures helped preservation of moisture, improved water yield and production of fodder, 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 (30 Gujar families and 2 Jat families) and land distribution in the village is not so unequal as to create obstructions by the dominant group.

4. Watershed Planning: Mittemari in Karnataka

Till 1983 Mittemari was like any other drought-stricken 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 Mittemari is 690 mm. During the drought of 1985 the village received 387 mm of rainfall but amidst the widespread drought Mittemari smiled with well-grown fields of groundnut and pigeonpea. There is yield improvement, 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 co-operation 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.

Field bunding has been done in an area of 197 hectares. 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
	<u>14.93</u>

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 (Table 5.3). 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. In 14 out of 100 years, the annual rainfall was less than 400 mm., in 24 per cent of the years it was between 401 and 500 mm. In 18 per cent of the years it was between 501 and 700 mm and in only 20 per cent of the years it was above 700 mm. This distribution is an indication of the drought-proneness of the area.

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.

Though the village was never supplied water through government tankers, there was an acute scarcity of potable water, especially in the summer months. Only two wells had water throughout the year. Consequently all the villagers were dependent on those two wells, so that women were forced to walk a distance of 2 to 3 kms. daily to fetch water. This also led to overcrowding at the wells and constant squabbles for water.

People: The population according to 1981 Census was 1508 with 234 households. The majority of the people are Marathas, only 94 persons belong to the scheduled castes and tribes. There are 5 landless families and 13 artisan families. Most of the people are small landholders with holdings between 1 and 3 hectares. Only 12 farmers own land over 6 hectares (Table 5.4).

Ordinarily, the average landholding at 2.6 hectares should have been adequate to sustain its tillers, but because of recurrent drought the income generating capacity of the land was low. The yield of jowar and bajri was 3-4 qts/ha.; these are the staple crops of the area. About 60 per cent of the total cereal requirement was being produced in the village. As a result of this, many villagers had to migrate or seek employment under the Employment Guarantee Scheme (EGS).

Early Attempts to Combat Drought: The year 1972 was the worst year in the living memory of the villagers as the rainfall slumped to a total of 200 mm. Almost all the villagers were employed on relief work (metal breaking). This being the situation, the Tata Relief Committee built a community well in the village with the potential to irrigate 8 hectares, depending on the recharge.

In 1975, construction of a percolation tank was sanctioned under the EGS. Its capacity was estimated at 11.4 mcft and its cost at Rs. 4.8 lakh. However, because of inadequate supervision and the bureaucratic nature of operations, the intended objectives were not achieved. It was observed that the tank could not store the accumulated water for any length of time, as the water seeped away through the bund because impervious stratum in the hearting of the bund was not provided.

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 realised 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 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. (Table 5.5). 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, so that wells below, could be recharged by the nala bunding works.

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 (Table 5.6). Productivity has recorded significant increase in the case of all the crops (Table 5.7). The production at aggregate level has increased substantially because of the expansion in irrigated area.

Consequently the village is now self-sufficient in foodgrains production even in a year of deficient rainfall. A grain bank is run by the Tarun Mandal of the village and charges an annual interest at 15 per cent to be paid in kind. This is set up to cater to the needs of the economically backward sections of the village.

Drinking Water: As a part of the development programme, three borewells were constructed near the village (60 m depth) and piped water is supplied to cluster of houses. Rotations and timings for different outlets have been fixed. No one has to walk more than 100-150 metres to fetch drinking water. Although the year 1987-88 was comparable with the year 1972-73 as the village received only 220 mm of rain, there was no problem of drinking water.

Afforestation: A programme of afforestation has been taken up in the village in which the soil conservation office has also participated, by planting trees in the developed watersheds. Almost two lakh trees have been planted. It is worth noting that the survival rate of village plantations is as high as 90 per cent. The afforestation has been done in government forest land, gayran area, area owned by harijans and along the field bunds of private lands (Table 5.8).

Fuel: Previously, the villagers used firewood and cowdung cakes as fuel. But they have now realized the importance of afforestation and take care to guard the newly-planted trees despite the absence of fencing. There is now a tendency towards relying more on bio-gas for 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 and economically disadvantaged families, who look after the plant. These plants are mainly fed by human excreta. The remaining

plants are near the residences of the villagers and are fed by cow dung and individual latrines. In addition, smokeless chulhas have been installed, because of which an annual saving of about 67 tonnes of firewood has been effected. These innovative methods have contributed about 142 tonnes of coal replacement (c.r.) in terms of energy, to the village fuel supply, which amounts to 33 per cent of the village fuel needs.

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. Reportedly, Rs. 5,000 is realized annually, which is credited to the Tarun Mandal, which oversees the developmental efforts in the village.

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 debris 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 material 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.

Another experiment involving school children is being conducted. Pits of 180 cu.ft., have been dug near the two commercial bio-gas plants. The children, during their spare hours or as a part of PP discipline are encouraged to collect dried biomass from the fields and roadsides. A layer of this is spread,

followed by a layer of earth, which in turn is covered with a layer of bio-gas slurry. This is repeated till the pit is filled. This compost is later removed and auctioned. This method ensures 5 kg. of rich compost with an investment of just one kg. of dung or its slurry. Having seen the benefits, villagers are now ready to go in for similarly designed compost pits.

Pit latrines are to be 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.

Livestock: There are now about 70 crossbred cattle in the village. The milk yield of crossbred cows is in the range of 7 to 8 litres per day, compared to about 1 to 1.5 litres given by the local breed. The milk supply in the village has thus increased considerably. An ambitious project to demonstrate the benefits of dairying on scientific lines has been started. A cowshed accommodating about 50 crossbred cows is built. The villagers, chosen mostly from the disadvantaged class, will be given one animal each to look after. The dung would be collected at one point to feed a bio-gas plant with the capacity of 85 cu.m. costing Rs. 2.5 lakh. The gas would benefit about 70 families. The underlying principle is that common facilities would be maintained collectively, while individuals would be responsible for the animals' welfare.

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.

Training: As the achievements of the projects initiated by Hazare in Ralegan have been publicised within and outside the

State, Hazare is being approached for guidance. Consequently, Hazare decided to start a training programme. He has taken a 2 hectare plot in Ralegan, and has drafted a rigorous two year course with the help of Poona University with emphasis on technical aspects of rural development and social motivation. (Dalye, 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 emphasizes the village collectivity/community.

Another noteworthy feature of the programme is that all the developmental activities are carried out either through government scheme funds or bank loans. Grants and donations from Indian and foreign philanthropic agencies have been declined, as Hazare believes that free grants and donations make the villagers idle, irresponsible and power-hungry. He would accept such money only provided the objectives are clear and fit in with the total programme. Thus, the training programme, which cannot be undertaken by the villagers, has been funded from outside.

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. Out of three years, one year is on an average drought stricken either due to low rainfall or prolonged dry spells which destroy crops. In the absence of soil conservation measures considerable amount of rain-water was wasted.

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. Comparatively better soils were worked to exhaustion in the absence of inputs required to enrich the soils.

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 gober 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 population of Adgaon, according to 1981 Census, was 1304 with 234 households. The number of households in 1939, when the survey was carried out, was reported to be 265. The number of workers in 1981 was 550 of which 320 were cultivators and 148 were agricultural labourers.

The total area of the village is 1063 hectares. There were 424 landholders, with 65 per cent holders having less than 2 hectares each (Table 5.7). 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 vertisoils 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 change in area under crops and area irrigated. The gross cropped area increased; the increase in area under kharif and rabi crops is 200 hectares and 268 hectares respectively. The recharging capacity of all the 153 wells is enhanced. Seventy per cent of the wells are operational even in summer. The wells away from such structures especially on uplands go dry after the month of March but the rabi crop is assured. There is an increase of 300 hectares in the irrigated area. The appreciable rise in the area under irrigation, utilizing about three times the quantum of water available earlier is mainly due to the completion of check dams, gully plugging and lift irrigation schemes and the good rainfall in the year 1987 and 1988 viz., 1081 mm and 714 mm., respectively which was above average annual rainfall. The Mandal proposes to increase the height of all the existing masonry structures by 50 cm. to enhance storage capacity of the same, and construct more masonry structures.

The runoff on the farms was controlled by contour bunding by the farmers on their own. The aim was not only to increase the

rate of percolation but to check the soil erosion on wasteland having high gradient. However, ICRI SAT, Hyderabad technicians opined the work to be unscientific. The distance between two bunds was not related to the slopes. Hence further contour bunding and contour trenches were carried out under the competent supervision of the officials of ICRI SAT. It covered 120 hectares. It was decided to bring this area under plantation.

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 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. The plantation will yield timber, biomass, fruits, oil and fuel.

Crop Pattern: There is a marked expansion in the gross cropped area and some changes in the cropping pattern. The area under wheat has increased. Sunflower cultivation has expanded and a few farmers have taken to seed plots of sunflower. The area under mosambi increased from 8 hectares in 1984 to 82 hectares in 1987-88 and 10 hectares were put to vegetable cultivation (Table 5.10).

Information about yields was collected from a cross-section of 15 farmers from Adgaon. The pre-project and post-project situation is summed up in Table 5.11. The productivity has increased considerably mainly because of the increase in the moisture retention so that the crops do not have to 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. (Table 5.12). In order to supply the saplings at 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.

Horticatures: 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. Now some of the farmers have understood the problem and are planting mosambi in well-drained plots. All the orchards are irrigated. The watering interval is eight days irrespective of the water absorbing capacity of the soil. The watering is completely stopped in the month of December to make a favourable situation for flowering. Normally the orchards are sold to traders from Jalna, Aurangabad, Pimpri Raja and Tad Pimpri, on the basis of fruit bearing.

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. Now bor, wood apple, pomegranate are taken on a large scale. Training in bor budding was conducted by Training and Visit Scheme for local youths and eight of them are capable of carrying out the same in the village.

Three farmers have adopted better methods of irrigation techniques. Two of them have been using drip irrigation and one uses sprinkler for one hectare. The funds were made available by MSS Mandal and IRDP. The Mandal is planning to increase the area under drip irrigation to irrigate mosambi plantations. The farmers wishing to go in for grapes are also interested in these techniques.

Animal Husbandry: The dairy sector supplements the agriculture income of the family. The production varies from season to season. The flush season is from July to October. The total milk sold in the flush season is 350 litres per day and consumption within village is approximately 200 litres per day. The daily milk production is only 400 litres in summer, of which 300 litres per day is marketed. The milk production prior to 1986 was only 200 litres per day. The number of crossbred cows increased after 1986 due to the availability of green and dry fodder throughout the year. The average milk yield per day per cow ranges from six to eight litres.

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 poor 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 Agriculture 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.

It may be noted that the farmers sold their goats which is a source of income (and rearing in rural areas does not involve any inputs) just for the sake of village development and growth of plantations. So far poultry has not been given importance. Most of the families have a few birds. The eggs and birds are consumed locally. Two persons have a proposal to start poultry on a commercial basis.

When the MSS Mandal launched the programme in 1984, a few problems were experienced. The nala which was selected for check dams was basically used as a bullock cart tract. Since it was to be submerged arrangement for alternate road was necessary. Some farmers opposed this and the work was almost held up. A village meeting called by the Mandal to seek a solution resulted in the formation of the Dhanraja Asthai Samiti consisting of 20 members. The function of the Samiti was to give assistance to Mandal in all respects - provide supervision on construction, arrange donation of labour (shramdan) and resolve problems relating to the village approach road.

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.

The net result of the programme is increased area under irrigation, increased productivity, self-reliance in foodgrains production and availability of potable drinking water, generation of employment in agriculture and increase in annual family income. All sections - landless, small and marginal farmers - are assured of stable production and employment. They do not any longer depend on EGS works for their livelihood. (Datye, 1989)

Achievements: In Adgaon, augmentation of water resources is achieved exclusively through watershed planning while in Ralegan this is supplemented by bringing in part of the water resources from outside the region. As both these villages are located in semi-arid region there are obvious constraints to the total water resources available within the locale. However as Adgaon experience shows 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 proposed investment under COWDEP is Rs.24.7 lakh while work worth Rs. 13.1 lakh was completed by 1988. In Ralegan Rs. 58 lakh were spent on wells, tank and watershed development and Rs. 38 lakh on lift irrigation on Kukdi canal. The overall 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 co-ordination, (3) deficiencies in execution of plans, (4) lack of people's involvement or conflicts among interest groups. We will briefly review 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.

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 Manatalai in Bichhiwara Block, Dungarpur district, Rajasthan. The terrain is hilly inhabited by Bhils, ekigout 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 denuded common lands. In 1986, first attempt to involve the community in plantation on 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 metres long dam across the stream. Soil and water conservation and afforestation work was taken up in the catchment area, which covered both 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 was to be terraced for crop cultivation. About 110 hectares of common land was treated with staggered trenches on contour (2 m x .5 m x .5 m). Saplings were planted in pits on down hill of the two ends of each pit at a spacing at 2 m. Interspace between 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 is about 10 to 20 per cent and grass 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 way the project was executed, villagers from Manatalai got excluded from 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 has been 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) In important schemes such as terracing, mango plantation, etc., the achievements are meagre. The implementation has suffered various limitations of a basically faulty perception of the Agricultural Department at the planning stage and this failure

is carried forward through implementation process which resulted in poor results. (ii) The lack of coordination with allied departments such as Forest and Dairy resulted in 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 lands 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 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 5.2.)

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 is at the cost of 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.

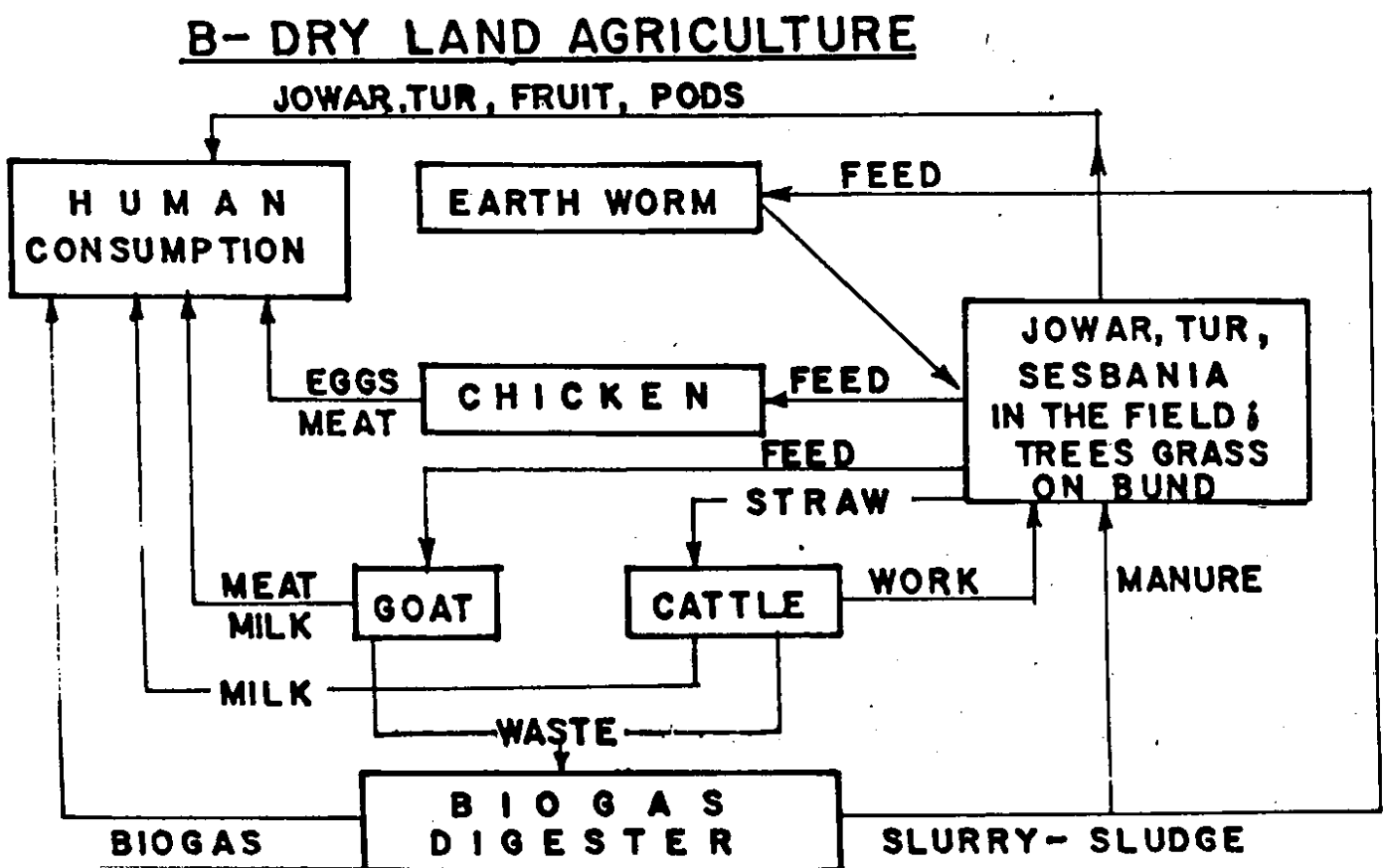
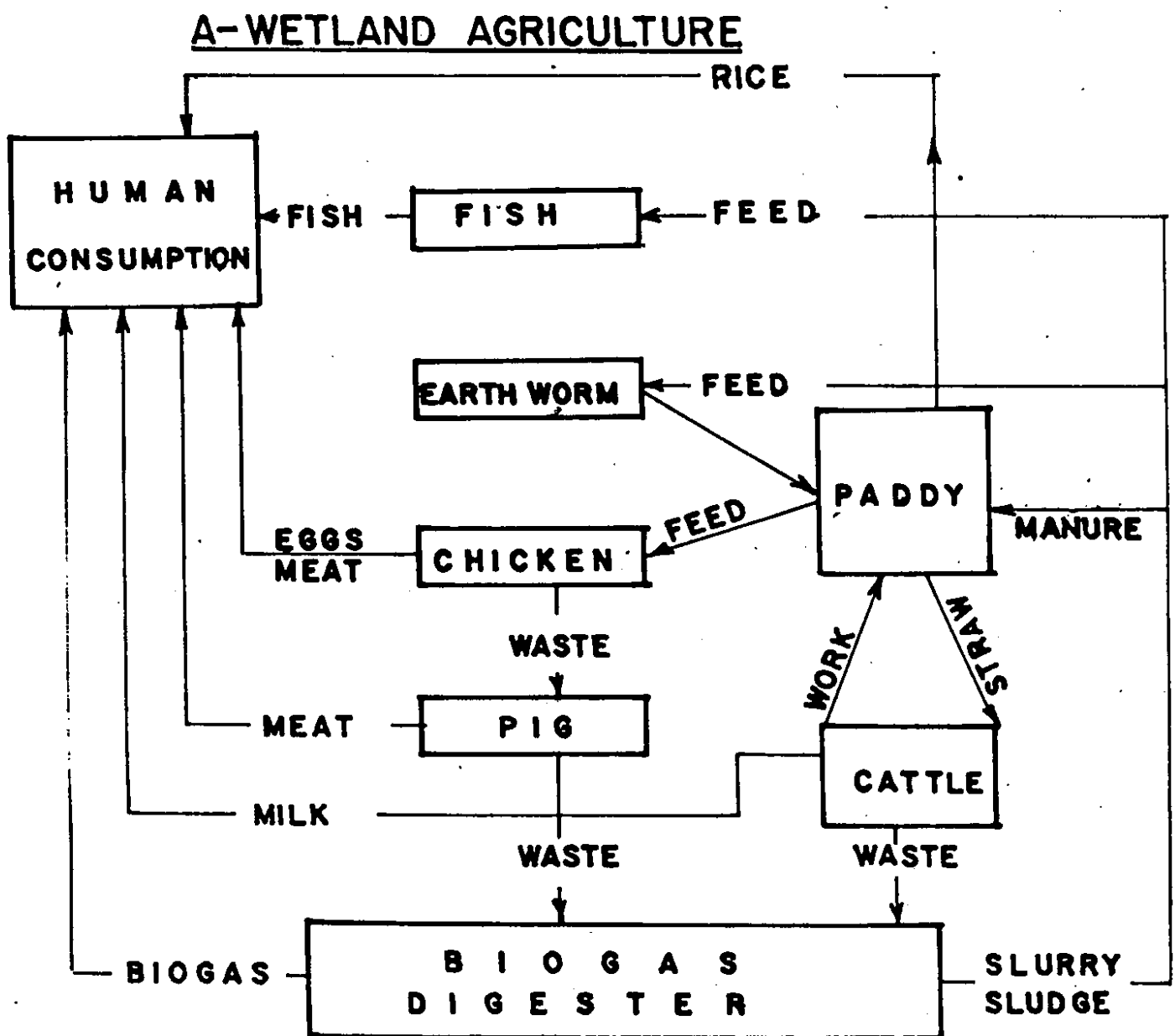
11. Experiment in Integrated Planning: Baliraja Dam in Sangli District

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.

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 Shodhak 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 Yerala 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 Vidgana Yatra (Science Fair) organized in December 1984 jointly by the Maharashtra State Peoples Science Organization, 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 Kolhapur University and specialists e.g. engineers and agronomists from Bombay, Pune. A scheme for a small dam across Yerala 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 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.

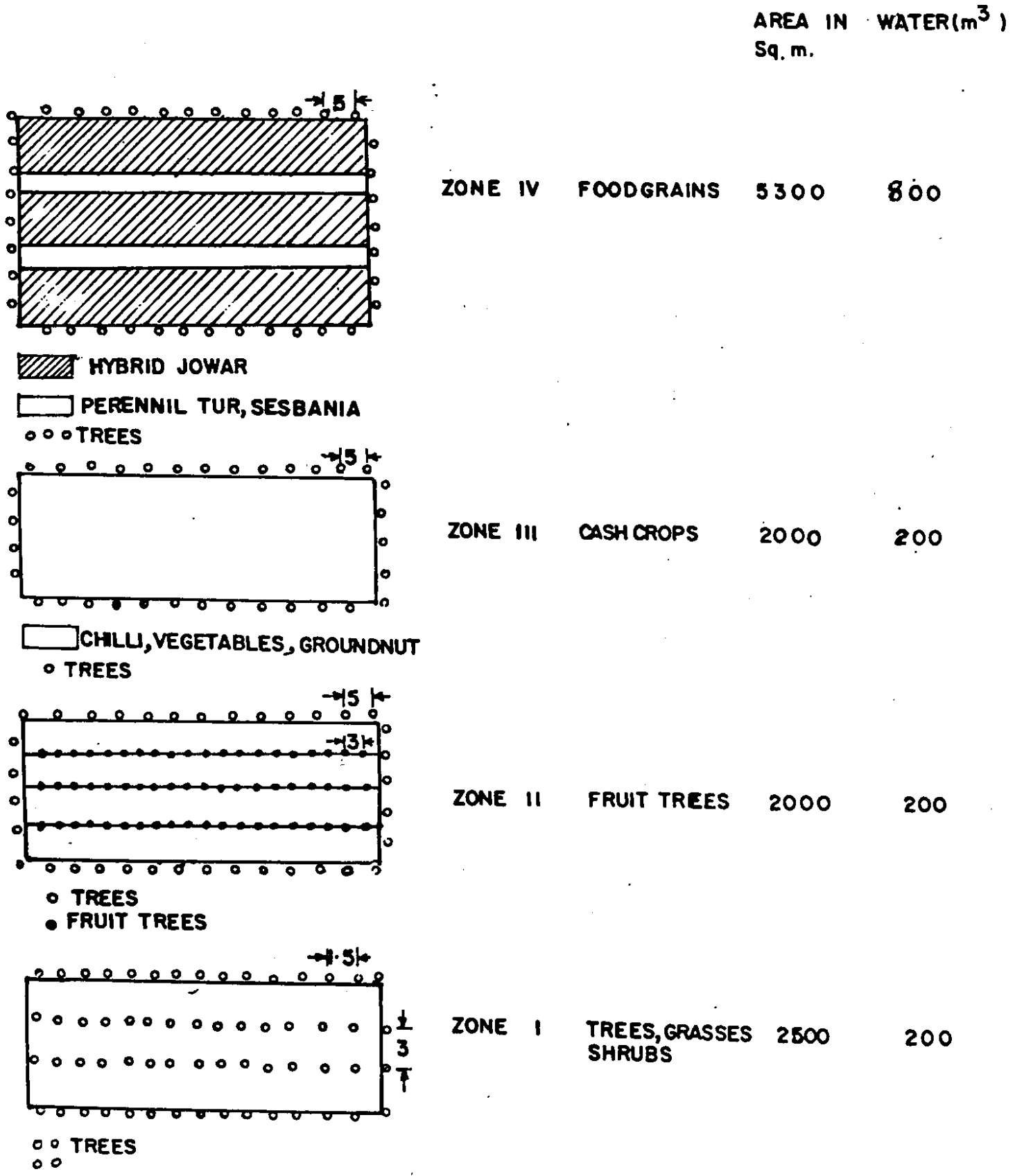
The entire command area of Baliraja dam is treated as one unit and integrated plan for land **and** water use is prepared for the command. The area is divided into four zones according to land capability: land under trees, under fruit trees, under cash crops and under cereals-pulses in proportion of 25 per cent, 15 per cent, 15 per cent, 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 5.3. 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 enables 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 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.

PROPOSED LAND USE PLAN (BALIRAJA DAM PROJECT)

Fig 5-3



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

Suggested Plant Species for Different Zones
(Baliraja Dam Project)

Zones II, III, IV	(a) <u>Trees on the Border</u>	
	Species	No. of Plants
	Tectona grandis	50
	Acacia arabica	50
	Eucalyptus sp.	50
	Casuarina equisetifolia	50
	Mangifera indica	5
Zone IV	(B) <u>Trees in the Strip between Jowar</u>	
	Cajanus cajan	
	Moringa oleifera	
	Gliricidia sepium	
Zone II	(C) <u>Fruit Trees in the Plot</u>	
	Species	No. of Plants
	Zyzyphus jujuba	100
	Panica granatum	75
	Citrus acida	10
	Anona squamosa	10
	Feronia limonia	2
	Semecarpus anacandium	2
Zone I	(D) <u>Trees on the Border</u>	
	Species	No. of Plants
	Eucalyptus sp.	750
	Gliricidia sepium	250
	Anona squamosa	150
	(E) <u>Trees in the Plot</u>	
	Dalbergia sissoo	200
	Azadirachta indica	200
	Casuarina equisetifolia	200
	Acacia auriculiformis	200

Table 5.1 : Irrigation Structures in Sukhomajri

	S ₁	S ₂	S ₃	S ₄
Year of construction	1976	1978	1979	1984
Catchment area (Ha)	4.30	9.10	1.50	2.63
Storage Capacity (Hectare metres)	0.80	5.50	0.93	1.93
Command area (Ha)	6.50	20.00	2.00	9.00
Total cost* (Rs. 000)	72	247	22	150
Cost at 1986 prices (Rs.000)	159	460	41	173
Cost per hectare (Rs.)	11077	12350	11000	16667

* includes cost of dam, watershed treatment, water conveyance (by pipe) and land levelling.

Source: Chopra, 1988.

Table 5.2 : Change in Composition of Livestock in Sukhomajri

	1977	1981	1986
Cows	28	16	6
Buffalo	136	149	182
Goat	89	50	10
Total value (Rs. 000)	445	472	562

Source : Chopra, 1988.

Table 5.3 : Land Use Pattern in Ralegan Shindi

	Area in hectares
Total Geographical Area	971.44
Cultivable Area	651.13
Waste Land	122.71
Government Pasture	50.78
Government Forest	136.78
Area under Gaothan	3.95

Source: Sub-Divisional Soil Conservation Office, Parner.

Table 5.4 : Distribution of Landholdings by Size of Holding in Ralegan Shindi

Size of landholding (ha)	No. of holders	Land held (ha)	% land holders	% land held
0 - 0.4	80	31.80	21.1	5.0
0.41 - 1.0	90	9.80	23.0	11.0
1.1 - 2.0	100	199.00	26.4	31.3
2.1 - 3.0	94	133.11	24.8	21.0
3.1 - 4.0	17	56.25	4.5	8.9
4.1 - 6.0	6	27.70	1.6	4.4
6.1 - 8.00	6	42.30	1.6	6.7
Above 8.0	6	74.41	1.6	11.7
Total	379	634.37	100.0	100.0

Source : Village Records.

Table 5.5 : Nala Bunds in Ralegan Shindi

Watershed	No. of nala bunds	Storage capacity (000 m ³)	Catchment area (ha)
1	2	17.58	106
2	13	112.00	872
3	13	123.95	848
4	3	28.65	223
Total	31	282.18	2049

Source : Sub-Divisional Soil Conservation Officer, Parner.

Table 5.6 : Crop Pattern in Ralegan Shindi

	(Area in ha)						
	1975-76		1985-86		1985-86		
	Dry	Irrigated	Dry	Irrigated	Kharif	Rabi	Total
Bajri	240	20	60	150	210	-	210
Jowar	320	53	90	252	2	340	342
Wheat	12	1	7	23	-	30	30
Pulses	80	-	55	24	70	9	79
Oilseeds	50	1	13	32	13	27	45
Vegetables	-	5	-	145	60	85	145
Total	702	80	225	626	360	491	351

Source : Village Records.

Table 5.7 : Crop Productivity in Ralegan Shindi

	Quintal per hectare			
	1975-76		1985-86	
	Dry	Irrigated	Dry	Irrigated
Bajri	3	9	5	15
Jowar	3	10	6	20
Wheat	-	13	-	20
Pulses	6	-	8	12
Oilseed	4	-	8	12

Source : Village Survey.

Table 5.8 : Tree Plantation in Ralegan Shindi

Species	No. of trees	Species	No. of trees
Bor	13000	Subabul	40000
Mango	8000	Eucalyptus	93000
Custard apple	11000	Shisoo	3000
Tamarind	8000	Shiris	2000
Other fruit trees (Mango, Guava, etc.)	1800	Neem	6000
		Total	135800

Source : Village Survey.

Table 5.9 : Landholding Pattern in Adgaon (1988)

Size of holding (ha)	No. of landholders	Area held (ha)	% Holders	% Area held
Upto 1.0	102	59	24.1	6.2
1.1 - 2.0	184	227	43.4	23.7
2.1 - 4.0	87	311	20.5	32.6
4.1 - 6.0	41	264	9.6	27.6
Above 6.0	10	94	2.4	9.9
Total	424	955	100.0	100.0

Source : Village Records.

Table 5.10 : Crop Pattern in Adgaon (1987-88)

		Area in hectares
<u>Khharif</u>		
Jowar	..	1
Bajri	..	425
Moog	..	12
Tur	..	21
Other	..	19
Total	..	478
<u>Rabi</u>		
Jowar	..	389
Wheat	..	50
Gram	..	7
Safflower	..	30
Other	..	11
Total	..	487
<u>Irrigated (Perennial)</u>		
Mosambi	..	32
Sugarcane	..	2
Vegetables	..	10
Total	..	94

Source : Village Records.

Table 5.11 : Crop Productivity in Adgaon

	Quintal per hectare	
	1984-85	1987-88
Jowar	7	11
Bajri	3	7
Wheat	8	14
Fur	4	8
Safflower	5	8

Source : Village Survey.

Table 5.12 : Horticultural Plantation (1988) in Adgaon

Species	No. of plants
Mosambi	27000
Bor	104000
Mango	2900
Avāla	4000
Custard apple	8700
Wood apple	2000
Tamarind	6700

Source : Village Survey.

CHAPTER VI

PERSPECTIVE LAND USE PLANNING, AND OPTIMUM LAND USE MODEL FOR MAHARASHTRA

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 6.1). 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 group are presented in Table 6.2, the estimates of food-items are given in Table 6.3 and the estimates of work force in Table 6.4. 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.

In the present chapter the broad zonal land use plan for Western India is first considered. In the second section linear programming model constructed for Maharashtra with a view to optimize the crop pattern to attain maximization of net return/employment is presented.

In Section III, the special problems of preservation and development of Western Ghats and in Section IV the problems of drinking water supply are discussed.

I. Perspective Land Use Plan

The major considerations in deciding upon the appropriate land use are (a) Reduce the runoff and encourage infiltration so as to improve groundwater resources, and bring about more 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 water-logging. 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, desert stabilization area and agricultural areas are shown in Map 6.1.

Suggested Land Use Plan for Maharashtra

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.

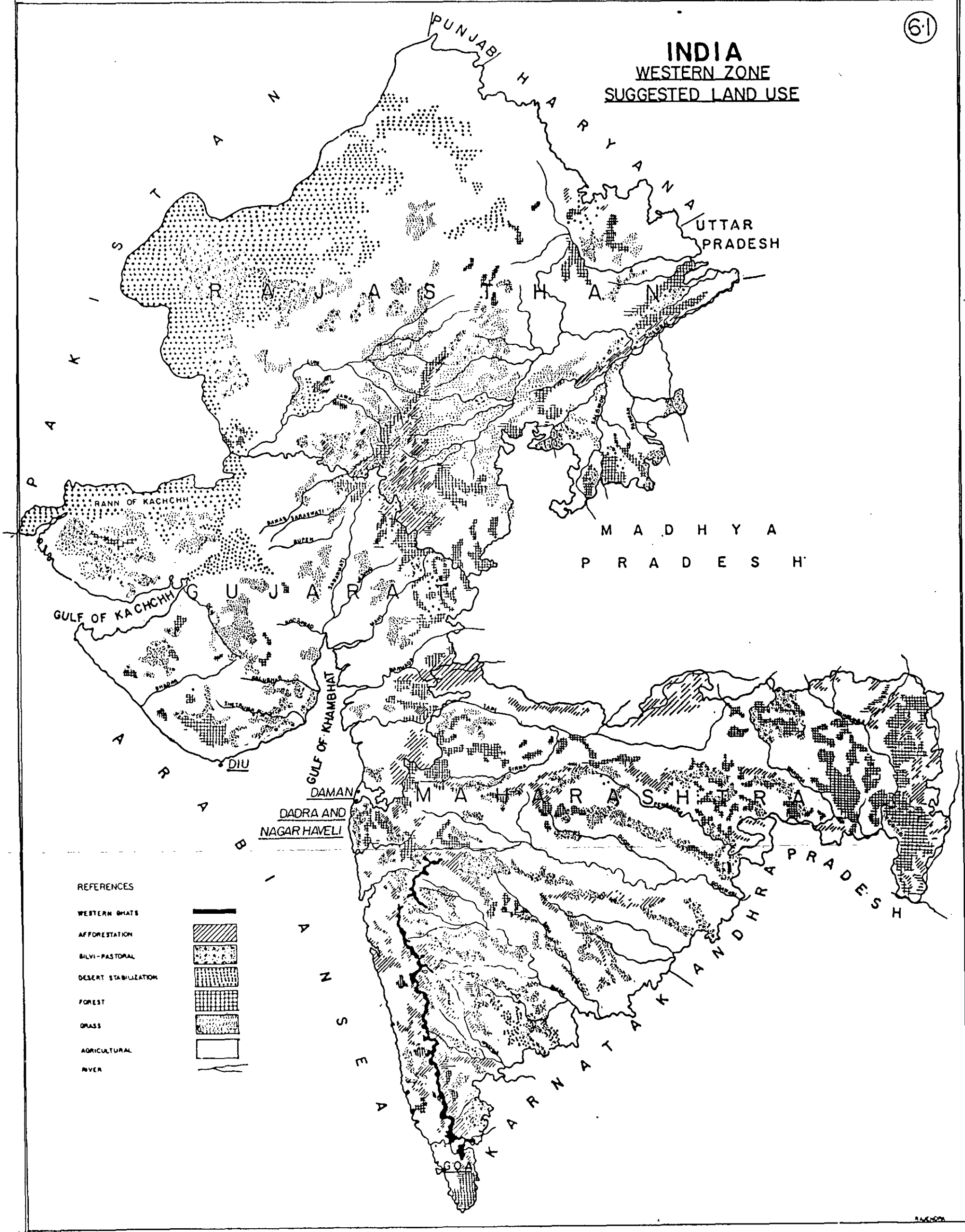
Land use for agriculture is a function of soil-water-plant relationship. Similar groups of soils occurring in different geomorphic units influenced by differential soil forming processes and environmental factors have different land use potentials. The soil climatic environment may create arid and humid 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 6.2 for Maharashtra State and described in Tables 6.5 and 6.6.

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.

INDIA

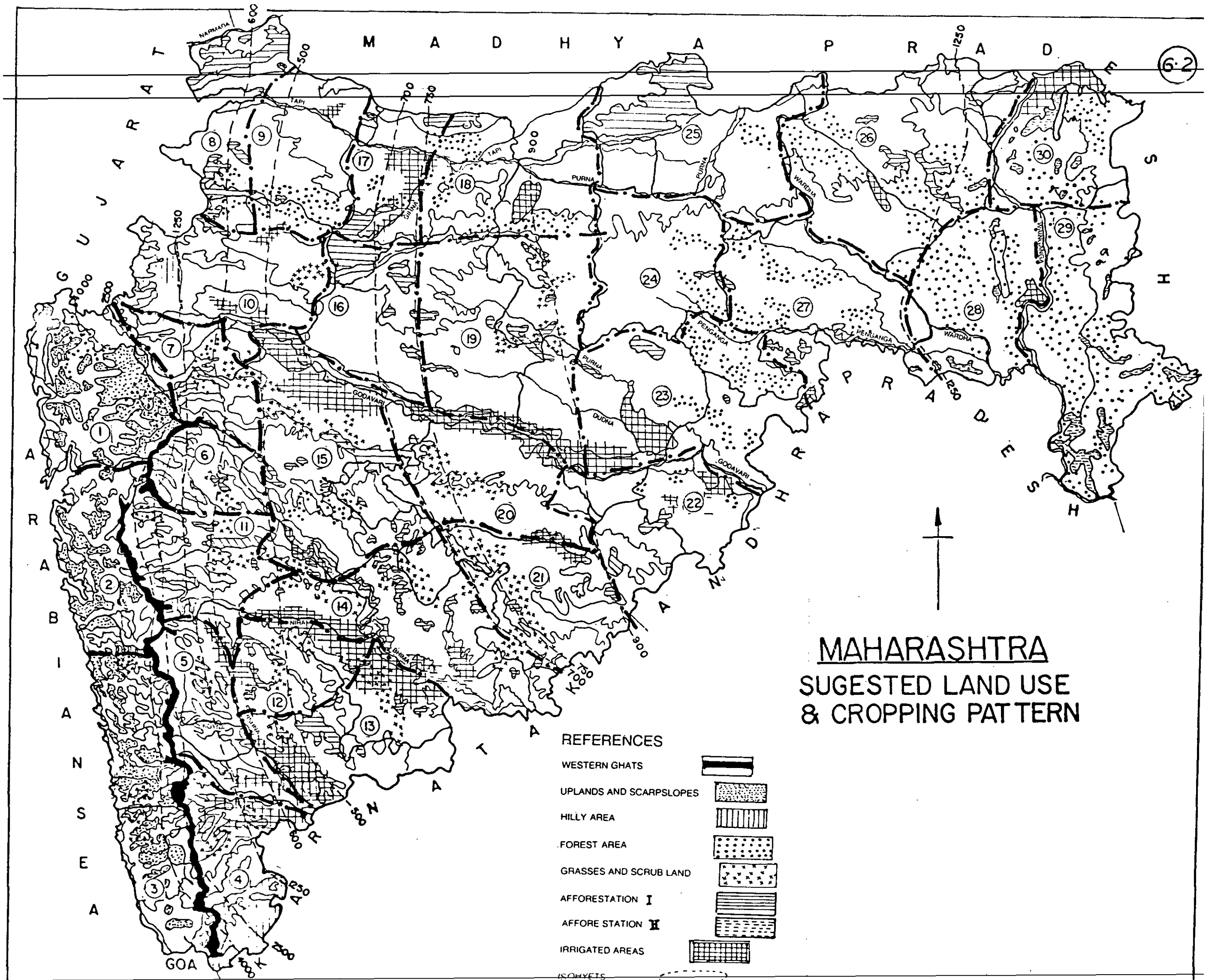
WESTERN ZONE

SUGGESTED LAND USE

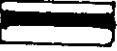
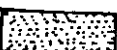

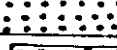
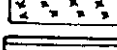
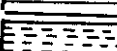

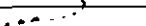



REFERENCES

- WESTERN GHATS
- AFFORESTATION
- SILVI-PASTORAL
- DESERT STABILIZATION
- FOREST
- GRASS
- AGRICULTURAL
- RIVER



MAHARASHTRA
SUGESTED LAND USE
& CROPPING PATERN

- REFERENCES**
- WESTERN GHATS 
 - UPLANDS AND SCARPSLOPES 
 - HILLY AREA 
 - FOREST AREA 
 - GRASSES AND SCRUB LAND 
 - AFFORESTATION I 
 - AFFORE STATION II 
 - IRRIGATED AREAS 
 - ISOLYETS 

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. They have drainage difficulties 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 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 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 stabilize and bring 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. 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 cultivated to 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 cultivated to jowar, bajri, sugarcane and pulses. Since rainfall is considerably high in Kolhapur and Pune areas (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. Since the development of irrigation wheat, fruit crops, sugarcane, jowar and oilseeds are 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 for this pattern 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 crop to be sown in a given season is taken by individual cultivators; there are over 31 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 rainfed 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 type and two, socio-economic type. The technical factors relate to land availability, soil type, rainfall, irrigation water availability, 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_{IJKL} 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 |
| = OC - 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 6.3). 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 eastern Maharashtra. Even though productivity of rice has increased in recent years in Konkan and there is some further scope for the same, yet the spatial limitations are severe. 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 requirement 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 fruit trees with 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>
Kharif	2500	38.5
Rabi	2950	45.4
Summer	400	6.1
Three seasons	650	10.0
	-----	-----
	6500	100.0

The existing crop rotations or desirable crop rotations as shown in Table 6.7 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 6.8.

Information about yields as recorded for irrigated and

rained 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 6.9). Figures of water requirement as suggested by the Department of Agriculture were used. The L.P. model is given in Appendix A.

When optimization was carried out from the point of view of maximization of net return the crop pattern that emerged under rained 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, udid, 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 more than the quantum of sugarcane produced, the area under sugarcane has to be maintained at the existing level. The model was therefore modified to put the constraint of existing hectareage 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 6.10. It will be noted that if net return is maximized then sacrifice only to the extent of about 3 per cent is made in employment, and less than 0.1 per cent in the case of return to water. However if 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. The emerging trends are growth in the productivity of gram, safflower, paddy, sunflower. In estimating production for the year 2001 these latest trends are taken into account.

The suggested cropping pattern is presented in Table 6.11. 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.

Increase in the land under chilli-vegetable demands technological inputs (skill in husbanding vegetables - particularly pest control, timely picking and packing that makes for good profits) 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 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. Extension of fruit, like vegetable cultivation, demands technical skills and marketing/processing facilities. Again fruit cultivation is important from nutritional view. 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 model to maximize net return (Table 6.12). 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 need, in pockets, to provide supplementary work. This could be provided in the developmental work in silvi-pastoral schemes and afforestation in different areas. 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, fruit, 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 6.13). 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 6.14).

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 hectares 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 80° - $15'$ N latitude in Nagercoil district (Kerala). The Western Ghat region is characterized by hilly terrain and is composed of an assemblage of discontinuous hills and plateaux like Bhimashankar, Mahabaleshwar. A unique feature of these hills is the occurrence of undulating surfaces with gentle valley slopes at an altitude of 1000 m. 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 50° - $30'$ 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 (Table 6.15). 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.

Near the crest line there are five talukas viz. Mahabaleshwar (Satara district), Igatpuri (Nashik district), and Bawada, Chandgad and Radhanagari (Kolhapur district) with very heavy rainfall (over 250 cm) and rugged terrain. On the eastern slopes and spurs are situated 15 talukas that receive rainfall between 150 cm and 250 cm. These together form about 6 per cent of the total area of the State with a population of 23 lakh in 1981 (Table 6.16). The forest area forms about 30 per cent and the sown area is less than half of the total area. Paddy, ragi-vari and fodder crops are the main crops of the Group I talukas, whereas in Group II talukas, paddy, ragi are important in western part, and bajri, jowar, pulses, etc., are cultivated in the eastern part.

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. It is estimated that about 8 to 9 per cent of the land is under shifting cultivation in a season. 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 share of income from agricultural produce was about 30 per cent, forest produce, sale of trees, milk, etc., accounted for 25 per cent and the rest was earned by wage work (Brahme, 1986). The average annual estimated income in 1987 was Rs. 6,000. 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, 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 planning expansion of tourism. The growth in vehicular traffic is creating the problem of pollution. There is an urgent need to keep the vehicular traffic in check. Thus in the expansion of tourism at popular hill resorts like Mahabaleshwar, Matheran, Khandala, Bhimashankar, etc., conservation aspects rather than revenue earning should be the primary consideration. 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 Warasgav 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) Switch from shifting cultivation to horticulture, pasture development and forestry. (3) Prohibition of free uncontrolled grazing that makes regeneration of vegetation impossible even in this heavy rainfall region.

If ban is imposed on felling of trees, shifting cultivation and free grazing, there is a need to provide for alternative source of income to the inhabitants in the region as the above measures would deprive them of their present sources of livelihood. 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 found difficult to re-establish vegetation as the soils are shallow and have little moisture holding capacity. One may briefly note here the findings of experimentation with re-plantation carried out in the Panshet reservoir catchment area since 1987 (Brähme, 1990). In this experiment the conventional method of afforestation programme viz. planting seedlings of exotic and native species in dug pits and the successional approach were used. Percentage germination of seed in nursery of the species planted in pits is given in Table 6.17.

Among the local trees performance of Pisa, Limbara and Shivan is 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.

When treated seed was planted in open plots of local species like Bombax ceiba, Mangifera indica, Carissa congesta, Erythrina stricta, Zizyphus rugosa, Meynia laxiflora, Syzygium cumini, Artocarpus heterophyllus, the rate of germination varied from nil to about 40 per cent. Survival of plants through summer was 10 to 40 per cent and the rate of growth is very slow, only a few cms in one season, if protected from cattle menace.

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 new growth of seedlings planted in June was 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 (Table 6.18).

(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 tiliaefolia, 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 any 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 unbanded 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, Emblica 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. For this tree planting along both the sides of the road should be immediately taken up. 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.

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. When improvements in the fodder resources are achieved and the basic infrastructural facilities are provided, plan for the introduction of improvement in the milch animals can be considered.

It is important that the Gavli Dhangars inhabiting Western Ghats region get involved 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 Returns: Estimation of economic returns is difficult as little information is available on rates of survival,

growth rates, annual yields, etc., of trees for the Western Ghats. Crude estimates are attempted on the basis of information about the performance of the existing stock obtained through field studies.

Mango is expected to yield returns from the 7th year and the expected return (80 trees) is about Rs. 2,400 in the 7th year, Rs.2,700 in 8th year, Rs.4,000 from 9th to 15th year and Rs.4,500 from 16th year. Jackfruit bears fruit from about 10th year and a return of Rs.2,500 (50 trees) is expected from 10th year. Other trees/shrubs growing wild also yield marketable fruit e.g., karvand, but the labour expenditure involved in collection of karvand is rather high. If karvand shrubs could be established in clusters or strips along contour, there will be a saving in the labour time. Bamboo gets ready for harvesting from the 7th year, and can be harvested in 7th, 10th, 13th, 16th i.e. every third year. If rotation of three years is followed, the average expected return per hectare is Rs.2,000 per year. Expected yield from the quick growing trees like Casuarina in terms of fuelwood and poles (for 150 trees) is Rs.4,500 and Rs.3,000 respectively in the 8th year. Trees like hirda, neem, yield valuable fruit. For example, about 3000 kg. of fruit can be obtained from neem tree in the sixth year and 4,500 kg. from the 7th year (150 trees). The return at 20 ps. per kg. comes to Rs. 900 per hectare. In addition the leaves have insect repellent value but its potential is not yet fully explored. Loppings are useful as fuel and if the tree is lopped from the 3rd year, it leads to higher fruit yield. The tree can be felled in the 10th year and the value of poles would amount to Rs.2250 ha. If full potential of its use is researched the neem tree can give higher return. In case of hirda, even though hirda fruit is of economic value, the return is uncertain due to price fluctuations. It is necessary to set a floor price and the government should assure a minimum return in case the

market price falls below the floor. The Government can buy hirda fruit and open up a centre for processing to increase the return on fruit sale to the local inhabitants. Other trees like char, behda, kokam yield valuable fruit. The regulation of prices is essential to provide a stable return. Apta leaves have a steady demand and collection of leaves can yield about Rs.20 per day. In addition trees like shivan, limbara, jambhool, varas are useful as small timber; these can be harvested with short rotation (10 year). Bherli mad was abundant in the region and can be re-established. It yields madi which can be used fresh or for gur manufacture. The important fruits that grow in the region like mango, jackfruit, awla, jambhool, karvand can be used for making mawa, chatani, pickles, jams, jellies, squashes, etc., by setting up local cottage industry units. Grafting of mango trees will help improve the returns per tree.

There is a potential to grow medicinal plants like shatawari, sarpgandha, kuda, vavding, nirgudi and trees with high medicinal value like awla, hirda, behda. Some of the plants like erandi, rui, adulsa, etc., are used by the local population for treating certain ailments. Further investigations into the medicinal value of native plants could indicate their potential future use.

There is thus a rich potential of using the biomass resources of the region for traditional uses as well as explore the possibility of new uses. However if the leaves, fruit, etc., are harvested, collected and transported raw out of the region the return to the local population would be small. It is therefore important to experiment with the alternative end uses of the biomass resources as chemical intermediates (palms and tubers), structurals (bamboo, Dulbergia sissoo), food stuff processing industry, medicinal uses, use of dung and leaf litter for biogas generation, etc. If part processing is completed in the region, it will help reduce the bulk and give better return to the local

population. R & D efforts in these directions should form a part of the Western Ghat Development Programme. . If a ten year programme is launched forthwith some results should be available by the time the trees mature and yield fruit.

Even if it is assumed that the biomass resources will be put only to traditional uses the possible economic benefits are expected to be higher than the returns obtained today from shifting cultivation and other activities. A broad estimate of the income after a ten year period is made at 1984 prices, and compared with the income noted in 1984. It is expected that the plantations will begin yielding fruit, etc., by 1994. The average returns as indicated above are taken as the basis for the estimation. In case an estimation is not available, the returns are assumed to be of the order of low-income yielding tree like neem. 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. As noted above 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 1984 was about Rs.5300. The proposed plan should bring about an increase in their earnings by at least 40 per cent and place all the families above the poverty line.

Another advantage is the year-round availability of work in the forest-plantation area. There will be work in the nursery, plantation work, weeding, bamboo cutting, leave plucking, fruit harvesting, collecting honey and in addition there will be some employment in silk-worm rearing, fruit processing, primary processing of medicinal plants, basketry, rope-making, etc. There is also a potential to increase the return to labour by organizing locally certain further stages of processing of say hirda, medicinal plants, etc.

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. Provision of food and services to the students, hikers, etc., can provide some work opportunity to the local population. Care, however, must be taken to develop the place only for healthy recreation and for study and research and not for garish tourism.

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 (e.g. use of jalshakti - a chemical developed by the National Chemical Laboratory to be mixed with soil to enhance the moisture retaining capacity, use of an emulsion spray developed by Hico, to help conserve moisture in the plant or use of earthen pots for delivery of water to the active root zone so as to save on waterings).

Experimentation with planting of seedlings of varying age viz., 6 months, 1 year and 2 years growth should also be taken up to evaluate the response to water stress and the rate of survival. The plants to be experimented with should be mainly the indigenous species that provide fuelwood, forage, timber, fruit, bio-fertilizer or have medicinal value.

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, Walwan, Shiravata, Bhatghar, Panshet, Warasgaon, Mulshi, Pawana, Koyana, Dhom, Kanher in the Western Ghat region of Pune and Satara districts while Chaskaman, 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 road-heads 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 (i.e. transgression of the region by motor-launches, gaudy commercial eating/drinking places littering the hills and lakes with cigarette stubs, soiled paper, plastic bags, leftover of food, etc.). 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 steps must be taken to see that it is not captured and spoiled by the speculators, builders and the urban rich for their week-end bouts.

IV. Problem of Drinking Water Supply

There are 40760 villages in Maharashtra. According to a survey carried out by Government in 1978-80 there were 12753 villages that lacked adequate drinking water. It was recommended that the problem could be eased by adding dug-wells or tube-well. In the case of 4359 villages piped water supply was considered essential either because of lack of adequate quantum of groundwater or contamination and health hazards.

During the Fifth Five Year Plan (1974-1980) 15085 tube-wells were dug of these 11131 were considered successful. During the period 1980-81 to 1982-83 additional 31758 tube-wells were dug and 27338 tube-wells were deemed successful. In addition by 1983 March, 1462 villages were provided with piped water supply. The position in 1983 as per Government statistics was that the number of problem villages should have been about 5400. However in 1984 (a year of normal rainfall) about 16000 villages faced the problem of shortage of drinking water in summer months and water supply through tankers becomes essential for part of these villages.

A survey conducted by the Government in May 1985 revealed that 23639 villages had drinking water problem. Of these 17690 were partially covered by drinking water facility. During the Seventh Plan it was planned to take programme for 20140 villages, so that by 1990 the problem should not remain acute (Midterm appraisal, p. 162). However the problem remains serious.

A survey of villages was carried out in 1989 in some talukas of Pune and Aurangabad districts to assess the problem and the efforts made by the Government to solve the problem. It was noted that except for Aurangabad taluka where piped water

supply from assured sources is provided, shortage of water supply is faced in nearly all the villages from the month of January/February. Shortage is so severe that water has to be delivered by tankers in half the villages in Khed, Daund and Shirur talukas.

Not that expenditure did not flow for improving the situation. Particularly since the eighties large number of tube-wells for drinking water purpose have been dug. In fact it is an important business in which the GSDA is involved. However the success is not satisfactory. It was noted that in the surveyed villages 65 to 80 per cent of the bore wells were not working for a variety of reasons, e.g. some wells yielded water initially but later turned barren, some were not usable due to non-functioning of the pumps. Water-yield is uncertain and variable, maintenance and repair poor; the main interest lies in digging bore wells, without worrying about solving the problem of drinking water supply. (Tables 6.19 and 6.20.)

In Marathwada, piped water supply is posing a new hazard, the hazard of malaria due to stagnant water pools. Because of unsanitary conditions around wells incidence of jaundice and other stomach infections, were reported from a number of villages from Marathwada.

The major reason for such a sorry state of affairs is the lack of planning in land and water resources. Denudation of hills is leading to flash floods in rainy season and shortage of water by January. Even in Konkan and Western Ghats with rainfall over 2000 mm. shortage of drinking water becomes acute as nearly all the rain water is lost through runoff.

Secondly, the solution to the problem of drinking water supply is sought mainly through digging wells/tube-wells without proper assessment of the availability and utilization of groundwater resources in different watersheds. In fact the first charge on groundwater should be drinking water supply for humans

and animals and for domestic purpose. Supply must be assured all round the year and drinking water must be safe.

The water supply for domestic use should not dry up because of the use of groundwater for irrigation purposes by individual landowners. As well-digging is in private domain those who can afford it are drawing water from greater depth while the poor in the village face acute shortage of water even for drinking and the women have to spend hours to carry water from over long distances. Supply of minimum necessary food items and drinking water must receive topmost priority in land-use planning. To ensure the necessary water supply, water has to be treated as a social property and not as private property.

Particularly, for a State like Maharashtra where the geological conditions are not favourable for water percolation two measures are essential to ease the problem of domestic water supply. Firstly to create favourable conditions for reduction of runoff through contour bunding, trenching, grass cover, check dams, percolation tanks, sub-surface dams, nala training, etc. These measures have to be planned and executed on watershed basis over as large an area as possible according to the availability of manpower. To make watershed planning successful it is essential to prohibit felling of trees and uncontrolled grazing; mere engineering or mechanical devices are not enough to maximize water harvesting in situ.

Secondly, irrigated crop pattern has to be prepared for each watershed making first full reservation for domestic water use assuming sub-normal rains (say 25 per cent below normal). The surface water and groundwater resources have to be used conjunctively in preparing water use plans. Provision for urban water supply and re-use of the waste water must also form a part of water use planning. If the rainfall in a particular year is above the assumed level, then the extra water available in

storage can be used for short seasonal crops in rabi or summer season, decision about which could be taken after the rainy season is over. Contingent plans will have to be kept ready to use the extra water.

The location of settlements is governed by the availability of water supply. That the problem is becoming more and more acute despite spending crores of rupees is because of over-exploitation of groundwater and faulty planning of surface water resources, denudation of hills, over-grazing, etc. Unless the approach to land and water use planning is radically changed the country will face deeper and deeper water crisis.

Table 6.1 : Agro-climatic Features of Zones of Western India

Region/Zone	State	Districts	Rainfall (mm)	Climate	Soils	Crops
<u>VI. Trans Gangetic Plains Region</u>						
Arid	Rajasthan	Ganganagar	350	Arid	Calcareous, Sierozemic 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.

(continued)

Table 6.1 : (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 Aravalli 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 and 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.
Plateau Zone North	Rajasthan Maharashtra	Jhalawar Akola, Amravati, Aurangabad, Beed, Buldhana, Parbhani, Jalgaon, Latur, Osmanabad	374	Semi-arid (wetter half)	Medium black, deep black, mixed red and black, shallow red.	Jowar, cotton, wheat, gram.

Table 6.1 : (continued)

Region/Zone	State	Districts	Rain-fall (mm)	Climate	Soils	Crops
Plateau Zone South	Maharashtra	Nagpur, Nanded, Wardha, Yeotmal	1040	Semi-arid to dry sub-humid	Medium black, shallow black.	Cotton, jowar, tur, wheat.
<u>XII. 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.
<u>XIII. 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.
Middle Gujarat	Gujarat	Panchmahals, Kheda, Vadodara	904	Semi-arid	Medium black	Rice, cotton, maize, bajri.
North Gujarat	Gujarat	Mehsana, Amre- dabad, Banas- kantha, Gandhi- nagar, Sabarkantha	735	Arid to semi-arid	Grey brown, coastal alluvium	Bajri, cotton, jowar, wheat.

(continued)

Table 6.1 : (continued)

Region/Zone	State	Districts	Rain-fall (mm)	Climate	Soils	Crops
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 6.2 : Projected Population for Maharashtra, Rajasthan and Gujarat in 2001 A.D.

Age-group	(Population in '000)				Total
	Rural		Urban		
	Male	Female	Male	Female	
<u>Maharashtra</u>					
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
<u>Rajasthan</u>					
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
<u>Gujarat</u>					
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	73	67	6	5	156
Grand Total	59061	57596	39177	35319	191153

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

Table 6.3 : 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
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 6.2.

Table 6.4 : 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	Males	Females
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 6.2.

Table 6.5 : Suggested Land Use for Maharashtra

Zone	Sub-zone ①	Per cent area under			
		Forest *	Grass	Horticulture and other plantation ‡	Agriculture
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 6.1.

- * Forest tree species given in Table 6.5-4. 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 sizeable 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, cardamum, 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 6.5(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, F., 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>Bombusa 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>Holigarna arnottiana</i>	Ti, RG, O.	
	<i>Hymenodictyon obovatum</i>	Ti, Fo, DT, Md.	
	<i>Lagerstroemia parviflora</i>	Ti, Fo, RG, DT, Fi.	
	<i>Ligustrum neiligherrense</i>	Ti, Fe.	
	<i>Linociera malabarica</i>	Ti.	

(continued)

Table 6.5(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>Clea 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 wodicr</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 6.5(A) : (continued)

Region	T r e e s	U s e s	
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>Embllica 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 6.5(A) : (continued)

Region	T r e e s	U s e s
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.

N o t e

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

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 6.6 : Suggested crop pattern by Sub-Zone in Maharashtra

Sub-zone	C r o p
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, cardamum, <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 6.6 : (continued)

Sub- zone	C r o p
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 6.7 : Crop Rotation in Medium and Deep Black Soils in One Agricultural Year in Maharashtra

Crop rotation	Season		
	Kharif	Rabi	Summer
Without irrigation			
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	-
With irrigation			
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 6.8 : Requirement of Soils for Different Crops

C r o p	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 6.9 : Yield, Net and Gross Return and Labour Days for Major Crops in Maharashtra

Season/Crop	D r y				Irrigated			
	Yield kg./Ha.	Labour Days/Ha.	Net * Return Rs./Ha.	Gross * Return Rs./Ha.	Yield	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
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

(continued)

Table 6.9 : (continued)

1	2	3	4	5	6	7	8	9
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 6.10-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 6.10-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	3.905	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 6.11 : 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 ---(Production in 000 Tonnes)	Irri- gated	Total	Dry --(Area in 000 Ha.)--	Irri- gated	Total
1	2	3	4	5	6	7	8	9	10
<u>Kharif :</u>									
Rice	1063	431	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	150	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	459	1	470
Other Pulses	491	10	501	169	11	180	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 6.11 : (continued)

1	2	3	4	5	6	7	8	9	10
<u>Rabi :</u>									
Jowar-Local	1600	278	1878	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	550	1260	282	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	-	280	280	-	483	483	-	93	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 6.12 : Area and Production of Cereals, Pulses and Oilseeds for 1983-84 and for Optimum Crop Pattern (*) for Maharashtra

1	Cereals Pulses Oilseeds Others* ----- (Area in '000 Ha.) -----					7	Cereals Pulses Oilseeds Others* ---- (Production in '000 Tonnes)			
	2	3	4	5	6		8	9	10	11
<u>(I) Crop Pattern 1983-84</u>										
<u>Kharif :</u>										
Dry	6071	2253	1252	3167	12743	61.32	5230	920	706	256
Irrigated	569	13	22	400	1004	4.83	1018	9	27	20
Total	6640	2266	1274	3567	13747	66.15	6298	929	733	276
<u>Rabi :</u>										
Dry	3780	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	-
<u>Summer :</u>										
Irrigated	29	-	98	-	127	0.61	52	-	136	-
<u>Perennial :</u>										
Irrigated	-	-	-	455	455	2.19	-	-	-	3593
Grand Total	11439	2961	2245	4087	20782	100.00	10055	1235	1209	
%	55.28	14.25	10.80	19.67	100.00					

(continued)

Table 6.12 : (continued)

(II) Optimum Crop Pattern for 2001 A.D.

<u>Kharif :</u>										
Dry	5629	2290	1253	3581	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	100.0					

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(*) 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 6.13 : 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	Pulses	Oil- seeds	Others x	Total	%	Cere- als	Pulses	Oil- seeds	Others x	Total	%
2	3	4	5	6	7	8	9	10	11	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	16735	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	33118	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	19.29	-	-	-	34745	34745	13.71
Grand Total	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 6.13 : (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	17.58	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	800433	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 6.14 : 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 2000-1983-84 for total
	Dry	Irri gated	Total	Dry	Irri gated	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.

Table 6.15 : Annual Precipitation at Selected Centres in Western Ghat Region

District/Centre	Normal rainfall	1982		1983	
		Rainy days	Rain- fall	Rainy days	Rain- fall
Nashik					
Surgana	1862	72	262.4	95	3219.0
Pune					
Paud Mulshi	1519	69	1085.0	76	1537.8
Vadgaon Mawal	1134	57	960.2	63	1115.3
Velhe	-	83	1981.4	97	2827.0
Satara					
Mahabaleshwar	6226	106	4469.1	115	5484.7
Panchagani	1865	86	1744.7	87	2304.8
Patan	1832	80	1711.8	69	1553.7
Medha (Jaoli)	1723	67	1278.7	69	1400.4
Kolhapur					
Gaganbavada	6212	110	5594.2	115	7227.2
Radhanagari	3818	96	3658.2	97	4012.0
Chandgad	2696	82	2981.1	84	3126.5
Ajra	2250	84	1966.0	91	2380.0
Shahuwadi	1961	70	1261.0	87	1816.0
Gargoti	1542	90	2059.0	76	1983.9

Source : Statistical Abstract of Maharashtra.

Table 6.16 : Land Use in Western Ghat Talukas of Maharashtra

	Group I	Group II	Total	Maharashtra State
Rainfall (cms.)	Above 250	150- 250		
No. of talukas	5	15	20	235
Area (sq.km.)	3370.8	15674.3	19045.1	307690
Population Density	152	143	149	204
Population (1981) in 000				
Male	257	1137	1394	32415
Female	255	1185	1440	30369
Forest area (sq.km.)	1010	3893	4903	53049
Land Use :				
% area under				
Forest	30.0	25.0	25.0	5.6
Barren and un- cultivated	9.7	7.8	8.1	5.6
Pasture	2.0	6.6	5.8	8.1
Culturable waste	14.3	3.1	5.1	3.1
Net cultivated	40.5	50.3	48.0	59.8
Major crops				
% area under :				
Paddy	29.1	13.5	16.3	7.3
Ragi	10.2	3.1	4.4	1.1
Fodder	26.2	31.2	30.3	4.2

Source : District Statistical Abstract and Socio-Economic Review, Pune, Satara, Kolhapur, Nashik districts.

Table 6.17 : Percentage of Germination of Seed in Nursery (1983)
in Western Ghat Region

	Per cent germina- tion
<i>Acacia auriculiformis</i>	80
<i>Albizzia</i> sp.	50-60
<i>Albizzia procera</i>	50-60
<i>Albizzia stipulata</i>	50-60
<i>Artocarpus</i> sp.	50-60
<i>Bombax ceiba</i>	60-70
<i>Bridelia squamosa</i>	20-25
<i>Eutea frondosa</i>	80
<i>Carrissa congesta</i>	60
<i>Dalbergia sissoo</i>	80
<i>Erythrina stricta</i>	80
<i>Gmelia arborea</i>	50-60
<i>Mangifera indica</i>	80
<i>Melia composita</i>	40
<i>Meynia laxiflora</i>	30
<i>Pongamia pinnata</i>	70-80
<i>Tamarindus indica</i>	70
<i>Terminalia alata</i>	50-60
<i>Terminalia bellerica</i>	60-70
<i>Terminalia chebula</i>	40
<i>Zizyphus rugosa</i>	50-60

Source : Brahme, 1990.

Table 6.18 : Survival Rate and Growth of Seedlings Planted in June 1987 in Western Ghats Region

Species	Survival rate upto Nov.1988 (per cent)	Average growth in cm.during the period				Average height in Nov.1988 (cm.)
		June to Nov.87	Nov.87 to Feb.88	Feb.88 to June 88	June 88 to Nov.88	
<i>Acacia auriculoformis</i>	90	21	21	27	28	106
<i>Tectona grandis</i>	84		14	21	44	87
<i>Syzygium cumini</i>	78	4	3	4	1	20
<i>Terminalia bellerica</i>	96	4	1	1	8	25
<i>Terminalia alata</i>	90	6	5	1	1	53
<i>Dalbergia sissoo</i>	100	24	} Growth stunted due to cattle menace			
<i>Melia composita</i>	60	26				

Source : Brahme, 1990.

Table 6.19 : Month from which Shortage in Water Supply is Experienced in Surveyed Villages from Aurangabad and Pune Districts

Month from which shortage experienced	Taluka				
	Aurangabad	Vaijapur	Daund	Shirur	Khed
-----Number of Villages-----					
December	4	-	1	6	-
January	8	3	3	4	3
February	2	7	1	8	9
March	1	8	6	4	11
April	1	6	-	-	4
May	-	2	-	2	2
Year round	--	3	-	-	-
No problem	8	1	1	2	2
Villages surveyed (total)	24	30	12	26	31

Source : Field Survey, 1989.

Table 6.20 : Facilities for Drinking Water Supply in Surveyed Villages from Aurangabad and Pune Districts

District	Taluka	Total villages surveyed	Piped water supply			Water supply by tanker in summer	Total Bore Wells (No.)	Operative bore wells
			Scheme completed	Scheme defunct	Shortage experienced in summer			
			-----Number of villages-----					
Aurangabad	Aurangabad	24	19	4	7	-	49	14
Aurangabad	Vaijapur	30	19	10	7	6	78	15
Pune	Daund	12	7	3	3	6	66	21
Pune	Shirur	26	14	8	4	15	164	55
Pune	Khed	31	9	5	2	13	51	11

Source : Field Survey, 1989.

CHAPTER VII

PERSPECTIVE LAND USE PLAN FOR RAJASTHAN

In formulation of land use plan the tracts where the lands suited for cultivation are very limited either due to 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 cm² 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 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 of about 26.5 per cent of the arid area. Based on the assessment of the land resources and their examination in relation to 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 7.1.

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 was 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, keir, lana, jhinjani are helpful. However due to pressure for fuelwood existing matts are disappearing. Formerly it was jagirdars' responsibility to protect 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 trees/shrubs get established. Mechanical barriers for protective purpose are costly and may not prove effective. Social barriers would be effective but to enforce social barriers alternative institutional arrangement are essential. These aspects are discussed in Chapter XI.

(B) Contour bunding has also been found useful on 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 with bunding is possible in a normal rainfall year. 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 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 (seedling and grainfilling) if there is 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, 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 7.2. In 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. Improving upon the traditional practices of trees, shrubs, grasses grown in combination with crops and suggestions for effective adjustments according to changed situation and its adoption in practice is important for improving and stabilizing 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 sawan, 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.

4. Silvi-Pastoral Approach

An analysis of rainfall data from 1901 reveals that normal rainfall (350-400 mm) and good rainfall (above 400 mm) year occur with 48 per cent probability which have 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.

On the basis of the nutrient content and palatability rating of leaves the recommended trees are shown in Table 7.3. A good pasture may have 30 trees per hectare.

At 1981 prices the net annual per hectare income from fuel-wood, 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 Prosopis juliflora only Rs. 900 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, 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 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 7.4.

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 grasslands under Lasiurus sindicus (sewan) remain underutilized due to non-availability of drinking water. Provision of tanks 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 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

* 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

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 60³ cm) have given successful results. Trees and shrubs recommended under different rainfall zones are shown in Table 7.5.

6. Protective Forests

Establishment of protective forests is an effective means of improving ecology of 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 met 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 7.6. 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 7.7.

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 all through 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 wider 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 revealed that the area under forest in 16 districts of Rajasthan (Table 7.8) 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 tribal. 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 7.9.

III. Agricultural Lands

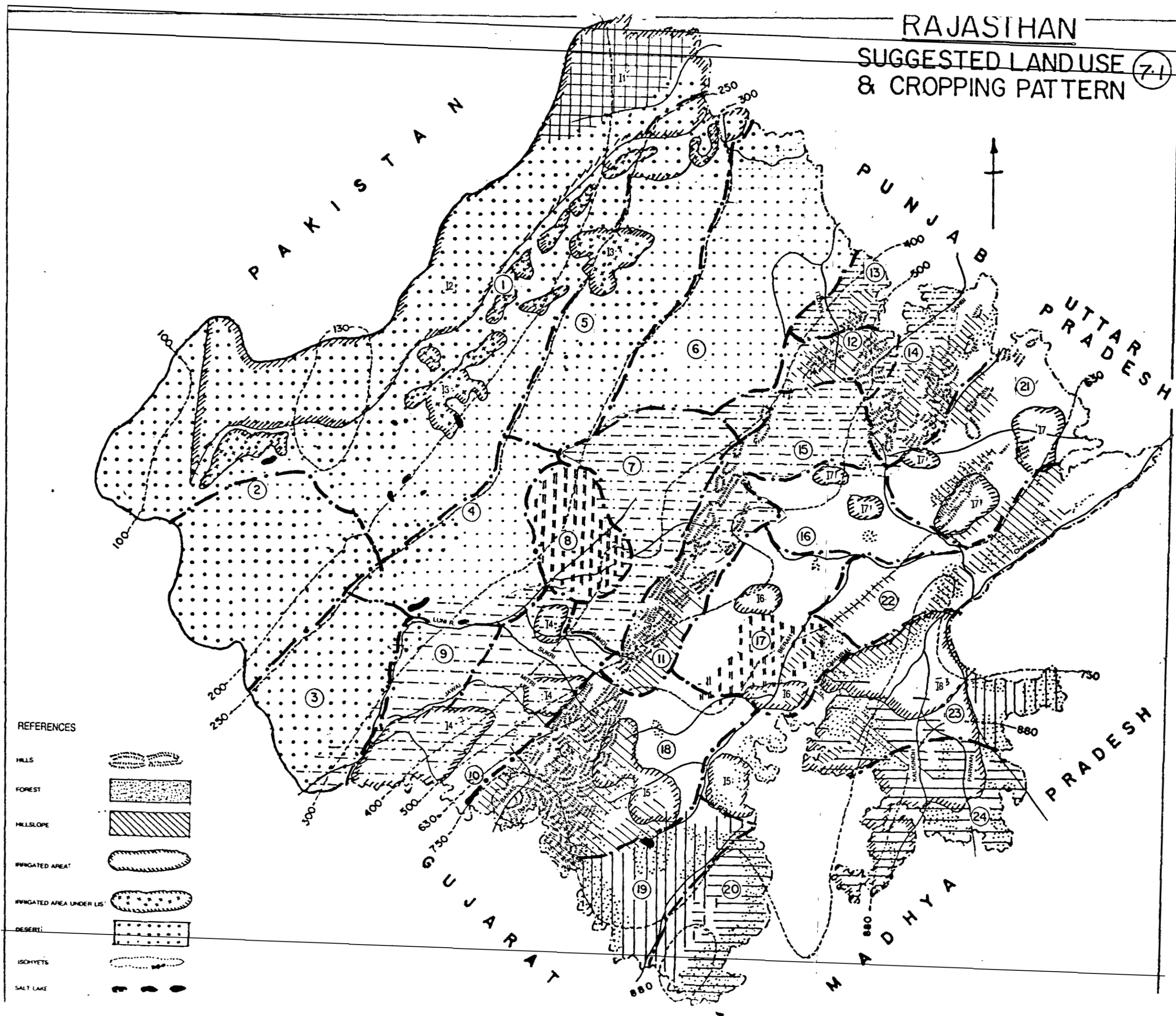
The entire State has been divided into 24 sub-zones taking into consideration the average precipitation, soil type and topography. In addition eight irrigated sub-zones are demarcated (Map 7.1). Marginal lands not suited for cultivation are to be put under pasture or silvi-pastoral or afforestation schemes. The extent of area, in each sub-zone, to be put under cultivation, grass and forest is indicated in Table 7.10. 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 xerophytic 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 continue to be to 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 7.11. 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 rapeseed, mustard, til, sunflower, safflower and groundnut. The projected area under different crops and the projected production is given in Table 7.12. The major suggested 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 7.13). 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. 1600 to Rs. 2650. The number of mandays of work are likely to increase because of increased intensity of cropping, to about 82 days per hectare (Table 7.14). 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 XI.

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 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 XI.

Table 7.1 : 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	Present land use	Nature and magnitude of desertification hazard	Recommended management
1	2	3	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 1,000 ha; fencing essential. After initial grubbing, to be re-seeded with Cenchrus/ Lasiurus indicus @ 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 7.1 : (continued)

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

(continued)

Table 7.1 : (continued)

1	2	3	4
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 7.2-A : Trees Suitable under Agro-Forestry System

Rainfall in cm.	T r e e s	C r o p s
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 7.2-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	57.3	59.3	38.7	48.8
Grass Production (T/ha.)	0.78	1.32	2.34	0.85	1.66

Table 7.2-C : Forage Yield (Total with Contribution of Perennials) under Different Tree Species

Particulars	Tree species				Years observa- tion recorded
	Prosopis cineraria	Tecomella undulata	Albizzia lebbek	Acacia senegal	
<u>Expt. I</u>					
1. Total forage yield (t/ha)	*1.494	*1.413	*1.354	0.632	5 years (1972-76)
2. Yield of perennial sp. (t/ha)	1.117	*0.759	*0.917	0.333	
3. Percentage of perennial grass species	74.77	53.73	67.36	52.50	
4. No. of trees per ha.	*566.6	*383.3	*283.3	1516.6	
<u>Expt. II</u>					
1. Total forage yield (t/ha)	*1.546	*1.478	*1.406	0.691	4 years (1972-75)
2. Yield of perennial sp. (t/ha)	*1.211	*0.755	*0.735	0.372	
3. Percentage of perennial grass species	78.33	51.1	66.5	58.8	
4. No. of trees per hectare	*1377.5	*942.8	*688.8	3724.4	
<u>Expt. III</u>					
1. Total forage yield (t/ha)	*1.154	-	*1.123	0.683	5 years (1972-76)
2. Yield of perennial sp. (t/ha)	*0.862	-	*0.958	0.563	
3. Percentage of perennial grass species	74.7	-	85.3	82.43	
4. No. of trees per ha.	*1743.3	-	298.3	*1812.4	
<u>Expt. IV</u>					
1. Total forage yield (t/ha)	*1.070	*1.099	0.935	0.739	6 years (1972-77)
2. Yield of perennial sp. (t/ha)	*1.048	*1.090	0.908	0.740	
3. Percentage of perennial grass species	97.94	99.18	97.11	98.79	
4. No. of trees per ha.	*1264.8	*1111.1	362.9	*1280.5	

* Values in a horizontal line do not differ significantly.

Source : Agro Forestry in Arid and Semi Arid Zones, 1989, p. 165.

Table 7.3 : Palatability Ratings and Chemical Analysis of Individual Top-feed Species
(Figures represent the Percentages of the Constituent on Dry-wt. basis)

Botanical name	Common name (Local)	Palatability ratings	Crude protein	Crude fibre	Nitrogen-free extract	Ash	Phosphorus	Calcium	Magnesium
<i>Acacia arabica</i> Wild	Babul	Good	13.9	9.2	69.8	7.1	0.1	2.6	0.4
<i>Acacia senegal</i> Wild	Kumat	Moderate	10.3	9.5	65.7	16.4	0.05	6.9	0.6
<i>Albizzia lebbek</i> Benth.	Siris	Moderate	29.2	25.3	43.8	7.5	0.2	1.8	0.5
<i>Anogeissus pendula</i> Edgew	Dholkra	Moderate	7.6	19.0	65.3	8.1	0.1	3.5	0.3
<i>Anogeissus rotundifolia</i>	-	Moderate	8.9	20.0	62.2	8.6	0.1	3.7	0.5
<i>Azadirachta indica</i> L. juss.	Neem	Fair	12.4	11.4	66.6	9.4	0.1	3.4	0.6
<i>Calligonum polygonoides</i> Linn.	Phog	Moderate	7.4	20.7	64.2	7.6	0.1	2.4	0.8
<i>Cassia curiculata</i> Linn.	Tarwad	Poor	10.9	12.5	67.3	9.1	0.1	3.7	0.7
<i>Grewia tenax</i> Forsk	Gangan	Fair	10.3	18.9	61.1	9.5	0.1	3.8	0.5
<i>Gymnosporia spinosa</i> Borel	Kankora	Fair	9.3	19.0	63.5	8.1	0.2	1.8	0.8
<i>Prosopis juliflora</i>	Bilaya-thi babool	Fair	21.4	20.8	50.0	7.7	0.2	1.5	0.5
<i>Prosopis spicigera</i> Linn.	Khejri	Good	13.9	20.3	59.2	6.5	0.2	1.9	0.5
<i>Salvadora oleoides</i> Dunc	Pilujal	Good	9.6	9.3	40.2	40.8	0.1	11.9*	0.7
<i>Salvadora persica</i> Linn.	Kharajal	Good	14.2	9.4	44.9	31.4	0.2	8.8	0.7
<i>Tecomella undulata</i> Seem	Bordi	Fair	12.2	15.2	63.0	8.9	0.2	3.4	0.9
<i>Zizyphus nummularia</i> Rox	Bordi	Good	11.7	16.0	65.0	7.2	0.2	1.6	0.3

* Contains free Ca₂SO₄

Note : Palatability ratings of "Good", "Moderate", "Fair" and "Poor" were arrived at by conducting trials with sheep, following 'cafeteria technique'.

Source : Desertification and Its Control, 1977, p. 206.

Table 7.4-A : Trees Suited for Plantation in Arid and Semi-Arid Region

T r e e	U s e s			
<i>Prosopis cineraria</i>	-	Fodder	Fuel	Bean, flower edible
<i>Tecomella 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 7.4-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>Lerva pseudotomentosa</i>
<i>Crotalaria burnia</i>
<i>Haloxylon sulicornicum</i>

Table 7.4-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 indicus (Sewan)
Sand Dunes	Panicum turgidum (Murut), Panicum antidotale (Gramma)
Saline Soils	Sporobolus marginatus (Kharada), Eleusine compressa (Tantia)
Medium to Heavy Soils	Dichanthium annulatum (Karad)
Sandy Soils	Lasiurus indicus (Sewan)
Buried Pediment	Dactyloctenium indicum Boiss (Ganthia)
Well Textured Soil	Panicum antidotale (Gramma)
Piedments and Inter-montane Plains	Oropetium thomeum (Khargesh chutti) Aristida spp. (Lampra, Dholio Lamp)

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

Table 7.5 : Trees, Shrubs and Grasses Recommended for Sand Dune Stabilization

Rainfall (in cm.)	T r e e s	S h r u b s	G r a s s e s
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 jujuba	Cenchrus ciliaris Lasiurus indicus Cenchrus setigerus Sacharum munja
Above 40	Prosopis cineraria Albizia lebbek 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 7.6 : Comparative Performance of Selected Exotic and Indigenous Tree and Shrub Species

Species	Year of planting	Establishment (%)	Mean growth		Mean annual increment	
			Height (cm)	DBH (cm)	Height (cm)	DBH (cm)
<u>A. Exotics</u>						
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. tereticornis	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	657	15.1	44.8	1.0
8. A. salicina	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	13.3	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
<u>B. Indigenous</u>						
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	-

(continued)

Table 7.6 : (continued)

Species	Year of planting	Establishment (%)	Mean growth		Mean annual increment	
			Height (cm)	DBH (cm)	Height (cm)	DBH (cm)
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	439	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. 250-51.

Table 7.7 : Tree Species Suitable for Various Land Forms in Rajasthan Desert

Land form	Rainfall (mm)	T r e e s
Shifting Sand Dunes	150 to 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 7.8 : 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 7.9 : Valuable Trees of Aravalis and Other Hilly Tracts in Rajasthan

Botanical Name	Marathi Name	Region *
1. Acacia Catechu	Khair	S, SE, AN, AS
2. Acacia Leuceophloea	Lroonj	AN
3. Acacia Nilotica	Babul	S, SE, AN
4. Acacia Senegal	Kumat	SE, AN
5. Adina Cordifolia	Haldu	S, AS
6. Aegle Marmelos	Bel	S, SE, AS
7. Ailanthus Excelsa	Maharuk	AN
8. Albizzia Lebbek	Shirish	S, SE, AN, AS
9. Anogeissus Latifolia	Dhawda	S, SE, AS
10. Anogeissus Pendula	Dhok	SE, AN, AS
11. Azadirachta Indica	Neem	S, SE, AN, AS
12. Bambusa Strictus	Bamboo	S, AS
13. Bauhinia Racemosa	Kanchan	S, SE, AS
14. Bombax Malabaricum	Sawar	AS
15. Boswellia Serrata	Salai	SE, AN
16. Bridelia Retusa	Asana	SE
17. Butea Monosperma	Palas	SE, AN
18. Cassia Fistula	Bawa	S, SE
19. Dalbergia Lalifolia	Sissum	S, SE, AN
20. Dalbergia Sissoo	Shisavi	SE
21. Dendrocalamus Strictus	Bamboo	S, AS
22. Diosphyros Melanoxylon	Timru	S, SE, AS
23. Emblica Officinalis	Awla	S, SE, AS
24. Ficus Bengalensis	wad	S, SE, AN
25. Ficus Religiosa	Pimpal	S, SE, AN
26. Grewia Tiliaefolia	Dhamani	S, AS
27. Holoptelea Integrifolia	Wavali	S
28. Kydia Calycina	Ranbhendi	SE
29. Laranea Coromadelica	Gundi	SE, AN
30. Madhuka Indica	Mahua	S, SE
31. Mangifera Indica	Ambe	S, SE, AS
32. Mimusops Indica	Khirni	SE
33. Phoenix Sylvestris	Shindi	SE, AN
34. Pongamia Pinnata	Karanj	SE
35. Prosopis Cinararia	Khejri	SE, AN, AS
36. Salmalia Malberica	Savar	SE
37. Salvadoria Oleoides	Jal	SE, AN
38. Santalum Album	Chandan	S
39. Soyimida Febrifuga	Rohan	S
40. Sterculia Urens	Gular	SE
41. Syzygium Cumini	Jambul	S, SE, AN
42. Tamarindus Indica	Chinch	S, SE
43. Tectona Grandis	Sag	S, SE, AN
44. Tecomella Undulata	Rohida	SE, AN
45. Terminalia Arjuna	Arjun	S, SE
46. Terminalia Bellerica	Behda	S, SE
47. Terminalia Tomentosa	Ain	S

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

Table &.10 : 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 7.11 : Suggested Crop Pattern by Sub-Zone in Rajasthan

Sub-zone	C r o p s
<u>Rainfed Agriculture</u>	
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
<u>Irrigated Agriculture</u>	
11,12, 13	Hybrid bajri, wheat, rape, mustard, groundnut, sunflower, cotton, sugarbeet, vegetables, onion, garlic, chillies, barseem.
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 7.12 : Suggested Crop Distribution and Estimated Crop Production in 2001 A.D. and Crop Pattern and Production in 1983-84 in Rajasthan

C r o p	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	10883	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 7.13 : 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 7.14-A : 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 7.14-B : 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

CHAPTER VIII

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 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.

These forests are in areas where a large proportion of tribal population in the state lives. 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 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. The tree crop will be harvested at the end of 15 years and families will get a subsistence loan of Rs. 350/- per hectare per year which will be made an interest free loan at the end of 15 years. The results are yet to come. In effect social forestry is reduced to commercial tree farming. The distortion is to be contrasted against a remark in a World

Bank Report which says that a primary objective of Gujarat Social Forestry Project is to ensure that all rural households... have ready access to fuelwood and fodder for domestic consumption... and thereby to reduce the amount of time women and children have to spend daily in collecting fuelwood (as) also to encourage the diversion of animal dung from burning to use as organic manure". (India's Environment, 1984-85).

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. Another major failing of the social forestry projects is the lack of involvement of poor women who really ought to be beneficiaries of the program.

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 right 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 be covered by 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 for different sites and climatic conditions will vary, trials should be conducted extensively under different edapho-climatic conditions to determine the most suitable species of fodder

trees, grasses and legumes. Demonstration plots should be established under different edapho-climatic conditions to demonstrate the suitability of silvi-pastoral systems for fodder production from wastelands.

The selection of fodder trees, grasses and fodder legumes for wasteland afforestation 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 8.1.

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.

All efforts have to be made to propagate some sort of vegetative cover based on study of whatever species

that are existing in the region today. 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 that should be studied for such propagation is grouped under ecosystems suitable for 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) *Asparagas 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) *Lepidagathis 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) *Atriplex stocksii*.

The dominant floristic species of the coastal desert are: *Capparis deicdua*, *Zizyphus jujuba*, *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 care given in Chart 8.1.

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.

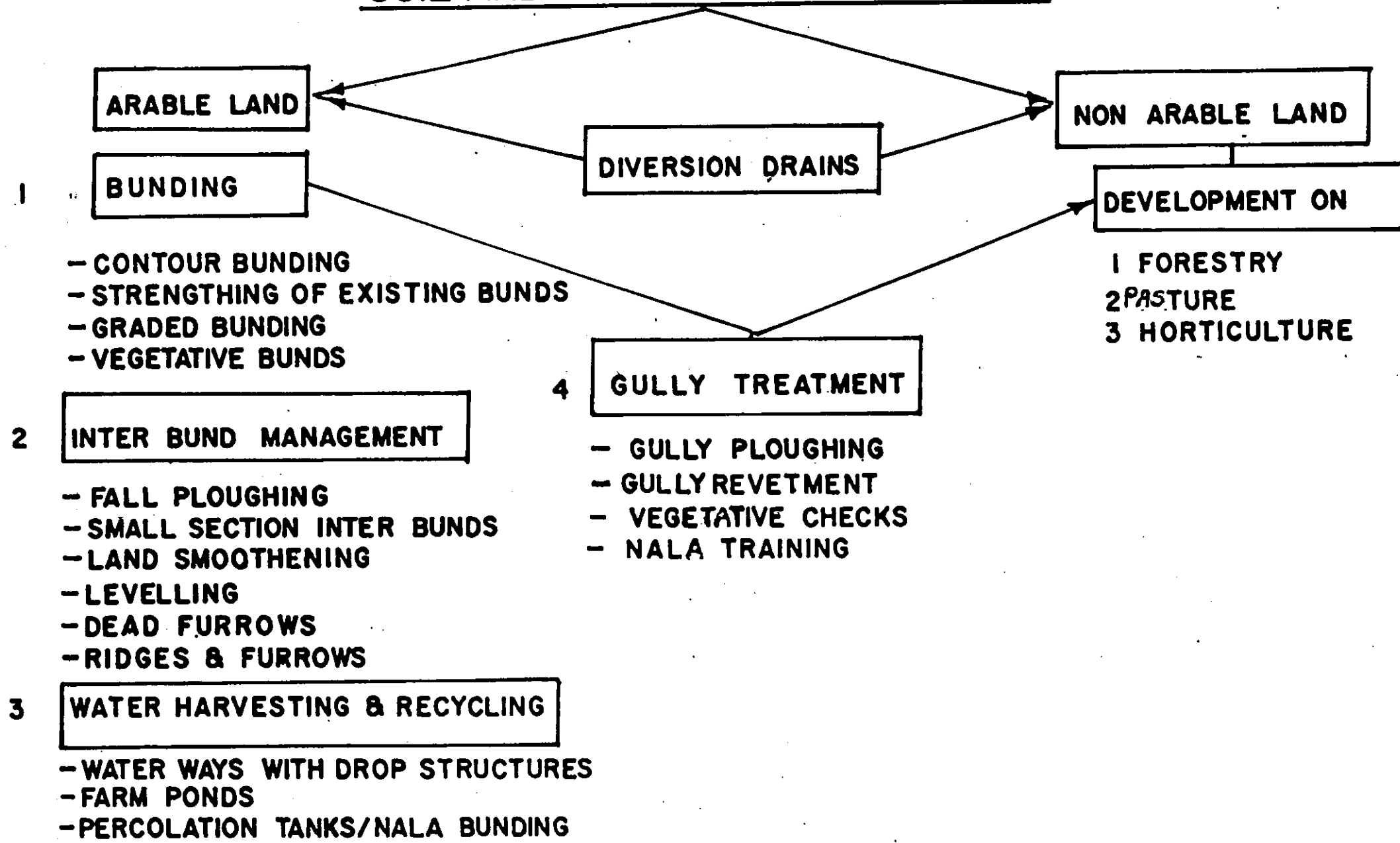
1. Coastal Lands

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 ground water 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., inside. 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 ground water bodies and the situation gets aggravated if farmers start utilizing water from wells adversely affected 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.

SOIL AND MOISTURE MANAGEMENT



These problems have already assumed serious dimensions & call for measures to arrest further ingress and possibly 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. (Table 8.2).

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. So, 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 Khambat, 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 ground water 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 trench 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, Girner hills area in Junagadh, Bhuj ridge 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 programmes. 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 recognized 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 being received in the June and 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 which is 54 per cent of 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 receive adequate attention.

Watershed development is not an engineering scheme alone. Creation of a forest cover is crucial for harvesting water on 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. Yields in different crops in block demonstration along with the control crops for kharif and rabi seasons for 1988-89 and for kharif season of 1989-90 are in Tables 8.3, 8.4 and 8.5.

Integrated National Watershed Development Project in Sangani, Surendranagar district has promoted water conservation works involving contour bunding, land smoothening, 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 ground water. (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 887 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 ground-water 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 ground water, 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 ground water 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 well over 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

The present position about surface irrigation and well irrigation and the assessed potential of the two sources are already discussed in Chapter IV. In surface irrigation, the main issue in Gujarat to-day is the construction of the proposed 138.68 metres high and 1210 metres long Navagam dam to create a live store of 4.73 MAF of water in the upstream reservoir viz. Sardar Sarovar. 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 with an estimate that about 18 lakh hectares would be irrigated in Gujarat. However, actually surface irrigation so far is being utilized only for 7.76 lakh hectares i.e. 43 per cent only. For example, in the Damanganga project the irrigation was planned for over fifty six thousand hectares of land at the cost of over 140 crore of rupees. As against this, in 1987, only about five hundred and sixty hectares received irrigation, (Estimates Committee 10th Report, Suresh Mehta Committee, 1988). Similarly in the Shetrunji Irrigation Scheme in Bhavnagar district over thirty four thousand hectares were estimated to receive irrigation every year. In point of fact between 1965 and 1987, the average annual irrigation has been only about twelve thousand hectares i.e. about 35 per cent of the estimated hectarage. Thus there is every reason that the Gujarat Government should pay more attention to speedy completion of on-going projects, command area development of irrigable land and see that the potential created is more or less fully utilized before venturing into the megallo project of Sardar Sarovar. Because, there is a further squeeze in the finance available for other irrigation works due to the heavy draft on resources for Sardar Sarovar project.

(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 8.6.

It may be observed that 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 ground water 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 four hundred 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 in 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. Besides the fact that 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.

This can be done with appropriate measures of integrated watershed planning, particularly in Gujarat which has a reasonably good supply of groundwater as estimated by the Ground Water Resource Development Corporation (GWRDC) of Gujarat. (See Chapter IV, Table 4.16). Thus it is clear that 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 water logging and soil salinity.

This study comprises of the Region 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 salinisation 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%
	<u>5,83,663 ha.</u>	

*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 (!) (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. The potential of groundwater to meet the needs of Gujarat population is clear from Table 8.7.

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	Agricultural 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 fores s

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 two 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 water logging, 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 Valsad district in Gujarat in 1982.

The programme operates with family as a unit. Each participating family works 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. On each plot of land, the tribal family works to take up measures such as land shaping, contour marking, bunding, terracing,

live hedge fencing, digging pits, plantation of trees and after-care. The family spends part of the work-time on Wadi 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 are taking care of 4850 acres of land in 1990. For a unit of 5000 families, BAIF has administrative-cum-technical team comprising one coordinator, 2 technical officers, 5 junior field officers (technical) and 25 field guides or community workers.

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. Mango trees have started yielding mangoes - about 250 to 500 kg. per Wadi from the 5th year. The yield is expected to increase in the subsequent years reaching 1000 kg. in the 8th year. About 80 to 100 poles (fetching Rs. 25 to Rs. 50 each) per Wadi are also available annually from 6th year onwards. Gross income of about Rs.6500 is expected to be earned in the sixth year and will increase over the years so that an income of around Rs.12000 is anticipated in the tenth year. The programme generates annual employment of about 200 to 250 person-days per Wadi.

The programme is based on the initial capital investment in land development and irrigation works etc., being funded by a number of agencies like Government of India, Government of Gujarat, National Waste Lands Development Board, UNICEF, CAPART, private well-wishers, etc.

At the local level, it emphasizes establishment of strong rapport with participating families through Ayojan Samiti (Planning Committee) which is formed of one man and one woman representative for every 20 families. This committee meets every month to plan and monitor the programme at each stage.

The programme also 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 and lands/rehabilitation of the tribals.

IV. Projected Agricultural Production and Employment

The farming community of Gujarat consists mainly of small farmers. Distribution of operational landholdings in Gujarat is presented in Table 8.8. 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. About one-fifth of the operational holdings accounting for 41.5 per cent of land are of medium size i.e. between 4 and 10 hectares. Only 4.5 per cent of 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 lakhs 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 Seventh Plan document mentions that the irrigation would be made available to about 36 lakh hectares by 1990 without Narmada. The net irrigated area in 1983-84 was around 22 lakh hectares, so one can project that 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 unirrigated land. The gross cropped area will increase from about 111 lakh hectares in 1983-84 to about 120 lakh hectares in 2001. (Table 8.9).

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, ten 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.

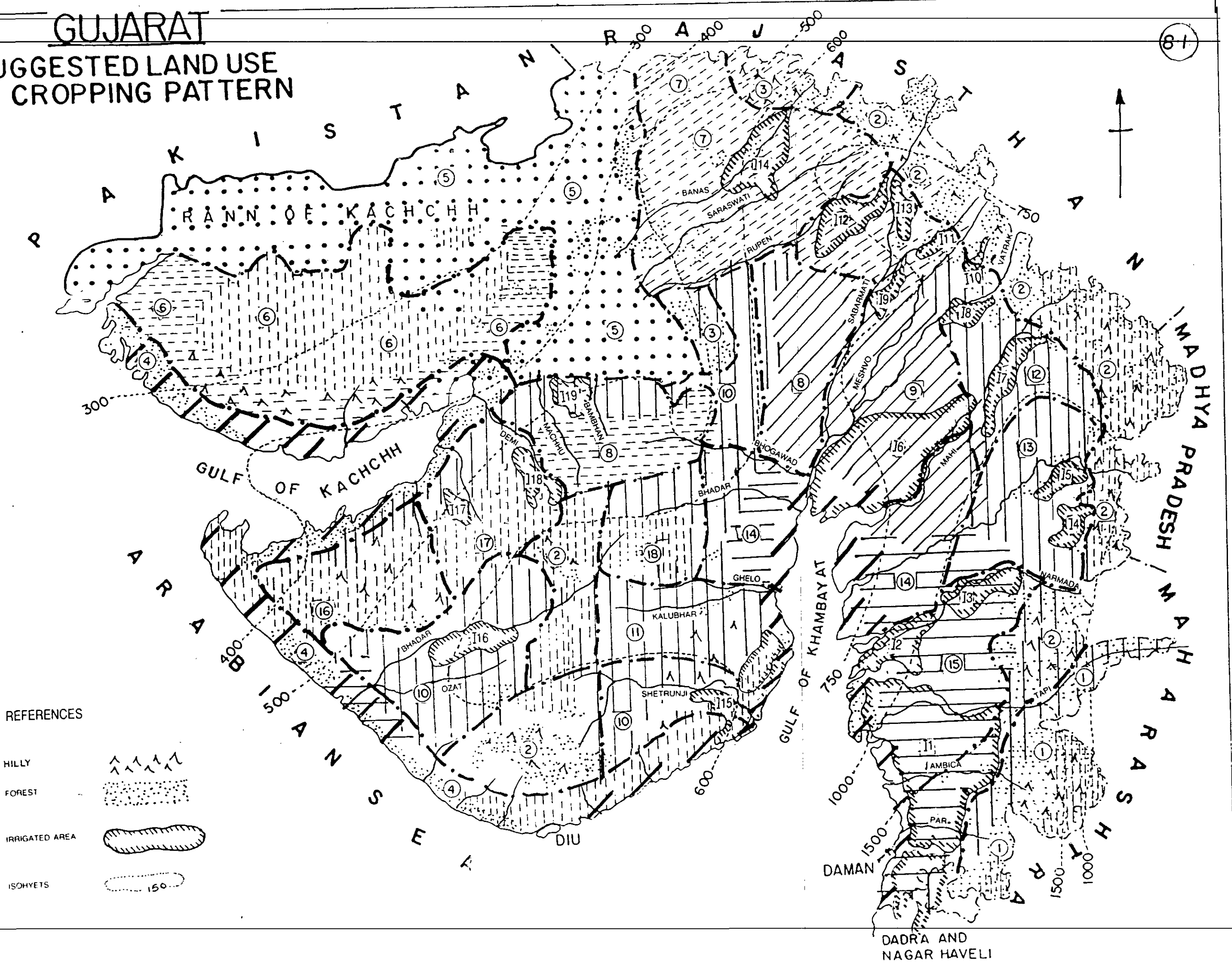
Suggested crop pattern based on the past trends, current practices and soil-climatic conditions is listed in Table 8.10. and presented in the map 8.1. The irrigated pockets in the State are numbered in the map and suggested crop pattern for different irrigated pockets in the State is presented in Table 8.11.

The main thrust in the suggested crop pattern is on utilising 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

GUJARAT

SUGGESTED LAND USE & CROPPING PATTERN

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REFERENCES

- HILLY
- FOREST
- IRRIGATED AREA
- ISOHYETS

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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 twenty five 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 twenty 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 Bharuch, 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 ten 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 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, Ahmedabad, 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.

The farmer in Gujarat is already aware of the importance of fodder crops and eight per cent of gross cropped area and five per cent of gross irrigated area is currently under fodder crops. With growing scarcity of fodder, it is suggested that area under fodder crops should be increased as this would be profitable for the farmer as well as essential for the State economy.

Cropping pattern in 1983-84 and 2001 is presented in Table 8.12. Production of major agricultural produce in 1983-84 and suggested cropping pattern for 2001 along with the estimated production based on the assumption that best performance in Gujarat in 1983-84 would be the average performance in 2001, and the gross value of agricultural output in 1983-84 and 2001 at 1983-84 prices are presented in Table 8.13.

There is some decline in the proportion of area under cereals but more than compensatory increase in pulses in 2001. There is significant increase in the area under oilseeds and area under cotton will remain the same.

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. (see Table 8.14). 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 8.15. 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 fuel wood requirements of rural population in 2001 would be around 70 lakh tonnes. Estimated production/availability of fuel wood 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 fuel wood. The estimated production of fuel wood in 2001 is 69 lakh tonnes. The expected fuel wood 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 8.16. The gross value of agricultural output in 2001 at 1983-84 prices is estimated to be Rs.5917.1 crores which is about 82.5 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 3.1 : 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 mufica, Bromus inermis, Dactylis glomerata, Eragrostis curvula, Festuca elaxior, 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, Demostachya bipinnata.

(continued)

Table 8.1 : (continued)Tropical :

(includes Semi-arid Areas)

Chloris gayana, C. dolichostachya, Cynodon plectostachyus, Dichanthium annulatum, Pennisetum pedicellatum, P. purpureum, Sorghum sudanense, Urochloa pullulans, U. mozanibibicensis 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, Zulaliopsis binata, Saccharum sp. Apluda mutica, Bothriochloa insculpta, B. odorata, E. 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. bromograss (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).

Black Soils :

Chloris bournei C. gayana, Dichanthium annulatum, Bothriochloa pertusa, Cenchrus setigerus, Chrysopogon fulvus, Eragrostis curvula, E. superba, Panicum maximum, P. antidotale, Pennisetum pedicellatum, P. polystachyon, Sehima nervosum.

(continued)

Table 8.1:(continued)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, Sehima 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, Nyriostachyawightiana, Spinifex littoreus, Polytrias amaura, Sporobolus marginatus, S. helvolus, S. airoides, Dichanthium annulatum, Iseilema prostratum, Cynodon dactylon, Brachiaria mutica, Chloris gayana, C. barbata, C. bournei, C. viragta, Cenchrus ciliaris, Echinochloa colonum, Eleusine compressa, Eriochloa procera, Paspalum scrobiculatum, P. raginatum.

Para grass, Giantstar grass, Sudan grass, Marvol and Natal grass are medium salt tolerant while blue panic, anjan grass, dhaman 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.

(continued)

Table 8.1 : (continued)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, Macroptilium lathyroides, Indigofera endecaphylla, Lotus corniculatus, Medicago sativa, M. polymorpha, Trifolium spp., Clitoria ternatea, Leucaena leucocephala, Stylosanthes gracilis.

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.

(continued)

Table 8.1 : (continued)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 ooieinensis, 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, Pithecellobium dulce, Schleicheria oleosa, Terminalia alata, T. arjuna, T. chebula, T. paniculata, Toona ciliata.

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,

(continued)

Table 8.1 : (continued)

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 cuminii*, *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*, *Soymida febrifuga*, *Spondias pinnata*, *Stereospermum suaveolens*, *Toona ciliata*, *Trema orientalis*, *Wrightia tomentosa*, *Ziziphus xylopyrus*.

 (continued)

Table 8.1 : (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); Pongamia pinnata, Ailanthus excelsa, Prosopis chilensis, Leucaena leucocephala, 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 syndicus, 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 ojeinensis, 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., Azadirachra 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 8.2 : Comprehensive Statement Showing the Details of Various Works/Measures Recommended by the HLC-I and HLC-II in the Saurashtra and Kachchh Coastal Area

Description	Unit	Una- Madhavpur HLC-I	Una- Bhavnagar HLC-II	Madhavpur- Malia HLC-II	Malia- Lakhpur HLC-II	T o t a l
Length	Km.	160	180	425	360	1,125
Affected area	Ha.	1,00,000	1,40,000	4,60,120	3,65,200	10,65,000
Affected population	Souls	2,80,160	2,20,200	5,79,373	2,50,000	13,30,000
Affected wells	Nos.	12,562	8,800	11,388	10,478	43,228
Affected villages	Nos.	120	166	248	245	779
Estimated cost	Rs.in crores	64	168	370	186	788
Land Reclamation	Ha.	-	10,000	15,500	10,000	36,500
Irrigation potential	Ha.	19,850	33,113	65,640	37,545	1,56,000
Check dams	Nos.	75	300	460	740	1,575
Tidal regulators	Nos.	7	8	23	15	53
Bandharas	Nos.	10	29	48	40	127
Afforestation	Ha.	50,000	15,750	25,000	14,000	1,04,760
Nala plugs	Nos.	10,000	20,000	45,400	20,000	95,400
Recharge wells	Nos.	200	450	680	150	1,480

Source : Measures to overcome the Salinity Problems of the Coastal Areas in Gujarat, J.F. Mistry, Secretary, Water Resources Department, Government of Gujarat

Table 8.3 : Yield of Different Crops in Block Demonstration Alongwith the Control Plots in 1988-89 (Kharif) in Gujarat

C r o p s	Average yield in kg./ha.		
	Block demon- stration	Control	% increase
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

Source : Gujarat Land Development Corporation, Ahmadabad.

Table 8.4 : Yield of Different Crops in Block Demonstration Alongwith the Control Plots during 1988-89 (Rabi) in Gujarat

C r o p s	Average yield in kg./ha.		
	Block demon- stration	Control	% increase
Wheat	3771	3410	10.58
Mustard	1290	1051	22.74
Gram	708	617	14.75

Source : Gujarat Land Development Corporation, Ahmadabad.

Table 8.5 : Yield of Different Crops in Block Demonstration Along with the Control Plots during 1989-90 in Gujarat

C r o p s	Average yield in kg./ha.		
	Block demon- stration	Control	% increase
Groundnut	849	682	24.49
Bajri	1425	1156	23.27
Maize	1800	1451	24.05
Tur	844	617	36.79
Paddy	3018	2447	23.33
Udid	532	384	38.54
Jowar	1646	1267	29.91
Mung	1050	826	27.12
Cotton-Hybrid-6	1089	853	27.67
Bajri + Mung	1159/174	835/133	30.96/30.83
Bajri + Tur	1221/850	933/355	30.87/139.44

Source : Gujarat Land Development Corporation, Ahmedabad

Table 8.6 : 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
Gandhi-nagar	261	45	106	45.3	38.9
Ahmedabad	1314	22	3313	73.7	76.2
Kheda	3138	49	1160	27.8	23.6
Pancha-mahals	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 8.7 : Districtwise Ground Water Requirement for Human, Cattle and Industrial Needs for Gujarat State

Sr.District No.	Cattle population	Cattle demand at the rate of 15L/head/day in MCM/Year	Rural human population	Rural human demand at the rate of 15L/head/day in MCM/Year	Urban human population	Urban human demand at the rate of 140L/Head/day in MCM/Year	Total cattle and human demand in MCM/Year. Col.4+6+8	
1	2	3	4	5	6	7	8	9
1. A. Ahmedabad	710818	3.891	1092885	21.939	2747587	114.327	140.157	
B.	924063	5.059	1332117	26.742	3869152	197.710	229.510	
2. A. Amreli	750941	4.109	855892	17.180	219874	11.234	32.523	
B.	976223	5.343	1043247	20.940	309627	15.819	42.102	
3. A. Bhavnagar	1334730	7.307	1251001	25.122	624870	31.930	64.359	
B.	1735149	9.497	1525576	30.623	880379	44.986	85.106	
4. A. Baroda	876219	4.797	1607565	32.271	950527	48.571	85.639	
B.	1139085	6.236	1959460	39.336	1338532	68.398	113.970	
5. A. Bharuch	552178	3.022	1054942	21.177	241509	12.341	36.540	
B.	717831	3.929	1285868	25.813	340093	17.378	47.120	
6. A. Banaskantha	1653217	9.416	1521631	30.547	143830	7.349	47.312	
B.	2149182	11.765	1854776	37.234	202541	10.349	59.348	
7. A. Dang	85386	0.467	113664	2.283	-	-	2.750	
B.	111002	0.607	138545	2.780	-	-	3.387	
8. A. Gandhinagar	109860	0.601	225234	4.521	62249	3.130	8.302	
B.	142313	0.782	274537	5.511	87659	4.479	10.772	
9. A. Jamnagar	950903	5.204	868709	17.436	521416	26.641	49.281	
B.	1236174	6.767	1058869	21.253	734259	37.485	65.505	
10. A. Junagadh	1104132	6.044	1459202	29.291	639458	32.674	68.009	
B.	1435372	7.858	1778521	35.704	900484	46.011	89.573	
11. A. Kheda	1069784	5.856	2408272	49.345	606358	30.066	85.167	
B.	1390719	7.613	2935442	58.928	853369	43.588	110.129	
12. A. Kutch	1721803	9.426	775828	15.574	273761	13.988	38.988	
B.	223344	12.254	945656	18.984	335510	19.699	50.937	

Table 8.7. : (continued)

1	2	3	4	5	6	7	8	9
13.	A. Mehasana	1263076	6.915	2033880	40.829	510736	26.097	73.891
	B.	1641998	8.989	2478096	49.747	719218	36.752	95.488
14.	A. Panchmahal	1703201	9.325	2064137	41.437	257552	13.160	63.922
	B.	2214161	12.122	2515976	50.508	362684	18.533	81.163
15.	A. Rajkot	124929	6.837	1195521	24.000	862615	44.079	74.916
	B.	1523608	8.839	1457220	29.253	1214734	62.072	100.244
16.	A. Surat	712148	3.899	1427172	28.650	10660390	54.474	87.023
	B.	925792	5.068	1739580	34.922	1501196	76.711	116.701
17.	A. Surendra-	793141	4.342	736670	14.788	296753	15.163	34.293
	B. nagar	1031083	5.544	897927	18.025	417887	21.354	45.023
18.	A. Sabarkantha	1114471	6.101	1349910	27.100	148146	7.57	40.771
	B.	1448812	7.932	1645405	33.031	208619	10.660	51.623
19.	A. Valsad	676538	3.704	1385274	27.809	388862	19.870	51.383
	B.	379500	4.815	1688510	33.896	547595	27.982	66.695

(continued)

Table 8.7 : (continued)

Sr. District No.	Industrial demand at 10% of total demand in MCM/Year	Total demand including industrial demand in MCM/Year	Quantity of water available from surface sources in MCM/Year	Net requirement from ground water in MCM/Year	Balance (MCM/Year) as reassessed in 1984	
1	2	10	11	12	13	14
1. A. Ahmedabad	14.015	154.272	-	154.272) 819.53	
B.	22.951	252.461	-	252.951		
2. A. Amreli	3.252	35.775	7.555	28.220) 299.14	
B.	4.210	46.312	9.446	35.866		
3. A. Bhavnagar	6.435	70.794	1.095	69.699) 711.34	
B.	8.510	93.616	1.358	92.248		
4. A. Baroda	8.563	94.202	-	94.202) 862.15	
B.	11.397	125.367	-	125.367		
5. A. Bharuch	3.654	40.194	-	40.194) 644.67	
B.	4.712	51.832	-	51.823		
6. A. Banaskantha	4.731	52.043	-	52.043) 825.04	
B.	5.934	65.282	-	65.282		
7. A. Dang	0.275	3.025	-	3.029) 121.78	
B.	0.338	3.725	-	3.725		
8. A. Gandhinagar	0.330	9.132	-	9.132) 72.63	
B.	1.077	11.849	-	11.849		
9. A. Jamnagar	4.928	54.209	18.100	36.109) 469.76	
B.	6.550	72.055	22.526	49.429		

(continued)

Table 8.7 : (continued)

1	2	10	11	12	13	14
10.	A. Junagadh	6.800	74.809	20.075	54.734	} 556.80
	B.	8.957	98.530	25.093	73.437	
11.	A. Kheda	8.516	93.683	-	93.683	} 1146.42
	B.	11.012	121.141	-	121.141	
12.	A. Kutch	3.898	42.886	4.380	38.506	} 485.41
	B.	5.093	56.030	5.475	50.555	
13.	A. Mehasana	7.384	80.225	-	80.225	} 251.24
	B.	9.548	105.036	-	105.036	
14.	A. Panchmahal	6.392	70.314	4.700	65.614	} 792.99
	B.	8.116	89.279	5.870	83.409	
15.	A. Rajkot	7.491	82.407	28.835	53.572	} 518.15
	B.	10.021	110.235	36.043	74.192	
16.	A. Surat	8.702	95.725	-	95.725	} 1503.75
	B.	11.670	123.371	-	123.371	
17.	A. Surendranagar	3.429	37.722	4.745	32.977	} 461.41
	B.	4.502	49.525	5.931	43.594	
18.	A. Sabarkantha	4.077	44.848	-	44.848	} 607.11
	B.	5.162	56.785	-	56.785	
19.	A. Valsad	5.133	56.521	-	56.521	} 835.46
	B.	6.669	73.362	-	73.862	

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Note : (A) Denotes 1981 position. (B) Denotes 1991 position : Rural 21.89% above 1981 population, Urban 40.82% above 1981 population, Cattle 30% above 1981 population.

Source : Report of the Group on Estimation of Groundwater, Resource and Irrigation Potential from Groundwater in Gujarat State - GWRDC, 1986.

Table 8.8 : Operational Holdings in Gujarat (1985-86)

	No. (000)	%	Area (000 Ha.)	% hold- ings
Marginal	799	4.2	414	25.6
Small	733	10.9	1075	23.5
Semi-medium	779	22.5	2217	24.9
Medium	671	41.5	4080	21.5
Large	142	20.9	2059	4.5
All	3124	100.0	9844	100.0

Source : Agricultural Statistics At a Glance, Ministry of
of Agriculture, 1990.

Table 8.9 : 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 8.10 : Suggested Crops in Sub-Zones in Gujarat

Agricultural Sub-zone	C r o p s
7	Bajri, cotton, tur, gawar (K), mustard, cumin, isabgul, wheat, gram, fenugreek, fodder (R).
8	Bajri, cotton, tobacco, pulses, tur, moog, moth, groundnut, sesamum, (K), wheat, potato, mustard, gram, chilli (R), Sunflower, groundnut, moog, bajri (S).
9	Paddy, bajri, vegetables, pulses, cotton, spices (K), wheat, cumin, mustard (R), moog, groundnut, bajri (S), fodder.
10	Bajri, tur, cotton, groundnut (K), wheat, gram, mustard (R), groundnut, bajri (S).
11	Bajri, jowar, groundnut, cotton, sesamum (K), wheat, cumin, onion, fodder (R), groundnut (S).
12	Paddy, pulses, groundnut, sesamum, maize, cotton, hilmillet (K), wheat, mustard, potato, chillies, vegetables (R), moog, groundnut, bajri, cowpea (S).
13	Paddy, pulses, maize, groundnut, sesamum, castor, tobacco (K), wheat, gram, potato, vegetables, fodder (R), groundnut, moog, cowpea (S), banana (perennial).
14	Cotton, jowar, bajri, paddy, vegetables (K), wheat, gram, rape and mustard, cumin, vegetables (R).
15	Paddy, nagli, jowar, groundnut (K), sugarcane (perennial), banana (perennial), tur, limabean, wheat, gram, ratoon jowar (R), moog, groundnut cowpea (S).
16	Bajri, pulses, jowar, groundnut, sesamum, castor, cotton (K), wheat, cumin, mustard, garlic, onion, isabgul, potato (R).
17	Bajri, pulses, groundnut, cotton (K), wheat, mustard (R), groundnut, bajri (S).
18	Bajri, jowar, gawar, castor (K), wheat, gram, potato, rapemustard, isabgul (R), bajri, moog, groundnut (S).

Note : Crops preceeding K in bracket are Kharif Crops.
 " Crops preceeding R in bracket are Rabi Crops.
 " Crops preceeding S in bracket are Summer Crops.
 " Crops preceeding perenial in bracket are Perennial Crops.

(continued)

Table 8.1C : (continued)

Agroclimatic Characteristics of Subzones in Gujarat.		
Agricultural Sub-zone	Soil type	Rainfall (in mm.)
7	Alluvial Sandy/Loamy	Below 600
8	Alluvial Sandy/Loamy	600 to 750
9	Alluvial Sandy/Loamy	750 +
10	Medium Black/Shallow Black	Below 600
11	Medium Black/Shallow Black	600 to 750
12	Medium Black/Shallow Black	750 - 1000
13	Medium Black/Shallow Black	1000 +
14	Deep Black	Upto 1000
15	Deep Black	1000 +
16	Other	400 - 500
17	Other	500 - 600
18	Other	600 - 750

Table 8.11 : 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 8.12 : Crop Pattern in Gujarat in 1983-84 and 2001.

C r o p	Area_00 Ha.			
	1983-84		2001	
	Gross cropped area	% Gross cropped	Gross cropped area	% Gross Cropped
Rice	5403	4.9	5862	4.9
Wheat	7412	6.6	7830	6.6
Jowar	9476	8.5	9600	7.9
Bajri	14366	12.9	15215	12.6
Other Cereals	4867	4.4	4985	4.1
Total Cereals	41524	37.3	43492	36.1
Tur	2996	2.7	3650	3.0
Gram	1221	1.1	2000	1.7
Other Pulses	3804	3.4	6000	5.0
Total Pulses	8021	7.2	11650	9.7
Groundnut	21496	19.2	24535	20.5
Other Oilseeds	5026	4.5	7000	5.9
Total Oilseeds	26522	23.7	31535	26.4
Cotton	13990	12.5	14000	11.7
Others	21440	19.2	19323	16.1
Total	111497	100.0	120000	100.0

Source : For 1983-84, Statistical Abstract of Gujarat State 1985 and 1986.

Table 8.13 : Area, Production and Gross Value of Output of Major Crops in Gujarat 1983-84 and 2001 in 1983-84 prices

C r o p	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	5362	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	21440		535.9	10000	30.0	1200.0
Other crops				9323	-	745.8
Total cropped area	111497		3242.5	120000		5917.1

Source : For Area, Production for 1983-84, Statistical Abstract of Gujarat

Table 8.14 : 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

(continued)

Table 3.14 : (continued)

Share of Six Crops *

I t e m	% 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 8.15 : 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	205.3	+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 8.16 : 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 man power 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
Annual family income with 1.5 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 IX

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 remained 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 the district of Daman comprised two talukas: Daman, and 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 10 lakh in 1981. There are 386 census villages and 15 towns. The urban population formed 32 per cent of the total population in 1981 (Table 9.1).

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, groundnut, chiku, mango. The population of Daman was 48560 in 1981, with 21003 persons in Daman town and 27557 persons distributed over 21 villages.

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 1981 Census was 30421 with 8020 persons in Diu town and the rest in five villages.

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 1981 was 103676 of which 81714 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 millenial 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.

The major deficiencies of Goa are that it 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 (Table 9.2).

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, Carcinia 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. The total area under forests is one lakh hectares and about one lakh hectares are classed as culturable wastelands. The extent of reported plantation work is thus quite substantial. 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. Plantation of commercial species like Eucalyptus, and teak was reduced. For example, in 1987-88 it was reported that 2490 hectares were covered under tree plantation spending about Rs. 89 lakh. In this, only about 50 hectares were under rubber, 324 hectares under cashew and no area under teak or Eucalyptus.

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

Land Survey Department of Goa had made cadastral surveys of some talukas prior to 1920. No firm data are however available till the eighties. The estimated net sown area was about 128 thousand hectares. The gross sown area remained around 130 thousand hectares for decades, though there are 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 (Table 9.3). 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 (Table 9.4).

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 (Table 9.5).

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 hectares 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 small sized holdings that lack means for proper rice cultivation. 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.

Sugarcane cultivation is concentrated in Sanguem taluka followed by Quepem and Satari talukas (Table 9.6). About 66 per cent of the total area under arecanut is in Ponda and 20 per cent in Satari. Cashewnut and coconut are cultivated in all the talukas, though there is some con-

centration of coconut cultivation in Salcete (about 25 per cent of the total coconut area in Goa).

Irrigation: 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. Irrigated area under paddy formed 12 per cent of the total area under paddy, and in the total cultivated area about 6 per cent area received 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. There was a decline in the area under arecanut and a substantial increase in the area 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 higher altitude and utilized for irrigating low-lying areas. Kharif rice is grown in the tank bed. These tanks irrigate only rice fields. 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.

In pre-liberation period there were no large irrigation schemes undertaken in Goa. During 'seventies, Selaulim - a major irrigation project - was taken up in Sanguem taluka to irrigate 14500 hectares of land and Anjunem - a medium

irrigation project on river Guleli in Satari taluka was taken up to provide irrigation to about 1900 hectares. In addition, Tillari irrigation project - a joint venture of Goa and Maharashtra Governments - is to benefit Pernem and Bardez talukas, irrigating 16978 hectares and Madovi irrigation project has an irrigable command of 5902 hectares in Satari and Bicholim talukas.

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. In 1987-88 the average yield of rice was noted to be 1837 kg./ha. in kharif season and 2739 kg./ha. in rabi season while the corresponding figures in 1986-87, a year of poor rainfall, were 1475 kg./ha. and 2199 kg./ha. respectively. Currently the rice production in a year of normal rainfall is about 111000 tonnes (Table 9.7). 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. It is customary to sell out a few coconut trees for tapping for a period from a few months to a year. Toddy tapping affects the productivity of coconut. 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 khajan 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. 13 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 (Table 9.8).

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 areca 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 of land due to the earth from overburdens that contains a small amount of iron ore being carried to the fields during the rainy season is reported from a large tract. The transfer of land to mine owners thrusts great hardship on the actual cultivator; as 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 (Table 9.9).

The Fisheries department has been undertaking fishing for the purpose exploration, and for demonstrating benefits of mechanized fishing. The Departmental boats carry two types of operations viz., trawling and purse-seining. For promotion of mechanization the Department encourages formation of fishing cooperative societies.

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 they 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 (Tables 9.10 and 9.11). 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. 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 khajan, ker or

* 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.

waingam 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.

Khajan 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 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. The measure taken under the plan schemes is to repair the embankments and recover the cost of the same 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 breakage is 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 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 grow crops like paddy, maize, groundnut, and tapioca nearer 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 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 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 fencing is essential. For provision of irrigation, cooperation between cultivators is necessary. For proper weeding, manuring, inter-cropping labour must be available. 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 overcome some of the difficulties, e.g. organize cooperative watch and ward, irrigation arrangement, etc.

Arecanut Cultivation: Arecanut cultivation is concentrated mainly in Ponda and Satari 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 scope for the cultivation of banana and pineapple as these gardens are watered regularly. Traditionally large trees like mango, jackfruit, breadfruit, kokam which do not require perennial supply of water are grown in arecanut gardens to provide shade. It is advisable to take banana, pineapple, betalvine, 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 re-organization 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 half-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 cooperative concerted 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 Satari talukas the waste lands together with forest 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 important to carry survey 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. Kumeri is being extensively practised in Satari, Sanguem, Canacona and Quepem talukas i.e. the talukas with high proportion of forest and waste lands. Particularly in Canacona taluka and parts of Satari, Sanguem and Quepem the problem is acute as alternative employment in mining activity is not available. The waste land in these talukas 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, jackfruit, 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 ever-green 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 even 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 9.12). 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 and high wages 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 X.

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 evergreen 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 9.1) 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.

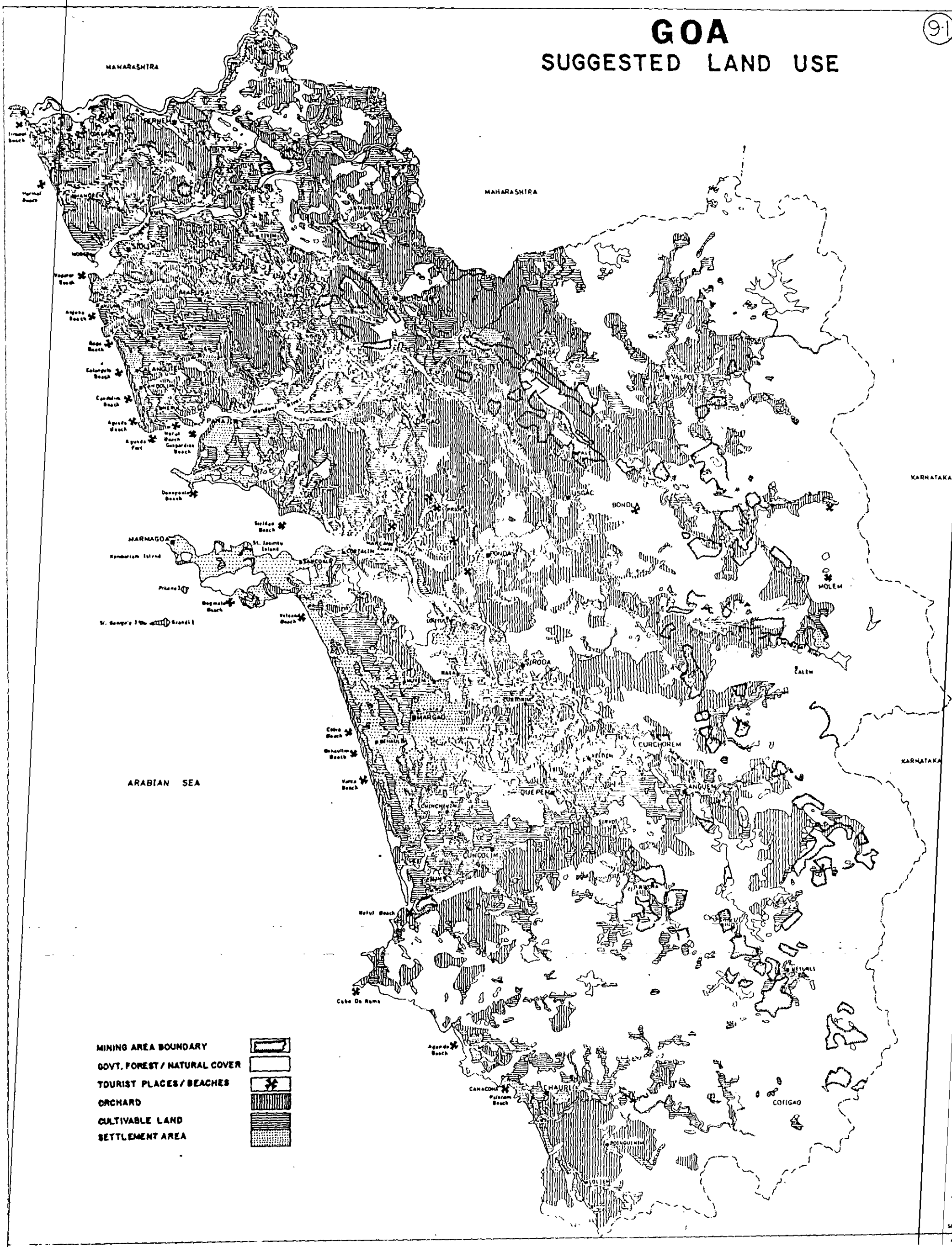
III. Planning Approach for Diu, Daman and Dadra and Nagar Haveli

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 VIII) is appropriate as the geo-climatic conditions are similar.

GOA

SUGGESTED LAND USE

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- MINING AREA BOUNDARY
- GOVT. FOREST / NATURAL COVER
- TOURIST PLACES / BEACHES
- ORCHARD
- CULTIVABLE LAND
- SETTLEMENT AREA

SCALE 1:100,000

For Daman, part of the area (about 2800 hectares) falling under Damanganga irrigation project should be planned as I1 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 (Table 9.13).

Except for the north-western part, most villages in the district have considerable area under forests. The forest 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 9.1 : Area, Population and Land Utilization in Goa, Daman, Diu and Dadra-Nagar Haveli in 1981

	Goa	Daman	Diu	Dadra and Nagar Haveli
Area (sq.km.)	3702	72*	40*	431
Persons (1981)	1007749	48560	30421	103676
Density (persons/sq.km.)	272	674	761	211
Percent urban population	32.0	43.3	26.4	6.7
Number of towns	15	1	1	1
Number of inhabited villages	386	21	5	70
Land utilization †				
Total reporting area for land utilization 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 miscellaneous 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

Source :

- (i) District Census Handbook, Goa District, Daman District and Diu District, 1981.
- (ii) District Census Handbook, Dadra and Nagar Haveli District, 1981.

Table 9.2 : Talukawise Area and Population and Land Use in Goa

State/ District/ Taluka	Area (in sq.km.)	Popula- tion (00) 1981	Density (per sq.km.)	No. of towns	No. of census villages	Percentage of urban popula- tion to total population	Percentage share in Reported Area		
							Forests	Culturable waste	Net sown
Goa State	3702.0	10077	272	15	386	32.0	29.2	27.3	33.8
North Goa	1713.9	5680	331	8	232	27.5			
Tiswadi	197.9	1319	667	1	28	58.5	-	9.1	71.8
Bardez	155.0	1539	604	3	41	28.9	-	17.7	61.7
Pernem	241.0	594	246	1	27	6.7	5.5	30.0	56.4
Bicholim	233.4	741	317	1	28	15.2	3.0	30.4	49.9
Satari	499.0	408	82	1	77	9.5	47.3	24.1	24.3
Ponda	287.6	1079	375	1	31	14.2	11.6	41.1	36.4
South Goa	1946.7	4397	226	7	154	37.9			
Sanguem	879.4	559	54	1	48	10.7	56.5	25.6	13.2
Canacona	351.1	359	102	1	8	4.5	41.2	33.9	21.3
Quepem	317.3	556	175	2	39	21.2	33.6	40.9	21.9
Salcete	293.0	1938	661	2	46	40.0	-	19.2	63.9
Mormugao	105.9	985	930	1	13	70.7	-	15.9	30.8

Source : (i) Statistical Pocket Book of Goa, 1987-88
(ii) Department of Agriculture, Goa.

Table 9.3 : Crop Pattern in Goa in 1960 and 1986-87

Crop	1960 *	1986-87 *		
	Total area under the crop (Ha.)	Total area under the crop (Ha.)	Per cent	Irrigated area (Ha.)
Rice	50800	42811	32.79	8861
Kharif	-	33950	26.00	-
Rabi	-	8861	6.79	8861
Ragi	23730	1490	1.14	-
Pulses	-	3760	2.88	-
Groundnut	-	550	0.42	-
Arecanut	1720	1304	1.00	1304
Coconut	18600	22976	17.60	-
Cashewnut	32500	46888	35.91	-
Sugarcane	400	1700	1.30	1700
Mango	7200	4024	3.08	-
Banana		378	0.29	-
Vegetables		4694	3.59	-
Total	130950	130575	100.00	11865

* Estimates.

Source : (i) Estimates of State Income of Goa, Daman and Diu, 1967-68 and 1968-69.

(ii) Statistical Pocket Book of Goa 1987-88.

Table 9.4 : Distribution of Operational Holdings in Goa According to Their Size

Size class of operational holding (Ha.)	1976-77				1980-81			
	Number of holdings	%	Area operated	%	Number of holdings	%	Area operated	%
Below 0.5	40052	55	12792	15	42008	56	10004	11
0.5 - 1.0	16781	23	15071	19	16877	22	12084	13
1.0 - 2.0	9253	13	15582	19	10069	13	14082	16
2.0 - 3.0	2599	4	7603	9	2925	4	6825	8
3.0 - 4.0	1248	2	4991	6	1193	2	4018	5
4.0 - 5.0	673	1	3342	4	774	1	3460	4
5.0 - 7.5	830	1	6071	7	586	1	3440	4
7.5 - 10.0	463	1	4262	5	487	1	4208	5
10.0 - 20.0	341		5798	7	331		5728	6
20.0 and above	163		7155	9	287		25807	28
	72403	100	82667	100	75537	100	89656	100

Note : As per Agricultural Census 1976-77 and 1980-81.

Source : Statistical Pocket Book of Goa, 1987-88

Table 9.5 : Area under Principal Crops by Size Distribution of Holdings (1970-71) in Goa

	Size Class (Ha.)						Total
	Upto 1.0	1.1- 2.0	2.1- 3.0	3.1- 4.0	4.1- 10.0	10.1- and above	
Area	20606	19873	10365	6230	16020	19327	92421
Gross cropped area	20885	19459	10036	6010	15514	15726	87630
Rice	15457	12318	4794	2382	4171	1687	40809
Ragi	1038	1475	725	505	1108	286	5137
Other food-grains including pulses	241	294	201	57	186	111	1090
Total food-grains	16736	14087	5720	2944	5465	2084	47036
Coconut	1749	1555	1109	881	2454	2479	10227
Arecanut	290	635	582	320	1074	788	3689
Cashewnut	1214	2313	1961	1454	5284	8926	21152
Total other fruits	896	869	664	441	1237	1449	5526
Total 'tree' crops, fruits and vegetables	4149	5372	4316	3066	10049	13642	40594

Percentage Distribution of Crops by Size Distribution of Holdings (Ha.)

Gross cropped area	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rice	74.0	63.3	47.8	39.6	26.9	10.7	46.6
Ragi	5.0	7.6	7.2	8.4	7.1	1.8	5.9
Other food-grains including pulses	1.1	1.5	2.0	0.9	1.2	0.7	1.2
Total food-grains	80.1	72.4	57.0	48.9	35.2	13.2	53.7
Coconut	8.4	8.0	11.0	14.7	15.8	15.8	11.7
Arecanut	1.4	3.3	5.8	5.3	6.9	5.0	4.2
Cashewnut	5.8	11.9	19.5	24.3	34.1	56.8	24.1
Total other fruits	4.3	4.4	6.7	6.8	8.0	9.2	6.3
Total 'tree' crops, fruits and vegetables	19.9	27.6	43.0	51.1	64.8	86.8	46.3

Source : Agricultural Census, 1970-71, Government of Goa, 1976.

Table 9.6 : Talukawise Crop Pattern in Goa - 1986-87

Taluka	Gross cropped area (Ha.)	Per cent share in gross cropped area in the taluka			Area under (in Ha.)			
		Cereals, pulses oilseeds	Cashewnut	Coconut	Sugar-cane	Areca-nut	Mango and banana	Vege-tables
District Total	130575	37.2	35.9	17.6	1700	1304	4402	4694
Tiswadi	12179	48.1	32.7	12.1	-	.4	226	630
Bardez	16857	36.1	34.9	15.6	-	2	143	2110
Pernem	14506	39.8	47.0	10.0	117	1	41	324
Bicholim	13179	32.2	53.1	10.6	41	54	136	320
Satari	12928	22.4	64.9	5.8	243	282	313	60
Ponda	10876	41.3	26.4	20.6	79	861	221	114
Sanguem	12855	23.5	45.2	20.1	891	45	585	45
Canacona	8068	34.4	32.1	19.4	94	25	859	160
Quepem	7846	42.6	23.0	24.4	229	28	467	55
Salcete	18717	49.6	7.8	31.0	6	-	1325	843
Mormugao	2564	38.2	11.3	45.7	-	2	86	34

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Source : Department of Agriculture, Goa.

Table 9.7 (A) : Area, Average Yield and Production of Major Crops in Goa in 1967-68 and 1987-88

Crop	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.
Toddy (million litre)			N.A.	36
Niro (million litre)			N.A.	11

* 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 9.7 (E) : Paddy Production in Goa 1967-68 to 1986-87

Year	Production of paddy in tonnes
1967-68	73000
1970-71	65589
1973-74	85916
1976-77	87232
1979-80	93971
1982-83	115961
1985-86	128789
1986-87	71070

Note : Figures of production upto 1982-83 include Daman and Diu also that contributed less than 3 per cent to the total paddy production.

Source : Statistical Pocket Books, Goa.

Table 9.8 : Mining of Ore in Goa, 1969-70 to 1986-87
(Lakh tonnes)

Y e a r	Iron ore	Manganese ore	Ferro manganese ore
1961 .)	65.28	0.38	0.71
1969-70	73.21	0.77	0.16
1970-71	102.08	1.96	6.65
1971-72	107.65	0.99	4.04
1972-73	102.54	1.28	2.56
1973-74	131.06	2.47	2.27
1974-75	N.A.	N.A.	N.A.
1975-76	115.62	0.88	2.42
1976-77	122.35	0.12	3.87
1977-78	102.55	0.35	1.75
1978-79	93.86	1.40	2.16
1979-80	128.70	1.84	1.43
1980-81	126.10	0.49	2.86
1981-82	134.12	0.38	2.14
1982-83	114.33	0.93	1.03
1983-84	115.48	0.61	0.62
1984-85	126.40	2.00	1.60
1985-86	141.90	1.30	0.90
1986-87	134.70	0.10	0.60

Source : Statistical Pocket Books of Goa.

Table 9.9 : Marine Fish in Goa by Variety for the Period 1966-1987

Year	Quantity	Mackerel	Sardines	Prawns	Seerfish	Pomfrosts	Kowal	Butterfish	Sciaenids	Others	Total
1966	Tons	9850	5552	330	52	43	74	-	436	8263	24600
1967	Tons	4016	2778	471	49	57	66	-	317	4706	12460
1968	Tons	6301	8668	317	122	48	69	-	503	2860	18888
1969	Tons	23872	1343	424	34	53	57	-	315	1461	27559
1970	Tons	14585	3398	318	36	19	63	-	431	1386	20736
1971	Tons	35258	2067	279	108	13	41	-	524	1690	39980
1972	Tons	19999	5958	561	67	34	49	-	576	3049	30293
1973	Tons	7617	4698	784	57	27	39	-	394	2124	15740
1974	Tons	7737	3316	795	241	32	47	-	409	5479	18056
1975	Tons	9897	18439	891	168	75	184	173	638	4190	34655
1976	Tons	7897	10510	2130	180	14	108	388	715	11706	33648
1977	Tons	6876	15677	2102	137	157	146	673	826	6059	32653
1978	Tons	3619	11913	1414	1497	206	415	457	457	6485	26463
1979	Tons	4370	12867	2016	424	74	351	490	678	5397	26596
1980	Tons	2446	8817	1855	735	86	35	185	583	9748	24490
1981	Tons	4566	11705	3109	305	61	263	263	611	10526	31409
1982	Tons	1489	10163	4876	631	261	256	509	1009	13818	33012
1983	Tons	1224	10534	5699	610	853	391	553	1407	13862	35165
1984	Tons	1746	14137	4993	396	393	555	335	1323	14186	38064
1985	Tons	5398	9583	3559	431	251	-	343	1310	19051	39926
1986	Tons	3057	5624	2637	733	123	-	175	943	16646	29927
1987	Tons	2815	8543	2706	405	116	-	302	1980	16202	33068

Source : Records of Fisheries Department, Goa.

Table 9.10-(A) : Occupational Distribution of Workers in
Goa - 1950, 1960, 1981

Occupation	1981				Total workers (percentage distribution)	
	Total workers	Per-cent	Rural workers	Per-cent	1960	1950
Cultivators	58376	18.8	54476	26.2	58.2	66.9
Agricultural Labourers	30556	9.8	28185	13.6		
Livestock, Forestry, Fishing, etc.	14583	4.7	12218	5.9	3.2	4.1
Mining and Quarring	18985	6.1	15102	7.3	9.0	2.6
Manufacturing processing - Household industry	10451	3.4	7911	3.8	7.5	8.4
-Other than household industry	36303	11.7	22060	10.6		
Construction	17133	5.5	10084	4.9	1.5	1.2
Trade and Commerce	36892	11.8	16420	7.9	5.0	4.8
Transport, Storage and Communication	25355	8.1	11136	5.4	6.3	4.2
Other Services	62612	20.1	30241	14.4	9.3	7.8
Total	311246	100.0	207833	100.0	100.0= 244261	100.0= 191607

Table 9.10 (B) : Occupational Distribution of Workers in Daman, Diu and Dadra and Nagar Haveli in 1981

Occupation	Daman		Diu		Dadra Nagar Haveli	
	Total workers	Per cent	Total workers	Per cent	Total workers	Per cent
Cultivators	3013	22.1	1183	15.6	26144	61.8
Agricultural Labourers	1431	10.5	405	5.4	4592	10.9
Livestock, etc.	1953	14.3	1976	26.0	938	2.2
Mining and Quarring	35	0.3	227	3.0	1	-
Other	7186	52.8	3805	50.0	10640	25.1
Total	13618	100.0	7593	100.0	42315	100.0
	Rural workers	Per cent	Rural workers	Per cent	Rural workers	Per cent
Cultivators	2900	35.4	1110	20.0	25502	64.0
Agricultural Labourers	1363	16.7	379	6.8	4486	11.3
Livestock, etc.	585	7.1	1830	32.9	843	2.1
Mining and Quarring	35	0.4	212	3.8	1	-
Others	3303	40.4	2027	36.5	9010	22.6
Total	8186	100.0	5558	100.0	39842	100.0

Source : District Census Hand Book, Goa District, Daman District and Diu District, 1981.
District Census Hand Book, Dadra and Nagar Haveli District, 1981

Table 9.11 : Net State Domestic Product at Factor Cost by Industry of Origin at Current Prices for Goa, Daman and Diu

(Rs. Lakh)

Year	Agriculture (proper) and Livestock	Forestry and Logging	Fishing	Mining and Quarrying	Total net State Do- mestic product	Per capita income (Rs.)
1986-87 *	7991.98	258.12	1619.13	3856.89	64099.89	5280.06
1985-86	6800.86	251.30	1671.01	2335.98	59054.50	4958.40
1984-85	7818.82	257.49	1732.38	2242.60	53249.83	4559.06
1983-84	7610.05	278.84	1915.22	2025.67	46745.99	4082.62
1982-83	5478.76	399.32	1827.05	1918.33	40681.98	3625.85
1981-82	4659.79	316.32	1417.44	2676.67	32569.15	2963.53
1980-81	4500.15	860.34	853.47	1863.50	28551.11	2793.65
1979-80	3900.73	1102.04	749.09	1804.98	25451.33	2527.44
1978-79	3831.38	292.07	683.75	1161.43	20998.86	2118.96
1977-78	3496.52	561.92	779.91	1262.68	19483.89	2000.40
1976-77	3188.15	395.12	702.88	1292.68	17143.85	1791.41
1975-76	2955.19	298.12	547.60	1110.70	15166.39	1615.16
1974-75	3018.84	280.87	346.65	1004.90	13902.41	1506.22
1973-74	2889.58	173.53	425.41	987.34	11612.97	1284.23
1972-73	2210.68	110.80	155.87	871.25	9276.43	1047.50
1971-72	2144.57	96.87	389.69	871.03	8612.36	993.30
1970-71	2082.37	74.91	213.51	894.23	7671.35	915.70
1968-69	1616.52*	19.75	121.51	575.30	4810.27	714.9
1967-68	1624.09*	16.97	97.83	549.42	4625.61	694.4

(continued)

Table 9.11 : (continued)

Year	Percentage share in total				Total net State Domestic product (Rs.lakhs)	Per capita income at 1970-71 prices
	Agriculture and Livestock	Forestry and Logging	Fishing	Mining and Quarrying		
1986-87*	12.5	0.4	2.5	6.0	64099	1659
1985-86	11.5	0.4	2.8	4.0	59054	1646
1984-85	14.7	0.5	3.3	4.2	53250	1617
1983-84	16.3	0.6	4.1	4.3	46746	1537
1982-83	14.1	1.0	4.5	4.7	40682	1437
1981-82	14.3	1.0	4.4	8.2	32569	1358
1980-81	15.8	3.0	3.0	6.5	28551	1420
1979-80	15.3	4.3	2.9	7.1	25451	1296
1978-79	18.2	1.4	3.3	5.5	20999	1420
1977-78	17.9	2.9	4.0	6.5	19484	1293
1976-77	18.6	2.3	4.1	7.5	17144	1238
1975-76	19.5	2.0	3.6	7.3	15166	1224
1974-75	21.7	2.0	2.5	7.2	13902	1148
1973-74	24.9	1.5	3.7	8.5	11612	1016
1972-73	23.8	1.2	1.7	9.4	9276	992
1971-72	24.9	1.1	4.5	10.1	8612	1006
1970-71	27.1	1.0	2.8	11.7	7671	916
1968-69	33.6*	0.4	2.5	12.0	4810	-
1967-68	35.1*	0.4	2.1	11.9	4625	-

* Only Agriculture

* Quick Estimate

Source : Statistical Pocket Books of Goa, Daman and Diu

Table 9.12 : Growth Performance of Different Local Species and Exotics at Arboratum in Goa.

Species	Verna- cular name	Year of plan- ting	No.of seed- lings	Survi- val (%)	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>Tactona 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
<u>Exotics</u>						
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.

Table 9.13 : Sizewise Distribution of Operational Holdings in Dadra and Nagar Haveli in 1980-81

Size class (Hectares)	No. of holdings	Per cent	Area of ope- rated hold- ings (Hectares)	Per cent
Below 0.5	2050	17.3	522	2.3
0.5 - 1.0	2743	23.2	2104	9.3
1.0 - 2.0	3919	33.1	5283	23.4
2.0 - 3.0	1373	11.6	3190	14.1
3.0 - 4.0	649	5.5	2230	9.9
4.0 - 5.0	329	2.8	1463	6.5
5.0 - 7.5	354	3.0	2130	9.4
7.5 - 10.0	150	1.3	1286	5.7
10.0 - 20.0	204	1.7	2606	11.6
20.0 and above	54	0.5	1739	7.8
Total	11825	100.0	22558	100.0

Source : Agricultural Census, Dadra and Nagar Haveli, 1980-81.

CHAPTER X

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, oil-seeds, 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 time, diversion of small quantities consumed at home by small farmers for cash which may not be used for 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 yield.

Actually from the point of view of sustained use of the natural resource base of the country and improvement in the standard of living of the poor and weaker sections a totally different approach to planning is necessary. Moreover, the standard of living should not be judged only on the basis of cash income but with reference to 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. The marginal lands thus have to 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 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 allocation of limited resources of concentrates 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 pure indigenous breeds and not go in for the exotic breeds alien to 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. Within 20 to 30 km. of urban centres, milch bovine should be maintained by stall feeding on high quality fodder crops. 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 cater the demand of milch cattle in the inner circle. In outer areas of the inner ring should be maintained dry and pregnant bovine.

Animal husbandry that befits rural areas is breeding of draught animals of recognized indigenous breeds. These animals are better adopted to low level of nutrition, wide seasonal fluctuations in feed and fodder availability and are hardy, adopted to adverse conditions e.g. shortage of drinking water supply, intense heat, etc. Local cattlemen have been always engaged in this type of animal breeding adopted to the environment. These indigenous breeds would provide draught cattle and milk for the owner and for local use, and organic manure. The manure supply will be augmented as the cattle gets better fed. As the natural grass-lands 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 grass-lands. Often the fines were levied on people from 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 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. The devastated pasture land could hardly provide any sustenance for the animals. In 1987 the Conservator of Forests, Dhule organized a meeting of the village level officials and workers to discuss the issue of regreening the pasture. Subsequently meetings in the concerned villages like Laling, Aarvi, Sonwadi, Ghanagao, Rawer, Ghodgeo, etc., were organized and 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 to be provided work on the water harvesting and other developmental works to be 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 is used for check dams which are planted with Anjan, Neem, Babhul. Two hundred hectares have been replanted with 173 thousand 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. It was particularly difficult to control the illicit transport of wood by bicycle; in this business the youth earned nearly Rs. 40 a day whereas the earnings on EGS were about Rs. 12 to Rs. 15. Through forfeiting their bicycles and enforcing fines, their activities were curbed by the villagers. So also control of sheep grazing had to be effected through collective efforts of the villagers by imposing fines on the shepherds.

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 Rs. 10 per half day or about Rs. 20 per day. This provided *income* to the landless and supply of fodder improved which boosted the dairy business in the villages nearby. The production and employment generated in 1987 and 1988 was as follows:

	Grass (in tonnes)	Mandays of work
1987	1500	30,000.
1988	3000	60,000.

The protection given to the area has promoted 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 and production of bor, Amoni, Pithoni and other wild fruit is providing nourishing refreshment to the labourers who work on grass cutting. The villagers are permitted to cut grass for own use at a nominal charge. Discussions with villagers revealed that even though the expenditure of cattle owners has increased they are happy with the project as they are getting adequate fodder from the

Laling pasture; the weaker sections have benefited due to grass cutting work. The enriched resources are providing basis for maintaining milch cattle. The pasture is attracting birds, wild life and is providing diverse material for nature study for the students from Dhule. 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) a little irrigated fodder crop to provide some high protein feed and a reserve for critical period. The regeneration of grass-lands can be accelerated by hoeing of surface 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 gauchar 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 co-operative 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 cultivated by 11 farms 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. Fodder prices are so determined as to cover the recurring costs. About 70-80 per cent of the buyers are landless or marginal and small holders. Fodder is sold in three ways (a) by weight, (b) sale of plot generally of 600 sq.ft. for one cutting, or (c) sale of plot for the entire season. A buyer can buy only one plot unless the demands of other buyers are already met. 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 outside 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 by law, and exploitation of the resources on commercial basis. When the resources have been depleted through indiscriminate exploitation, attempts made by the Forest

Departments using their 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 Arabari in Midanapur 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 were about Rs. 400 per hectare in the initial stages but in areas where root system of the Saal trees was intact, the expenditure was about 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. So also the flow of forest products going to families depends on the land protected by them. It was estimated that the families involved receive

food supplement and minor forest products worth Rs. 2 to Rs.9 per day. Harvesting has not yet been done in any of the areas. However, 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. For example, the cattle population in the area is fairly high and is increasing as more grass is available due to protection. The people are gradually 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 10.1) 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 large appetites for exotically high cost rations are satisfied, and improvement in milch performance will be at the expense of work capacity (George, S., 1985). To feed the high yielders appropriately, 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 or decline (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 into India of pasteurization and refrigeration technology began the modern dairy development in Kheda district, known for its milk production. In 1911, a German producer Mr. A.M. Collier started manufacturing casein in Gamdi, a few miles away from Anand. Later G.R. Rives, an Englishman established a dairy farm in Nadiad to produce pasteurized milk, butter, milk powder and cheese on a large scale. In 1929, Indianization of dairy product manufacture began with Polson, a Parsee entrepreneur installing a modern plant at Anand to manufacture butter, casein and milk powder - mainly to cater to the military demand.

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.

It should be noted that 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 so that the proportion of milk handled by the cooperative network is less than one-third of the milk production. Recently, the dairies have declared a 'six-day-week' for milk collection, leaving the milk for one day a week with the milk producer who will have to dispose it in some other way.

Pushing up 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 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 present costs of handling milk in this network are estimated for different types of packaging and presented in Table 10.2. It may be noted that the costs of handling range from 80 paise per litre for the conventional bottling of milk while they are 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 milchstock. 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 need to be made unless the present shortages in fodder supply are removed and the present livestock population is better fed.

Surplus Milk Processing: The surplus milk not delivered to the dairies is presently converted into ghee and khava by traditional methods. It is suggested that modern methods for khava and ghee manufacture may be adopted. A small plant of khava making using furnace oil can be

established at a modest investment of about Rs.50,000. The plant can handle one tonne of milk daily to produce about 220 kg of khava at an energy cost of 3 paise per litre. Three to five villages can cooperatively set up a plant in which about 6 persons would be employed on one shift basis. Similarly, a modern ghee making unit using cream separator can be established at a modest investment of about Rs. 35,000. Such a plant can process a tonne of milk daily to produce about 60 kg of ghee at an energy cost of one rupee per kg of ghee. In addition the separated milk, a by-product of ghee making process, can be used for making dahi which could be produced at an energy cost of 30 paise per litre. The unit can employ five to six persons on one shift basis.

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.

'Dairy India 1987' has given schemes for such units where it is stated that a two-animal dairy unit can be taken up by weaker sections in rural areas as a subsidiary occupation to supplement their incomes. On illustrative basis, the scheme for a unit of two crossbred cows is examined here in detail.

Capital investment including cost of the shed and equipment along with the cost of two crossbred cows is estimated at Rs. 13,300. Allowing for subsidies, a loan for Rs. 10,000 at 12.5 per cent rate of interest repayable in five years is assumed. Average annual repayment instalment would be Rs. 2,625.

The average annual expenditure including feed and fodder during lactation and dry periods, insurance and veterinary aid is estimated at Rs. 6974.8. Total annual average expenditure including operational or recurring expenditure and amortization of capital comes to Rs. 9600.

The annual average number of days in milk for two crossbred cows together is estimated at 524 or 262 each. Milk yield per day for crossbred cow is assumed to be 8 litres. At this yield, the average annual milk yield for the unit is calculated at 4192 litres which would fetch, at an assumed price of Rs. 2.75 per litre, Rs. 11,528 as income from sale of milk. In addition average annual income from sale of manure is estimated at Rs. 380. Thus, total income for the unit would be Rs. 11,908 per year.

The average annual net income from the unit is estimated at Rs. 2308 or Rs. 1154 per animal - which is less than one hundred rupees per month per animal.

The schemes usually calculate profit before repayment of loan which appears to be high and impressive. However even if we take the third year which is giving highest surplus, income per animal per month would come to Rs. 114. As no wage payment is involved, the income would accrue to family labour. If one person is engaged in taking care of cows for one year he would get Rs. 6.4 per day from his dairy business.

In this scheme, the cost of green fodder is estimated at 15 paise per kg which is a gross under-estimate. Besides, although the scheme proposes that the milch animal should be purchased in the first month of lactation, in actual practice, propagation of crossbred cows is done, in many cases, through artificial insemination of the country cow that farmers already possess. The A.I. service has to be available within 24 hours of the cow coming on heat. There is, therefore,

uncertainty about conception itself. Depending on the age of the cow, feeding practice, general hygiene, etc., there is always a risk of abortion, particularly in the case of malnourished cows. Heifer rearing is also difficult as veterinary aid is not easily and inexpensively available in rural areas. Mortality of heifers is higher at the field level. The uncertainty in supplies and prices of fodder and concentrates upset the calculations in dairy business.

Thus, at best, the scheme would be attractive where the entire cooperative network from A.I. service to purchase of milk is already established and there also, as seen above, the returns to family labour are rather meagre.

Dairy business based on high yielding exotic breeds has to be run as a regular industry with a sizable herd so that the risk is minimized and where an established infrastructural network is available for A.I. service, veterinary service and collection of milk. Such an industry can thrive on the urban fringe. In the interior rural areas, it is more rational to keep the cow for reproduction of bullocks, improve its breed crossing it with the indigenous dual purpose quality breed and keep the milk for home consumption or local sale. Improvement in the productivity of cows would go a long way in directly improving the nutrition level of rural population but does not seem to be a feasible proposition for additional cash income to the weaker sections in rural areas.

8. Sheep and Goat Rearing - Paper Schemes

Several beneficiary schemes based on subsidies and bank loans are being launched by State Governments both for commercial propagation of sheep and goat as well as dairy animals. Some of these schemes are designed particularly for weaker sections as subsidiary occupation to supplement their incomes.

A typical scheme as offered by the governments is examined in the following for illustrative purpose.

There is a goat rearing scheme for a unit of 5 does and 1 buck, offered by the Government of Maharashtra (MMSVM, 1989). It has a capital cost of Rs. 2825. With a 25 per cent subsidy to small farmers, a provision is made for a bank loan which would be, on net basis, of Rs. 2000 at 10 per cent rate of interest, repayable in 5 years. Total repayment works out to be Rs. 520 per year.

Operational costs are calculated to include concentrates, greens, medical expenses and insurance. All labour is assumed to be family labour, hence no wage payment is involved. Operational expenditure is calculated at Rs. 1160 for the unit.

In calculating the returns, a kidding rate of 160 per cent is assumed. Adult mortality is assumed to be 5 per cent and kid mortality at 10 per cent. Milk yield per goat is assumed to be 100 litres per year. Yield of manure is assumed at 1/8 tonne per goat per year. Estimated income is calculated at Rs. 3.50 per litre of milk, Rs. 300 each for adult goats and female kids and Rs. 350 for male kid and Rs. 500 per tonne of manure. Estimated gross income is Rs. 4030. With estimated expenditure being Rs. 1680, the net income from the goat unit is estimated at Rs. 2350 for farmers with subsidy and Rs. 2136 for persons who are not entitled to subsidy on capital costs.

The scheme appears to be very attractive on paper. Yet it is a fact that the weaker sections are not coming forward in large numbers to take advantage of the scheme. There are several reasons for this.

The first reason is that, in order to make the scheme look attractive, costs are depressed and productivities and expected income are inflated. For example, the cost of

greens is calculated at 15 paise per kg, which is quite unrealistic if greens are to be purchased in the market. The average price of greens is observed to be about 70 paise per kg. in places on the urban fringe and even in the interior villages it is around 30-35 paise per kg. The average production cost of greens is, according to knowledgeable sources, estimated to be about 20-25 paise per kg. A lower than realistic price unwarrantedly increases the profitability of goat keeping business on paper. So also though medical expenses may not be under-estimated, medical facilities are not available particularly in remote rural areas. Mortality rates, since they are based on timely and inexpensive medical help, are also, therefore, likely to be under-estimated. Besides, the bank loan is only to cover the capital expenditure. The question as to how the weaker section families would have resources to feed the animals adequately and scientifically remains unanswered. With the average management at the farm level, the animals are likely to be fed suboptimally.

The animals, therefore, would not be as productive as assumed for calculations for estimated incomes from the animals. The kidding rate, for example, is taken as 160 per cent with 60 per cent kiddings being multiple kiddings. Since sale of kids for meat is the major source of income for goats, the whole economics of goat scheme would collapse if 160 per cent kidding rate does not materialize in reality. In case of milk, market for goat milk at Rs. 3.50 per litre is assumed to be existing which may not be true. Consumer acceptance for goat milk has to be built up through educating the consumer about the nutritive value of goat milk. Besides, no allowance is kept for home consumption of milk in calculating the cash income.

All the estimates are done at 1988-89 prices as the scheme states... Even with all the assumptions of depressed costs and inflated returns, the net return to family labour, assuming that one person is engaged in goat keeping activity for half the time everyday, would be a six rupees per day - less than the minimum wages even under the Employment Guarantee Scheme. If these calculations go wrong, returns to labour will, to that extent, be reduced.

The schemes, in effect, become only technical schemes without much relevance to goat keeping by farmers or landless labour, accustomed to graze and feed them free of cost, taking all the risk of ill-health, disease and death along with the uncertainty of productivity in terms of both milk and meat.

9. Goat Keeping in Practice

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. In Ajmer the average gross receipts were Rs. 1451 per annum per family, the net receipts being Rs. 766. As one person has to attend the herd, the per day return worked to only Rs.1.8 in Ajmer. In Sirohi the return per labour day was only Rs.1.2 (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 reseeding, 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 animal. 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 cost. Provision for about 1.5 kg. of green fodder and 1 kg. of dry fodder mixed with urea and molasses per goat would have to be made. 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.

10. 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 thousand 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, in-breeding. The rearers show little interest in stock improvement measures because of the high risk and uncertainty. Consequently there is indiscriminate breeding and whatever animals survive serve as assets in times of need. About 92 to 95 per cent of ram lambs are sold after weaning and about 70 per cent of the income in this business 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 estimated average annual income per sheep was about Rs. 60. 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 cooperatives.

11. Special Case of GOA

During the Portuguese rule little attention was paid to the development of animal husbandry in Goa, Diu and Daman. After liberation, the Animal Husbandry department was established in 1962, and in 1963 the Department took up implementation of various routine schemes available under the Third Five Year Plan. Loans were extended for poultry, milch animal purchase, etc., without development of adequate infrastructure e.g. veterinary service, marketing arrangement, etc. 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. Because of common use of coconut there is not much demand for milk in rural areas. In western Goa with large Christian population, the main demand is for fish, mutton, pork and eggs.

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 as 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.

12. 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 10.3 for the Western Zone of India.

It may be noted that the main source for dry fodder is agricultural waste and hence the fodder supply would be dependent on the production of food crops in the State. It may also be noted that the incremental supply of green fodder is expected to be drawn chiefly from grass production in the pasture lands and waste land development.

The production of straw is estimated by applying appropriate ratios of straw and grain to the projected production of major food crops in 2001. All straw will be consumed in dry form and is taken as dry fodder. Fodder crops which comprise mainly of lucern and fodder jowar and maize are assumed to be available for consumption as green fodder.

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.

13. 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. The growth is high between 1972 and 1977 whereas it is less pronounced in the next five-year period - 1977-1982 (Table 10.4). 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, notable among them being IRDP and Special Livestock Production Programme (SLPP) on the basis of financial assistance as a mix of subsidy and soft loans. 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. Consequent to booming broiler industry, suitable techniques to solve the disposal problem associated with the tough meat from culled birds, spent layers and breeding stocks have been developed. These include artificial tenderization or developing further processed products like sausages, patties, chicken-spread, chicken essence, chicken pickle, etc. These processes can be viable only for very large hatcheries. For small chicken breeders, these solutions are not available and they have either to sell the disposable birds at distress price to the large hatcheries or try to sell them to poor customers at lower prices.

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

Among the maritime States in India, Gujarat, with 11 maritime districts viz., Kachchh, Rajkot, Jamnagar, Junagarh, Amreli, Bhavnagar, Ahmedabad, Kheda, Bharuch, Surat and Valsad, has the longest coastline of 1640 kms., and the continental edge in this part of Arabian Sea being farther from the shore than in any other part of the country, has the widest shelf area which covers about 1,64,000 sq.kms. Of the

continental shelf, 64,800 sq.kms., falls in the depth range of 0-50 metres which can be exploited by traditional as well as by mechanized craft. The State also has excellent estuarine potentials.

Fishery Development: Predominantly vegetarian in dietary habits, there had always been a general public apathy towards fishery development in Gujarat State. In the erstwhile Saurashtra State, there were objections even to have a fisheries department. It is only after the formation of Gujarat State in 1960 that a fisheries department has been established.

Introduction of mechanized boats started in 1956 in Veraval, one of the most important fisheries harbours of the State. However, the traditional fisheries accounted for the bulk of State's catches until late sixties. With the beginning of seventies, the picture gradually began to change and 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. However the activities of this sector centre around a few major landing centres such as Veraval, Mangrol, Porbunder and Jaffrabad.

The total landings ranged from 1.71 lakh tonnes to 2.51 lakh tonnes over 1975-1984 (Table 10.5). Although there are fluctuations in landing, there is an increasing trend. Landings are concentrated on the Saurashtra Coast (Bhavnagar, Amreli and Junagadh) (73 per cent) with Jamnagar coast (Jamnagar and Rajkot) coming next (11 per cent) and South Gujarat (Valsad, Surat, Bharuch and Kheda) and Kachchh with 5 per cent each. 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: 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 revealed 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 (Table 10.6). The catch rates also did not decline rapidly with increasing depth as observed in some other regions, and were also uniformly high throughout the year except during the south-west monsoon months i.e. July to September.

The total biomass available in the seven major areas along the Gujarat coast with an area of 71,000 sq.kms. was estimated, in this survey, to be 3.838 lakh tonnes and the annual potential yield was estimated to be 1.343 lakh tonnes. There is thus a good scope for further development of demersal fisheries along the coast. Midwater trawling operations revealed a very large resource. Horse mackerel forms the major component of midwater resources.

Development Potential: 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. These resources are not fully exploited. 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.

As it is observed that catch per unit effort has not generally reduced, there is further scope for introducing new units so as to harvest the potential yield fruitfully. 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 long 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 viz., Thane, Greater Bombay, Raigad, Ratnagiri and Sindhudurg. The State has a large continental shelf of 89,096 sq.kms. and offers rich potential for marine fisheries. The areas of potential fishing grounds in 0-50 m. and 50-200 m. depth are 2.55 and 10.48 million hectares respectively. Several types of boats, mechanized and non-mechanized using different gears land their catches. Bombayduck, panaeid and non-panaeid prawns, croakers, pomfrets, catfishes, elasmobranchs, perches and ribbon fishes are some of the commercially important groups which form the bulk of landings. From 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.

In general, heavier landings take place during October-March period followed by April-June period, monsoon period i.e. July-September being least productive period. About two-thirds of the annual catch is landed during October-March period.

Speciewise marine fish landings in Maharashtra for the period 1975-1984 are presented in Table 10.7. Total annual landings have been between 2.5 lakh and 3.0 lakh tonnes during this period.

On an average 40 per cent of the total landings are from the pelagic group and 60 per cent are from demersal group. Bombayduck and ribbon fishes, the most important varieties of pelagic group constitute 63 per cent of the pelagic landings. Another prized variety is non-penaeid prawns. The landings have, on the whole, declined over the period. Penaeid prawns are exploited intensively all along the coast and account for about 12-14 per cent of the total landings. Pomfrets are one of the most important commercially exploited fishes and account for 6-8 per cent of the total landings.

Mechanized landings have increased in proportion 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-penaeid prawns are landed by mechanized craft.

The most salient feature of the fish landings in the State is considerable improvement over recent years in the landings in the districts of Raigad and Ratnagiri. The fishing grounds off these two districts have not been fully exploited, but of late with increased efforts in their fishing grounds, producing higher catch rates, have resulted

in increasing catches in recent years. Hence, these two districts hold a promise of yielding higher catches and contributing significantly to the State landings. 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 (Table 10.8).

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 thousand tonnes in 1984 constitute between 1.8 and 2.6 per cent of total landings in the country. Major portion of landings i.e. around 69 per cent are during the fishing season i.e. October to March. Mechanized fleet contributes about 84 per cent of total landings and non-mechanized contributes about 16 per cent.

Annual landings of important species of marine fish in Goa for the period 1975-1984 are presented in Table 10.9. Although no discernible trend is seen between 1975-1984, there has been a 20 per cent increase in the second five year period as compared to the first half of the period.

Oil and other sardines, Indian mackerel, prawns, carangids, croakers are important species in Goa waters. These contribute about half of the total catch in Goa. 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 (Table 10.10).

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) Freshwater 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 of 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 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 in the following.

	Inland Fish Production (in 000 tonnes)	
	<u>1980</u>	<u>1984</u>
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.

Absence of an effective field mechanism to popularise the technique and effective coordination between different departmental agencies and non-availability of trained fishermen who could take up the scientific fish farming are some of the crucial factors for the slow growth of inland fishery development.

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 582 kg per hectare. However there is 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).

Marketing of inland fish production is done generally at the pond site to the wholesalers in Gujarat and Rajasthan.

In Maharashtra, the programme is implemented under the co-operative sector which ensures better prices to the fish farmer as compared to the return secured under pre-harvest contracting or sale to wholesalers at pond site.

To facilitate the implementation of the fisheries development programme, the Fish Farming District Agencies should be established in many more districts and should be strengthened emphasizing their role in training and in demonstrating the attractiveness of pisciculture. Arrangements for getting timely assistance, guidance, and inputs must be made. Innovation and research in fish farming has to be encouraged and infrastructure strengthened.

The centre of fisheries development is, naturally, the fishermen or the fish farmer. 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 or to the fish farmers' cooperatives. 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. Non-availability of fish seed also means that all the potential waterbodies cannot be covered under the fisheries development programme.

The area of waterbodies in ponds and the fish seed requirement in Gujarat, Maharashtra and Rajasthan at current seeding rates is presented in Table 10.11. Estimated potential for fish production in the reservoirs in Gujarat, Maharashtra and Rajasthan is given in Table 10.12.

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 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. These efforts to produce more fish seed locally and to reduce dependence on the Calcutta market for fish seed should be rigorously followed and kept up as seed availability is the crucial component of inland fishery development.

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 aquaculture or fish culture based on intensive fish-farming in moderate-sized ponds upto two hectares on seasonal as well as on perennial basis through capture fishing is vast. Integrated planning and reorganizational efforts are needed to realize the potential.

Table 10.1 : 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 10.2 : Cost of Handling of Milk in Large Dairies for Different Packaging

	Packaging		
	Bottle	Flexible pauch	Tetrapack
	-----Cost per litre in Rs. -----		
Transport *	0.40	0.40	0.40
Processing upto storage	0.20	0.20	0.20
Packaging	0.20	0.35	1.60

* Producer to Dairy + Dairy to Consumer

Table 10.3 : Estimated Fodder Production and Requirement for Western Zone of India in 2001 A.D.

		(in lakh tonnes)			
Year		Gujarat	Rajas- than	Mahara- shtra	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 10.4 : Statewise Distribution of Poultry in Western Zone of India, 1961-1982

State	('000 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 10.5 : Specieswise Annual Marine Fish Landings in Gujarat during 1975-84

Name of specie	(in tonnes)									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Elasmobranchs	11930	7896	17565	11511	4926	14558	13433	15447	11583	11050
Bels	2497	3283	8463	1886	2622	8403	2179	2790	4438	3049
Catfishes	2514	2140	8958	4159	5320	5235	10370	12662	10176	9313
Clupeids	23004	17995	13766	21511	12276	17264	21627	22607	20495	22033
Bombayduck	44554	34998	32389	53870	63984	36671	54114	37933	49851	55887
Lizardfishes	1267	2797	42	82	6	85	110	807	627	1620
Perches	3261	4641	1213	4174	973	2454	4832	3437	5026	8688
Threadfins	8832	6230	268	339	736	667	1585	3573	3546	3846
Croakers	45781	28693	39968	33968	28230	31625	35242	26962	29647	31877
Ribbonfishes	1097	12341	14180	6944	4491	10858	8327	9474	6305	7972
Carangids	1026	1670	1403	590	976	1483	3610	3143	3085	4271
Big-jawed jumper	5379	7765	7349	3360	783	2520	3769	6416	11562	7317
Pomfrets	5612	2116	9174	15141	9319	12587	19169	13229	12097	11295
Seerfishes	1879	1634	2022	3734	2682	4180	5536	2656	3773	3856
Tunnies	546	734	332	451	442	277	1600	358	427	2002
Mulletts	600	1097	900	1264	751	1034	1118	1234	2287	2384
Flatfishes	2991	2969	729	268	411	2459	3885	3026	1584	6792
Penaeid prawns	13395	11497	8861	7938	8606	14481	10985	12237	9959	10848
Non-penaeid prawns	2386	7778	1260	3096	3347	4109	4742	4148	8657	8539
Lobsters	2105	1491	424	339	211	204	786	483	482	1604
Crabs and other crustaceans	10	224	2471	584	783	4967	16549	12779	7978	18560
Cephalopods	611	2286	1439	1959	5351	3471	2743	3023	3972	2312
Miscellaneous	12498	9014	11562	24761	34086	23902	8199	8780	10775	15478
Total	193775	171294	189638	201929	191312	203494	234510	207204	215332	250593

Source : Central Marine Fisheries Research Institute (ICAR), Special Publication No. 38.
An Appraisal of the Marine Fisheries of Gujarat, Appendix Tables 1 and 2.

Table 10.6 : Catch Rates (Kg/hr.) in Various Latitudes/Depths and Percentage Composition of Dominant Species in Various Depths along Gujarat Coast. *

Latitude	Depth in Metres					Total
	20 - 40	40 - 70	70 - 100	100 - 150	150 - 200	
20° N	104	400	356	209	-	378
21° N	215	334	358	705	2289	3777
22° N	526	422	340	394	-	420
23° N	-	-	1809	-	-	1809
Dominant Species %	Shark and Rays 16 Sciaenids 12 Ribbonfish 6	Shark and Rays 17 Sciaenids 13 Perches 8 Nemipterus 7 Cuttlefish 5 Catfish 4	Pomfrets 10 Shark and Rays 9 Perches 7 Cuttlefish 6	Horse Mackerel 18	Horse Mackerel 30	

* As obtained by Matsya Nireekshani during June 1979 - August 1981

Note : Percentage composition of demersal resources was : Ribbonfish (34), Elasmobranchs (12), Dhoma (11), Catfish (8), Perch (7), Nemipterus (4), Caranx (4), Horse Mackerel (3), Pomfret (3),

Percentage composition of pelagic resources was : Horse Mackerel (34), Ribbonfish (28), Elasmobranchs (8), Pomfret (6), Catfish (4), Eel (3).

Source : Occasional Papers of Fishery Survey of India No. 4, December 1986.

Table 10.7 : Specieswise Annual Marine Fish Landings in Maharashtra during 1975-84

	(in Tonnes)									
Name of the species	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Elasmobranchs	8167	7089	7746	10072	12516	7752	9675	12375	13249	11508
Eels	1101	4168	3849	5384	4033	3154	2290	3843	3015	2868
Catfishes	8236	9522	8318	11081	10433	8653	11045	10919	11981	13418
Clupeids	31538	25993	29826	21720	23053	23935	28004	22394	25459	31491
Bombayduck	51615	49470	50803	68781	59667	57393	82136	45162	45348	58367
Lizardfishes	218	1089	1135	1815	2374	1057	1308	1160	3236	2170
Perches	2484	1460	2973	6951	3225	3712	2617	5716	8244	5849
Croakers	20576	19781	17086	17202	21366	13956	17475	15926	18241	22585
Ribbonfishes	9435	10052	6338	10400	10983	11550	8048	12355	10897	11612
Carangids	2414	1959	1397	2249	3166	2061	1509	2639	4656	5470
Silverbellies	493	-	358	323	724	406	129	169	929	1016
Big-jawed jumper	431	643	247	836	420	450	500	2519	3146	2475
Pomfrets	8351	17979	17295	13050	14941	10081	17144	16840	22524	19192
Indian Mackerel	1860	1944	875	787	1455	288	289	258	418	985
Seerfishes	1850	2116	3220	2915	4027	3215	2814	3515	7195	4757
Tunnies	274	463	312	1939	1772	1674	1248	3192	2624	2312
Unicorn cod	1030	380	30	21	276	159	13	69	131	2650
Flatfishes	487	1553	1245	1676	2304	1797	1784	2978	3505	5078
Penaeid prawns	24653	40772	26675	41091	45638	23433	21717	33914	36027	43934
Non-penaeid prawns	69012	63702	66978	44255	56208	47309	52855	40809	32134	39230
Cephalopods	482	2488	596	4557	3959	1191	1755	4781	6613	7650
Miscellaneous	11869	30978	17150	17139	10776	8533	8233	11895	10085	11168
Total	256576	293601	264452	284244	293326	231759	272588	253428	269657	306285

Source : Central Marine Fisheries Research Institute (ICAR) Special Publication No.37.

An Appraisal of the Marine Fisheries in Maharashtra, 1987 - Appendix Tables 1 and 2.

Table 10.8 : Catch Rates (Kg/hr.) in Various Latitudes/Depths and Percentage Composition of Dominant Species in Various Depths along Maharashtra Coast. *

Latitude	Depth in Metres					Total
	20 - 40	40 - 70	70 - 100	100 - 150	150 - 200	
16° N	464	92	103	-	-	196
17° N	208	-	124	-	-	132
18° N	487	307	232	-	-	321
19° N	193	200	108	35	-	175
Dominant Species %	Catfish 18 Perches 14 Ribbonfish 11 Promfret 11 Sciaenids 12	Ribbonfish 27 Sciaenids 15 Perches 10 Pomfrets 10 Nemipterus 8	Ribbonfish 37 Perches 10 Pomfrets 8 Sciaenids 8 Catfish 5	Ribbonfish 31 Lizardfish 28 Sciaenids 6 Perches 5 Nemipterus 4		

* As obtained by Matsya Varshini During April 1980 - May 1983.

Source : Occasional Papers of Fishery Survey of India No. 4, December 1986.

Table 10.9 : Specieswise Annual Marine Fish Landings in Goa during 1975-84

Name of specie	(in tonnes)									
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Elasmobranchs	572	1038	625	863	1230	894	1050	622	669	713
Catfishes	1367	334	918	1356	846	1151	2211	1941	1522	1272
Oil sardine	7526	1385	807	1398	3030	2367	7609	5513	5555	1675
Other sardines	3914	11100	4066	5151	2471	1798	2296	963	658	2441
Lizardfishes	151	25	239	279	104	199	707	403	540	736
Perches	45	310	505	781	203	269	1183	908	1495	1640
Croakers	3048	2640	2779	3256	1492	1530	1610	2298	2697	1677
Ribbonfishes	355	1123	449	504	548	1089	684	1035	1061	479
Carangids	1073	897	1216	1911	1673	1145	722	1430	1036	1991
Silverbellies	604	899	453	704	881	1727	2075	1011	1342	1669
Big-jawed jumper	189	338	375	443	291	614	820	966	1593	786
Pamfrets	102	100	296	367	138	257	123	363	323	336
Indian Mackerel	6779	6448	7661	3371	4391	2446	3939	2507	220	2684
Seerfishes	222	501	213	691	1101	735	643	635	724	366
Flatfishes	16	137	335	417	893	1311	727	619	864	2313
Crustaceans	1995	5517	2104	2217	2979	3804	4942	7923	11151	10593
Cephalopods	96	142	164	124	173	210	94	166	410	408
Miscellaneous	1111	1434	1521	3273	2894	2944	3063	4633	5828	6676
Total	29170	34968	24731	27111	25388	24490	34498	34041	37688	38505

Source : Central Marine Fisheries Research Institute (ICAR), Special Publication No. 36.
An Appraisal of the Marine Fisheries of Karnataka and Goa, Appendix Tables 3 and 4.

Table 10.10 : Catch Rates (Kg/hr.) in Various Latitudes/Depths and Percentage Composition of Dominant Species in Various Depths along Goa Coast *

	Depth in Metres				
	0-50	50 - 100	100 - 200	200 - 300	Total
15° N	157	91	245	9	145
Dominant species %	Catfish 37 Perches 14 Ribbonfish 11 Priacanthus 7	Priacanthus 25 Catfish 16 Ribbonfish 15 Perches 10 Nemipterus 9	Nemipterus 64 Priacanthus 25 Lizardfish 4 Perches 2	Priacanthus 78 Centrolophus 10 Squids 9 Cuttlefish 9	

* As obtained by Matsya Shakti and Matsya Vishwa during April 1985 - March 1986.

Source : Occasional Papers of Fishery Survey of India No. 4, December 1986.

Table 10.11 : 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 10.12 : 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 XI

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 within prosperity and growth, as it operates on 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 intermeshed 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 complementaries 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 re-organization of the agrarian system. In this approach land redistribution and scientific land use are to be given 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 ground water, 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 V, 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. Taking a clue from farm forestry in Karnataka and Gujarat where lands have been transferred from crop cultivation to Eucalyptus plantations, it is obvious 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 right of the government on forest lands and of 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 11.1 (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 positively 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 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 in the 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 cooperative. They will have to work in land shaping, nursery, tree planting and maintenance work and will have to be assured a full living wage till the area starts 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 stipulated plan. Cases of violation will have to be controlled through levy of heavy 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 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 ten 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 cooperator except in case of households in which no able-bodied person is available for work. Thus every cultivator will become a participating cooperator 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. Only if the cooperative organization is built from the grass-root level can it make possible the scientific management of the resources as a whole and take the benefits of such management to 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 resource 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, 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 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 to 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 peasants 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 economical 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 selectively in view of resource endowment, production priorities and provision of employment with progressive upgradation of labour productivity.

Table 11.1 : 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 re-generate 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

(continued)

Table 11.1 : (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 re-generate 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 a) Short term (1-3 years) b) Long term (15-30 years)	Moderate High	Very high High	Nil Low	Moderate Moderate-high
9. Land leased to private parties through open auction a) Short term (1-3 years) b) Long term (15-30 years)	High High	Very high High	Nil Moderate-high	- -

(continued)

Table 11.1 : (continued)

Institutional framework of ownership/usufruct right on waste lands	Need for powerful local level leadership (5)	Chances of the poor benefiting from the land (6)	Replicability of model on a larger scale (7)	Empirical basis for making the inferences (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 (prevailing 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.

(continued)

Table 11.1 : (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 a) Short term (1-3 years) b) Long term (15-30 years)	-	Low-moderate Moderate	High High	Experience with distribution of surplus land to poor
9. Land leased to private parties through open auction a) Short term (1-3 years) b) Long term (15-30 years)	-	Very low Very low	High High	Durga Prasad's findings

Source : Fodder Production - An Alternative for Marginal and Waste Land Development. National Waste Lands Development Board, Government of India.

CHAPTER XII

CONCLUSION AND RECOMMENDATIONS

The study covered three major 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 thousand sq.km and the population was 1323 lakh in 1931 (Table 12.1). 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 major measures taken for development of agriculture. It may however be noted that there are considerable year to year fluctuations even in irrigated agriculture (Table 12.2). For example in Gujarat, the yield of irrigated groundnut was 1730 kg/Ha in 1932-33 while it was 471 kg/ha in 1985-86. There are large year to year fluctuations in rainfed agriculture in most of 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 the 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 water-

logging 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. (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 interior 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 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 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.

Because decomposition is slow presumably owing to the absence of termites and other important decomposers, and lower temperatures about half of the organic carbon in northern coniferous forest is in the soil and half in wood, while in tropical rain forest only about 15 per cent is in the soil. Similarly about 58 per cent of the nitrogen in tropical rain forest is in vegetation while in a British Pine wood 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 failure when cultivation is attempted 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 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 varied 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 conservation 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 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 wastes 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 receive protective irrigation, while the extra water available in the year of good rainfall is used for supplemental irrigation. The land put to grass and tree cover will not only help in water retention, moisture retention but also in enriching the soil through leaf litter and micro-organic processes. This will help improve the water-holding capacity of the land and provide micronutrients. In addition, combination of cereals and pulses or nitrogen fixing trees/shrubs can help improve soil fertility. The shortfall in NPK can be made up by artificial fertilizer application. The use of chemical fertilizer can thus be minimized.

In selection of crops the aim will be to have a diversified cropping pattern with some crops that provide a basis for further processing. Production of cereals and fodder as by-product, pulses, oilseed, vegetables, fruit and nut, fuelwood and small timber, fodder and grass for animals adequate to feed the draught cattle and provide milk and meat for local consumption will be provided for. The cash crop will have to be selected on the basis of agro-climatic conditions. The broad crop pattern can 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 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. In the case of other benefits e.g. grass, fuelwood, timber, etc., permission to carry personally headload for personal use can be given, the rest will have to be disposed of through sale, with those engaging in cutting and transport of grass, etc., receiving the major portion of the sale proceedings. 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 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. Funds

of these dimensions can be mobilized 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 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. (iv) 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 be made for the local population who will have to discontinue shifting cultivation and free grazing, in 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 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 provision of irrigation facilities. Crop specialization and dairy business have been developed in the irrigated tracts. Economy and rationalization in 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 help 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 co-operation 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 12.3). 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 say 33 per cent 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 systems, 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.

Table 12.1 : Statewise Area, Population and Workers in Western Zone of India

	State/Union Territory							Total
	Maha-rashtra	Raja-sthan	Gujarat	Goa	Daman	Diu	Dadra and Nagar Haveli	
Area (sq.kms.)	307690	342239	196024	3702	72 [@]	40 [@]	491	850258
Total population 1981 (000)	62784	34262	34086	1008	49	30	104	132323
Density	204	100	174	272	674	761	211	156
Rural population (000)	40790	27051	23484	685	28	22	97	92157
% Urban population to total	35.03	21.05	31.10	32.03	43.25	26.36	6.70	30.36
Total main workers (000)	24301	10442	10984	311	14	7.6	42	46102
Cultivators (000)	8536	6431	4115	58	3	1.2	26	19170
Agricultural labourers (000)	6471	765	2488	31	1	.4	5	9761
% of workers in agriculture	61.75	68.91	60.11	28.62	28.57	20.92	73.81	62.75
Total Reporting Area 1983-84 (000 ha)	30758	34235	18829	361	6*	4*	49	84242
Net sown area (000 ha)	18302	16234	9583	122	4	1	24	..
% Net sown to total area	59.50	47.42	50.89	33.80	66.88	21.30	48.39	52.55

Note: @ according to the Surveyor General of India.

* As per local Land Survey Department.

Source : Statistical Abstract, India, 1986.

Table 12.2 : Irrigated and Unirrigated Yield of Principal Crops in Maharashtra, Rajasthan and Gujarat

(Kgs. per hectare)

Crop/State	Season	Irrigated						Unirrigated					
		1981-82	1982-83	1983-84	1984-85	1985-86	Average	1981-82	1982-83	1983-84	1984-85	1985-86	Average
RICE													
Maharashtra	Kharif	1559	1230	1806	1039	1358	1398	1625	1325	1561	1333	1423	1453
	Summer	1529	1726	-	-	1988	1748	-	-	-	-	-	-
Rajasthan	Kharif	1731	2028	1818	2484	-	2015	566	260	1073	751	-	663
Gujarat	Kharif	1975	1769	1932	2099	1571	1869	1197	632	1091	1044	812	955
JOWAR													
Maharashtra	Kharif	-	-	-	-	-	-	1074	-	-	-	-	1074
	Rabi	927	891	956	1106	758	928	407	316	335	429	295	366
Gujarat	Kharif	1358	984	944	1335	1048	1134	513	322	497	426	326	417
	Rabi	-	1277	1485	714	986	1116	960	1032	764	1008	899	933
BAJRI													
Maharashtra	Kharif	845	564	1123	757	424	743	433	313	483	309	242	356
Rajasthan	Kharif	1048	-	774	-	-	911	160	-	480	-	-	320
Gujarat	Kharif	1248	1108	1544	1436	1016	1270	946	690	1008	955	319	784
	Summer	1846	1776	-	2187	-	1936	-	-	-	-	-	-
MAIZE													
Maharashtra	Kharif	1018	1316	1197	-	1015	1137	834	685	687	-	454	665
	Rabi	1358	1400	-	-	1671	1476	1893	590	-	-	815	1099
Rajasthan		1337	1017	836	1523	-	1173	728	632	1399	1215	-	994
Gujarat		3103	1434	-	-	361	1663	1133	926	1477	1667	-	1313

(continued)

Table 12.2: (continued)

Crop/State	Season	Irrigated					Unirrigated						
		1981-82	1982-83	1983-84	1984-85	1985-86	Average	1981-82	1982-83	1983-84	1984-85	1985-86	Average
RAGI													
Maharashtra		-	-	-	-	-	-	1012	-	1056	-	-	1034
Gujarat		-	-	-	-	-	-	1039	891	1102	992	744	954
WHEAT													
Maharashtra		1009	1074	1288	1124	990	1097	531	464	571	552	416	507
Rajasthan		1395	1931	1631	-	-	1852	871	914	956	-	-	914
Gujarat		2411	2509	2694	2530	2248	2478	649	598	583	569	508	581
BARLEY													
Rajasthan		1459	1501	1549	1550	-	1515	843	777	1129	396	-	911
GRAM													
Maharashtra		533	448	603	551	479	523	340	308	375	349	284	331
Rajasthan		906	950	718	880	-	864	631	644	558	562	-	599
Gujarat		1066	-	1015	1214	663	990	740	614	890	813	502	712
GROUNDNUT													
Maharashtra	Kharif	-	-	-	-	-	-	643	594	859	-	673	692
	Summer	1753	1331	-	-	1272	1452	-	-	-	-	-	-
Rajasthan		1671	1633	844	864	-	1266	993	913	-	664	-	858
Gujarat	Kharif	1113	1780	856	801	471	1005	865	767	766	659	134	648

(continued)

Table 12.2 : (continued)

Crop/State	Season	Irrigated					Unirrigated							
		1981-82	1982-83	1983-84	1984-85	1985-86	Average	1981-82	1982-83	1983-84	1984-85	1985-86	Average	
<u>SUGARCANE</u>														
Maharashtra		96450	96910	90000	-	95929	94822	-	-	-	-	-	-	-
Rajasthan		38473	37114	42431	45326	-	40836	26240	36544	28761	44325	-	33968	
<u>TOBACCO</u>														
Maharashtra		-	-	-	-	778	778	586	565	-	-	-	576	
Gujarat		1977	1906	1859	1745	1661	1830	1659	1030	457	427	1103	935	
<u>RAPESEED AND MUSTARD</u>														
Rajasthan		813	762	839	817	-	808	563	598	752	793	-	677	
<u>COTTON (LINT)</u>														
Maharashtra		163	181	103	206	164	163	82	101	46	91	115	87	
Rajasthan		212	248	242	236	-	235	79	115	90	72	-	89	
Gujarat		391	361	-	479	429	415	152	119	-	159	140	143	

Source : Area and Production of Principal Crops in India, Ministry of Agriculture, 1989.

Table 12.3 : Statewise Distribution of Urban Population in Western Zone of India (1981)

State / Union Territory		Population size of city/town							(Population in 000)	
		Above 10 lakh	1 to 10 lakh	50,000 to 99,999	20,000 to 49,999	10,000 to 19,999	5,000 to 9,999	Under 5,000	Total	Percentage share in urban population of western zone
Maharashtra	No. Pop.	3 10665*	26 5076	2 1720	89 2617	100 1473	48 388	16 55	307 21994	54.76
Rajasthan	No. Pop.	- -	11 3306	10 662	55 1658	101 1385	23 195	1 4	201 7210	17.95
Gujarat	No. Pop.	1 2159	10 3157	27 1802	57 1783	86 1216	61 451	13 34	255 10602	26.40
Goa	No. Pop.	- -	- -	3 212	1 26	3 39	4 32	4 13	15 322	0.30
Daman	No. Pop.	- -	- -	- -	1 21	- -	- -	- -	1 21	0.05
Diu	No. Pop.	- -	- -	- -	- -	- -	1 8	- -	1 8	0.02
Dadra and Nagar Haveli	No. Pop.	- -	- -	- -	- -	- -	1 7	- -	1 7	0.02
Total	No. Pop.	4 12824	47 11539	65 4396	203 6105	290 4113	138 1081	34 106	781 40164	100.00
Per cent		31.93	28.73	10.95	15.20	10.24	2.69	0.26	100.00	

Notes: No. = No. of cities/towns. Pop. = Urban population in 000 in 1981.

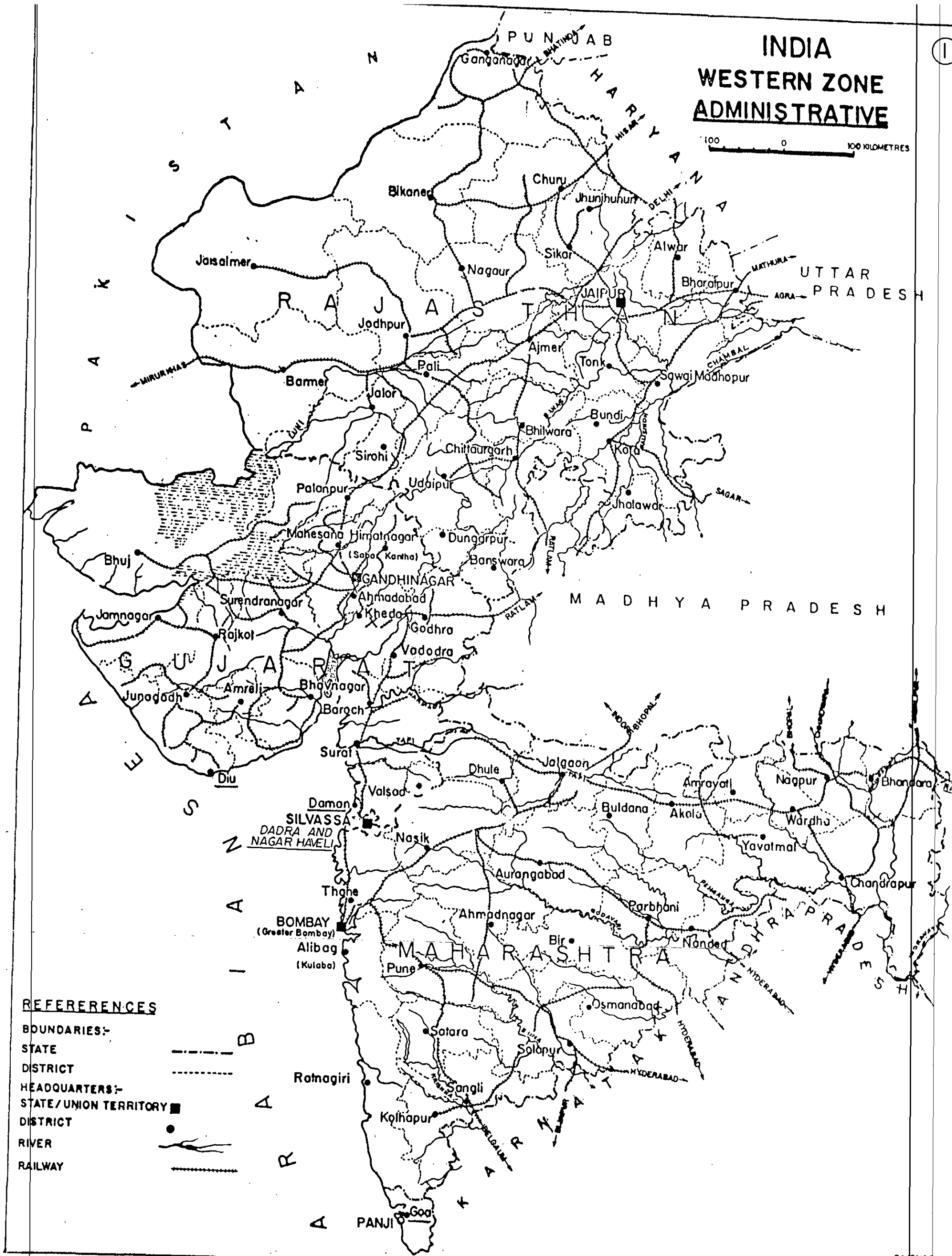
*. Greater Bombay 8243 thousand, Nagpur 1219 thousand, Pune 1203 thousand population.

Source : Statistical Abstract, India, 1986.

INDIA WESTERN ZONE ADMINISTRATIVE

(1)

100 0 100 KILOMETRES



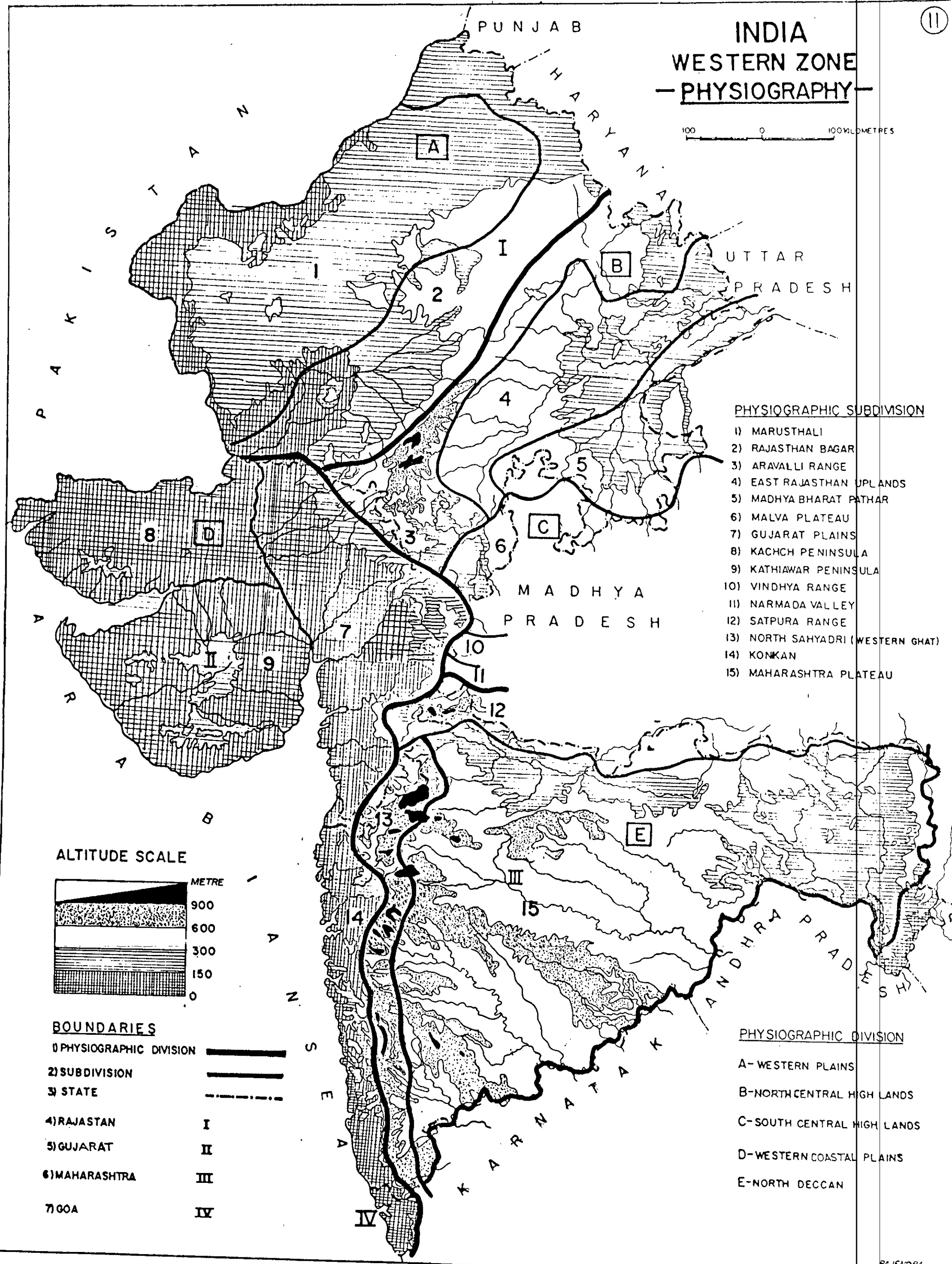
- REFERENCES**
- BOUNDARIES:-
 - STATE
 - DISTRICT
 - HEADQUARTERS:-
 - STATE/UNION TERRITORY
 - DISTRICT
 - RIVER
 - RAILWAY

RAJENDRA

INDIA WESTERN ZONE —PHYSIOGRAPHY—

11

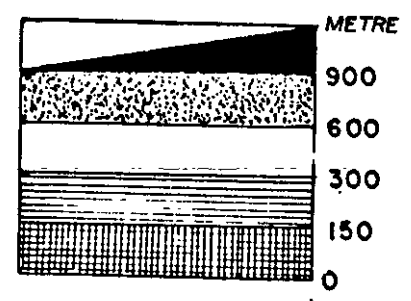
100 0 100 KILOMETRES



PHYSIOGRAPHIC SUBDIVISION

- 1) MARUSTHALI
- 2) RAJASTHAN BAGAR
- 3) ARAVALLI 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

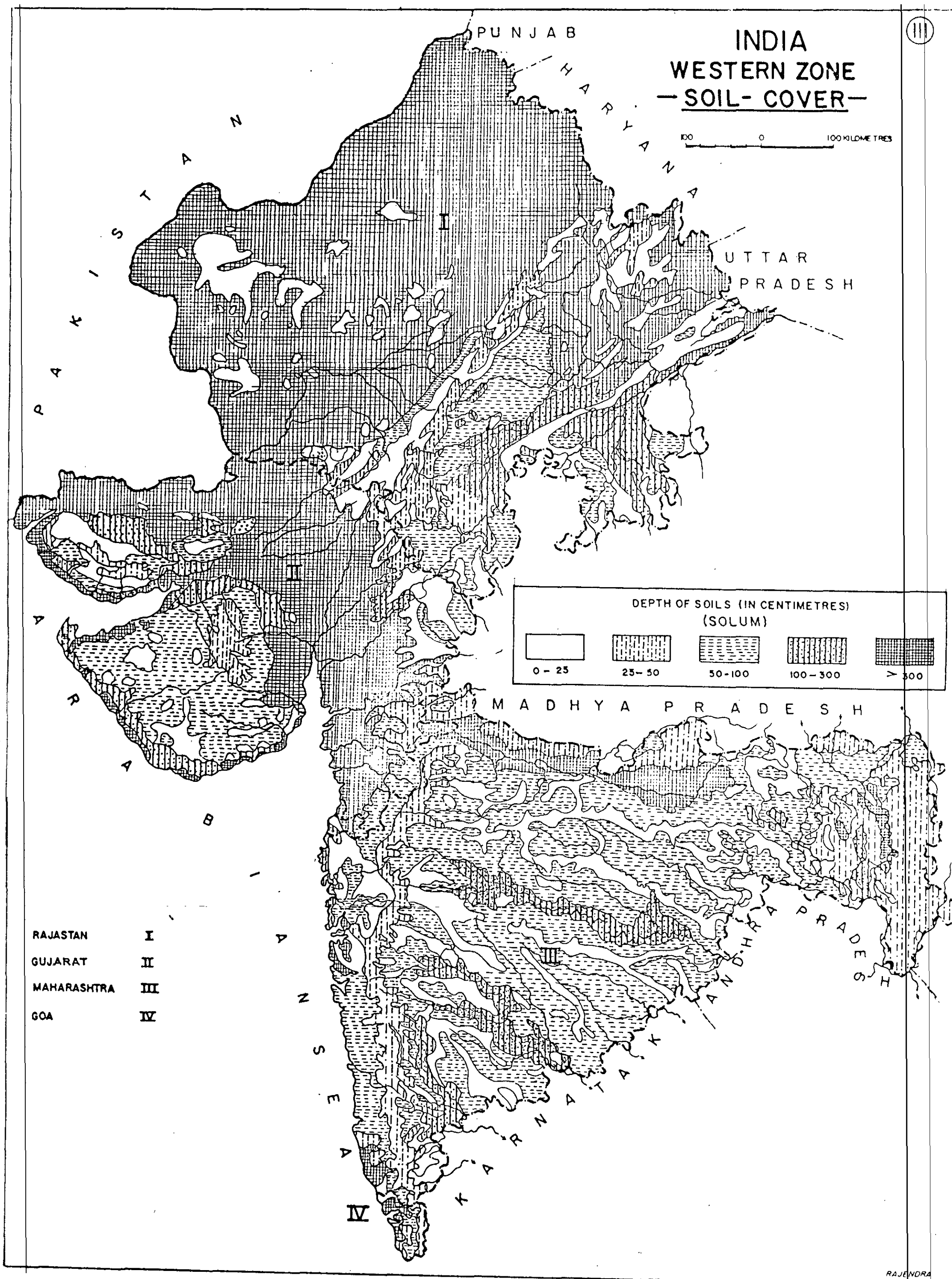


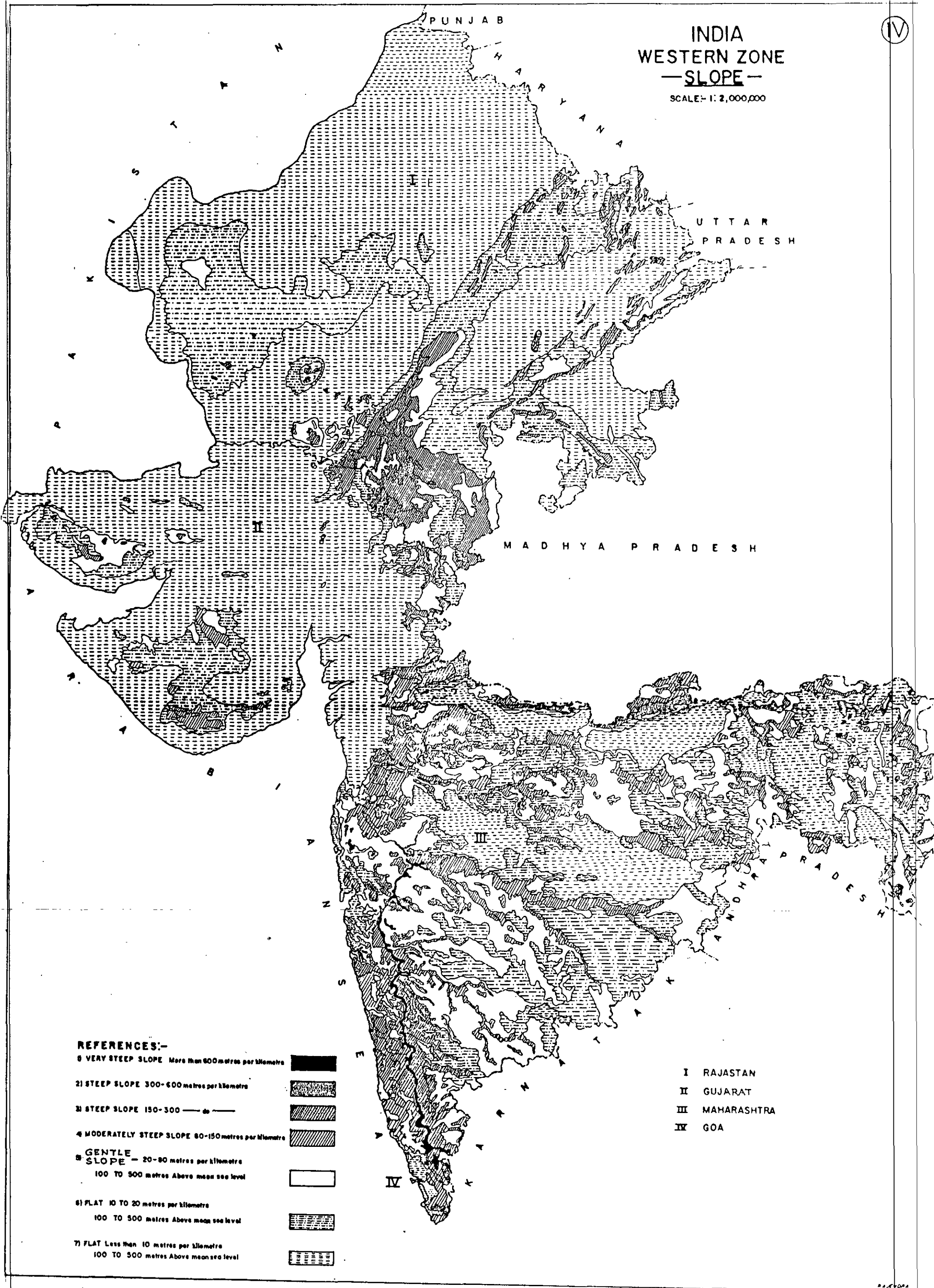
BOUNDARIES

- 1) PHYSIOGRAPHIC DIVISION ————
- 2) SUBDIVISION ————
- 3) STATE ————
- 4) RAJASTAN 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



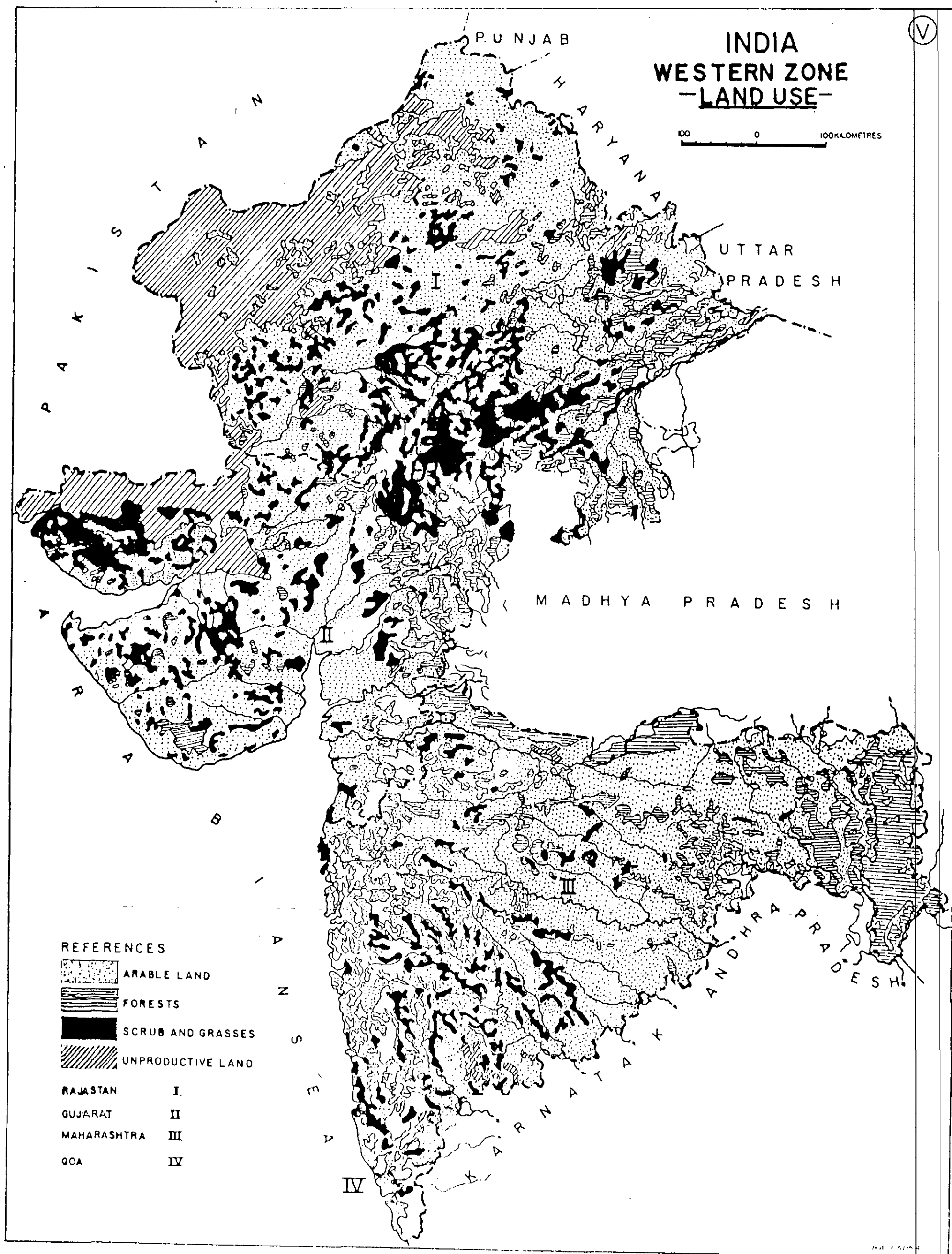


INDIA
WESTERN ZONE
— SLOPE —
SCALE: 1: 2,000,000

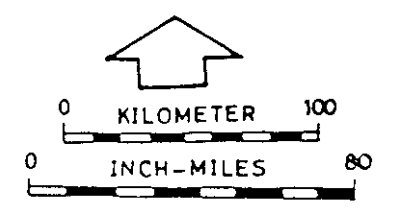
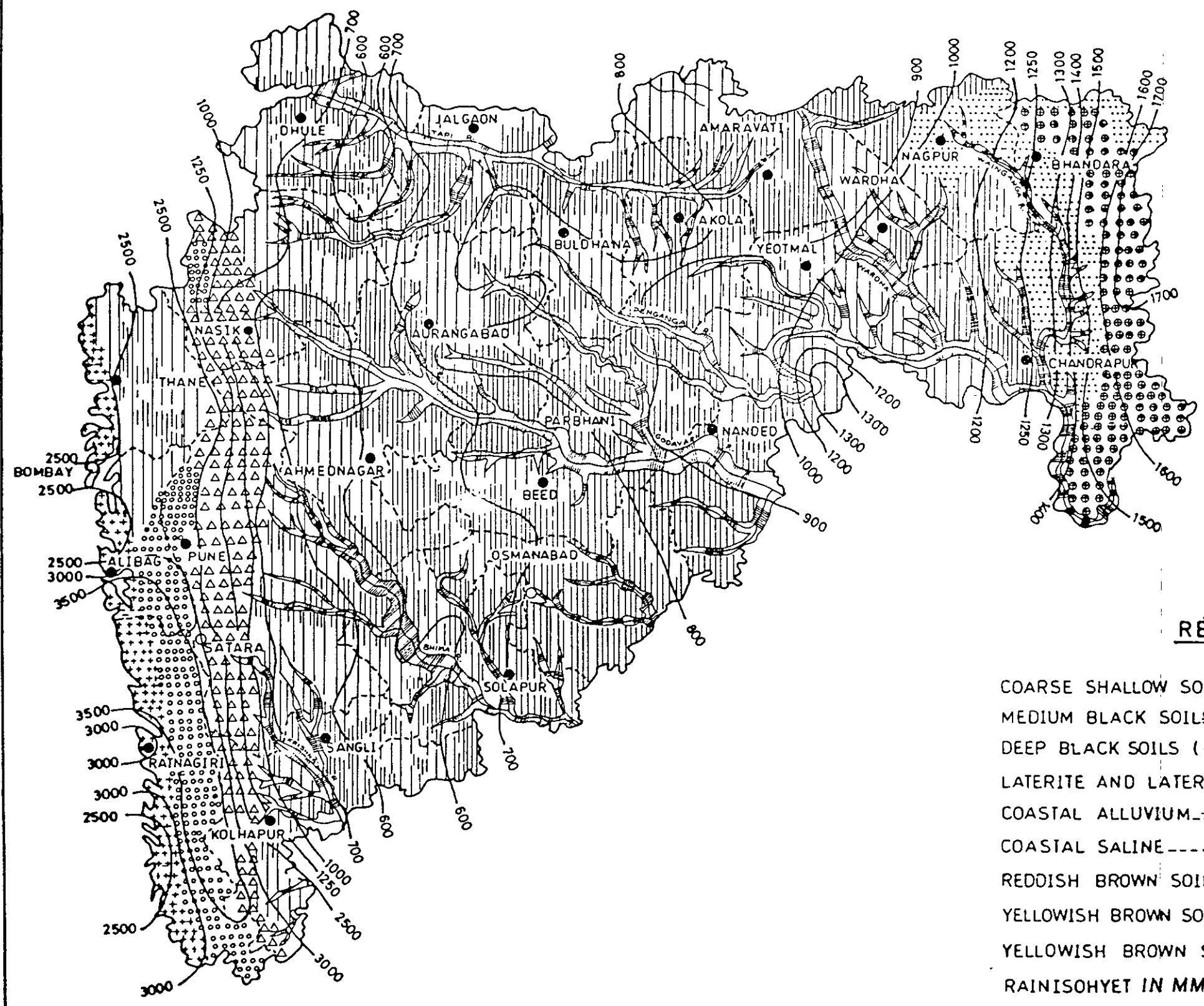
IV

- 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 80-150 metres per kilometre
 - 4 GENTLE SLOPE - 20-80 metres per kilometre
 - 5 FLAT 10 TO 20 metres per kilometre
 - 6 FLAT Less than 10 metres per kilometre

- I RAJASTAN
- II GUJARAT
- III MAHARASHTRA
- IV GOA

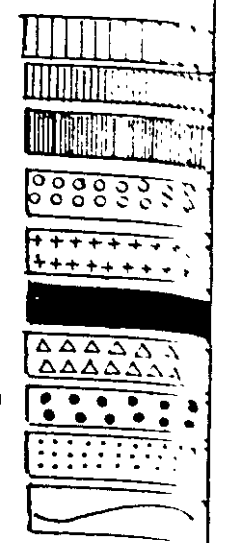


MAHARASHTRA SOILS AND ISOHYETS



RÉFERENCES

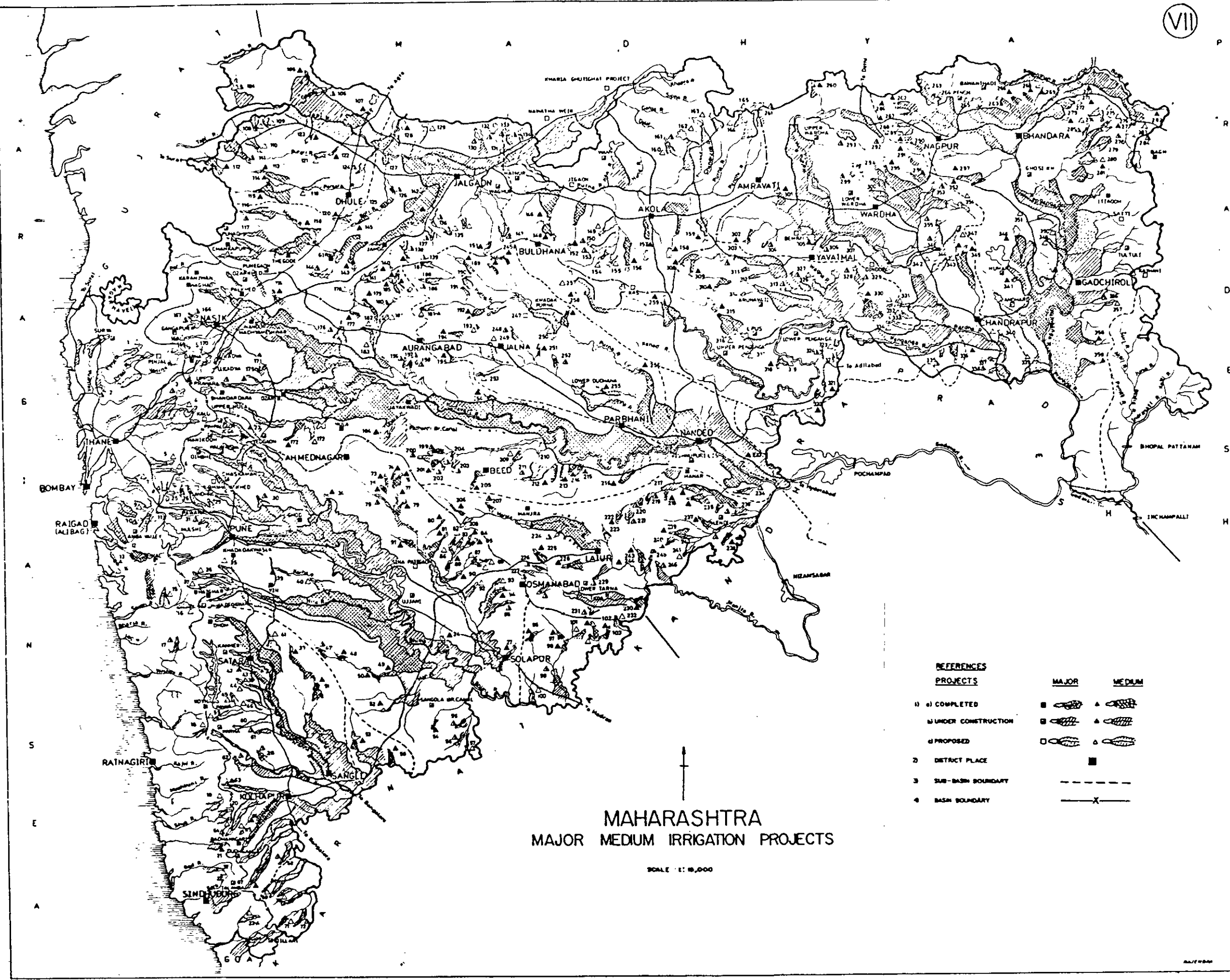
- COARSE SHALLOW SOILS (HIGH LEVEL).....
- MEDIUM BLACK SOILS (PLAINS).....
- DEEP BLACK SOILS (VALLEYS).....
- LATERITE AND LATERITIC SOILS.....
- COASTAL ALLUVIUM.....
- COASTAL SALINE.....
- REDDISH BROWN SOILS OF HILL SLOPES (TRAP).....
- YELLOWISH BROWN SOILS (MIXED ORIGIN)(ON HIGH LEVEL).....
- YELLOWISH BROWN SOILS OF PLAINS(MIXED ORIGIN).....
- RAINISOHYET IN MM.....



RAJENDRA

630

631



MAHARASHTRA
MAJOR MEDIUM IRRIGATION PROJECTS

SCALE 1:10,000

REFERENCES		MAJOR	MEDIUM
1) a) COMPLETED			
b) UNDER CONSTRUCTION			
c) PROPOSED			
2) DISTRICT PLACE			
3) SUB-BASIN BOUNDARY			
4) BASIN BOUNDARY			

Medium Irrigation Projects in Maharashtra

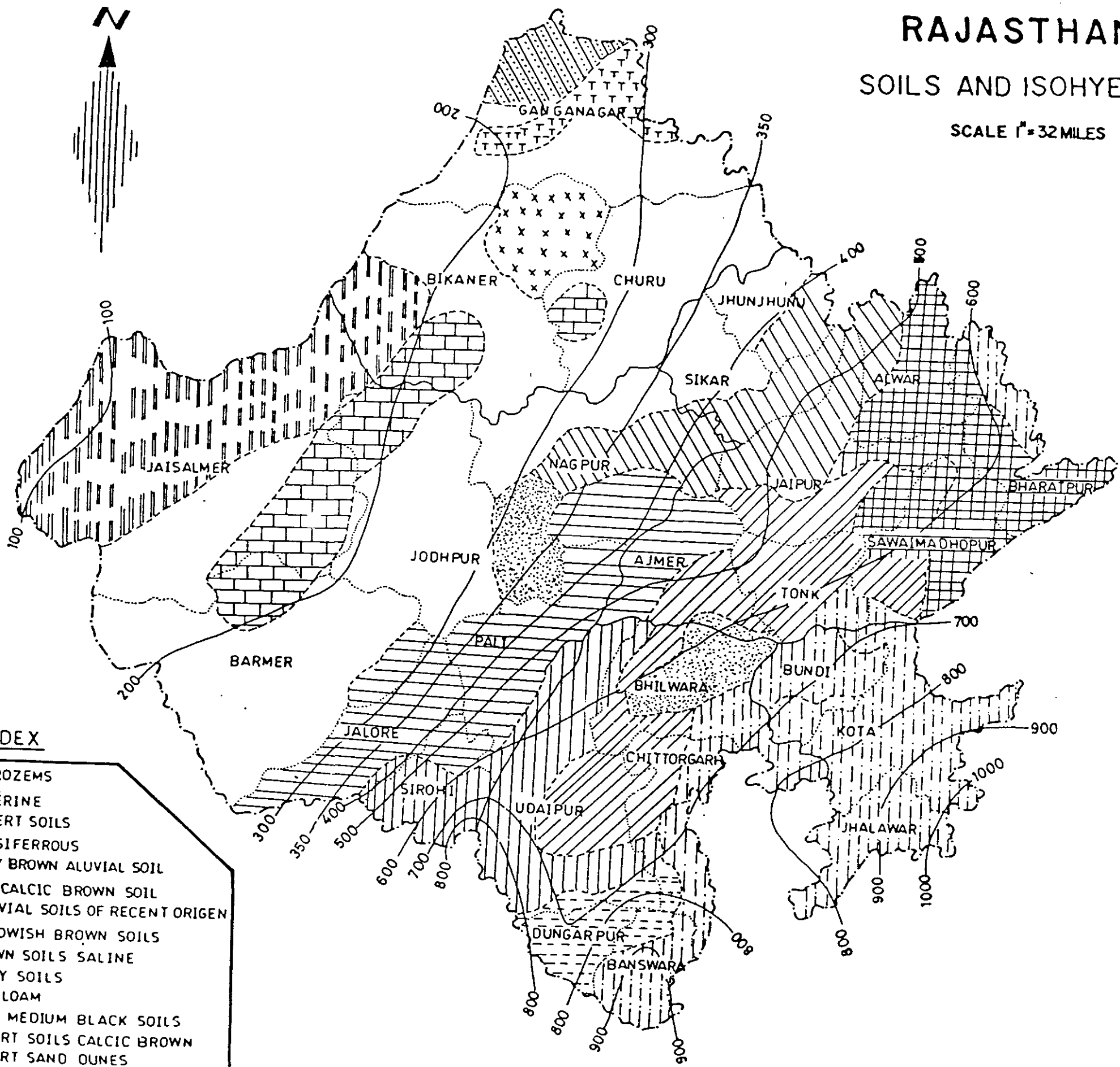
- | | | |
|--------------------|--------------------|-------------------|
| 1. Dehari | 2. Wandri | 3. Bhatsa |
| 4. Shahi | 5. Poshir | 6. Shilar |
| 7. Morbe | 8. Kondane | 9. Sungadewadi |
| 10. Hetavne | 11. Chimoda | 12. Sambarkund |
| 13. Chanera | 14. Amboli | 15. Gandhari |
| 16. Bhawe | 17. Natuwadi | 18. Gad |
| 19. Arjuna | 20. Janda | 21. Deogad |
| 22. Mohamadwadi | 23. Pushpawati B. | 24. Ashti |
| 25. Walwan | 26. Vadivale | 27. Ekrukhi |
| 28. Morna | 29. Jadhavvadi | 30. Thitewadi |
| 31. Kasarsai | 32. Sarambale | 33. Nher |
| 34. Visapur | 35. Ranje | 36. Gunjavni |
| 37. Chirmodi | 38. Tarli Bandhara | 39. Nazre |
| 40. Baranpur | 41. Vasma | 42. Urmodi |
| 43. Urmodi B. | 44. Tarali | 45. Kera |
| 46. Uttarmand | 47. Andhali | 48. Ranand |
| 49. Katphal | 50. Mhaswad | 51. Yeralwadi |
| 52. Budhiyal | 53. Siddhewadi | 54. Padwalkarvadi |
| 55. Doddanala | 56. Sankh | 57. Bhivargi |
| 58. Basappavadi | 59. Morna | 60. Wang |
| 61. Yeotimasoli | 62. Kadvi | 63. Kasari |
| 64. Kumbhi | 65. Dhamani | 66. Tulshi |
| 67. Pategaon | 68. Chikutra | 69. Chitri |
| 70. Tarohol | 71. Jambreungaon | 72. Jangamhatti |
| 73. Kamali | 74. Kadi | 75. Mehekari |
| 76. Kada | 77. Ruti | 78. Sinagangurde |
| 79. Talwar | 80. Khairi | 81. Khandeshwar |
| 82. Ralesangvi | 83. Tambevadi | 84. Ranganga |
| 85. Banganga | 86. Sakat | 87. Awal |
| 88. Babhulgaon | 89. Khasapur | 90. Chandani |
| 91. Mangi Tank | 92. Goradanala | 93. Pimpalgaon |
| 94. Hingni Pangaon | 95. Hingni Hatij | 96. Harni |
| 97. Kurnur | 98. Khandala | 99. Bori |
| 100. Dhubdubhi | 101. Benetura | 102. Jakapur |
| 103. Turori | 104. Dehali | 105. Dara |
| 106. Gomai | 107. Karvand | 108. Ranka |
| 109. Shiv | 110. Koradi | 111. Wagan |
| 112. Rangawali | 113. Malangaon | 114. Jamkhedi |
| 115. Panzara | 116. Haranbari | 117. Kelzar |
| 118. Wadel B. | 119. Akkalpada | 120. Purnapada |
| 121. Shewadi | 122. Chimthana B. | 123. Amravati B. |
| 124. Sonwad | 125. Bori | 126. Bhokarbari |

- | | | |
|---------------------|-------------------|--------------------|
| 127. Nandgaon | 128. Aner | 129. Gul |
| 130. Mor | 131. Suki B. | 132. Suki |
| 133. Abhora | 134. Mangrulpir | 135. Pimpalgaon |
| 136. Bahuli | 137. Hivara | 138. Agnawati |
| 139. Gadagga | 140. Wakadi | 141. Tittur |
| 142. Anjani | 143. Manyad | 144. Nagasakya |
| 145. Kanholi | 146. Nalganga | 147. Tondapur |
| 148. Paldhag | 149. Mas | 150. Torna |
| 151. Anjani Andheri | 152. Gyanganga | 153. Mun |
| 154. Utawal | 155. Viswamitry | 156. Nirguna |
| 157. Morna | 158. Katepurna | 159. Uma |
| 160. Kherkund | 161. Shahanur | 162. Chandra |
| 163. Sapan | 164. Arna | 165. Purna |
| 166. Alandi | 167. Kashyapi | 168. Waldevi |
| 169. Waki | 170. Mukane | 171. Bhojapur |
| 172. Mandohol | 173. Kalu | 174. Daraswad |
| 175. Adhala | 176. Narangi | 177. Kolhi |
| 178. Khari | 179. Dheku | 180. Shivna Tank |
| 181. Deogaon | 181-A. Girja | 182. Bordegaon |
| 183. Shivna Takli | 184. Adhi | 185. Ambadi |
| 186. Ralashi | 187. Nevapur | 188. Anjanpalsi |
| 189. Khelna | 190. Sillod | 191. Wakod |
| 192. Jivrekha | 193. Upper Dudhna | 194. Lahuki |
| 195. Sukhana | 196. Ghodgaon | 197. Tembhpurti |
| 198. Kham | 199. Ghatshil | 200. Belpara |
| 201. Sindhan | 202. Uthala | 203. Domri |
| 204. Narayangad | 205. Bindusara | 206. Mohasangvi |
| 207. Waghe | 208. Dokeyadi | 209. Makarni |
| 210. Majalgaon | 211. Kundlika | 212. Saraswati |
| 213. Bodhegaon | 214. Wan | 215. Borna |
| 216. Masoli | 217. Upper Manar | 218. Mahalingi |
| 219. Moha | 220. Thonga | 221. Nagthan |
| 222. Whati | 223. Renapur | 224. Raygavhan |
| 225. Tirna | 226. Kajla | 227. Rui |
| 228. Tayarja | 229. Masalga | 230. Murad Shajani |
| 231. Saroli | 232. Kolsur | 233. Kuual |
| 234. Talni | 235. Pethwadaj | 236. Talarani |
| 237. Kundral | 238. Karad Khed | 239. Tiru |
| 240. Rachanwadi | 241. Gurdhal | 242. Sangamwadi |
| 243. Ghirni | 244. Girkachal | 245. Sakol |
| 245-A. Dhamni | 246. Deoverja | 246-A. Jui |
| 247. Pimpalgaon | 248. Kalva | 249. Rajewadi |
| 250. Vidrupa | 251. Kalyan | 252. Girja |
| 253. Dhangar Pimpri | 254. Galhati | 255. Karpara |
| 256. Sidheshwar | 257. Pentakli | 258. Kordi |
















- | | | |
|-------------------|---------------------|----------------------|
| 259. Ekburjee | 260. Shekhdari | 261. Chargad |
| 262. Umri | 263. Khekra | 264. Pendhri |
| 265. Ramtek | 266. Sorna | 267. Betekar Bothali |
| 268. Bagheda | 269. Chandpur | 270. Khairbandha |
| 271. Sangrampur | 272. Bodalkasa | 273. Chorkamara |
| 274. Katgi | 275. Kalpathraj | 276. Owara |
| 277. Chulband | 278. Umarzari | 279. Kanharpayli |
| 280. Kalimatitola | 281. Navegaon Bandh | 282. Managad |
| 283. Pujaritola | 284. Kalisagar | 285. Rengepar |
| 286. Kolar | 287. Kesarnala | 288. Khumari |
| 289. Chandrabhag | 290. Mordham | 291. Venna |
| 292. Jan | 293. Kar | 294. Dongargaon |
| 295. Bor | 296. Kanholi | 297. Saiki |
| 298. Panchadhara | 299. Dham | 300. Madan |
| 301. Malkhed | 302. Sakhli | 303. Adan |
| 304. Ner | 305. Takli | 306. Borgaon |
| 307. Vardh | 308. Sonal | 309. Motsawanga |
| 310. Giroli | 311. Kumbharkinhi | 312. Mulgahan |
| 313. Devgaon | 314. Dhawandi | 315. Pus |
| 316. | 317. Jam | 318. Nignur |
| 319. Amdapur | 320. Dongargaon | 321. Nagari |
| 322. Sudha | 323. Maniramkhed | 324. Loni |
| 325. Shirpur | 326. Chapodah | 327. Goki |
| 328. Vaghadi | 329. Antergaon | 330. Saikheda |
| 331. Wai | 332. Nawargaon | 333. Sonegaon |
| 334. Hiwara | 335. Pagadi Guddam | 336. Analnala |
| 337. Bendara | 338. Dongargaon | 339. Dabhai |
| 340. Hattigota | 341. Naleshwar | 342. Deval |
| 343. Bamandoh | 344. Chandhai | 345. Chargaon |
| 346. Labhansarad | 347. Lalnala | 348. Ghorazari |
| 349. Nimbughat | 350. Gardi | 351. Buti |
| 352. Pandharabodi | 343. Lower Venna | 354. Hiwara |
| 355. Pothra | 356. Karvappa | 357. Pohar |
| 358. Dina | 359. Chenna | |

RAJASTHAN SOILS AND ISOHYETS

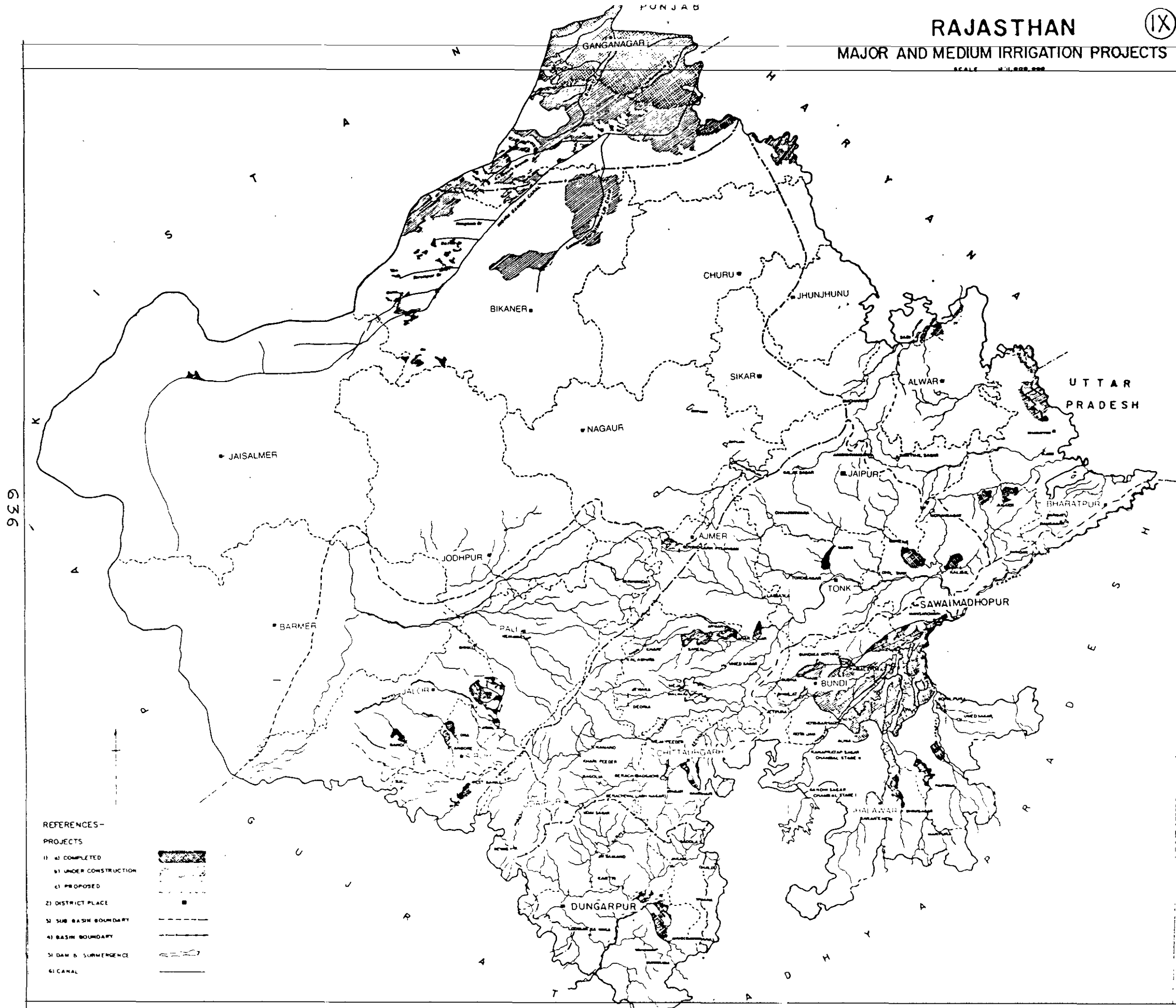
SCALE 1" = 32 MILES



INDEX

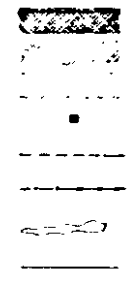
-  SEERAZEMS
-  REVERINE
-  DESERT SOILS
-  GYPSIFEROUS
-  GRAY BROWN ALUVIAL SOIL
-  NON CALCIC BROWN SOIL
-  ALLUVIAL SOILS OF RECENT ORIGIN
-  YELLOWISH BROWN SOILS
-  BROWN SOILS SALINE
-  WILLY SOILS
-  RED LOAM
-  DEEP MEDIUM BLACK SOILS
-  DESERT SOILS CALCIC BROWN
-  DESERT SAND DUNES
-  RAINFALL CONTOURS IN MM.

635



REFERENCES-
PROJECTS

- 1) a) COMPLETED
- b) UNDER CONSTRUCTION
- c) PROPOSED
- 2) DISTRICT PLACE
- 3) SUB-BASIN BOUNDARY
- 4) BASIN BOUNDARY
- 5) DAM & SURMERGENCE
- 6) CANAL







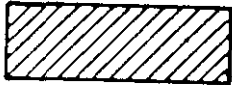

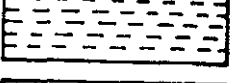

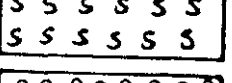
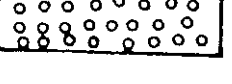
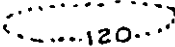
636

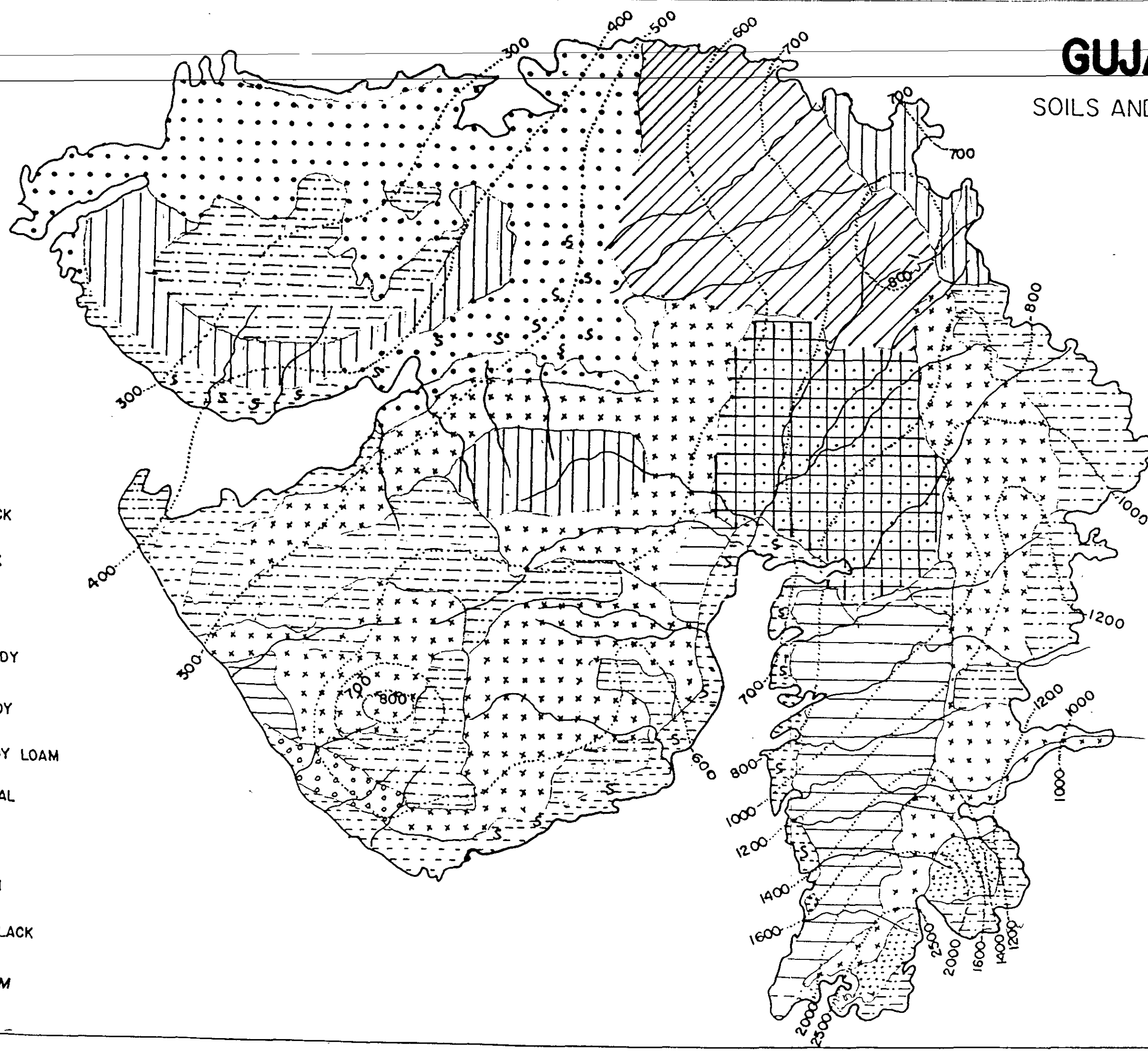
GUJARAT

SOILS AND ISOHYETS

637

REFERENCES

-  SHALLOW BLACK
-  MEDIUM BLACK
-  DEEP BLACK
-  RESEDUAL SANDY
-  ALLUVIAL SANDY
-  ALLUVIAL SANDY LOAM
-  COSTAL ALLUVIAL
-  DESERT
-  SALINE ALLKALI
-  MIXED RED & BLACK
-  ISOHYETS IN MM

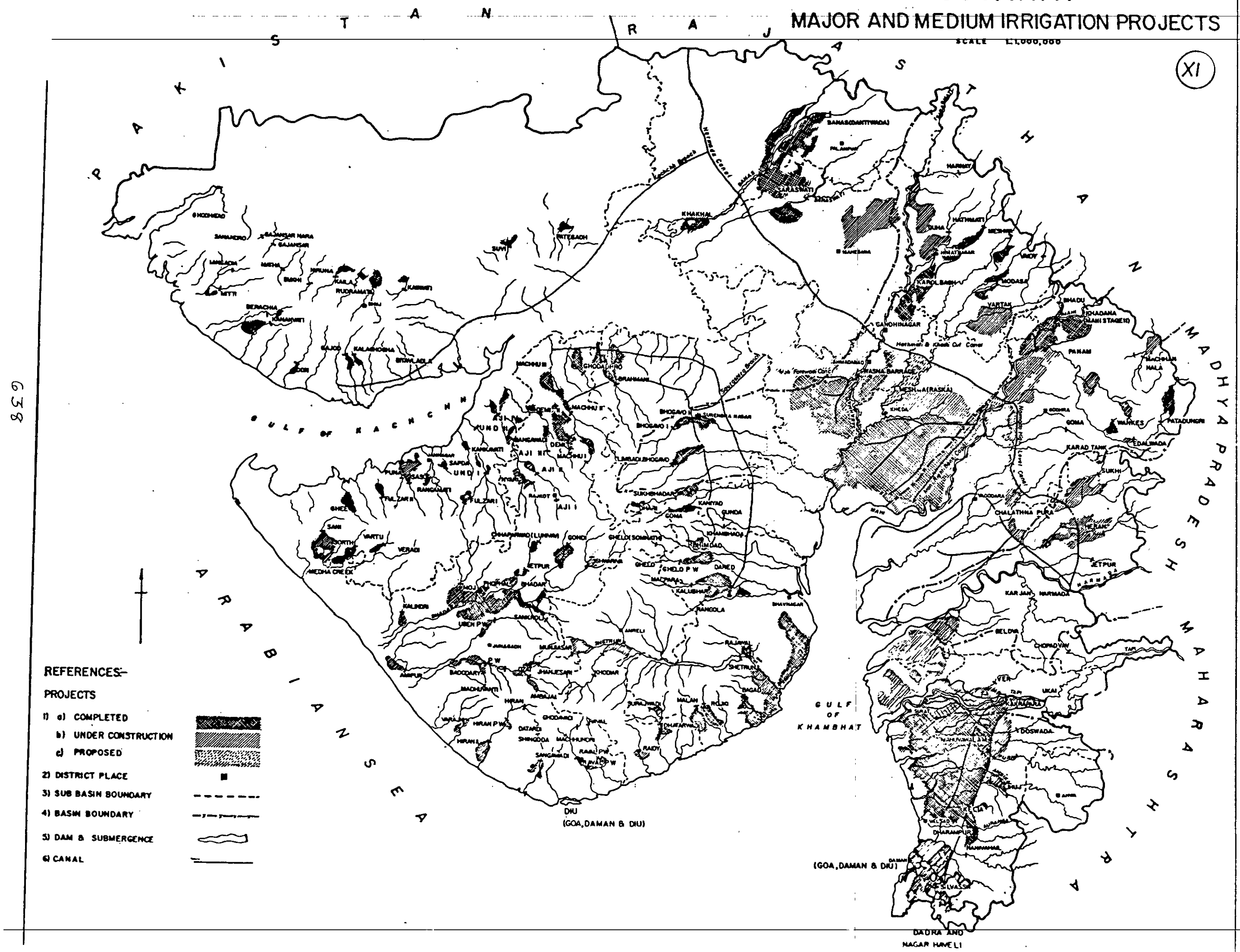


GUJARATI

MAJOR AND MEDIUM IRRIGATION PROJECTS

SCALE 1:1,000,000

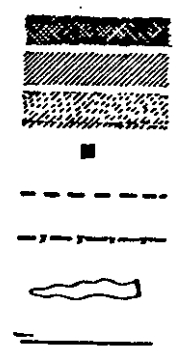
(XI)



658

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



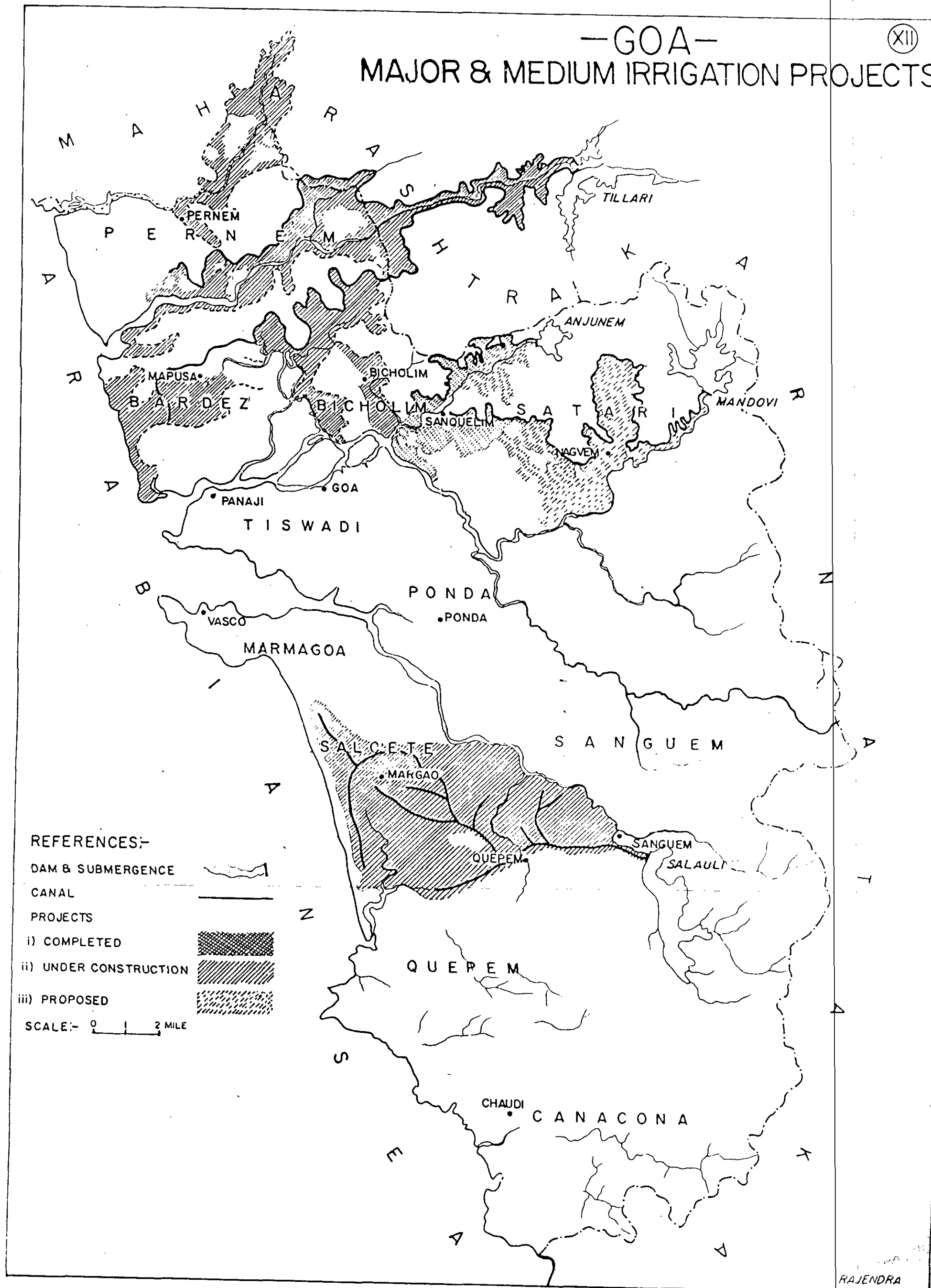
DIU
(GOA, DAMAN & DIU)

(GOA, DAMAN & DIU)

DADRA AND
NAGAR HAVELI

—GOA—
MAJOR & MEDIUM IRRIGATION PROJECTS

(XII)

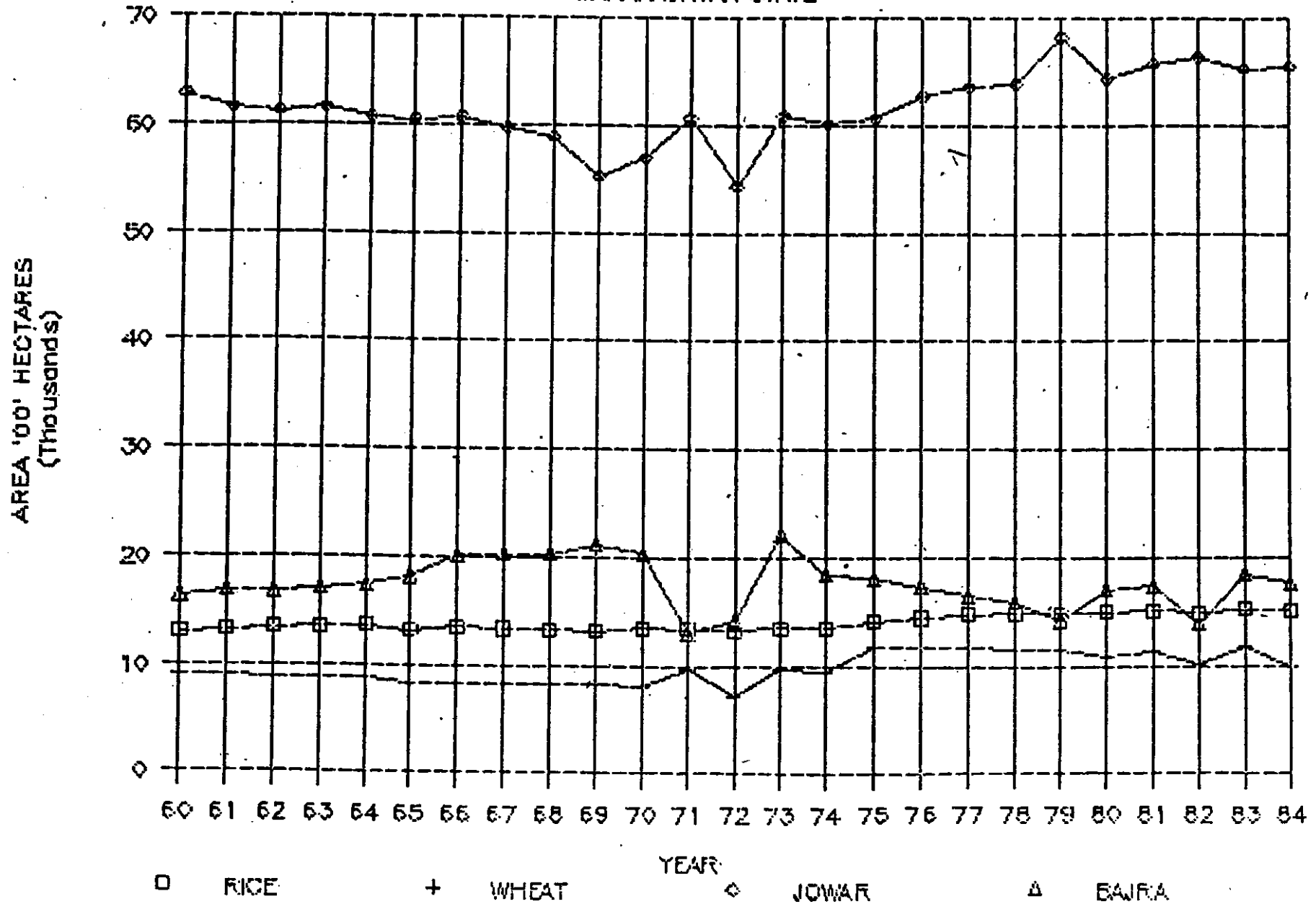


REFERENCES:-
 DAM & SUBMERGENCE
 CANAL
 PROJECTS
 i) COMPLETED
 ii) UNDER CONSTRUCTION
 iii) PROPOSED
 SCALE:- 0 1 2 MILE

640.

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

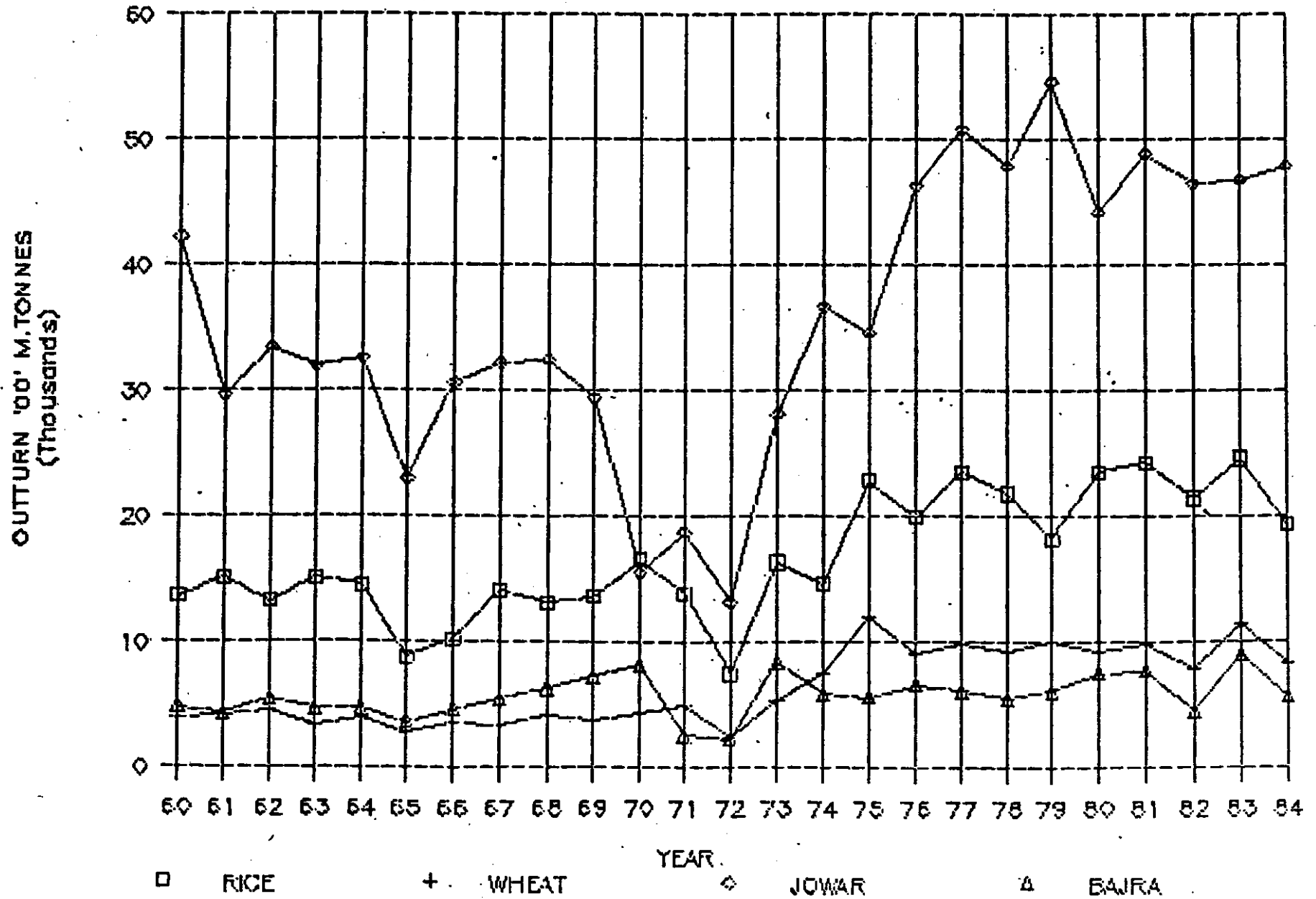
MAHARASHTRA STATE



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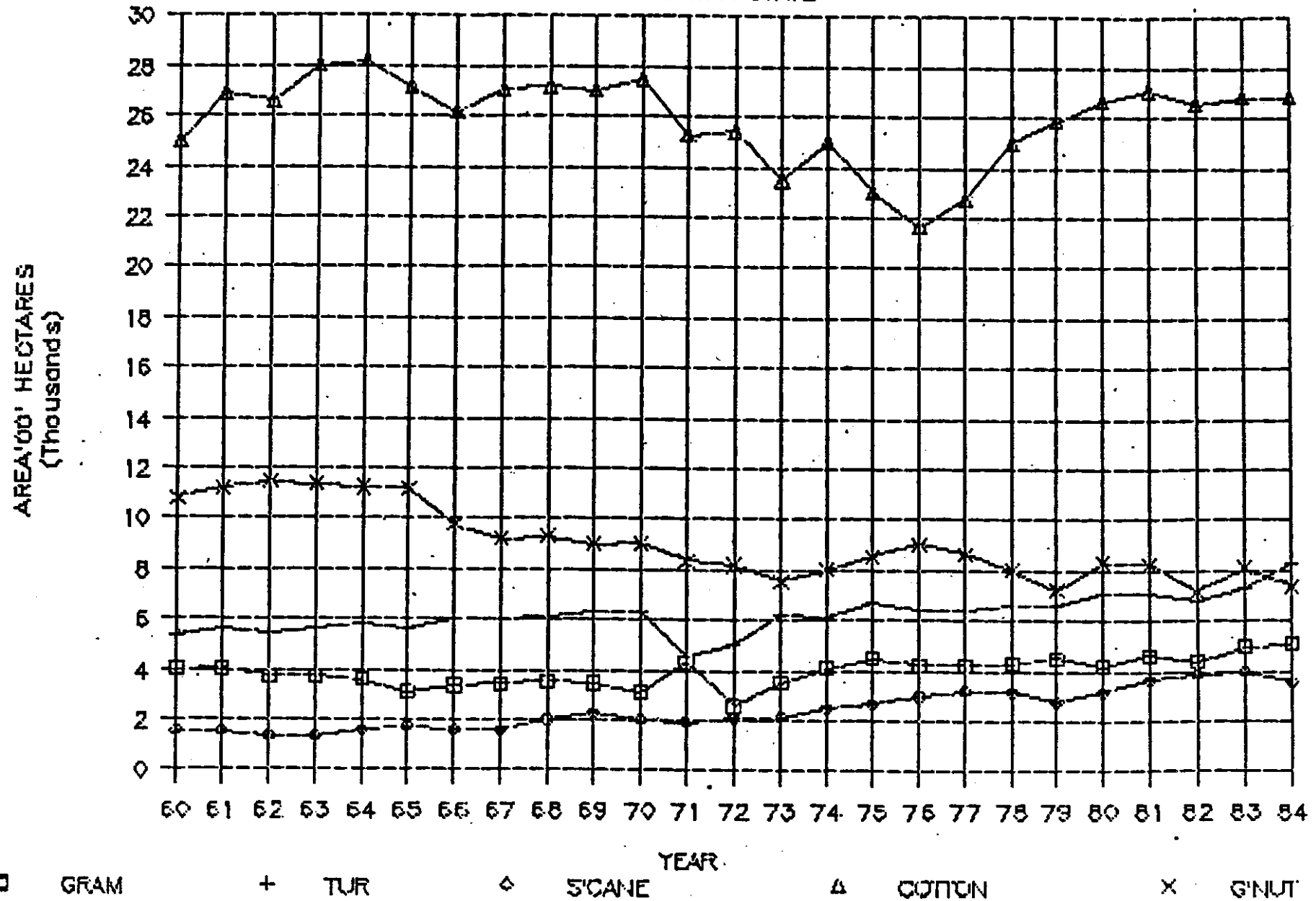
PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA STATE



AREA UNDER GRAM, TUR, S'CAANE, COTTON, G'NUT

MAHARASHTRA STATE

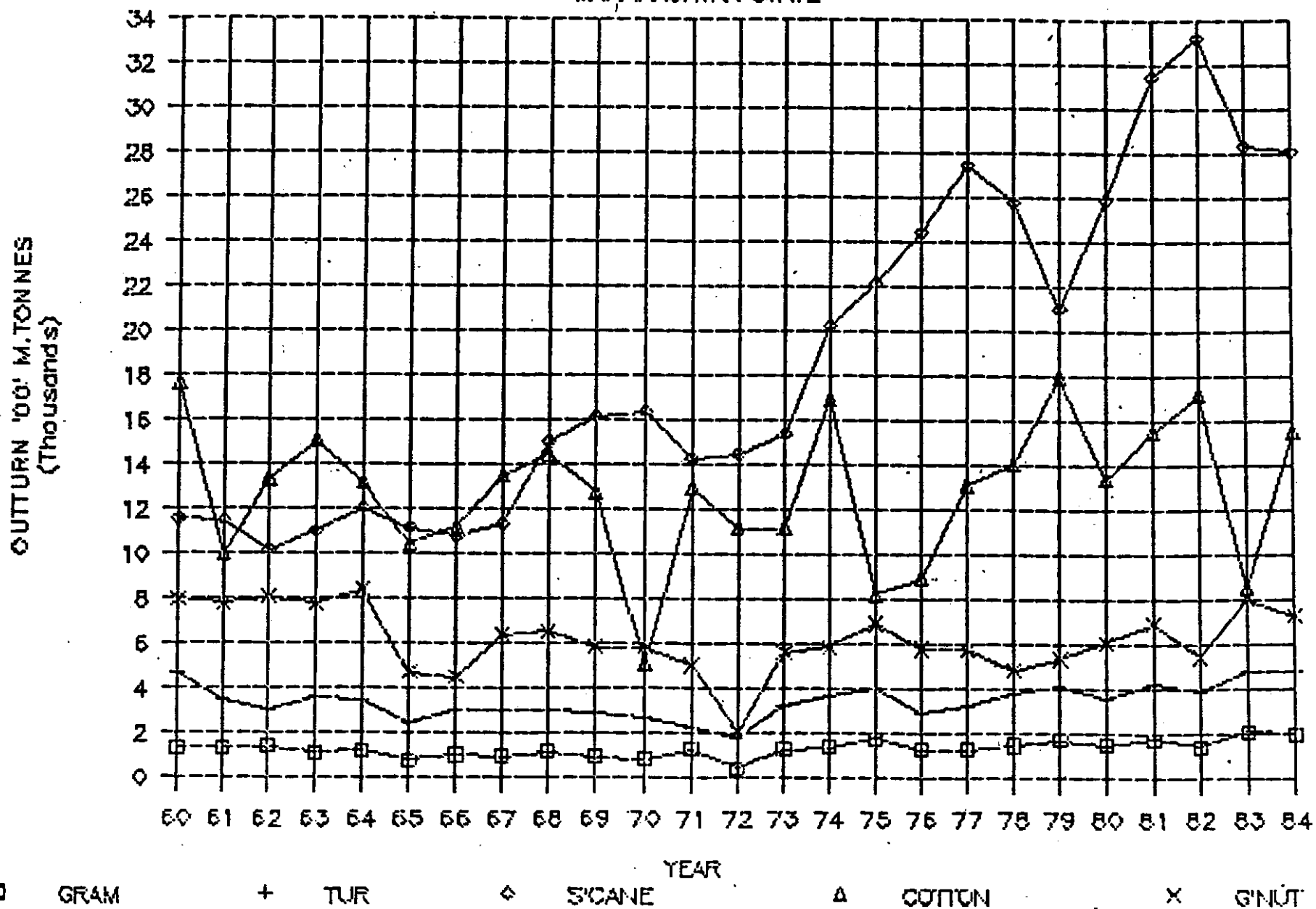


642

NO. 3

PROD. UNDER GRAM, TUR, S'CAANE, COTTON, G'NUT

MAHARASHTRA STATE

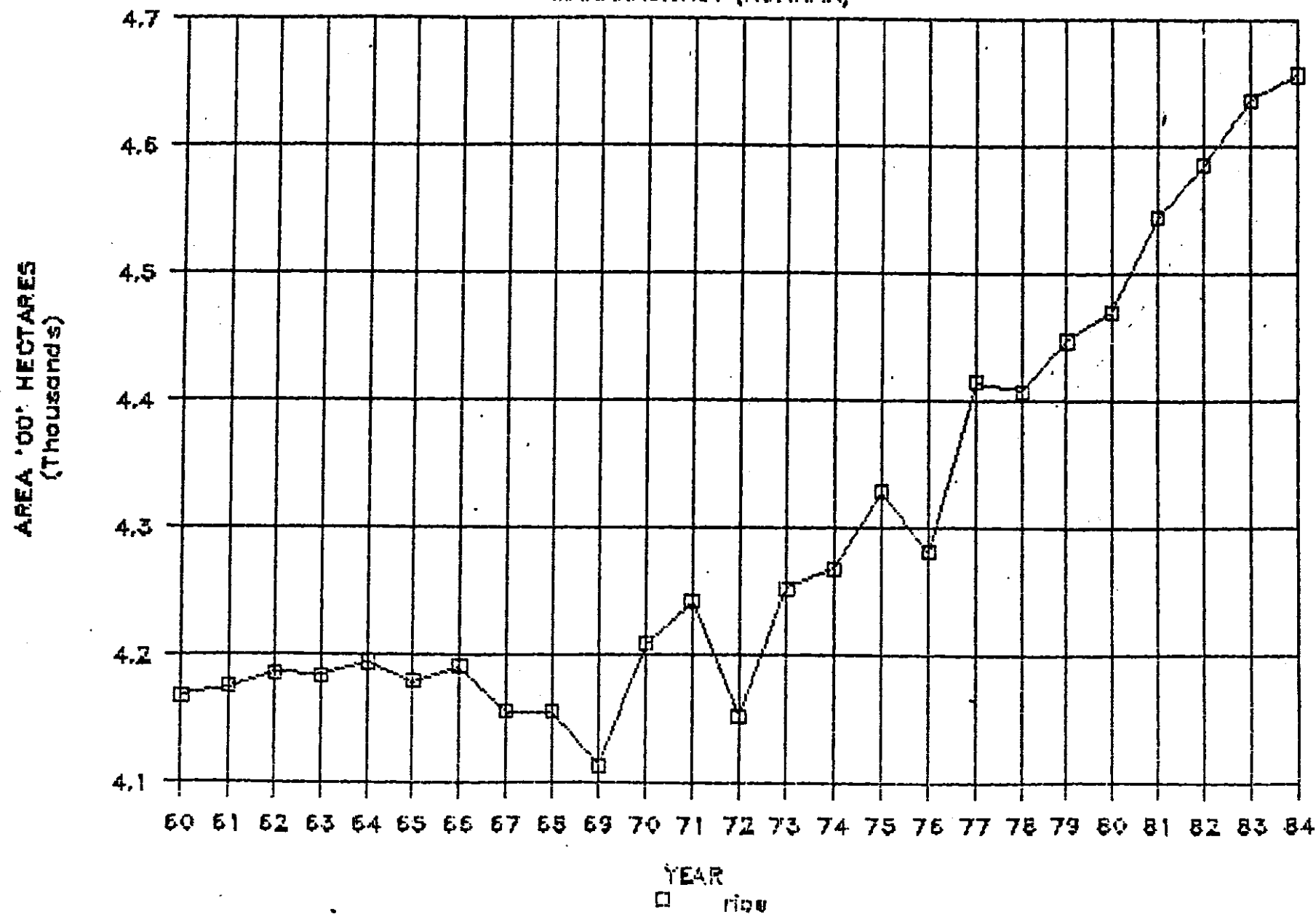


643

NO. 4

AREA UNDER RICE (1960-84)

MAHARASHTRA (KONKAN)

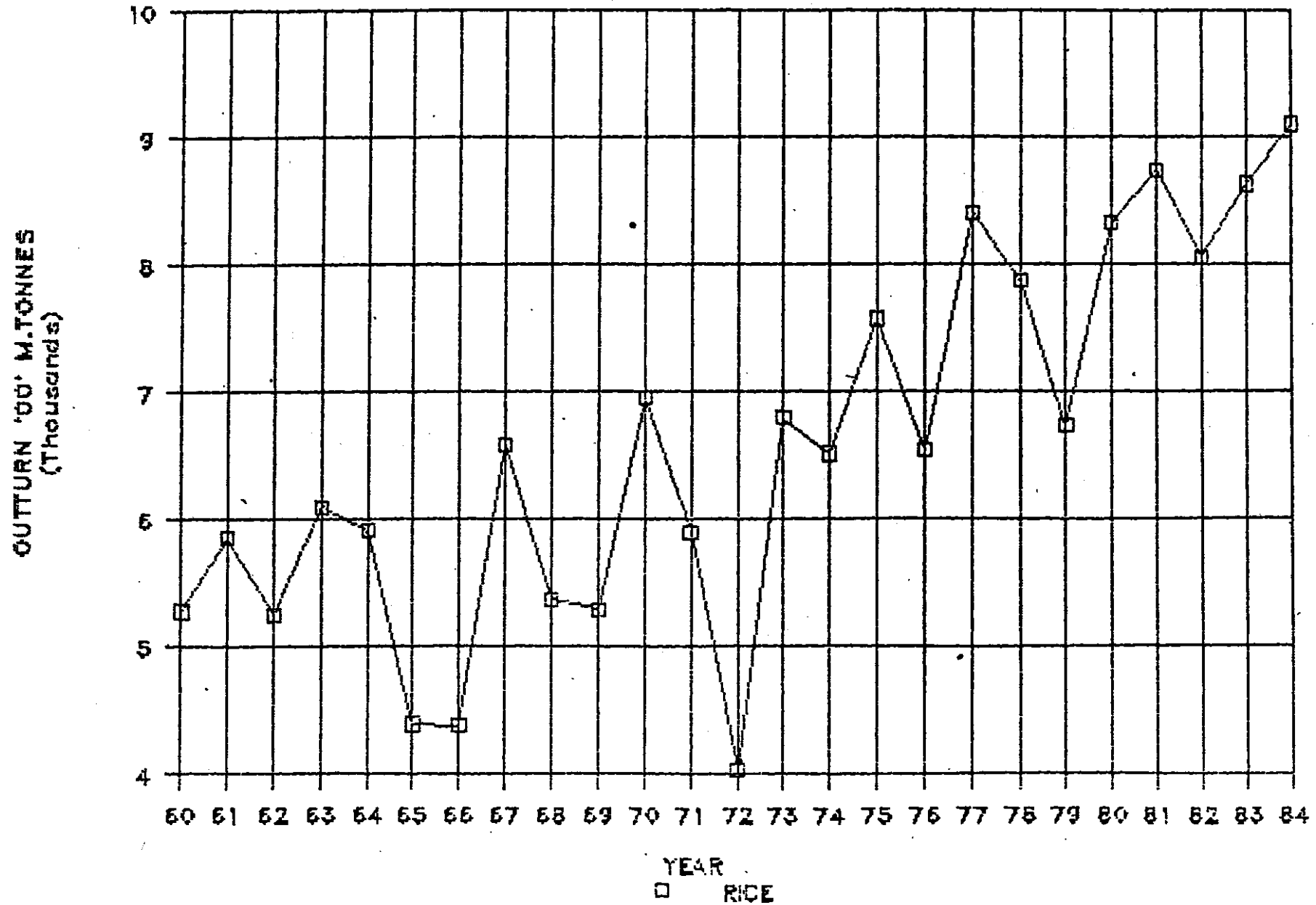


644

NO-5

PRODUCTION UNDER RICE (1960-84)

MAHARASHTRA (KONKAN)

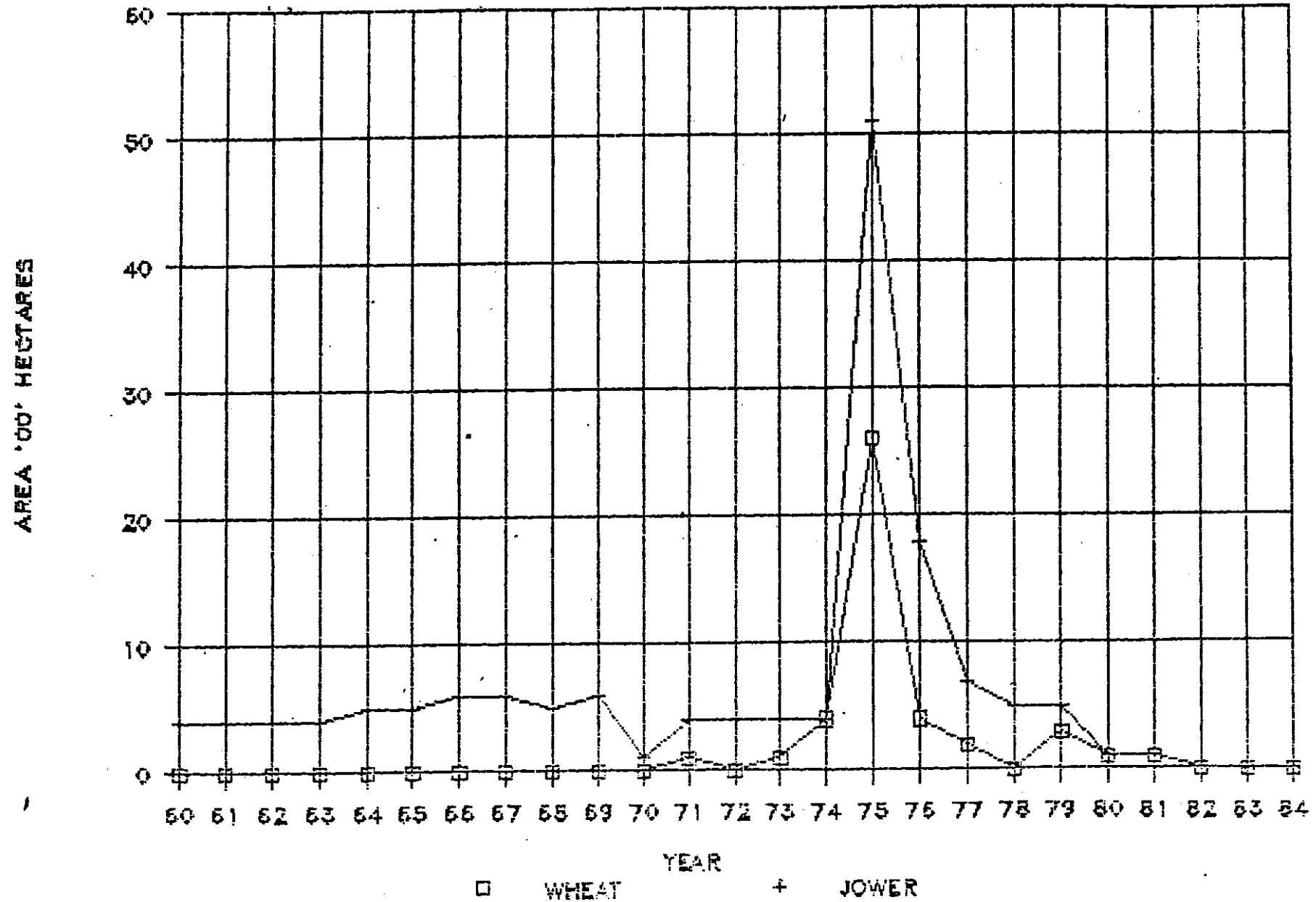


645

NO. 6

AREA UNDER WHEAT & JOWER

MAHARASHTRA (KONKAN)

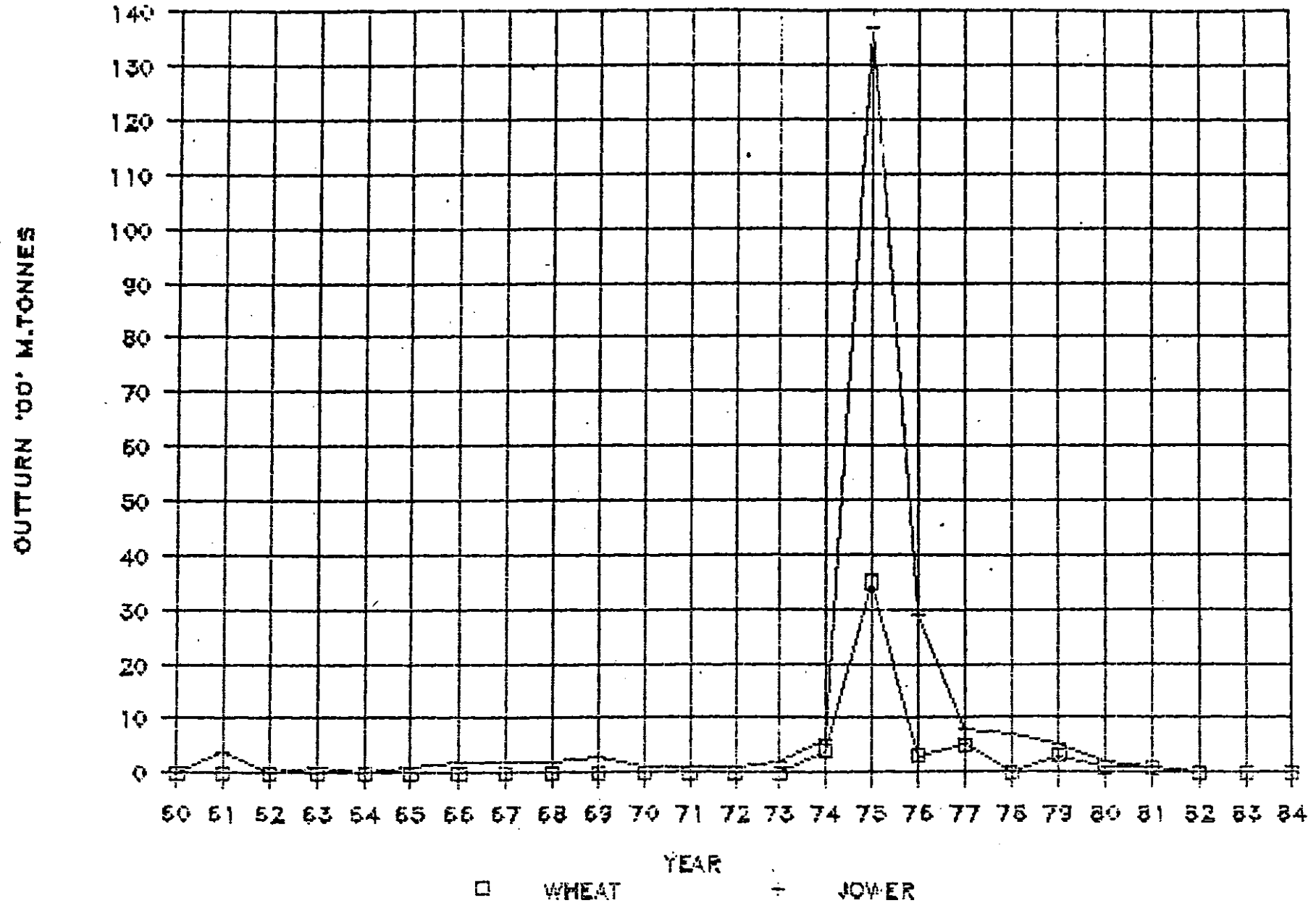


646

NO. 7

PRODUCTION UNDER WHEAT & JOWER

MAHARASHTRA (KONKAN)

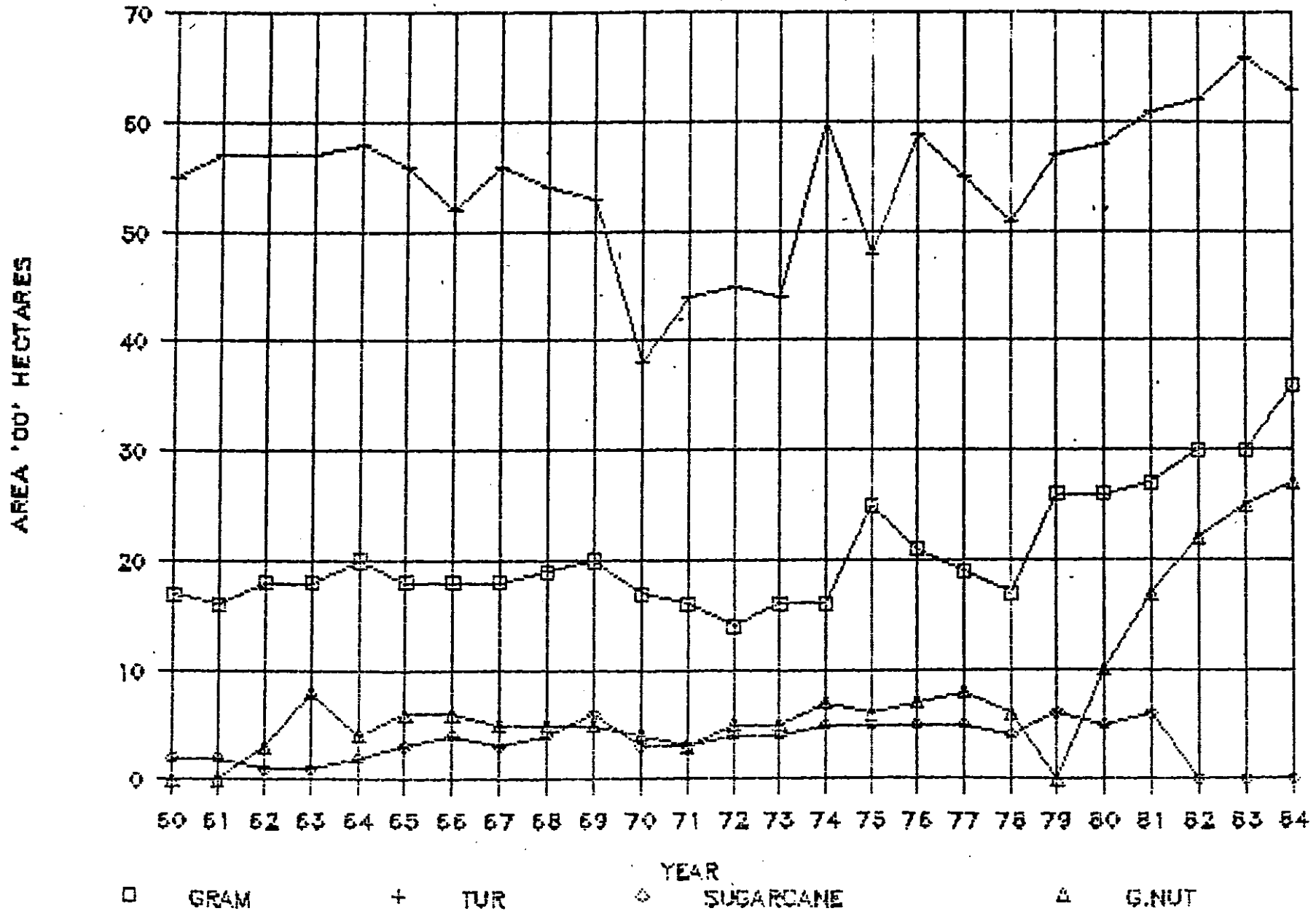


647

NO. 8

AREA UNDER GRAM, TUR, S' CANE, G' NUT

MAHARASHTRA (KONKAN)

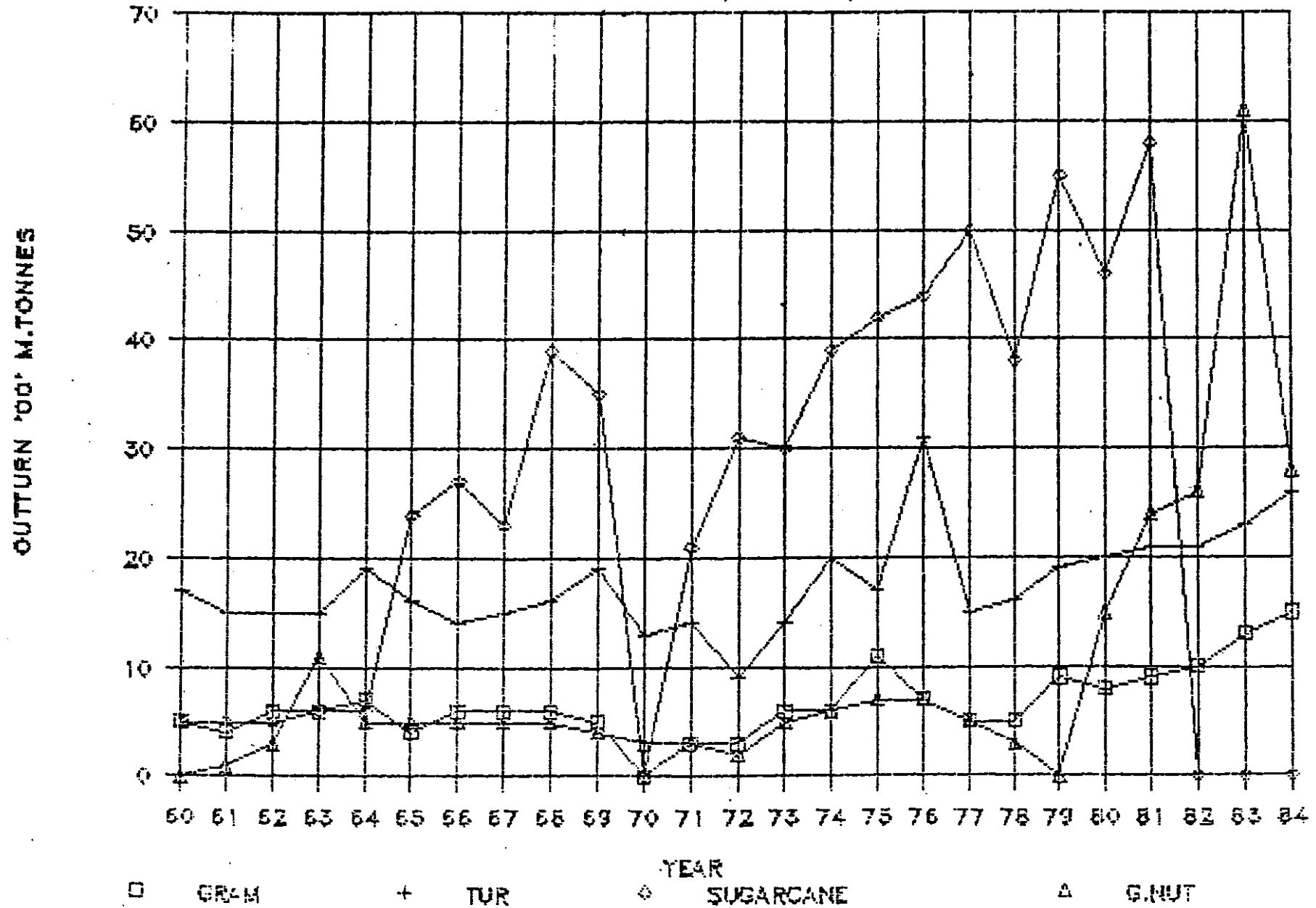


648

NO. 9

PROD. UNDER GRAM, TUR, S' CANE, G' NUT

MAHARASHTRA (KONKAN)

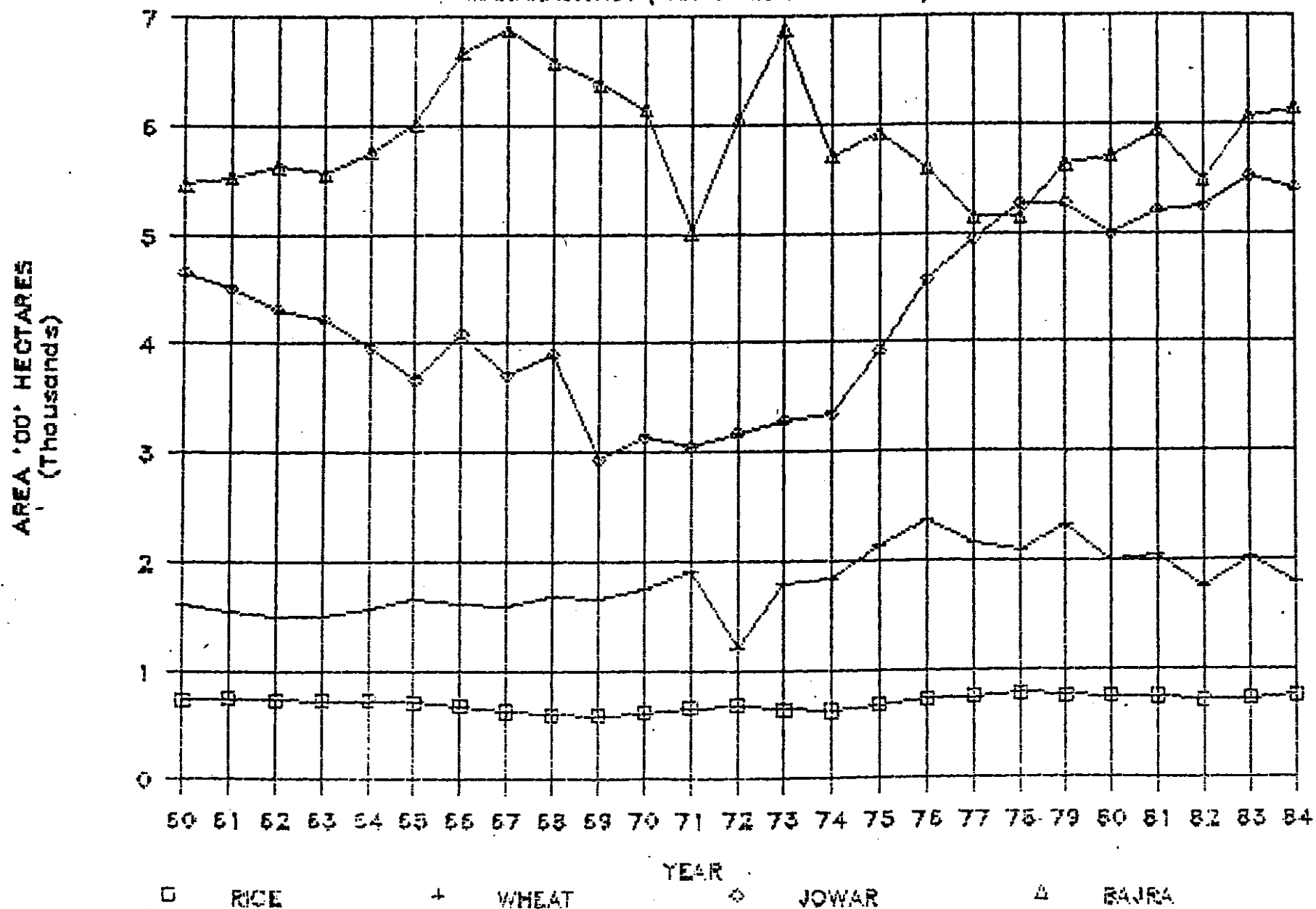


649

NO. 10

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (KHANDESH & NASIK)

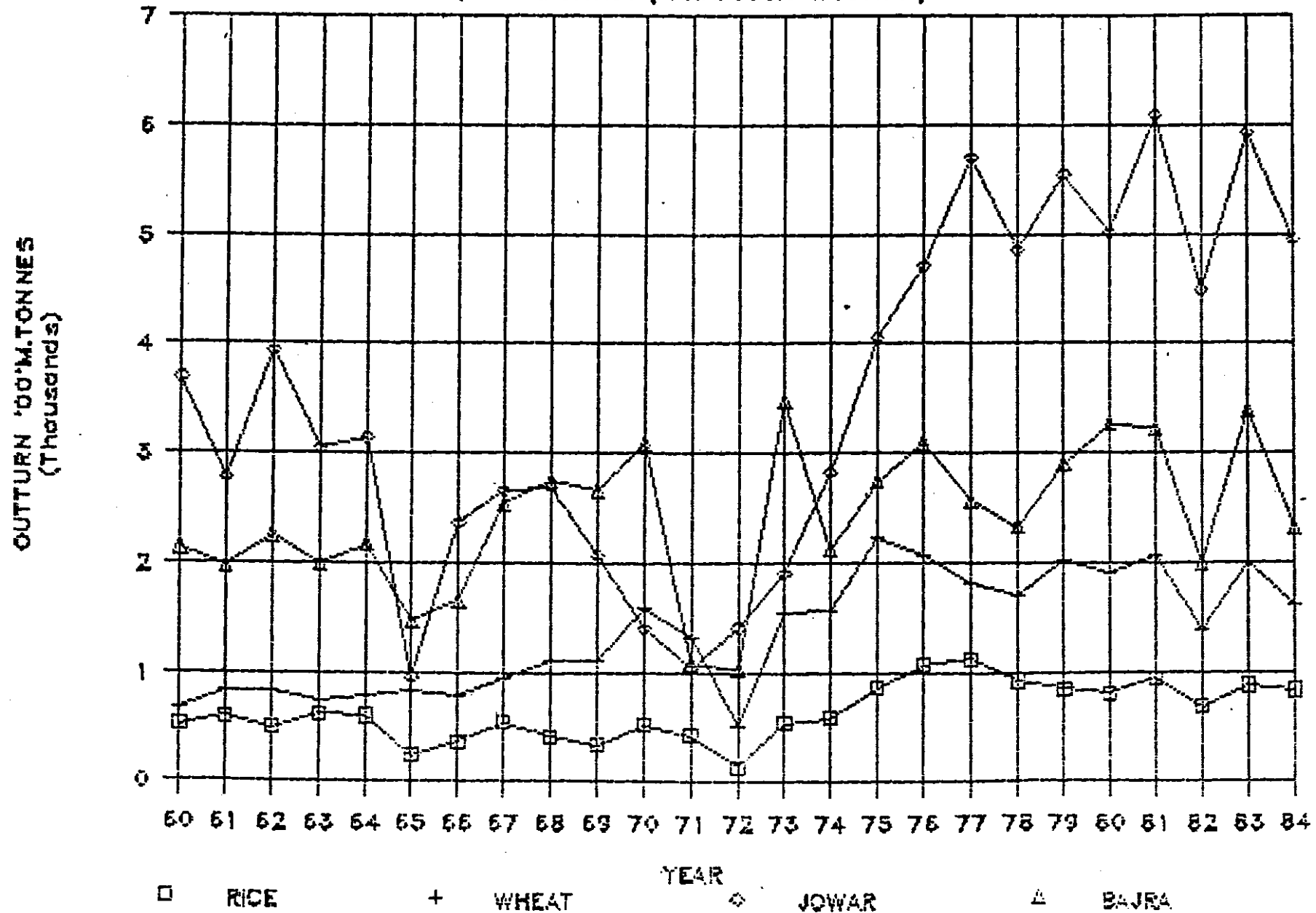


650

NO. 11

PROD. UNDER RICE, WHEAT, JOWER, BAJRA

MAHARASHTRA (KHANDESH & NASIK)

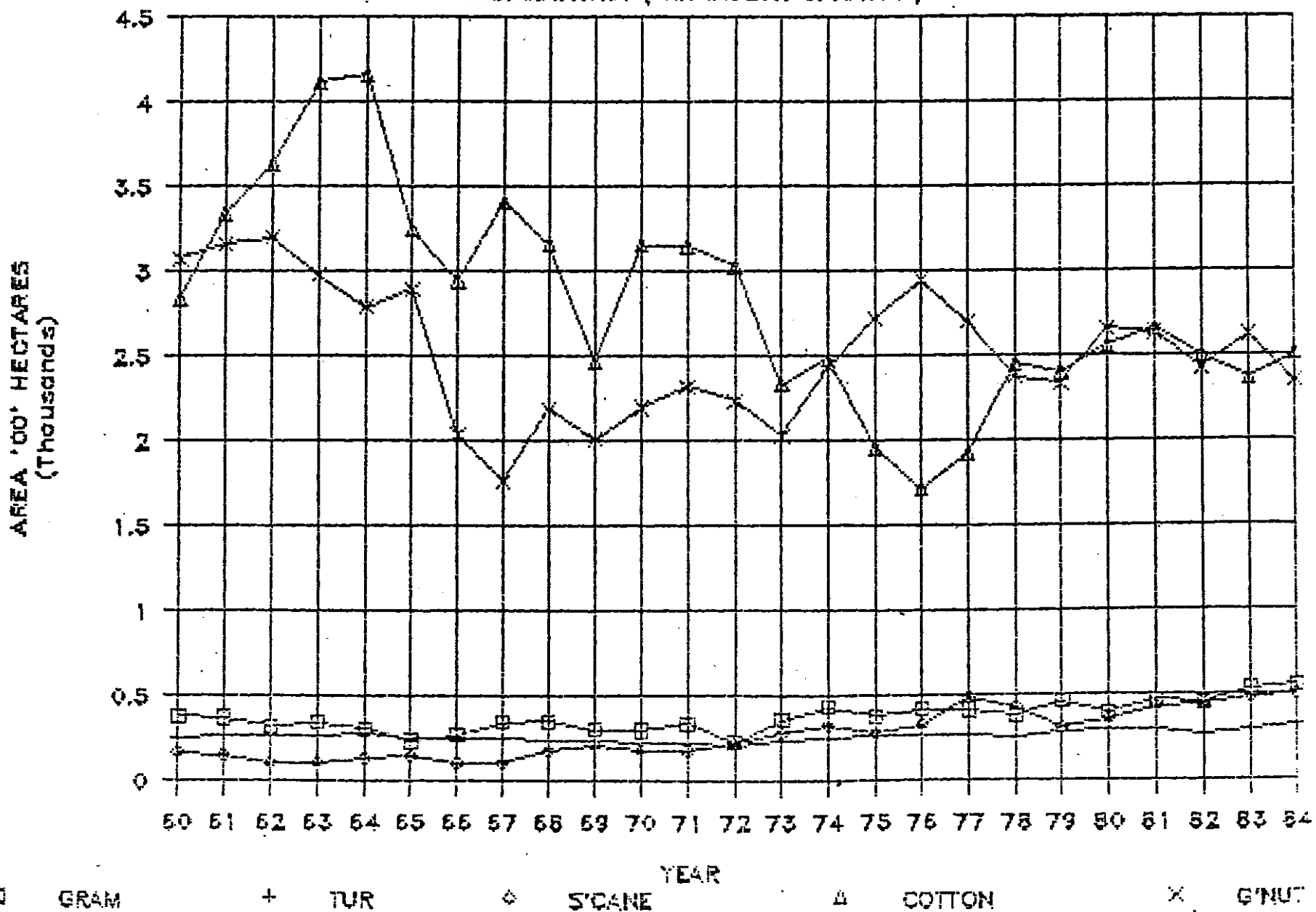


651

NO. 12

AREA UNDER GRAM, TUR, S'CANE, COTTON, G'NUT

MAHARASHTRA (KHANDESH & NASIK)

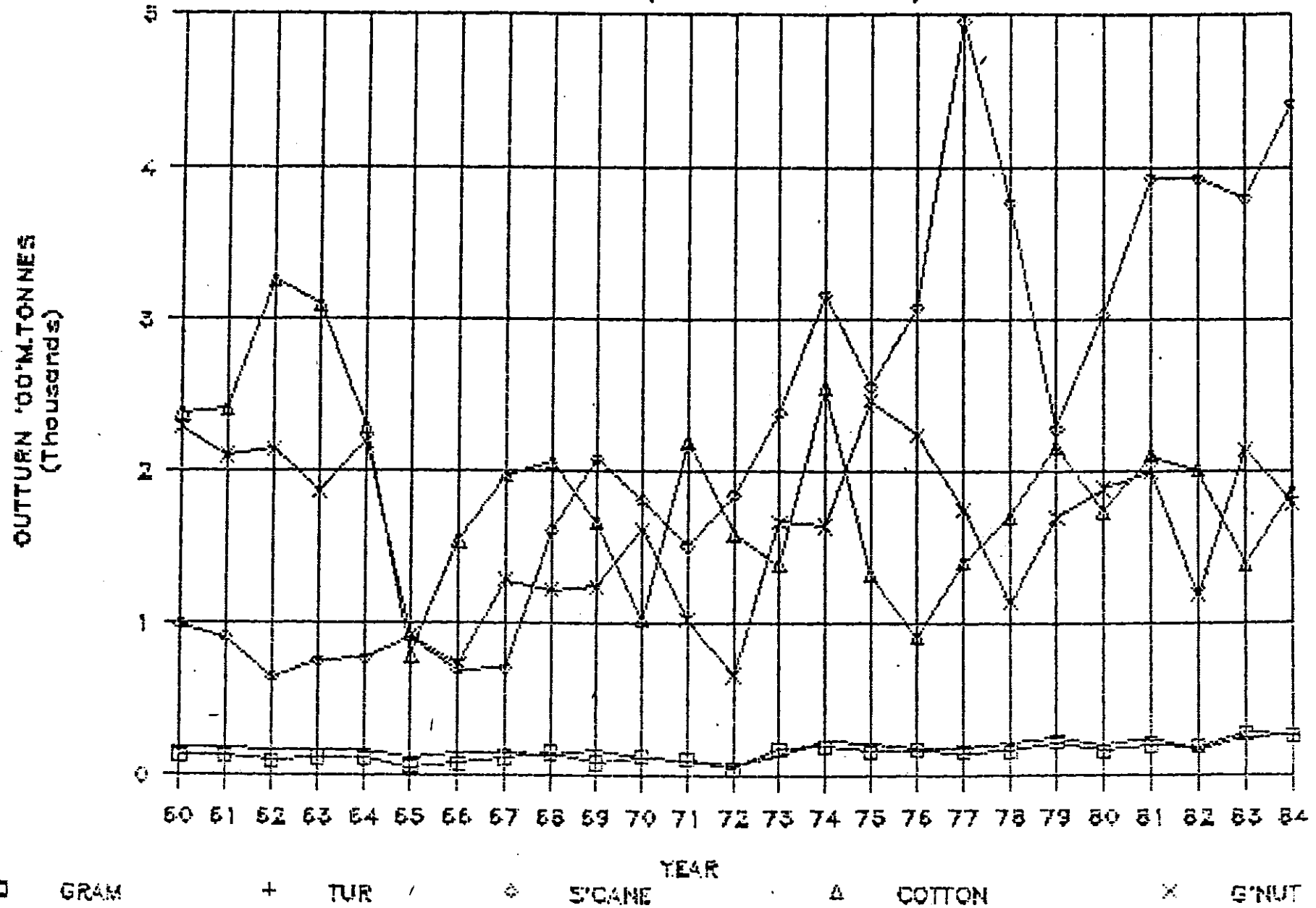


652

NO.13

PROD. UNDER GRAM, TUR, S'CANE, COTTON, G'NUT

MAHARASHTRA (KHANDESH & NASIK)

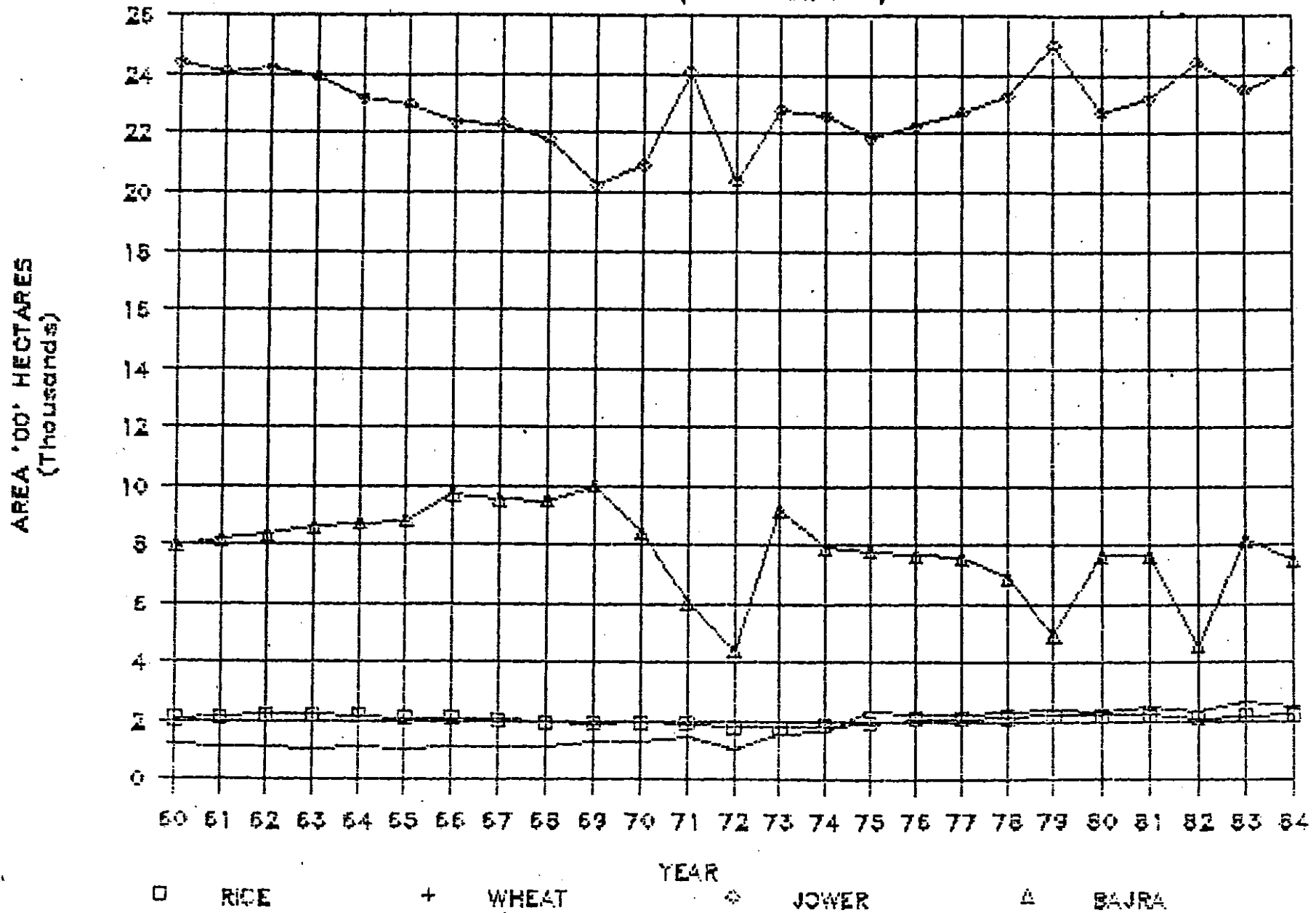


653

NO. 14

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (W. MAHARASHTRA)

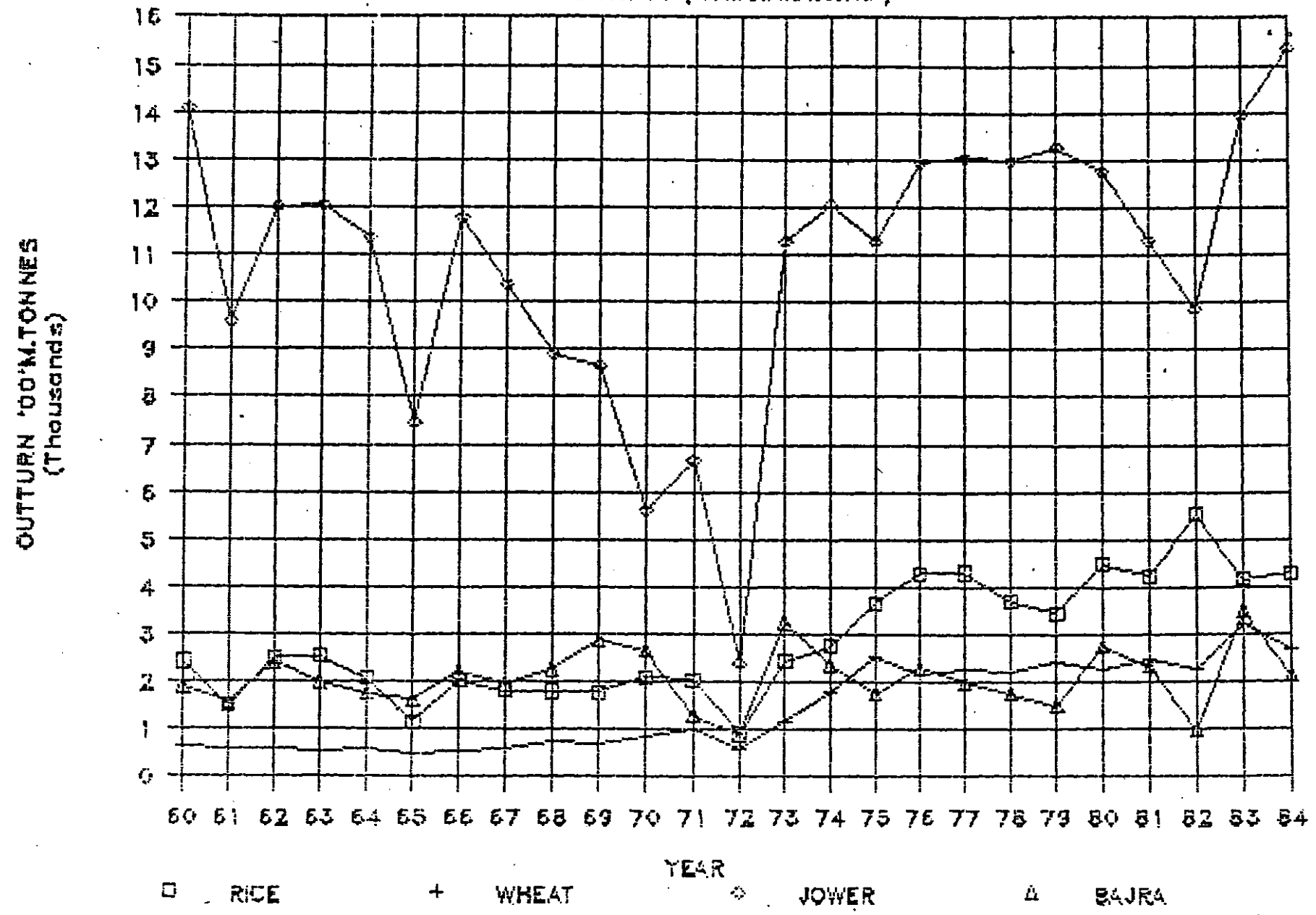


654

NO. 15

PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (W. MAHARASHTRA)



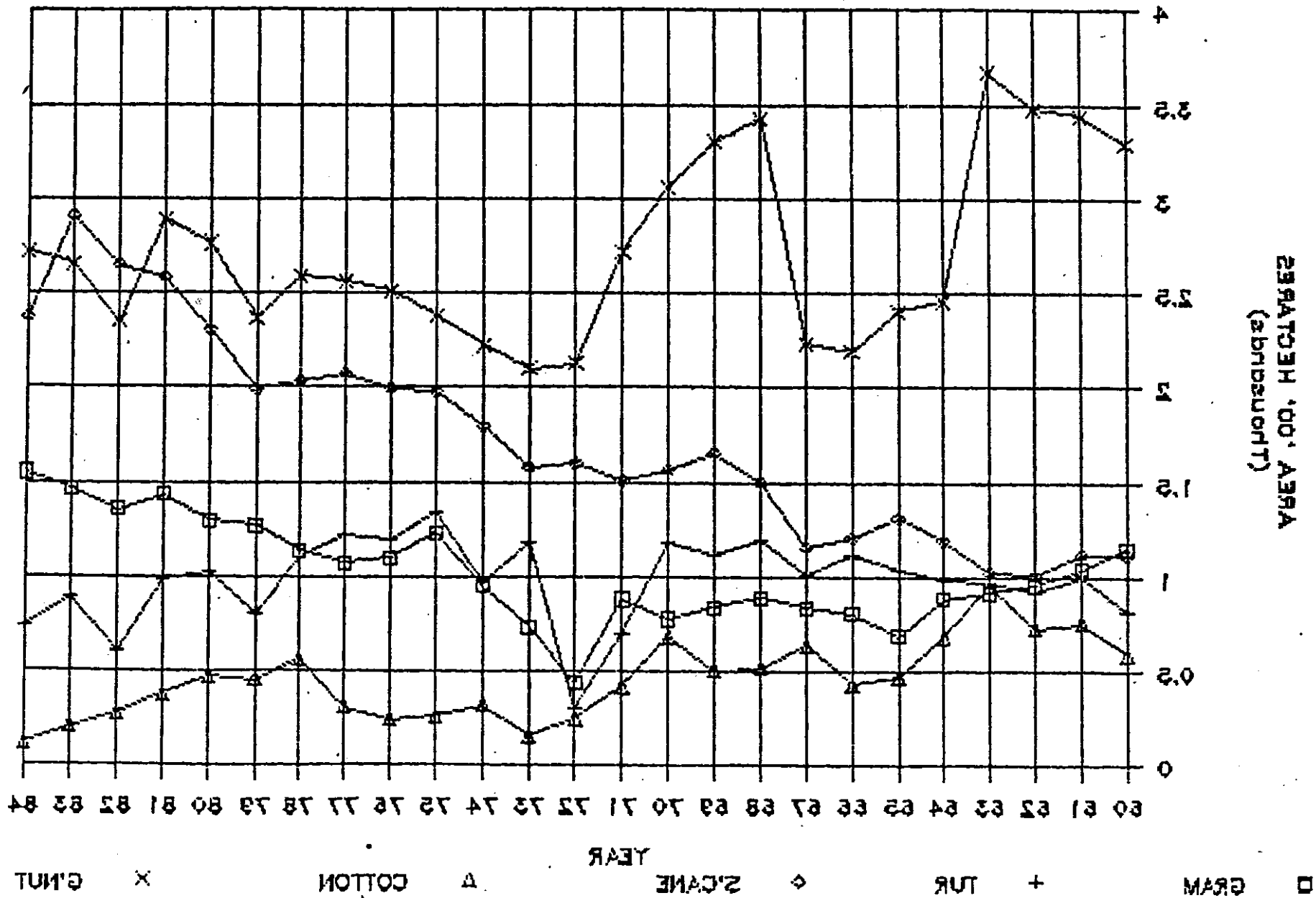
655

NO. 16

AREA UNDER GRAM, TUR, S. CANE, COTTON, G. INT

(MAHARASHTRA) (म.प्र.)

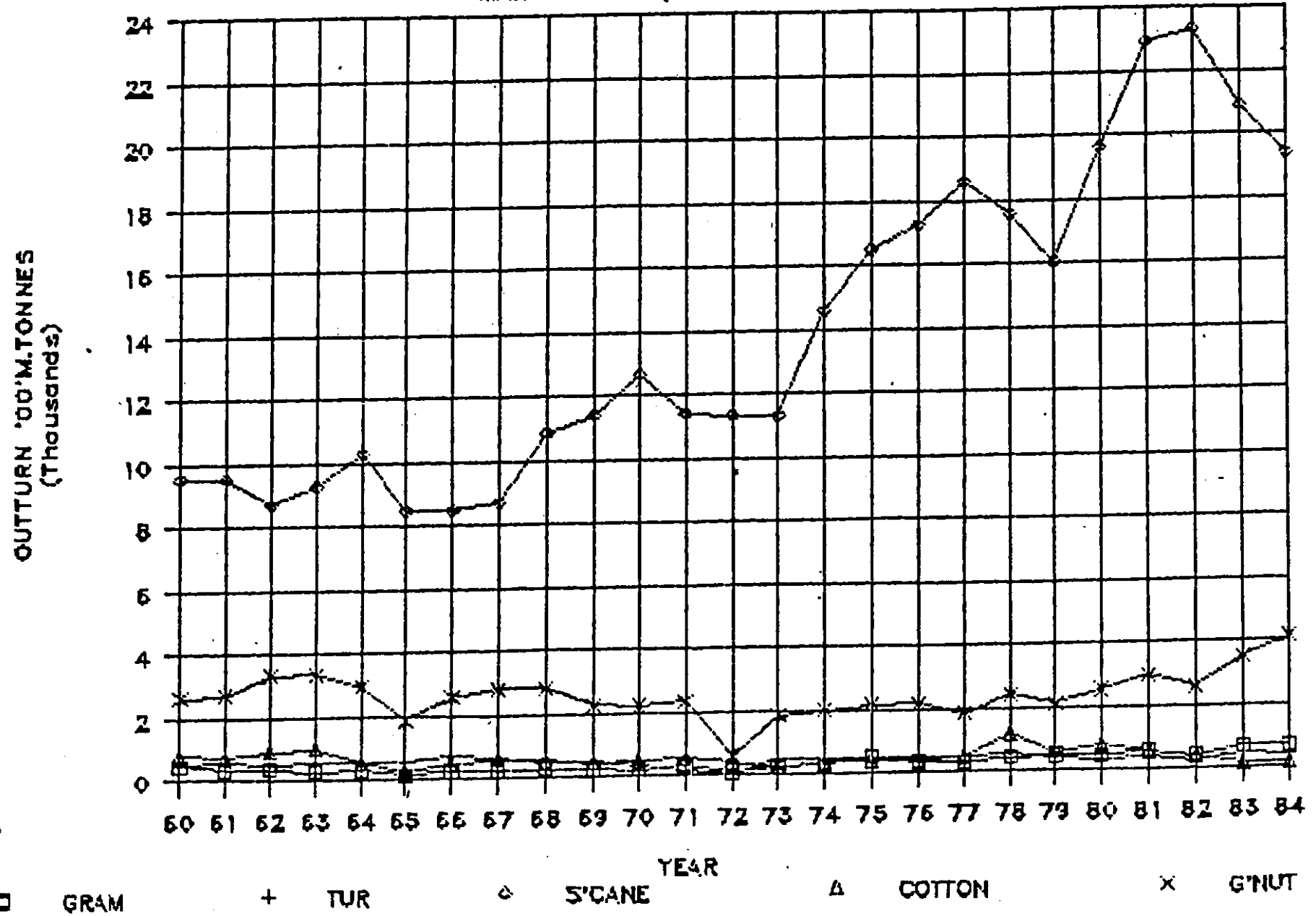
10-11



298475811 '00' AREA (0000HECTARE)

PROD. UNDER GRAM, TUR, S'CANE, COTTON, G'NUT

MAHARASHTRA (W. MAHARASHTRA)



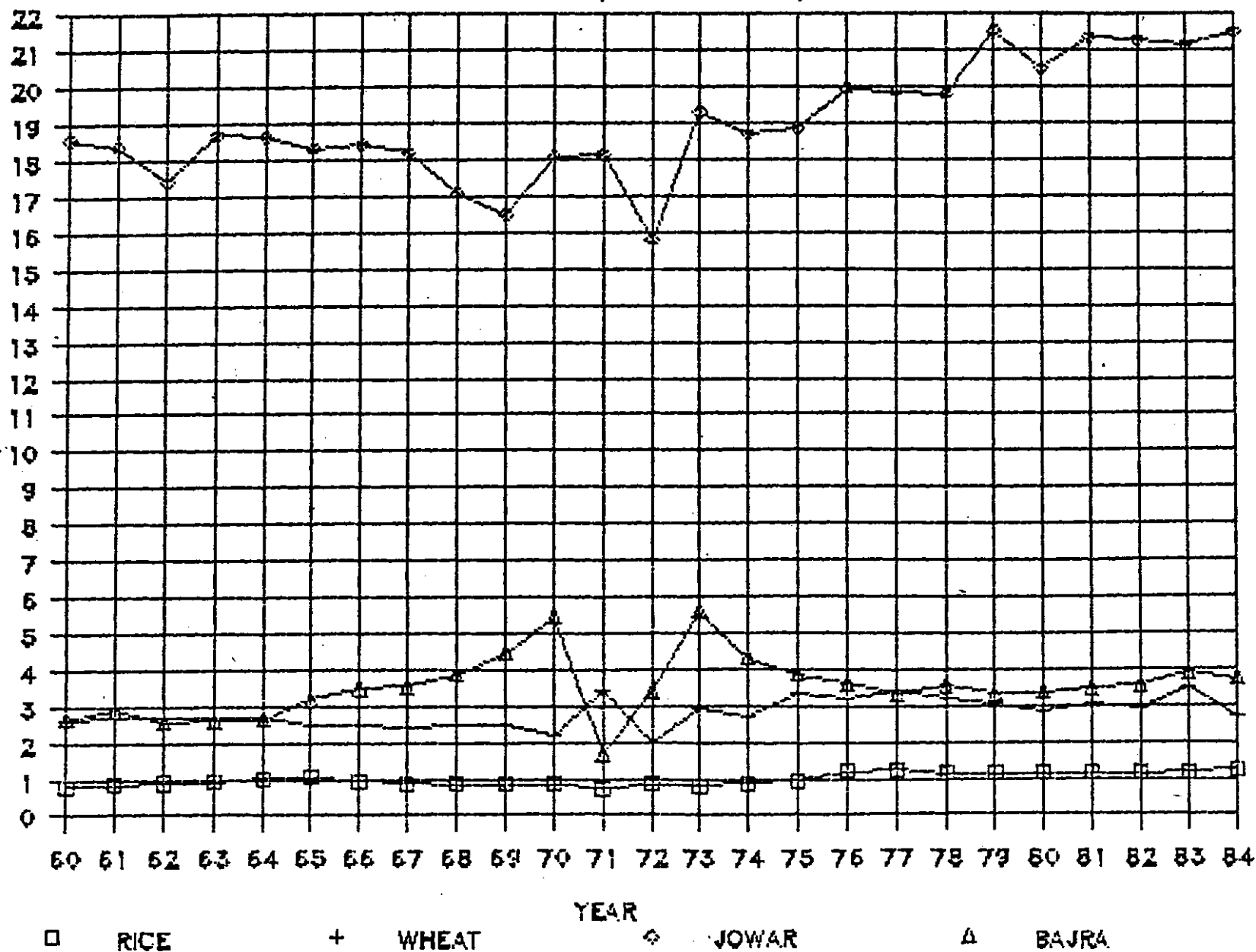
657

No. 18

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (MARATHWADA)

AREA '00' HECTARES
(Thousands)

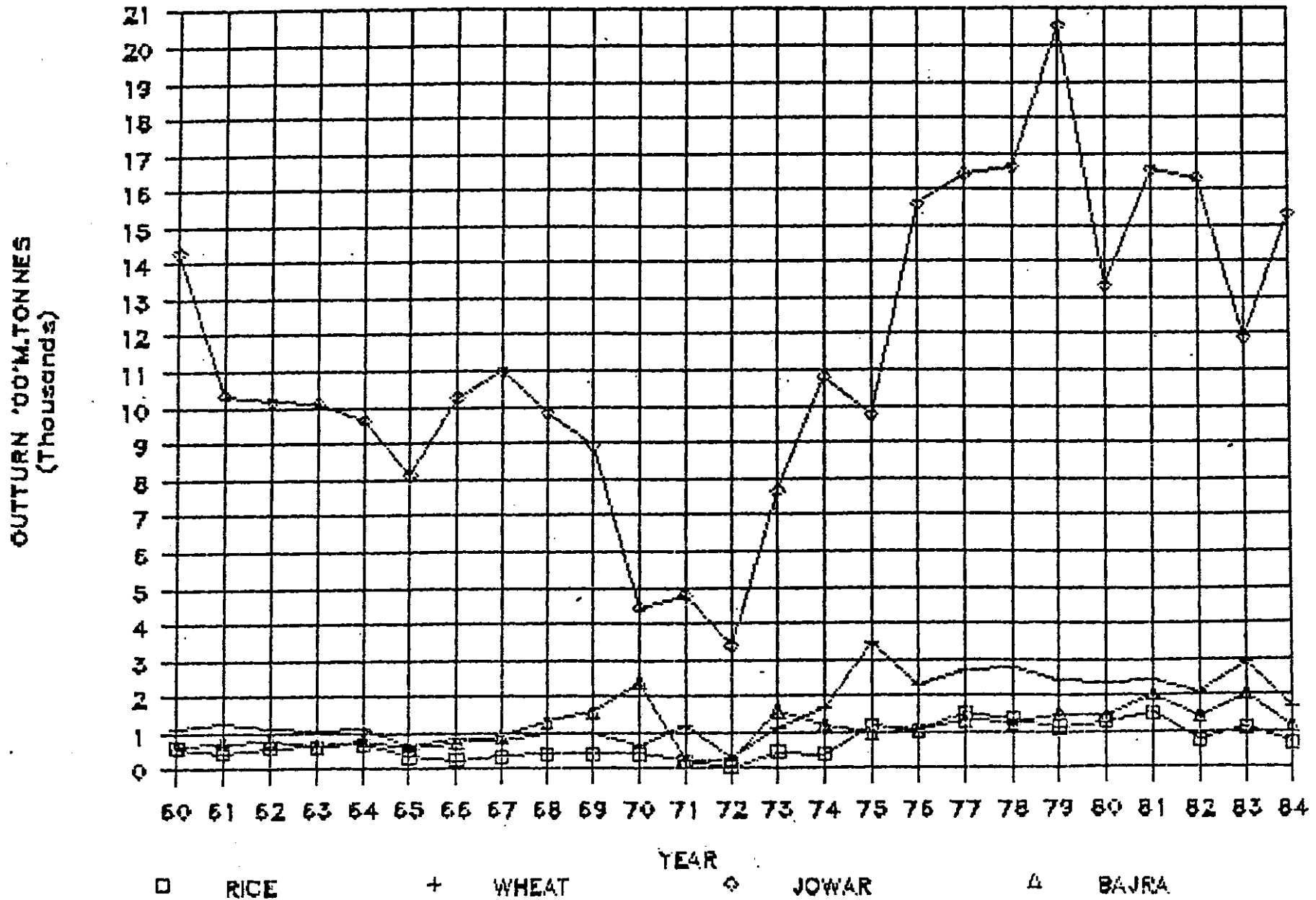


658

NO.19

PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (MARATHWADA)

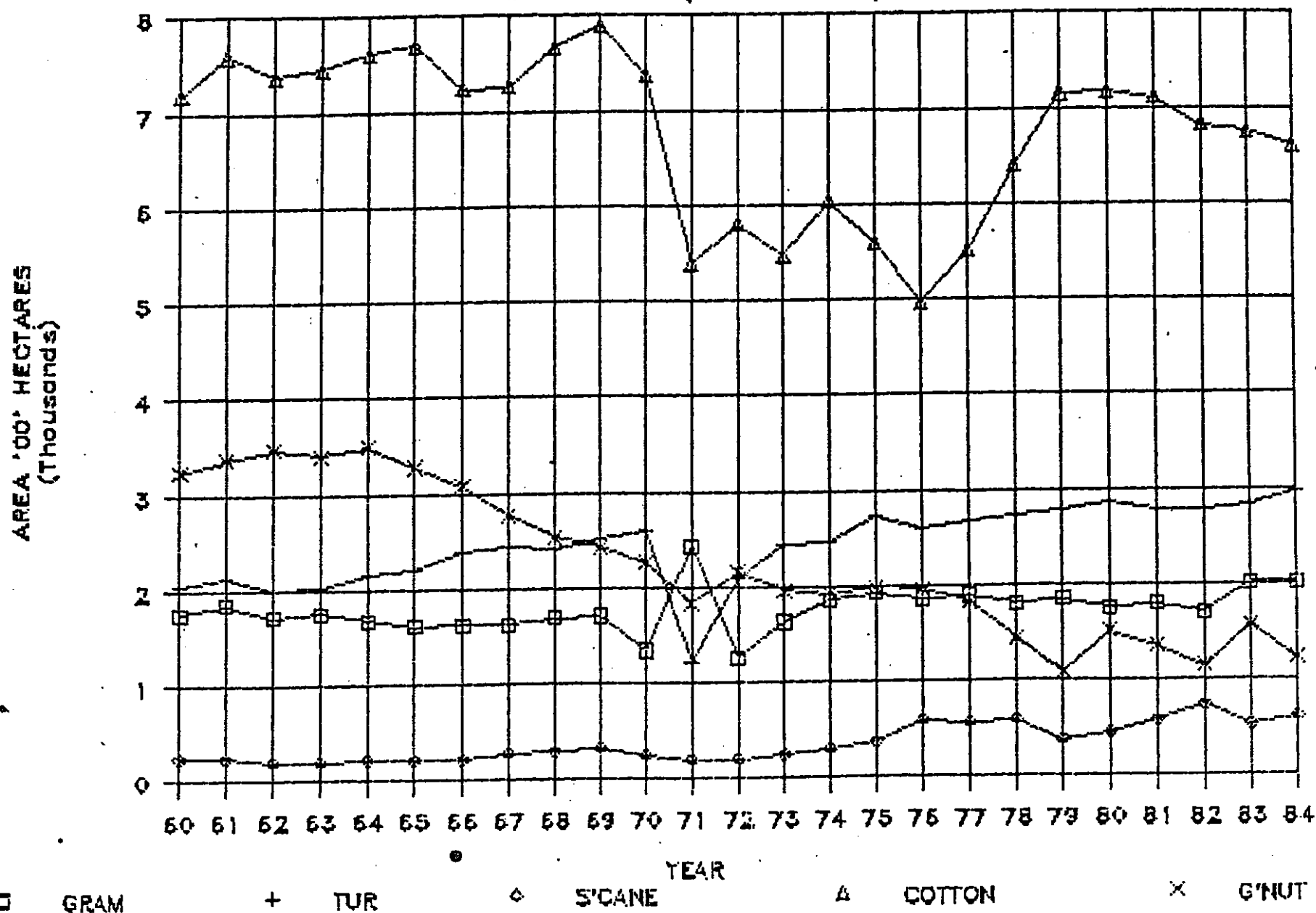


659

No.20

AREA UNDER GRAM, TUR, S'CANE, COTTON, G'NUT

MAHARASHTRA (MARATHWADA)

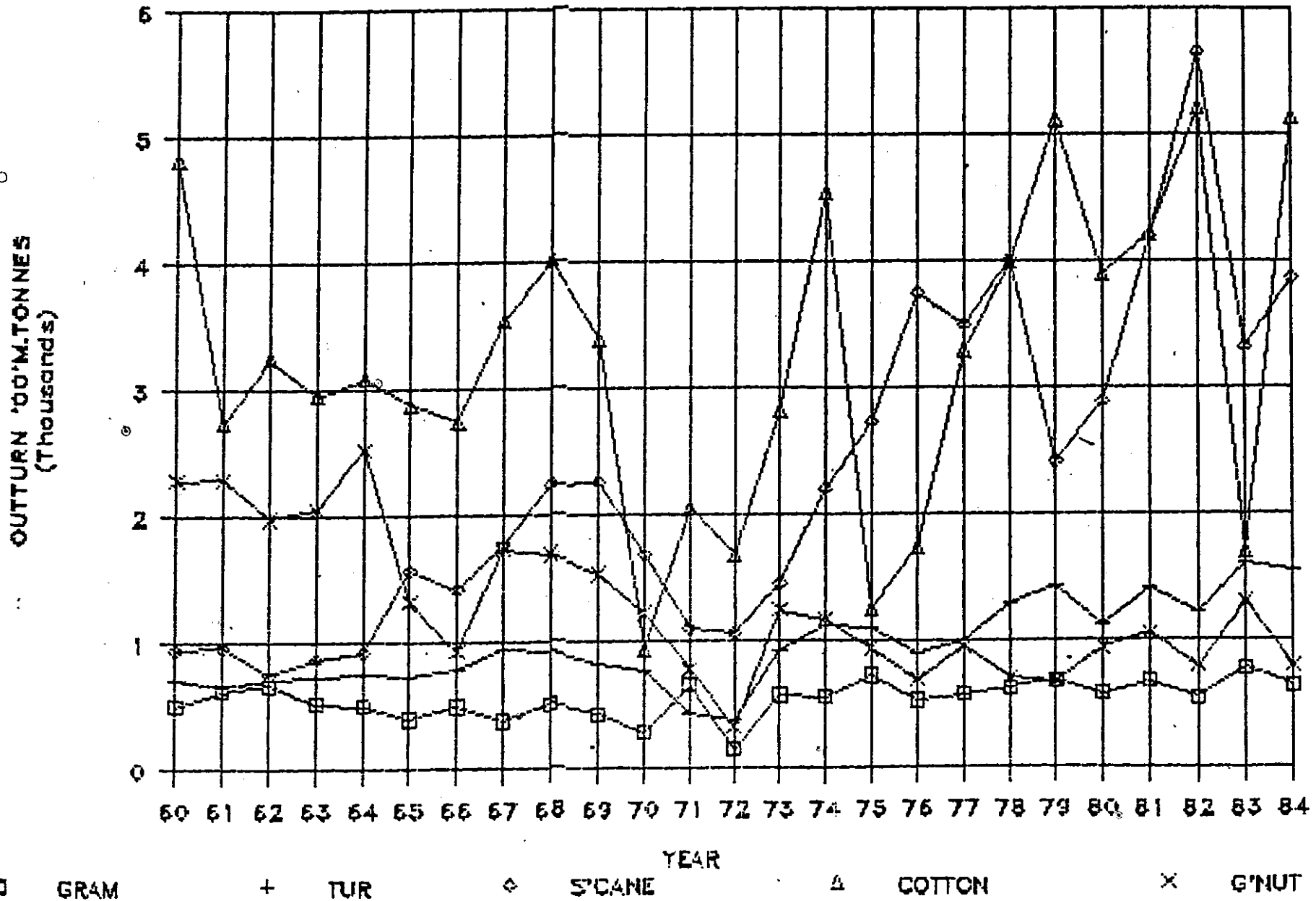


660

NO.21

PROD. UNDER GRAM, TUR, S' CANE, COTTON, G' NUT

MAHARASHTRA (MARATHWADA)

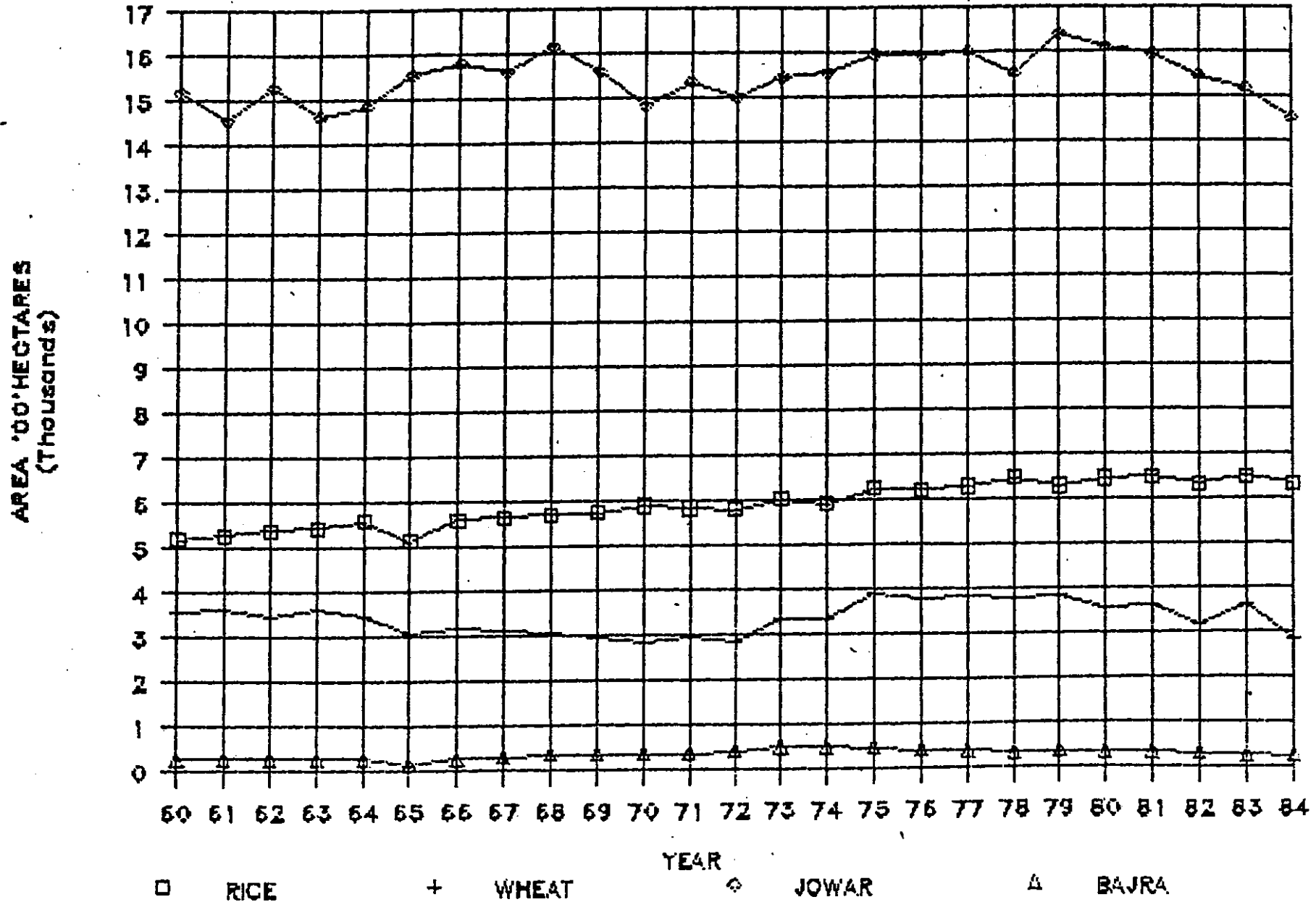


661

No. 22

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (VIDARBHA)

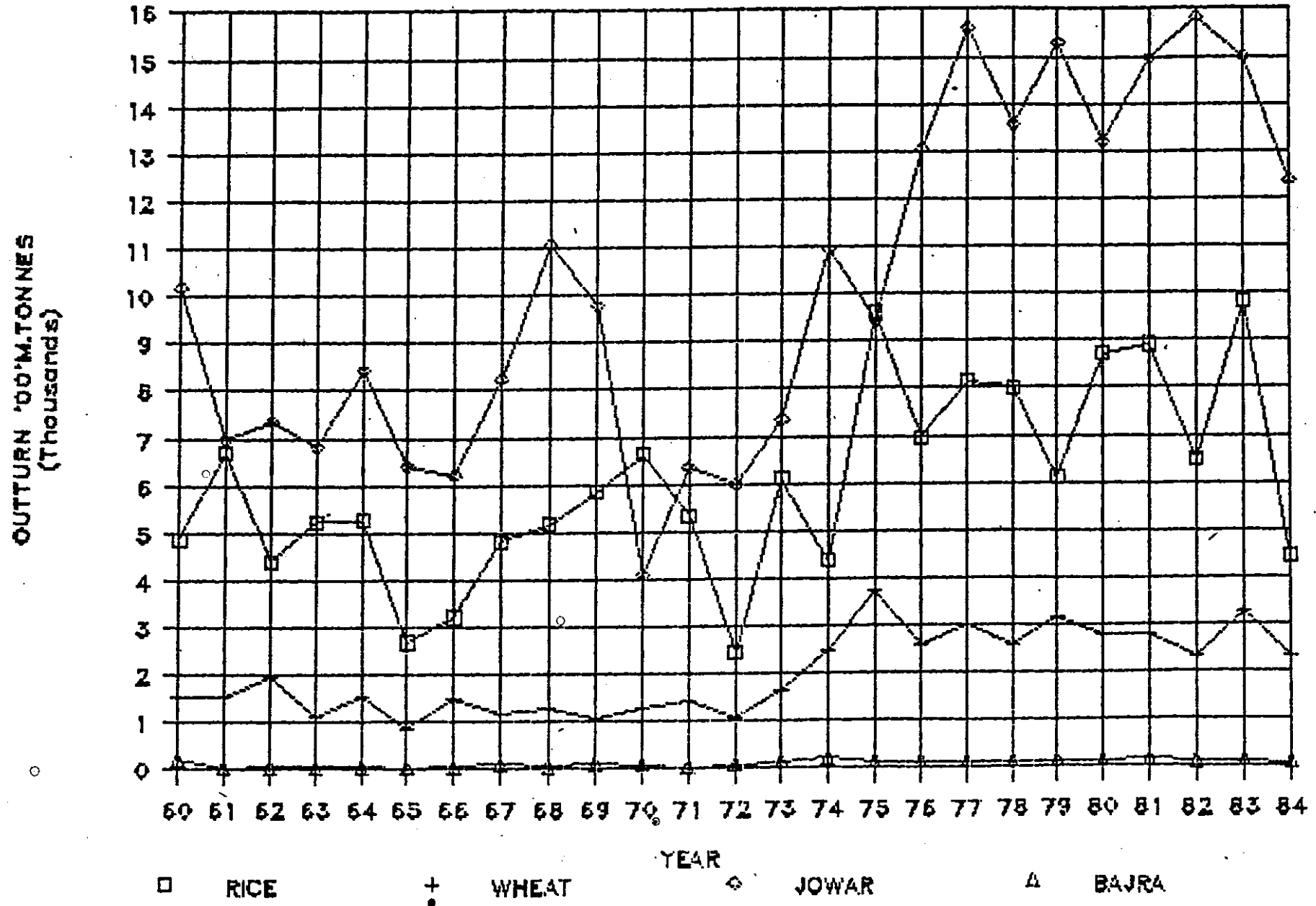


662

No. 23

PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

MAHARASHTRA (VIDARBHA)

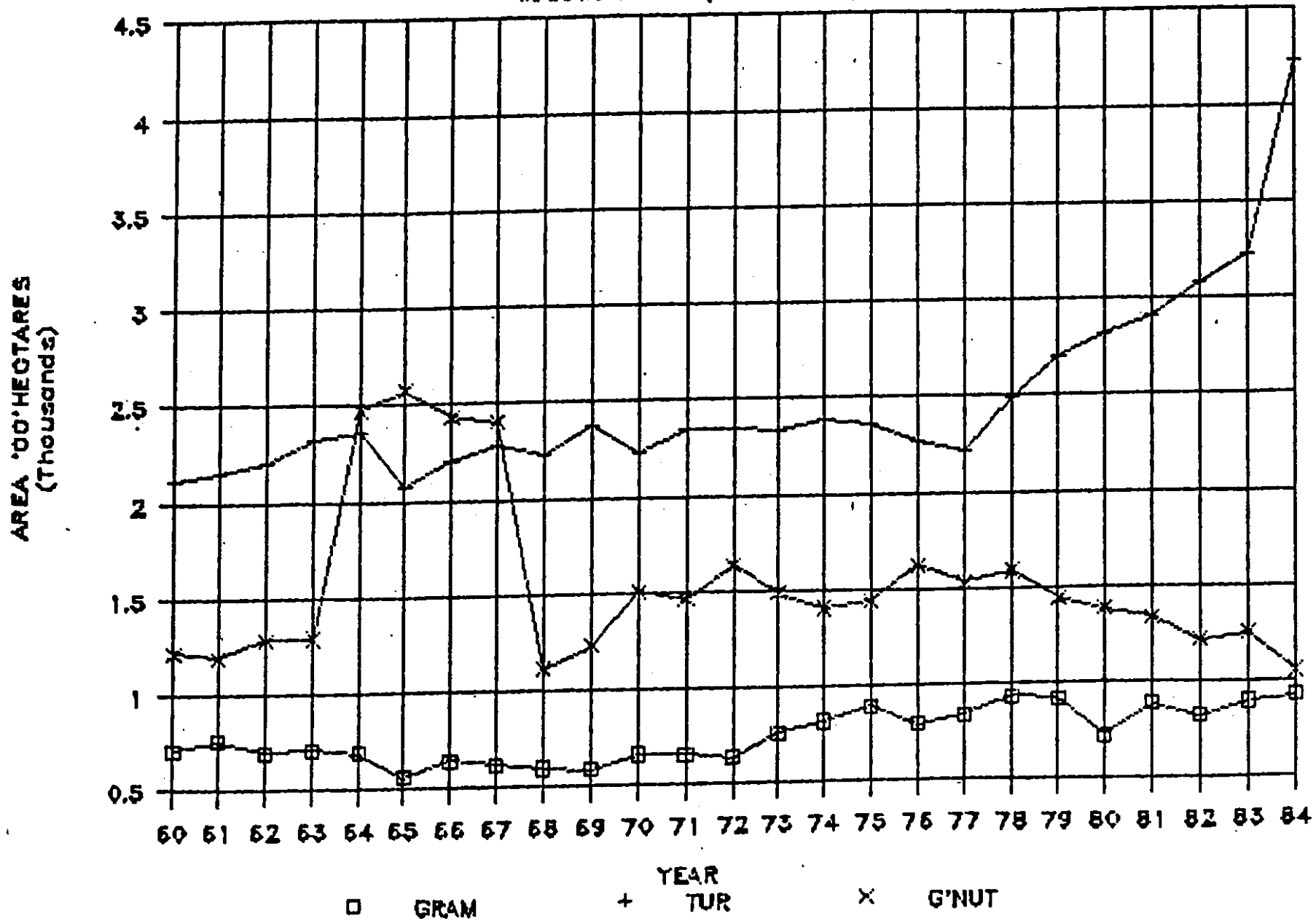


663

NO. 24

AREA UNDER GRAM, TUR, G'NUT

MAHARASHTRA (VIDARBHA)

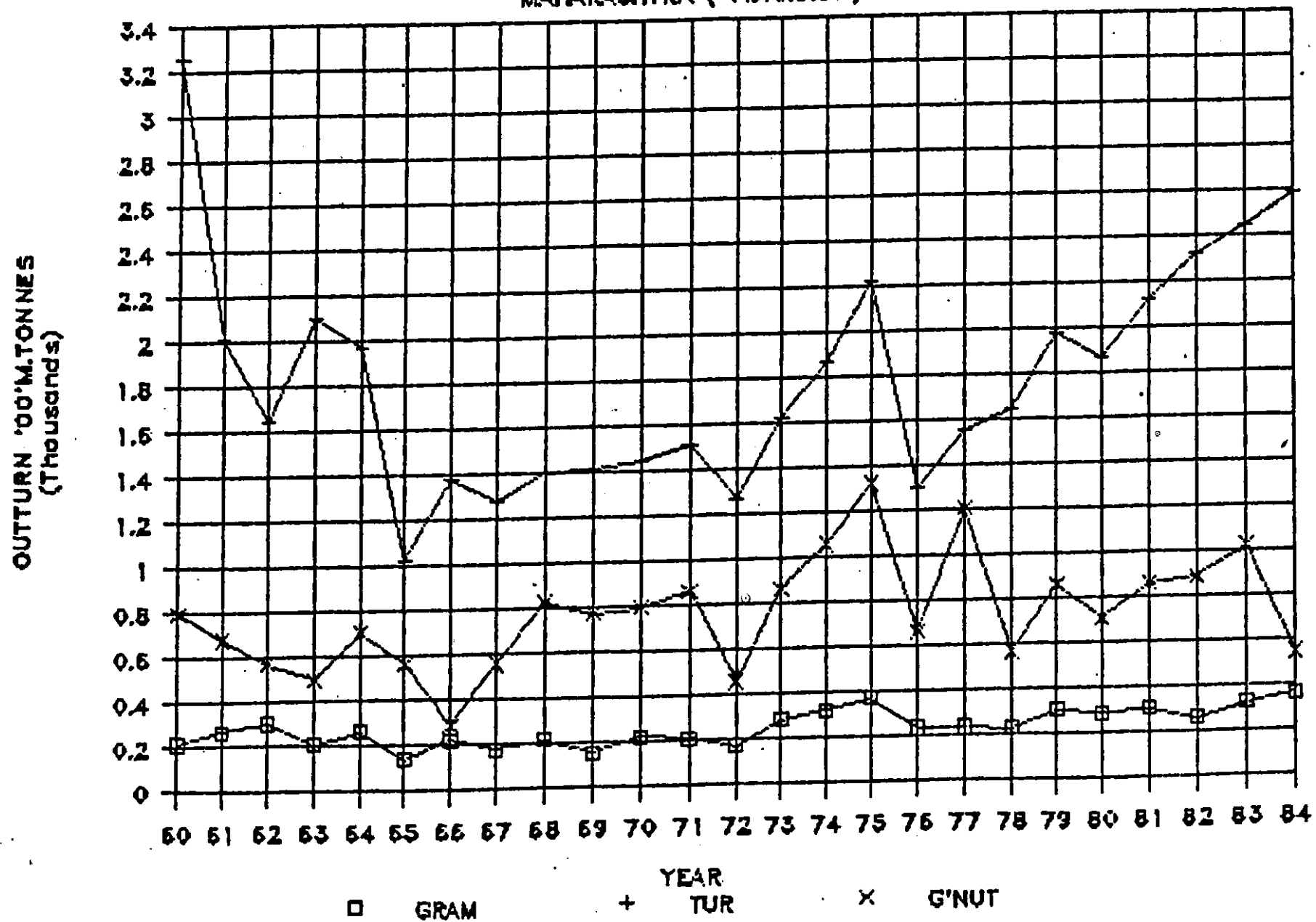


664

NO.25

PROD. UNDER GRAM, TUR, G'NUT

MAHARASHTRA (VIDARBHA)

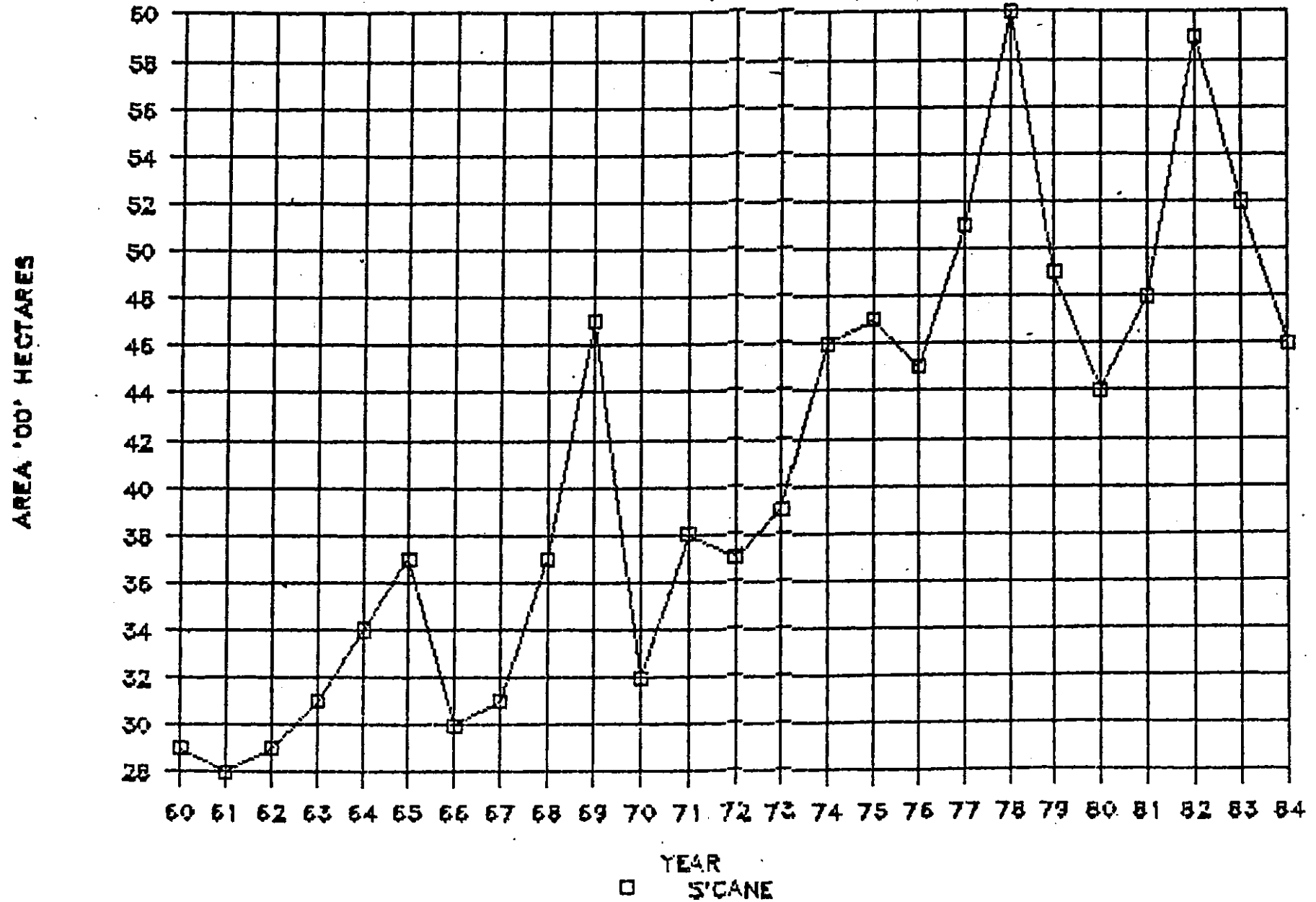


665

NO.26

AREA UNDER SUGARCANE

MAHARASHTRA (VIDARBHA)

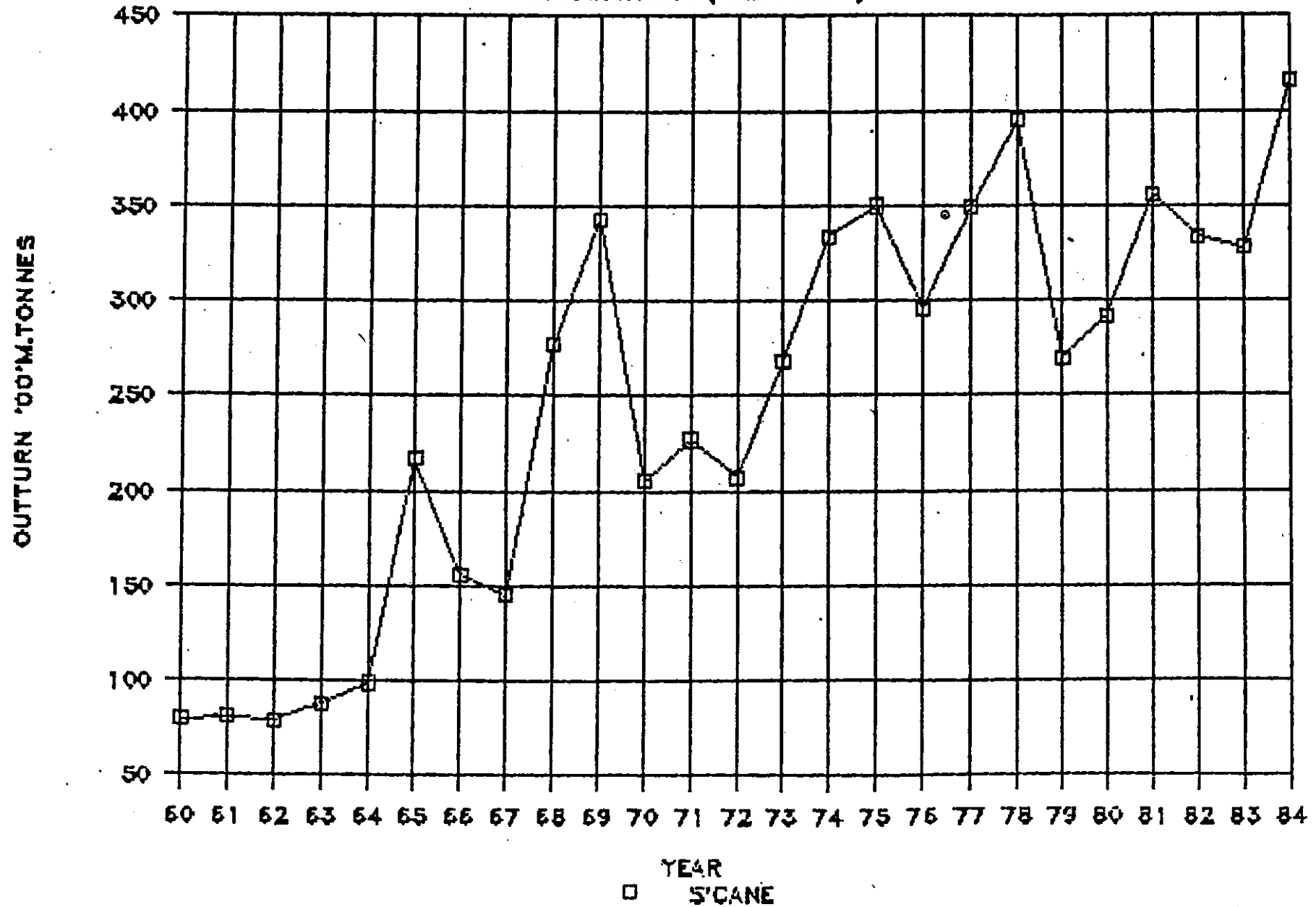


999

NO.27

PROD. UNDER SUGARCANE

MAHARASHTRA (VIDARBHA)

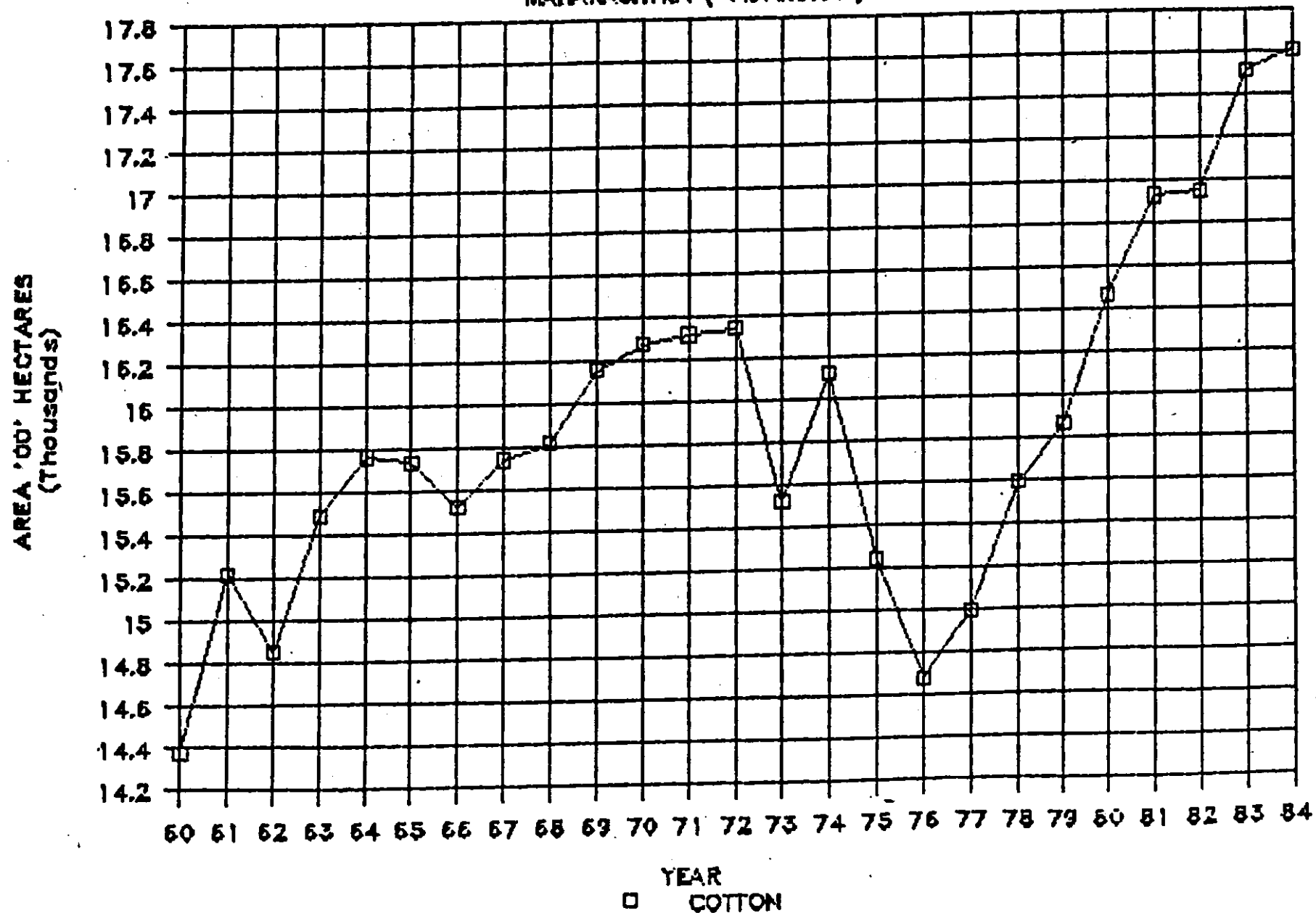


667

NO. 28

AREA UNDER COTTON

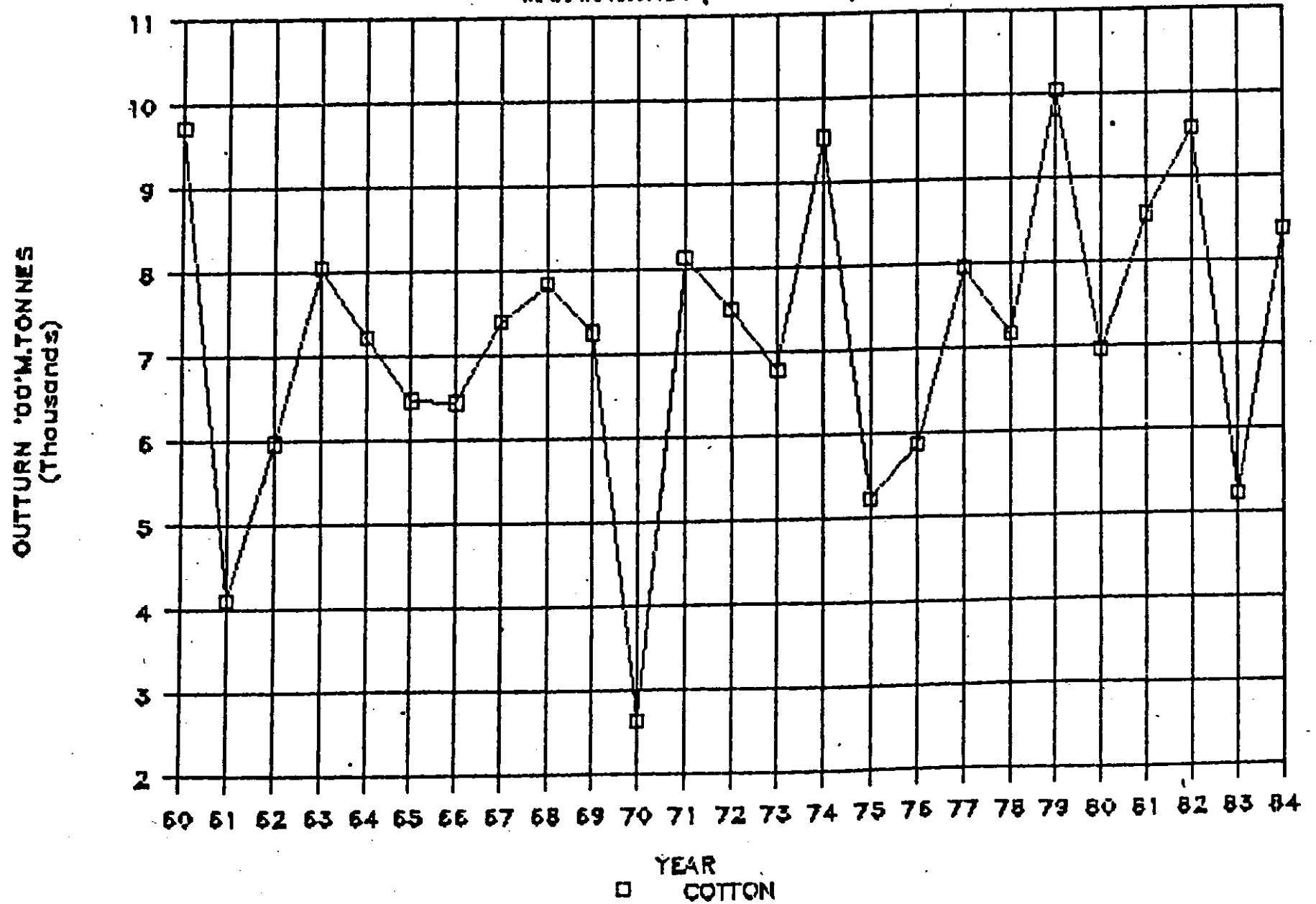
MAHARASHTRA (VIDARBHA)



No. 29

PROD.UNDER COTTON

MAHARASHTRA (VIDARBHA)

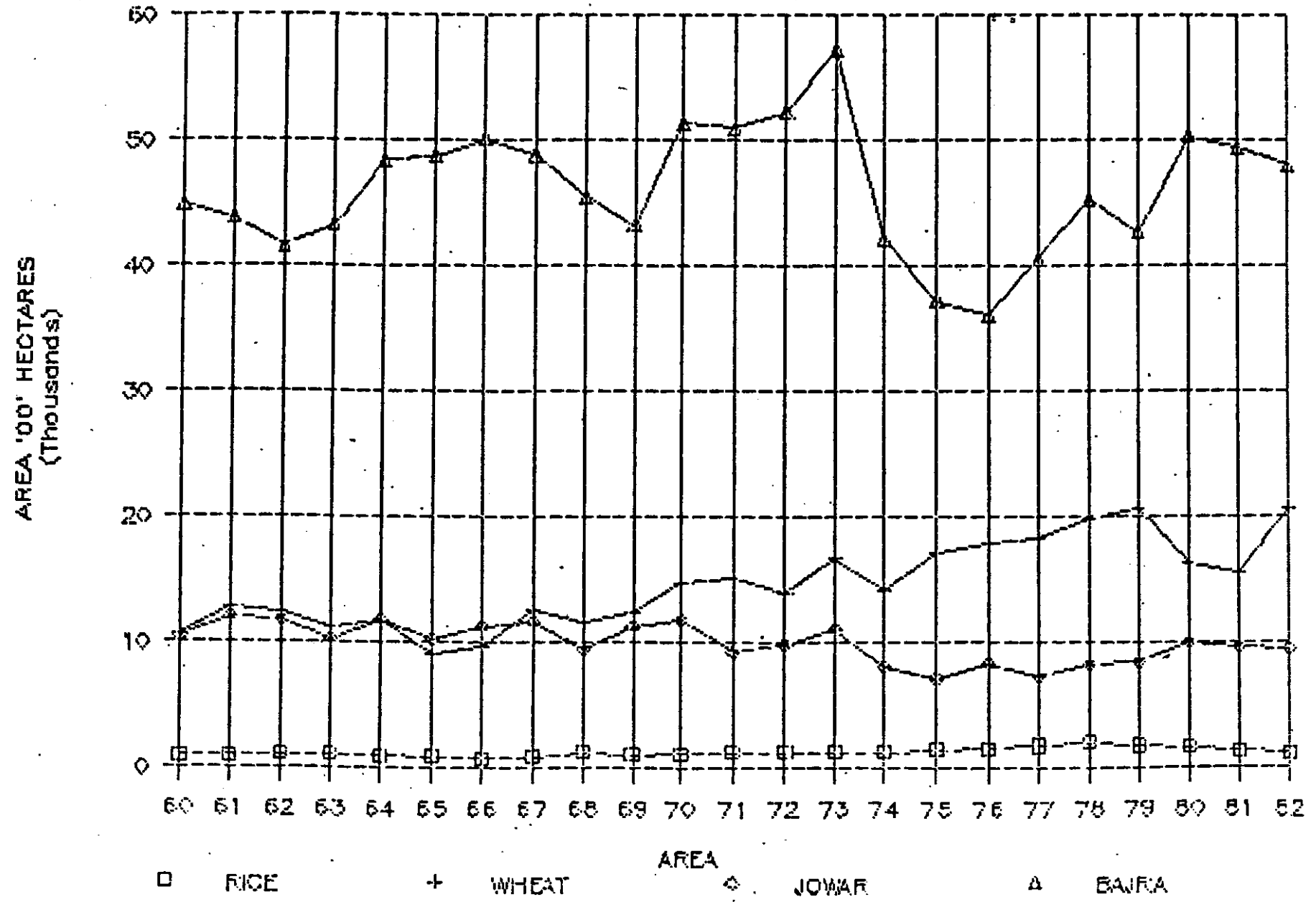


699

NO. 50

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

RAJASTHAN STATE

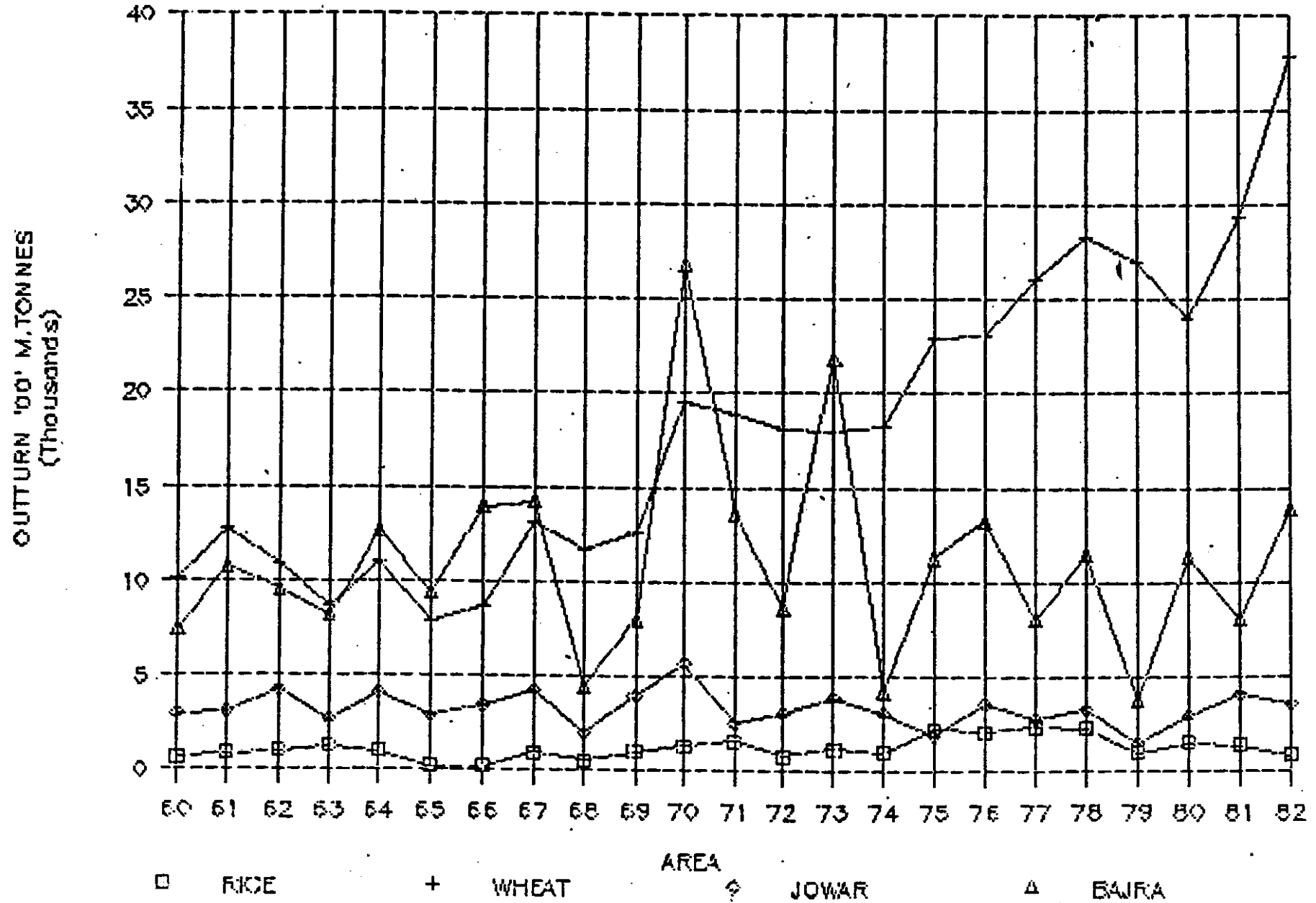


670

NO. 51

PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

RAJASTHAN STATE

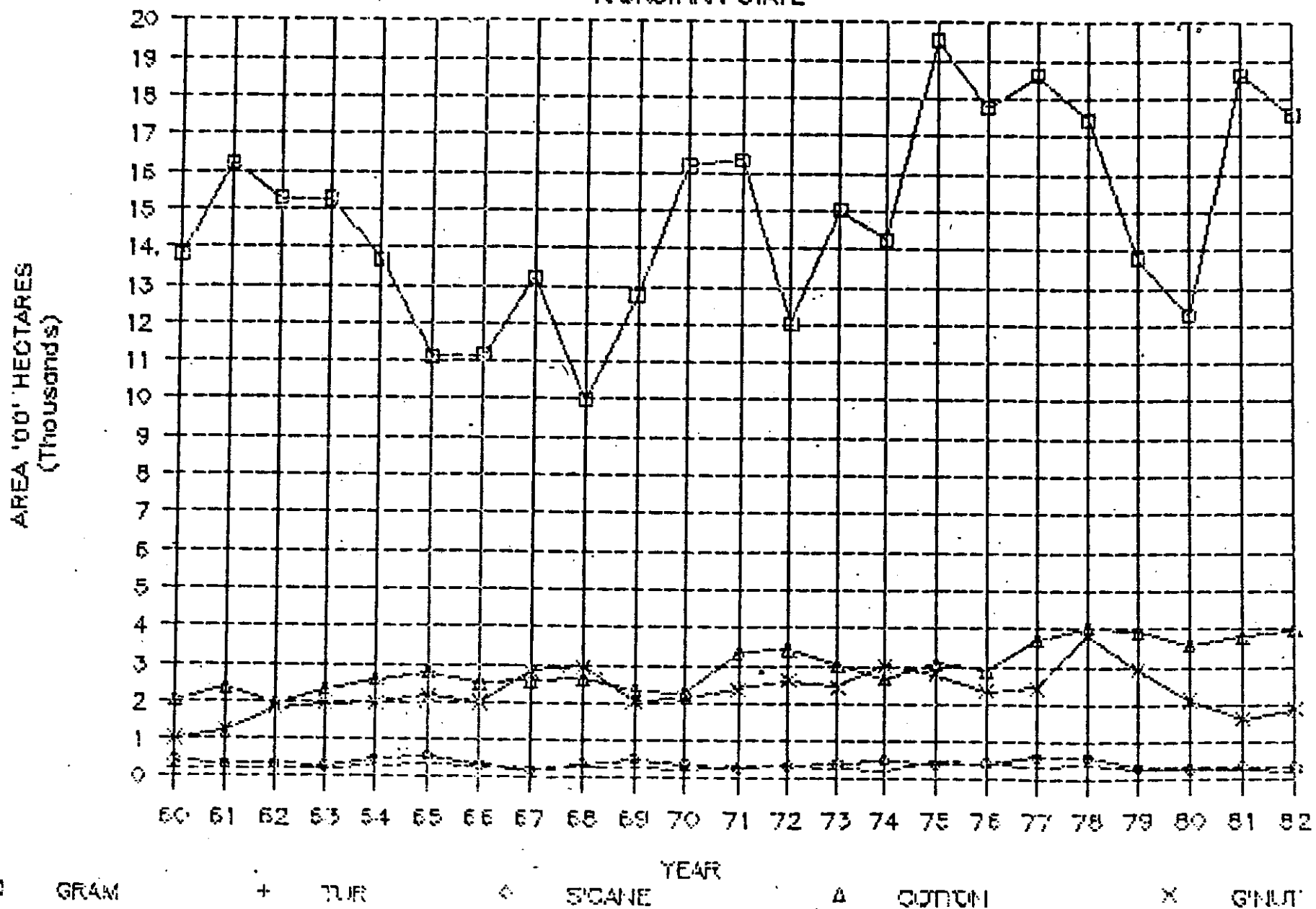


671

NO. 32.

AREA UNDER GRAM, TUR, S' CANE, COTTON, G'NUT

RAJASTHAN STATE

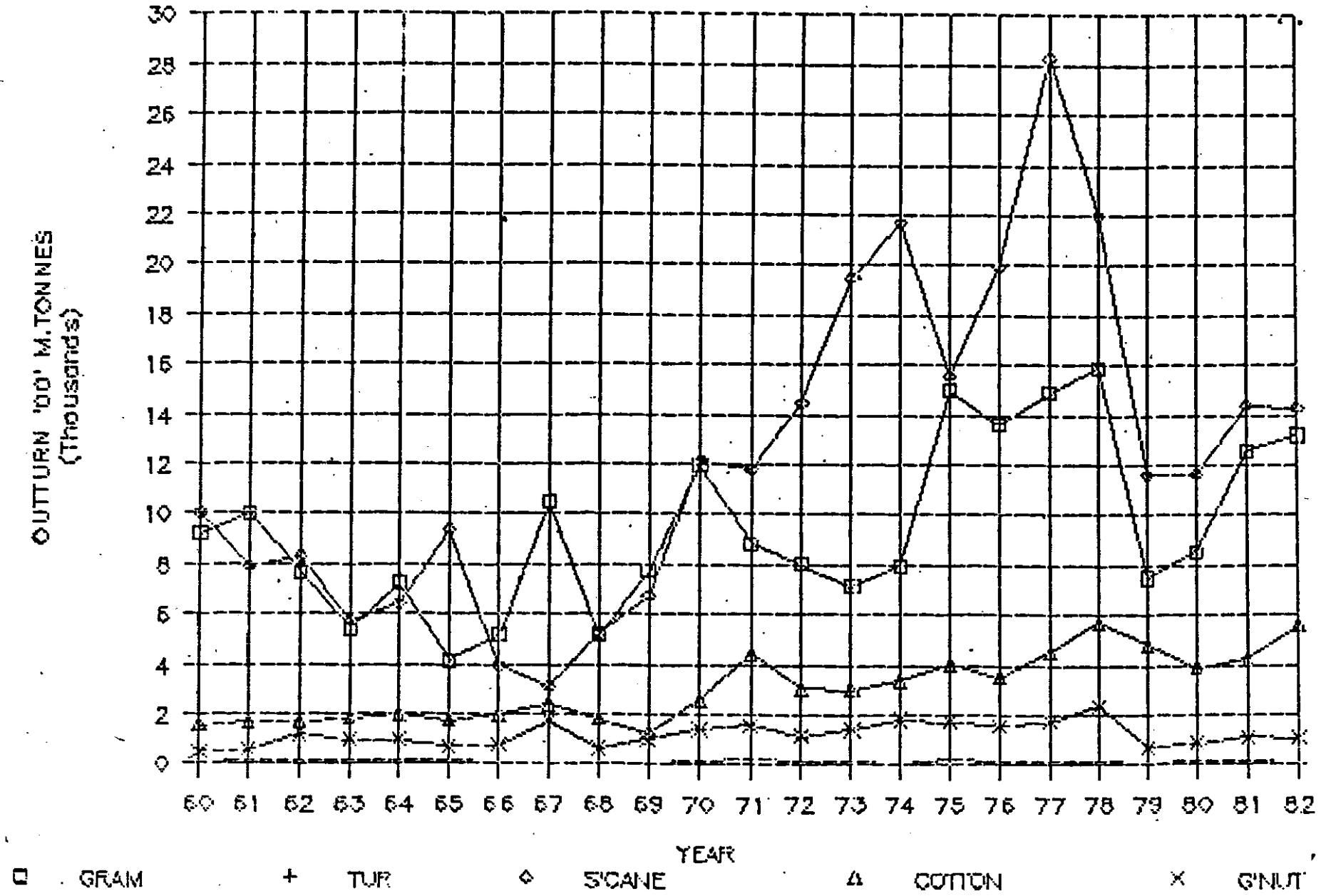


672

NO. 55

PROD. UNDER GRAM, TUR, S'CAINE, COTTON, G'NUT

RAJASTHAN STATE

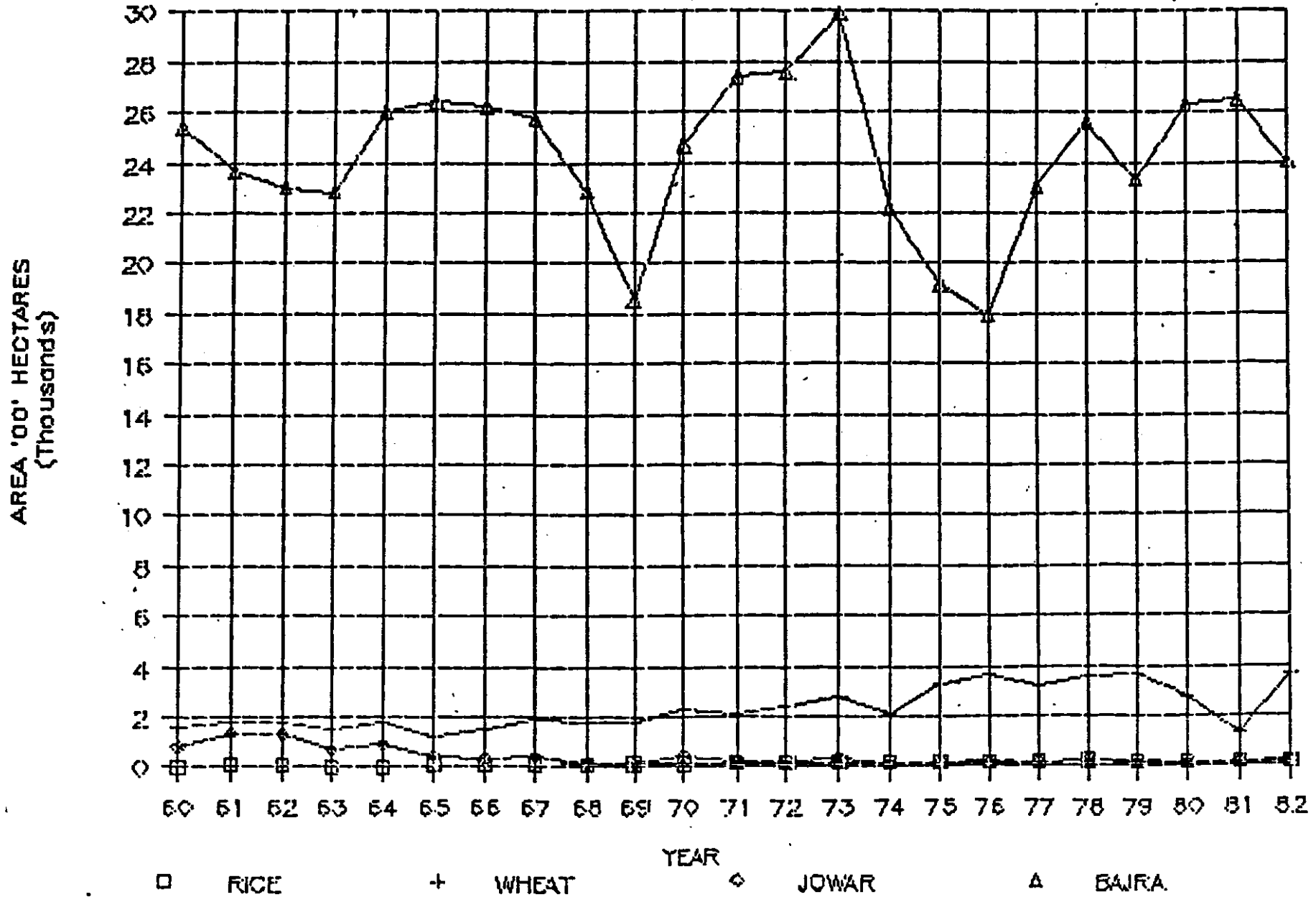


673

No. 54

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

RAJASTHAN (REGION : DESERT)

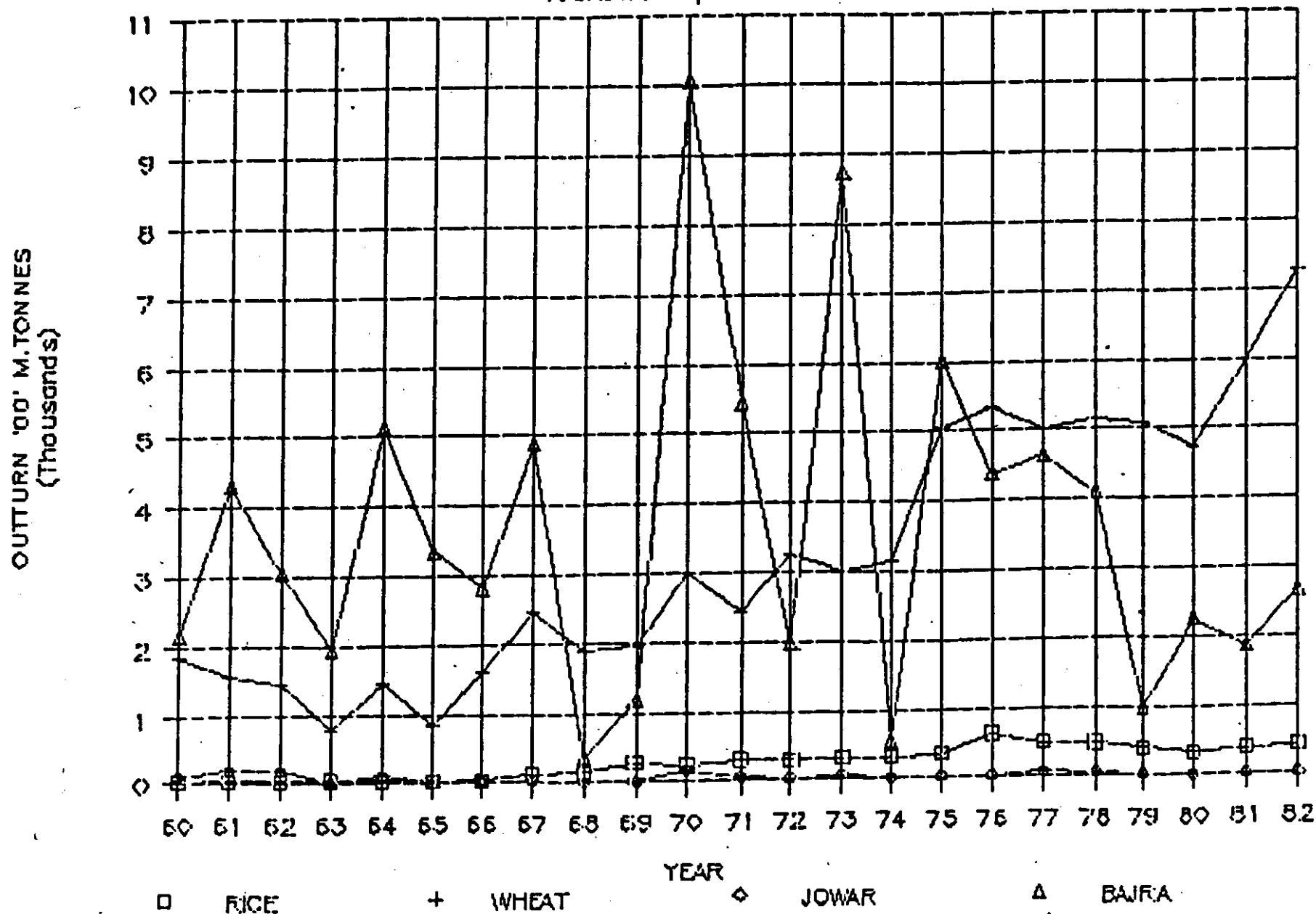


674

No. 35

PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

RAJASTHAN (REGION : DESERT)



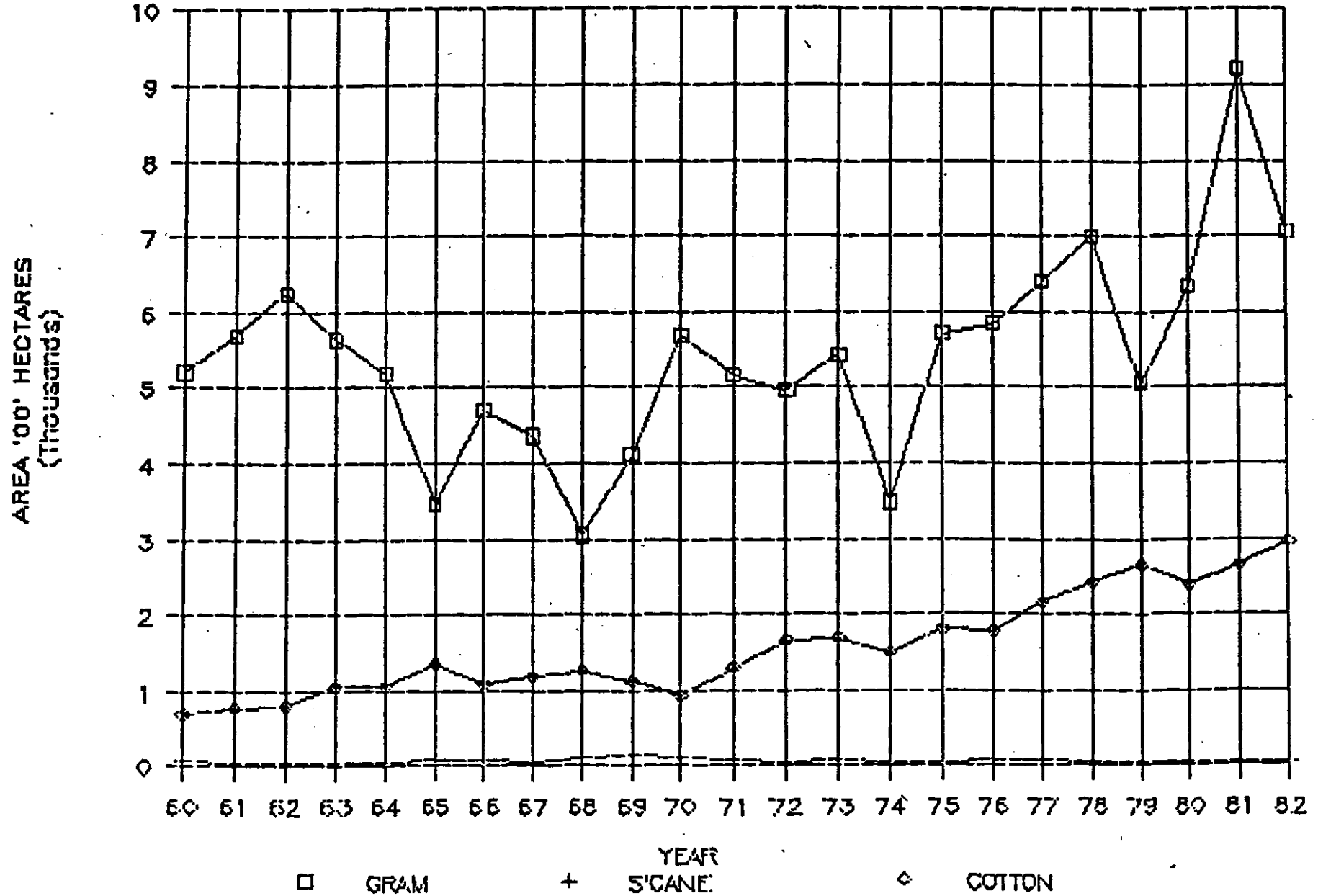
675

NO. 36

676

AREA UNDER GRAM, S'CA NE, COTTON

RAJASTHAN (REGION : DESERT)

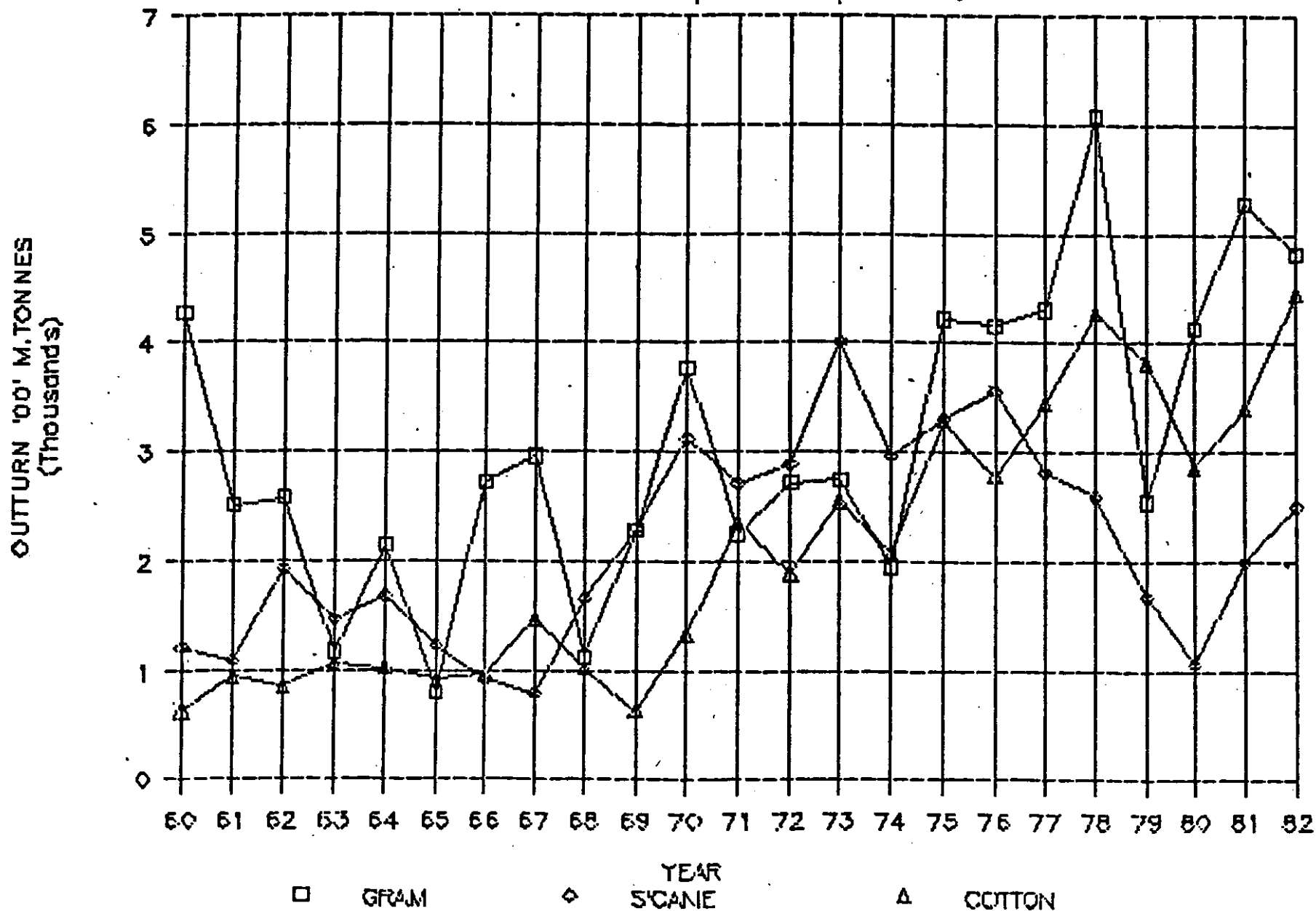


NO. 37

229

PROD. UNDER GRAM, S' CANE, COTTON

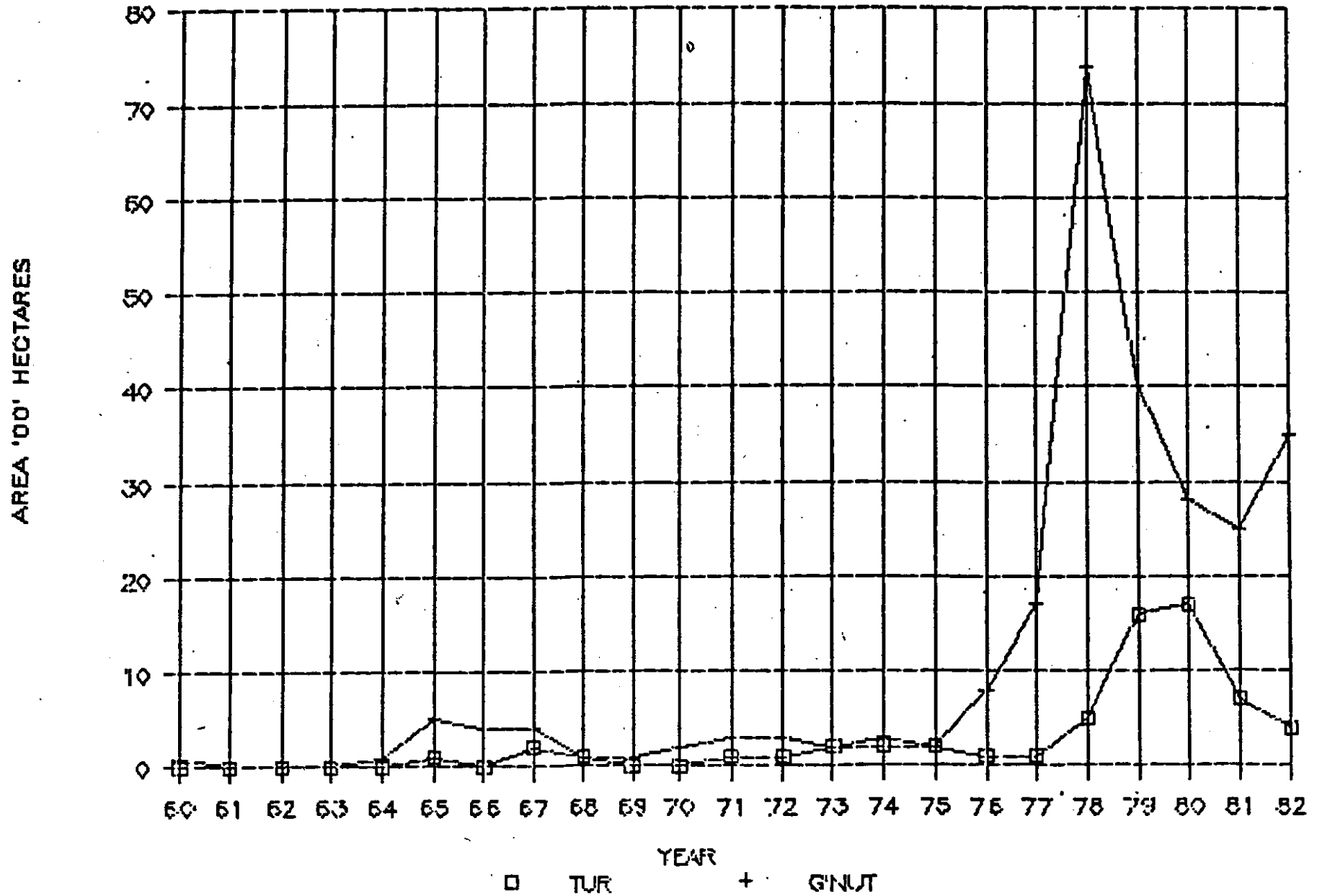
RAJASTHAN (REGION : DESERT)



NO. 38

678

AREA UNDER TUR,G'NUT RAJASTHAN (REGION : DESERT)

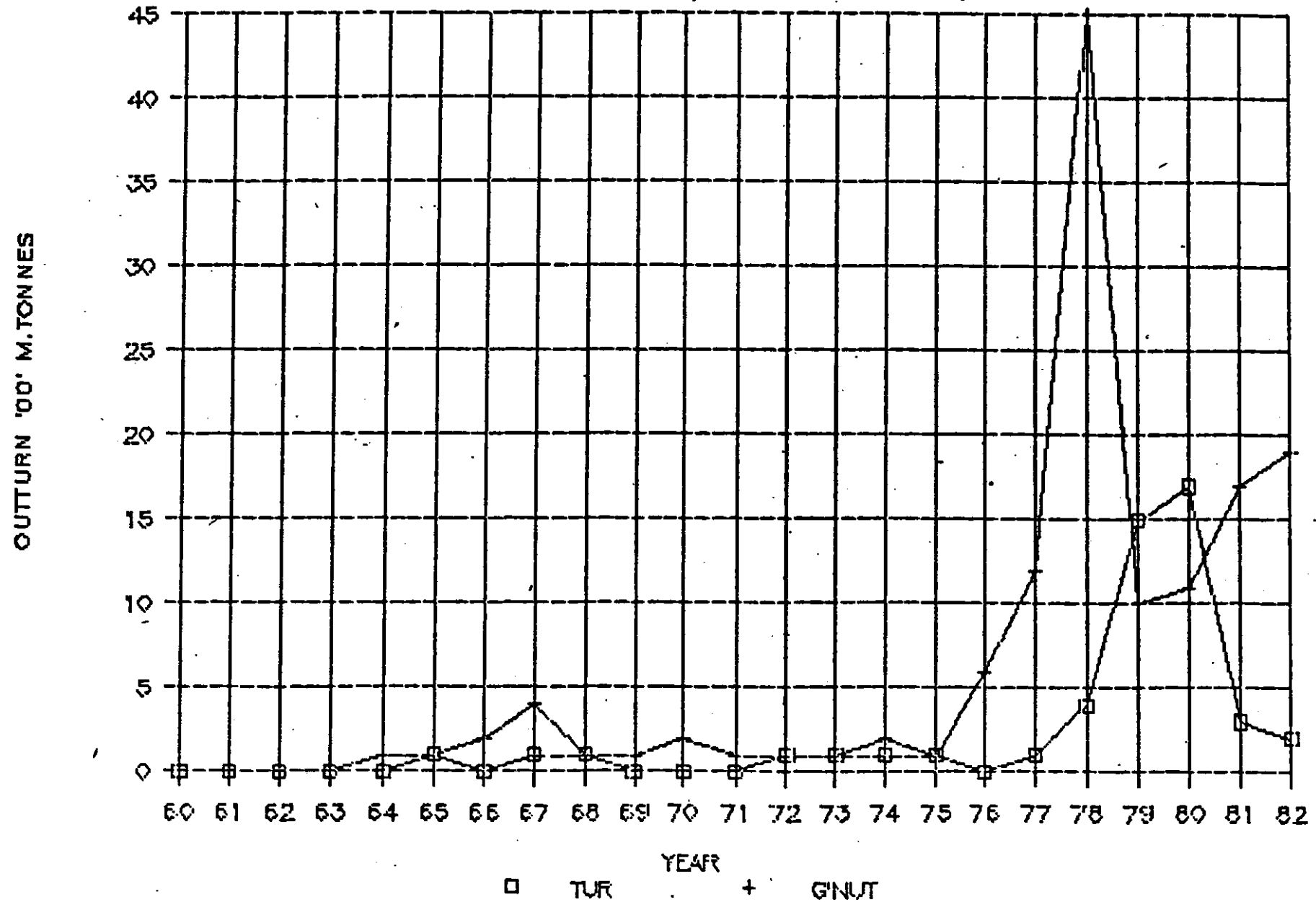


NO. 39

679

PROD. UNDER TUR, G'NUT

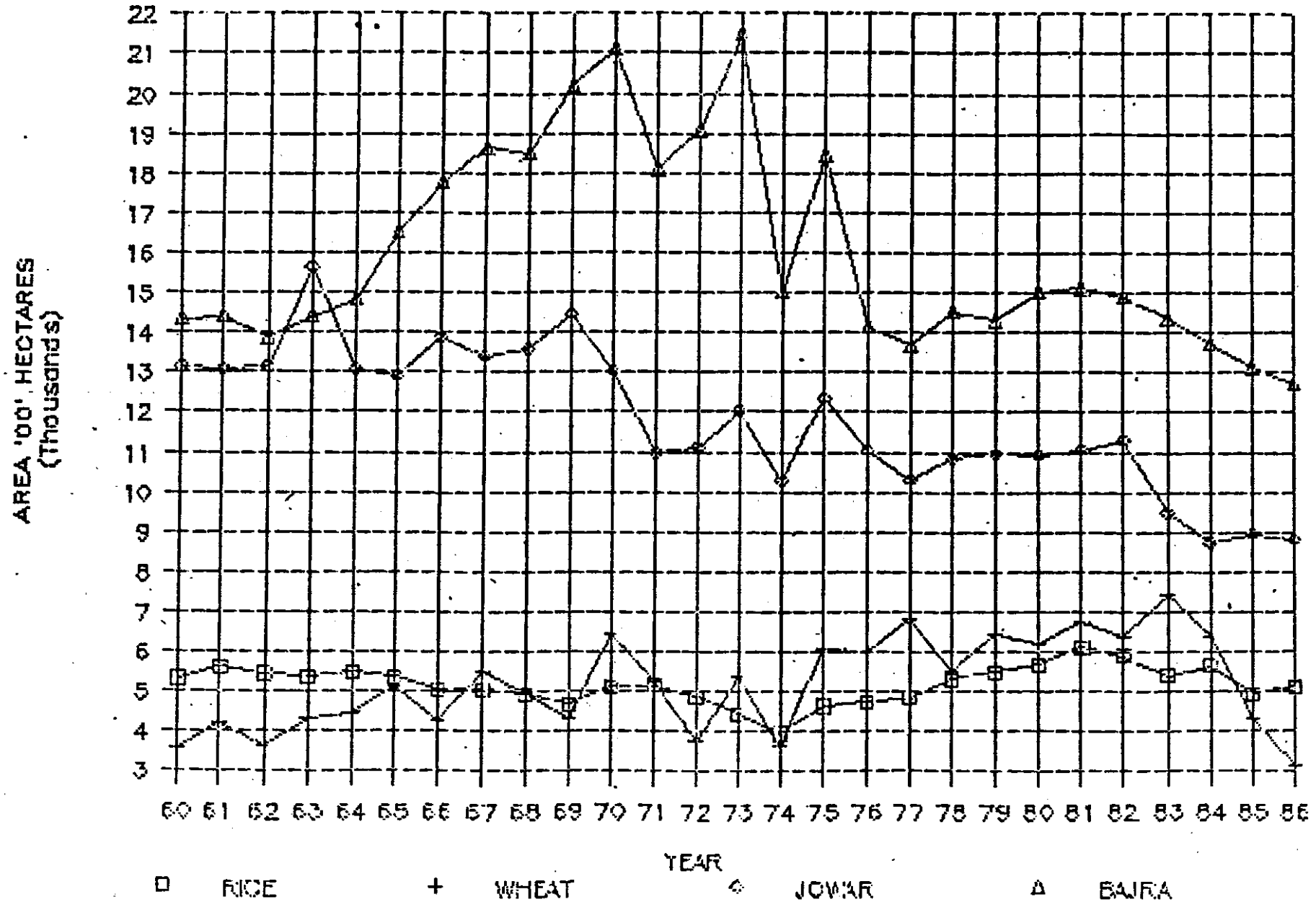
RAJASTHAN (REGION : DESERT)



NO. 40

AREA UNDER RICE, WHEAT, JOWAR, BAJRA

GUJRAT STATE

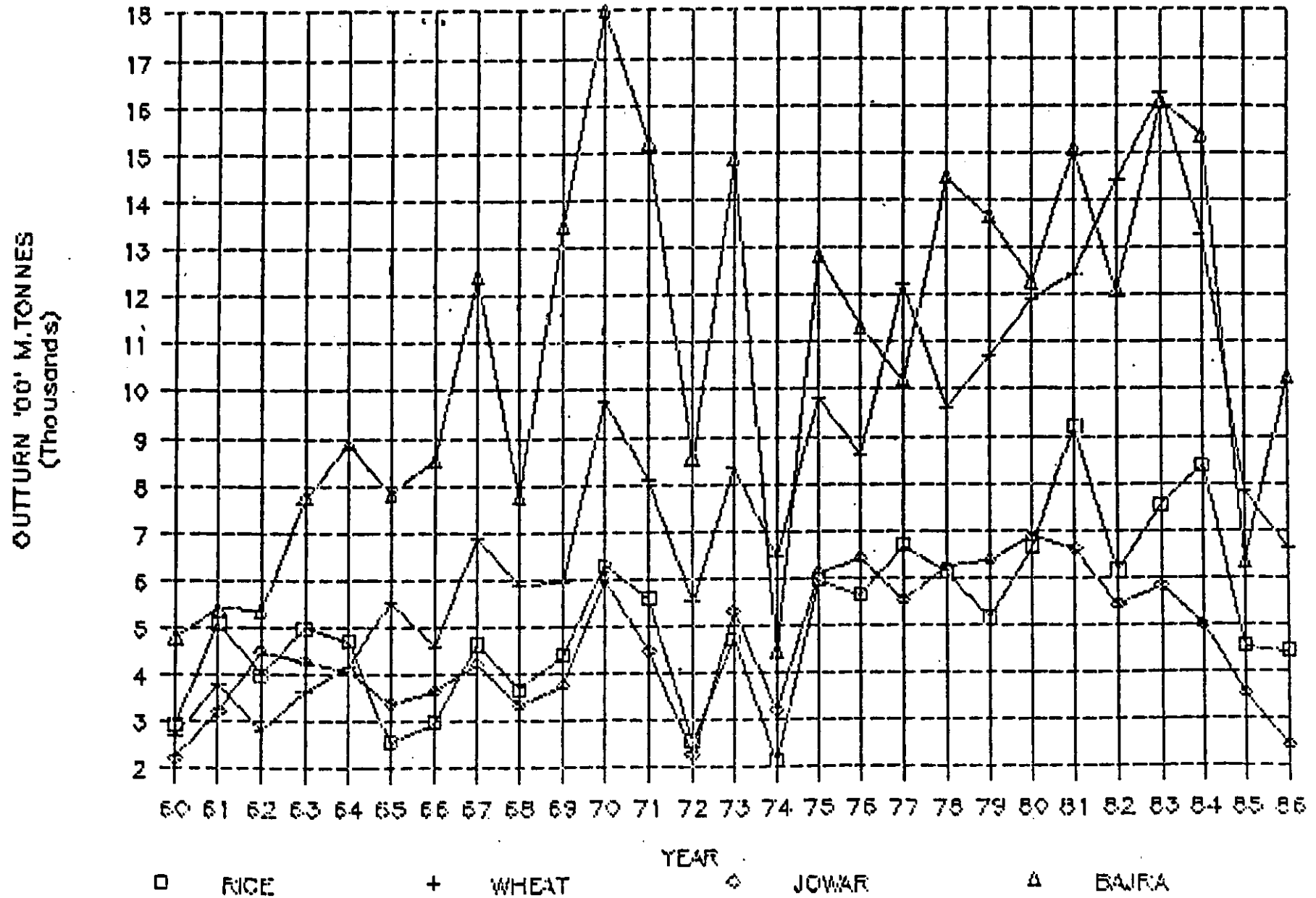


089

NO. 41

PROD. UNDER RICE, WHEAT, JOWAR, BAJRA

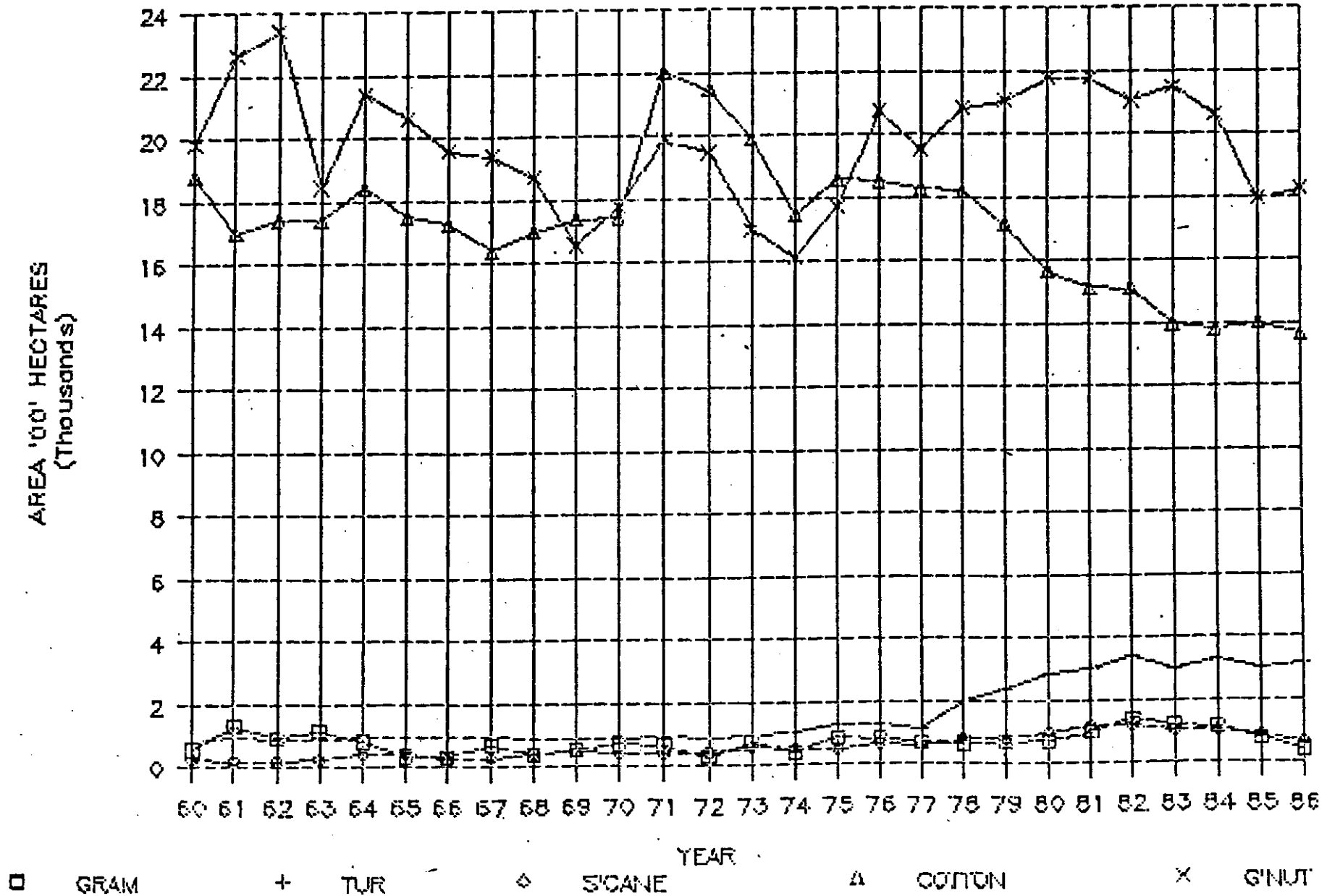
GUJRAT STATE



682

AREA UNDER GRAM, TUR, S'CAANE, COTTON, G. NUT

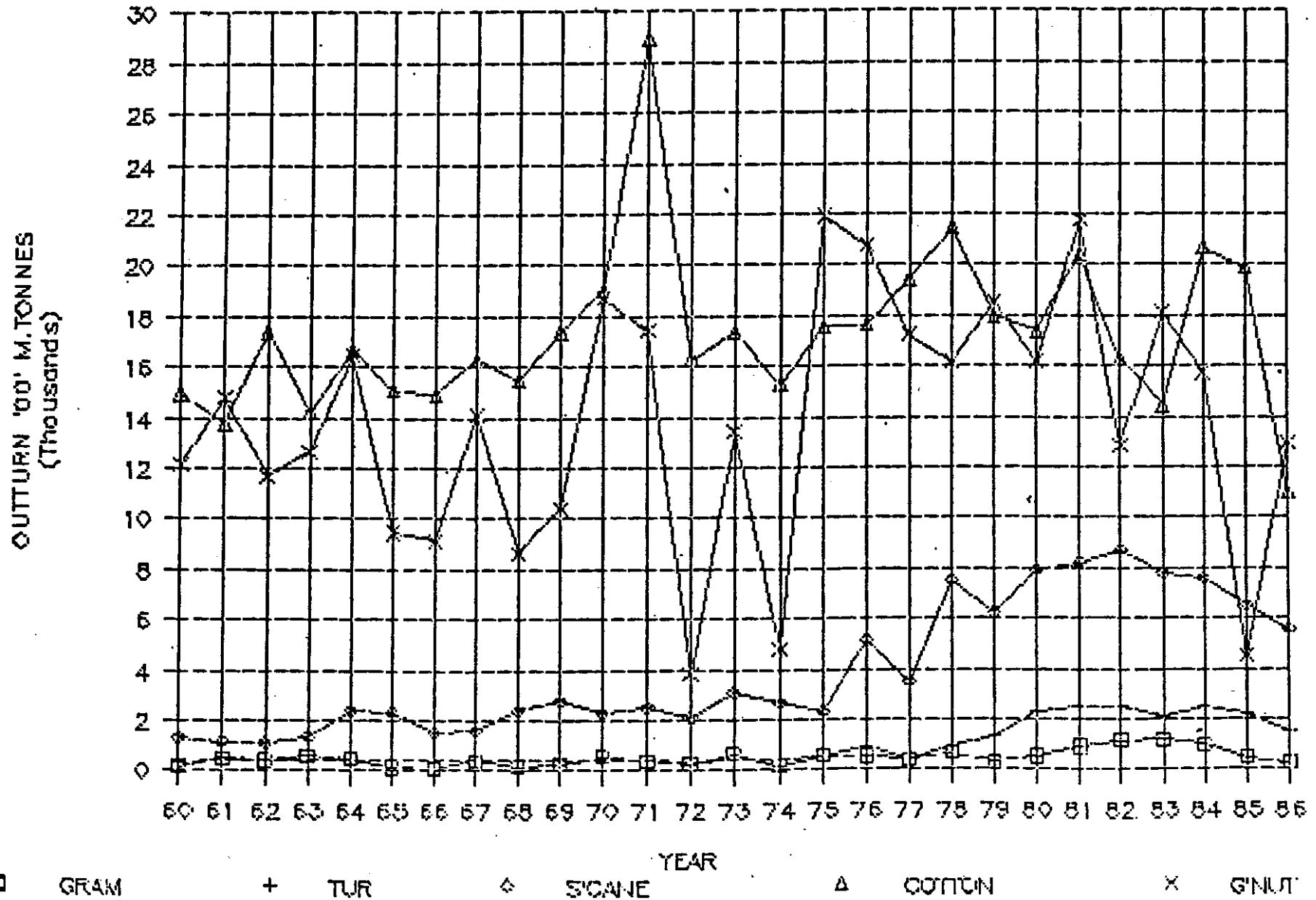
GUJRAT STATE



NO. 43

PROD. UNDER GRAM, TUR, S' CANE, COTTON, G. NUT

GUJARAT STATE



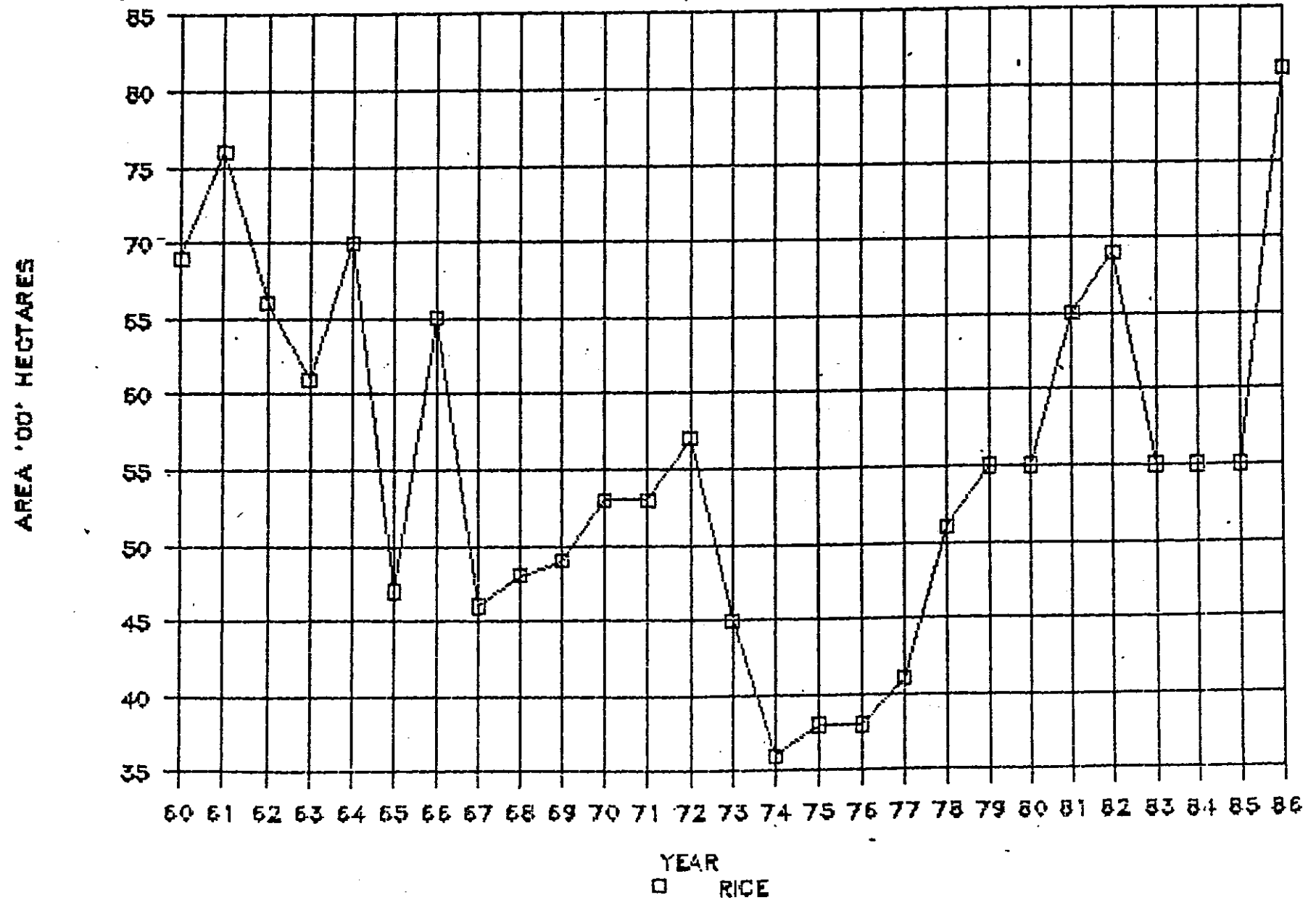
689

No. 44

684

AREA UNDER RICE

GUJRAT (DANGS)

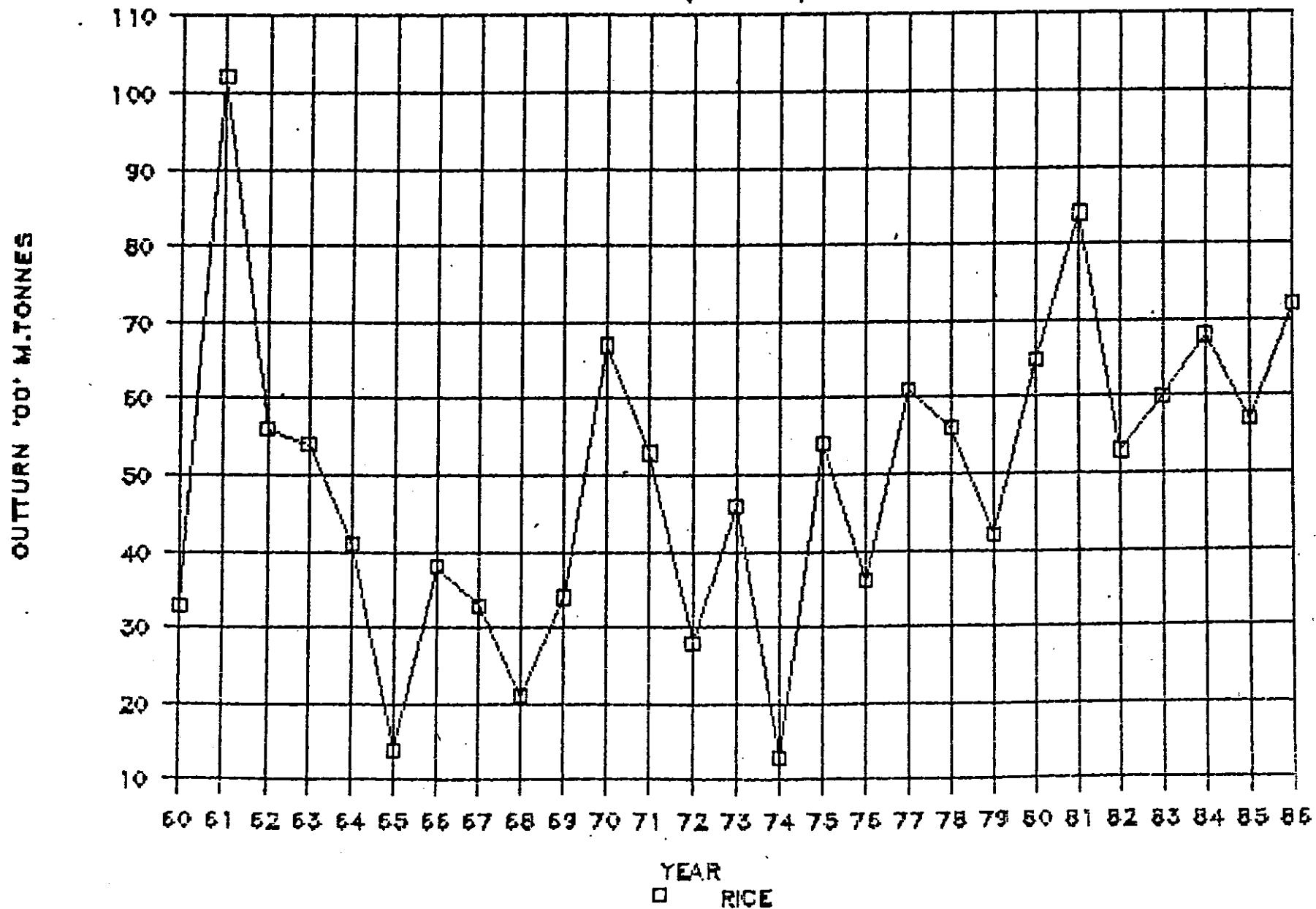


NO. 45

685

PROD. UNDER RICE

GUJRAT (DANGES)



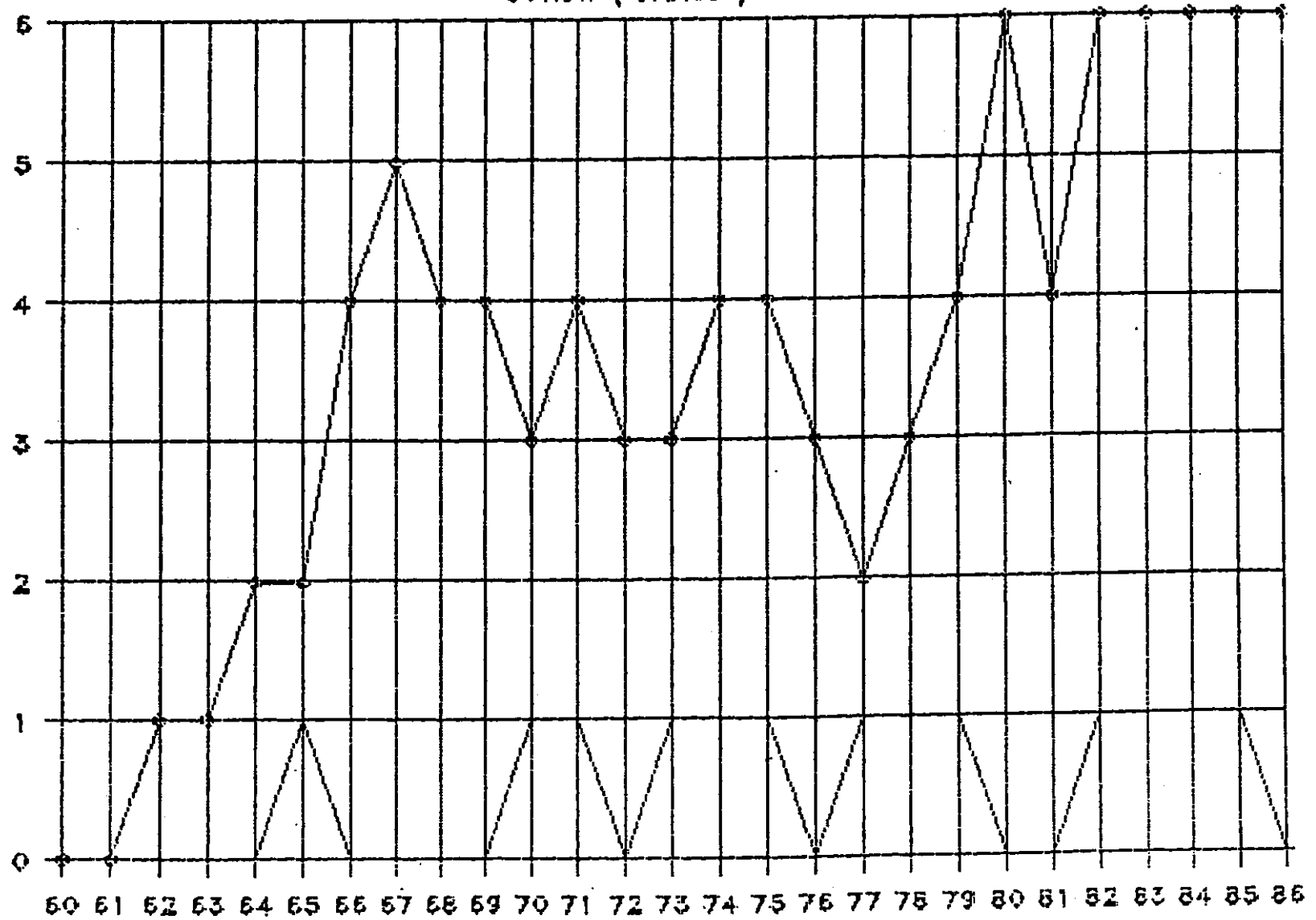
No. 46

989

AREA UNDER WHEAT, JOWAR

GUJRAT (DANGS)

AREA '00' HECTARES

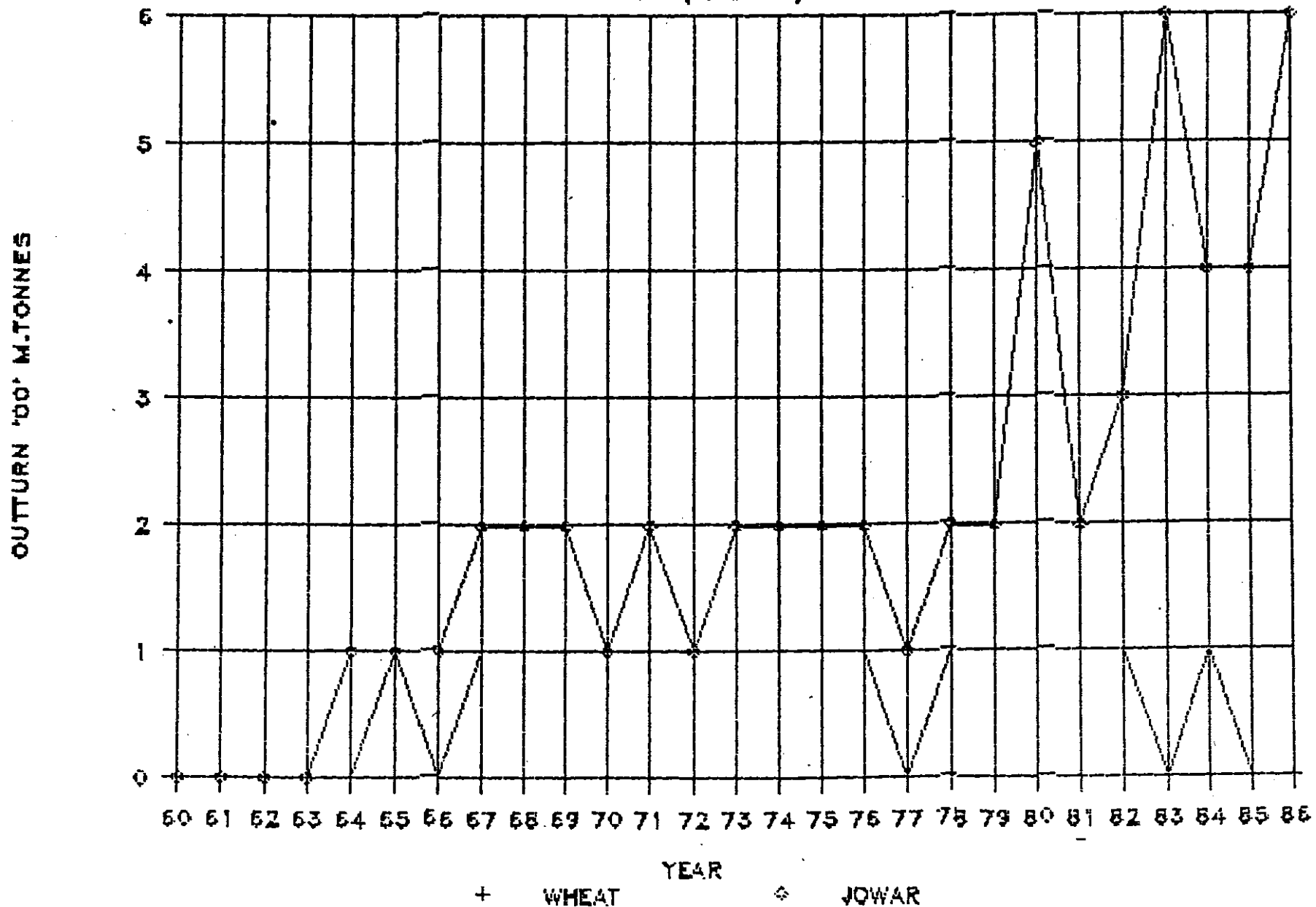


+ WHEAT ◇ JOWAR

NO. 47

PROD. UNDER WHEAT, JOWAR

GUJRAT (DANGS)

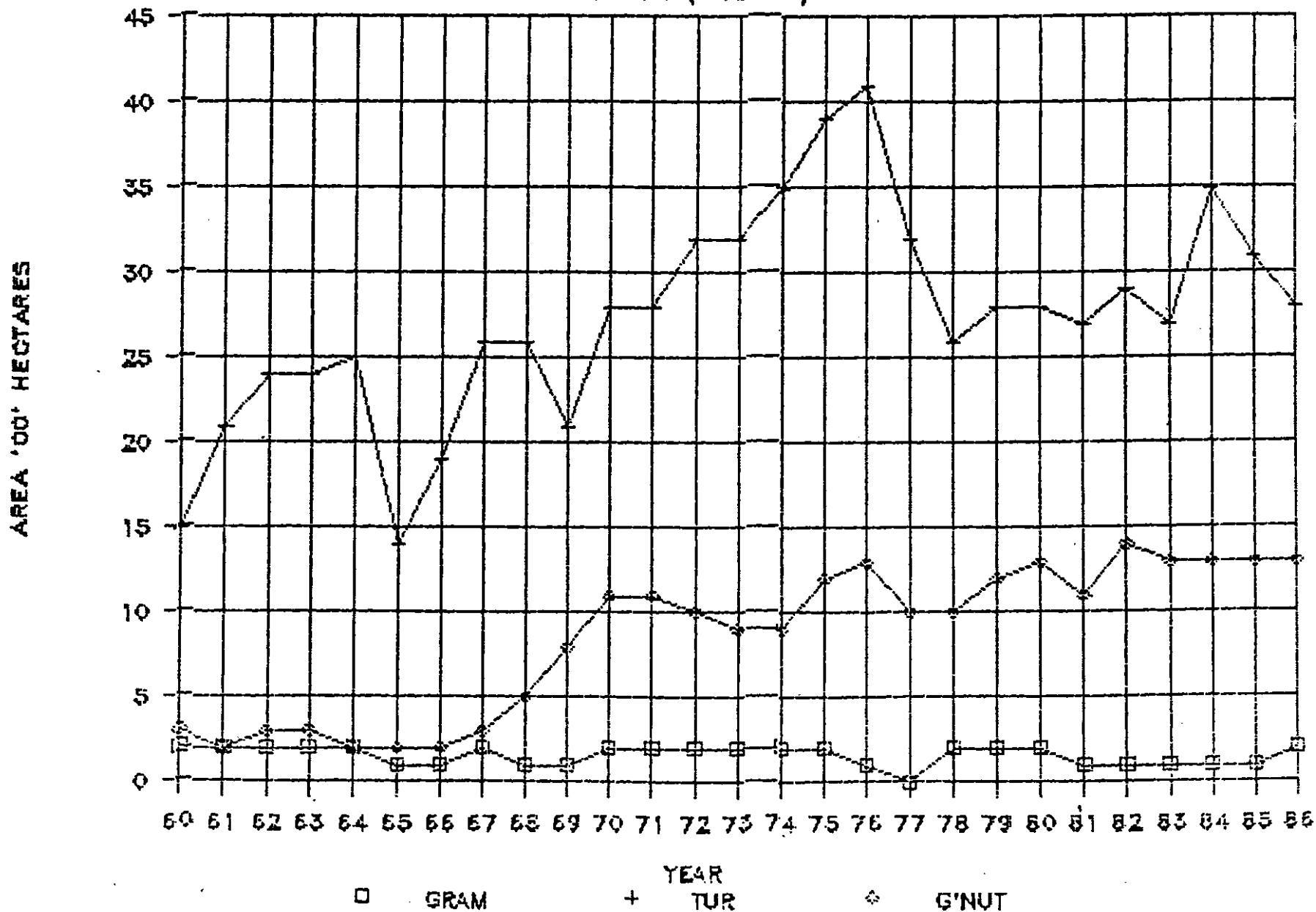


687

NO. 48

AREA UNDER GRAM, TUR, G'NUT

GUJRAT (DANGS)



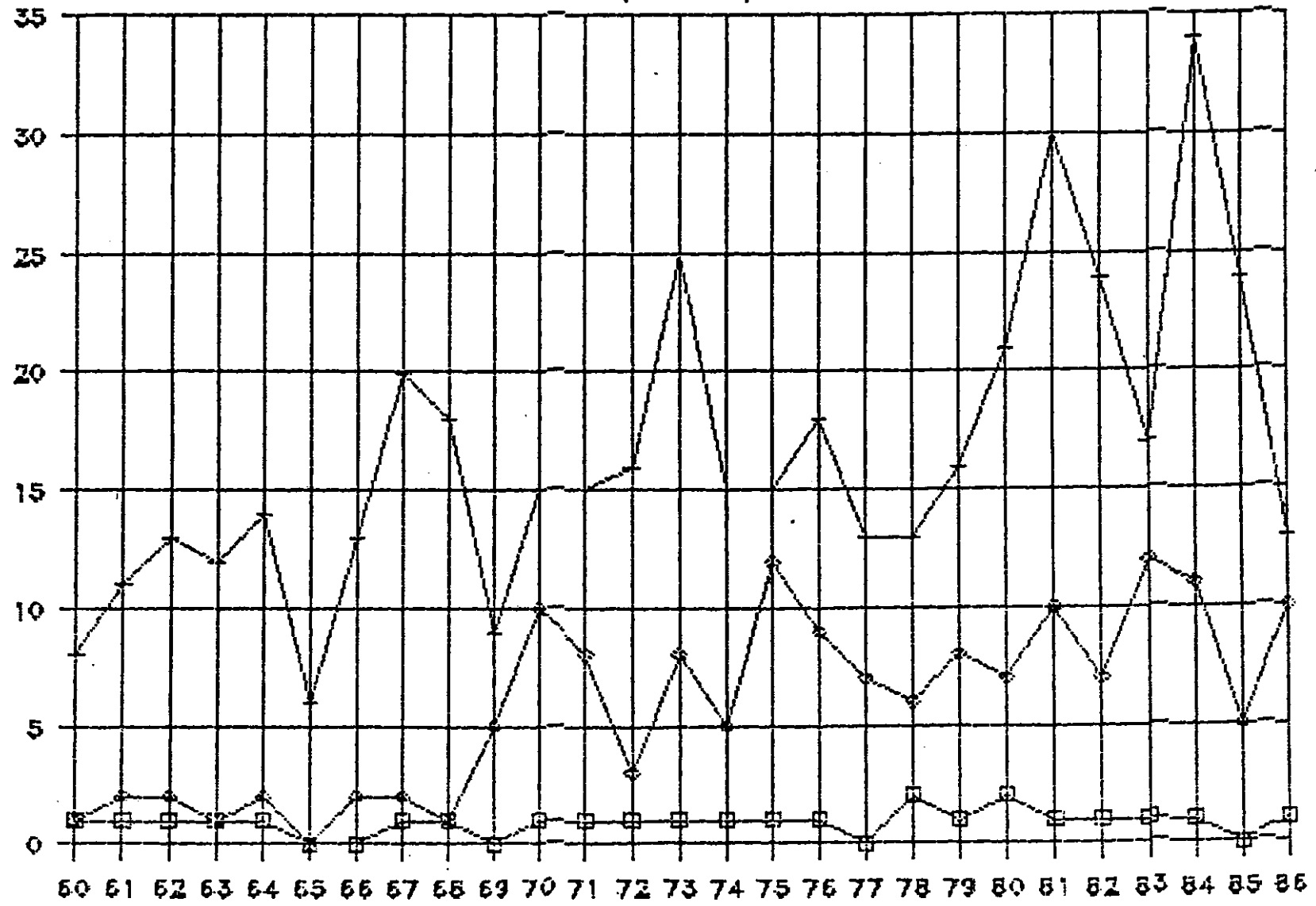
889

NO. 7 ON

PROD. UNDER GRAM, TUR, G'NUT

GUJRAT (DANGS)

OUTTURN '00' M.TONNES



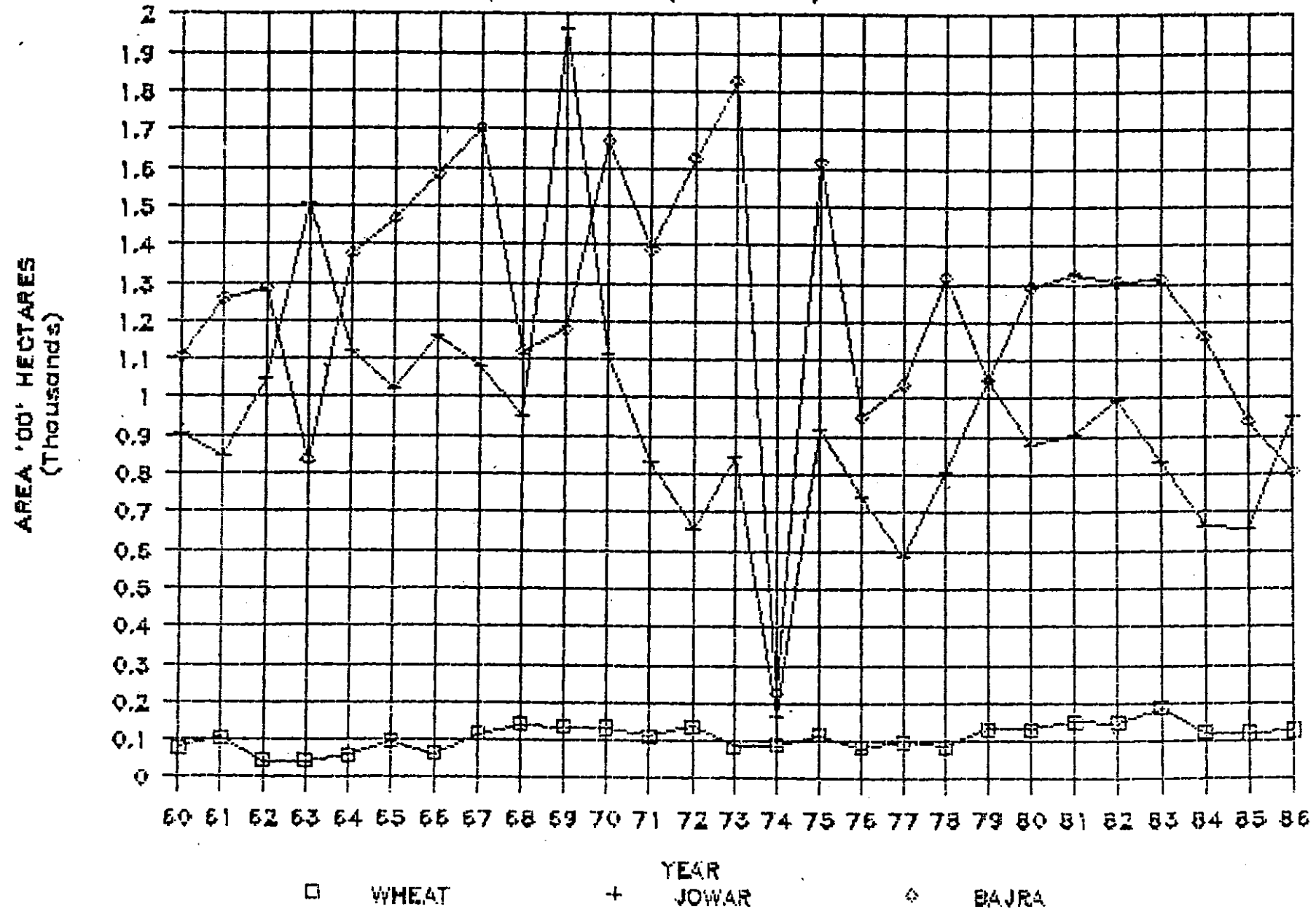
GRAM
 YEAR
 TUR
 G'NUT

689

NO.50

AREA UNDER WHEAT, JOWAR, BAJRA

GUJRAT (KUCHCHH)

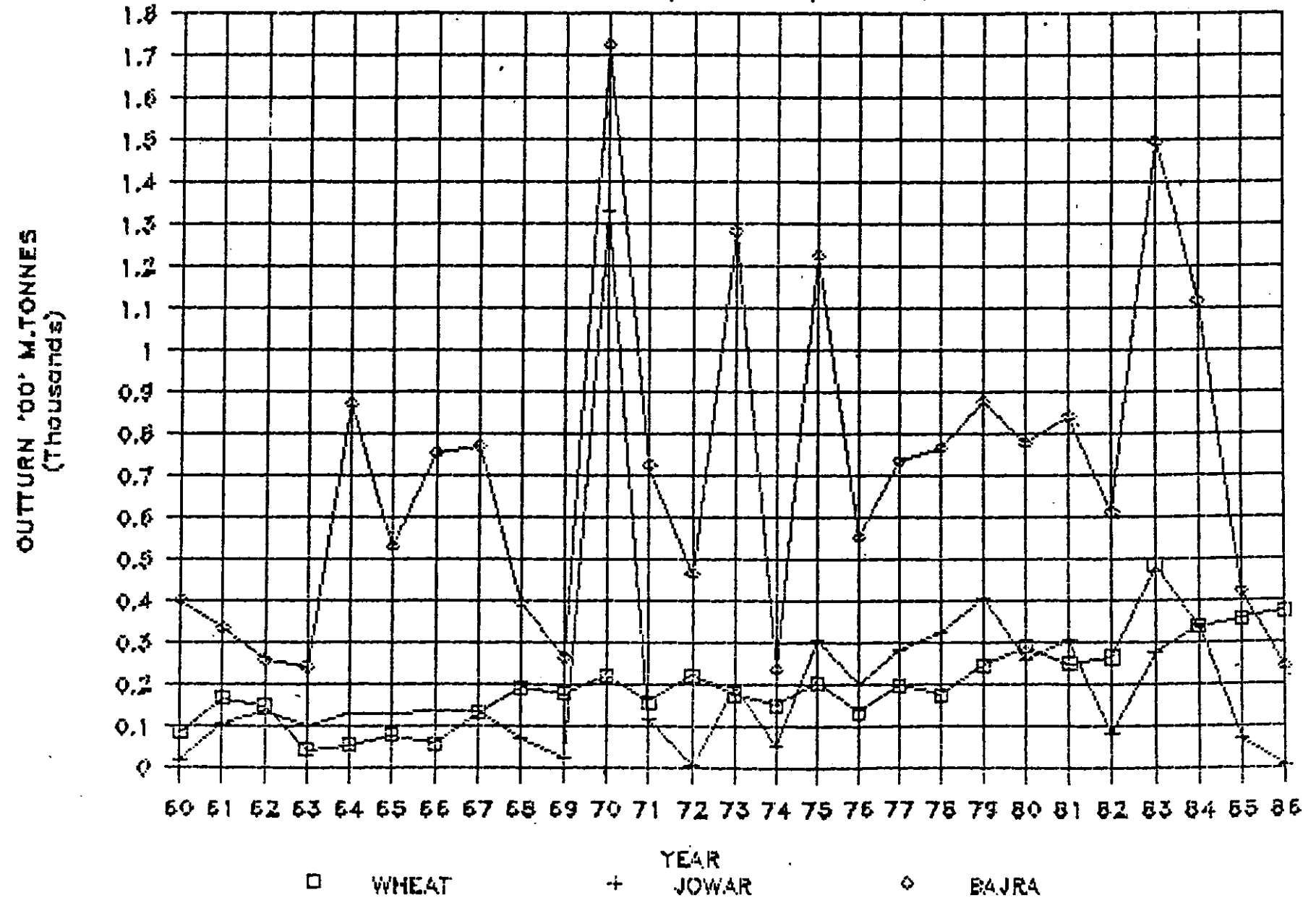


690

NO. 51

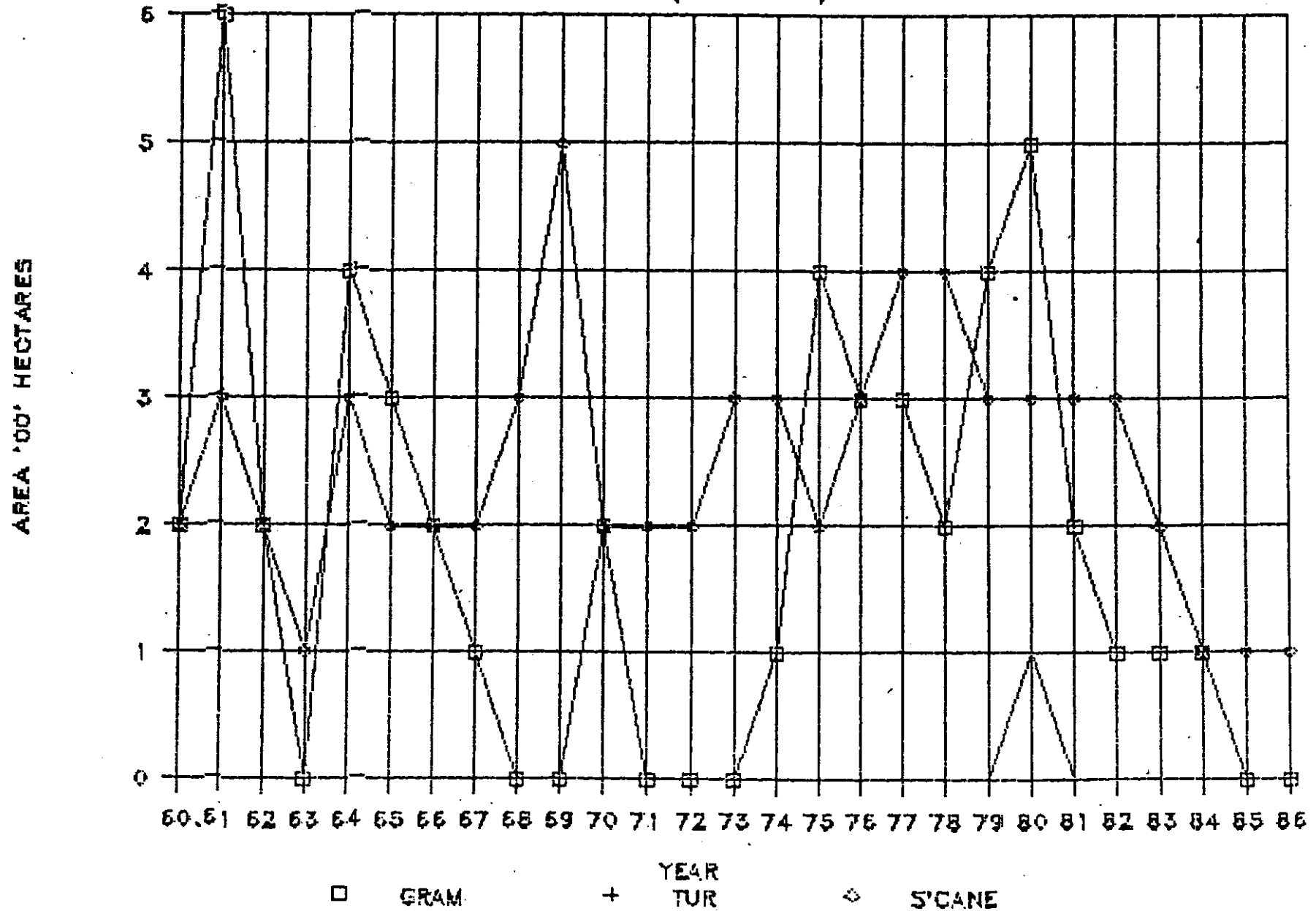
PROD. UNDER WHEAT, JOWAR, BAJRA

GUJRAT (KUCHCHH)



AREA UNDER GRAM, TUR, S'CANE

GUJARAT (KUCHCHH)

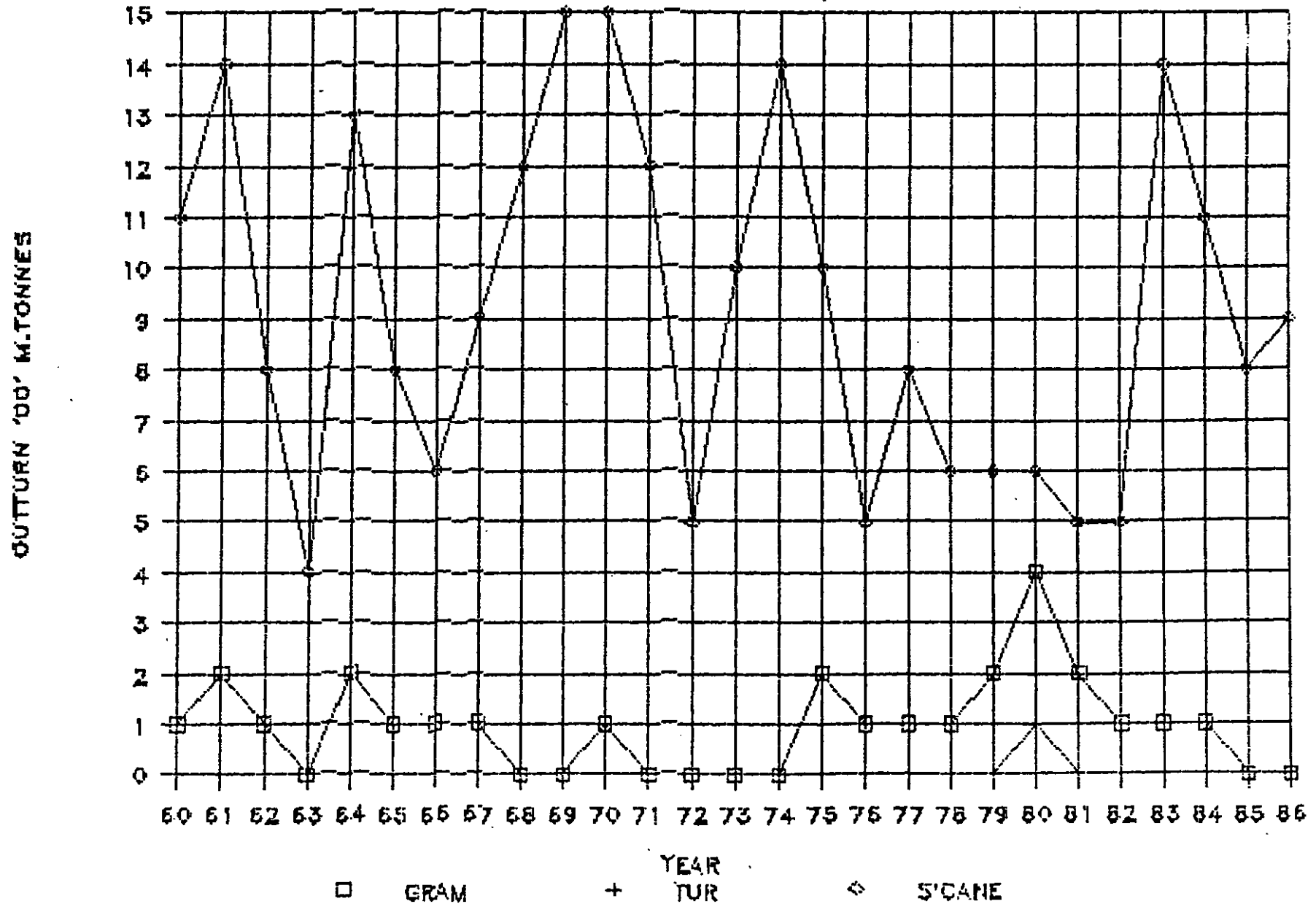


692

NO. 53

PROD. UNDER GRAM, TUR, S' CANE

GUJARAT (KUCHCHH)

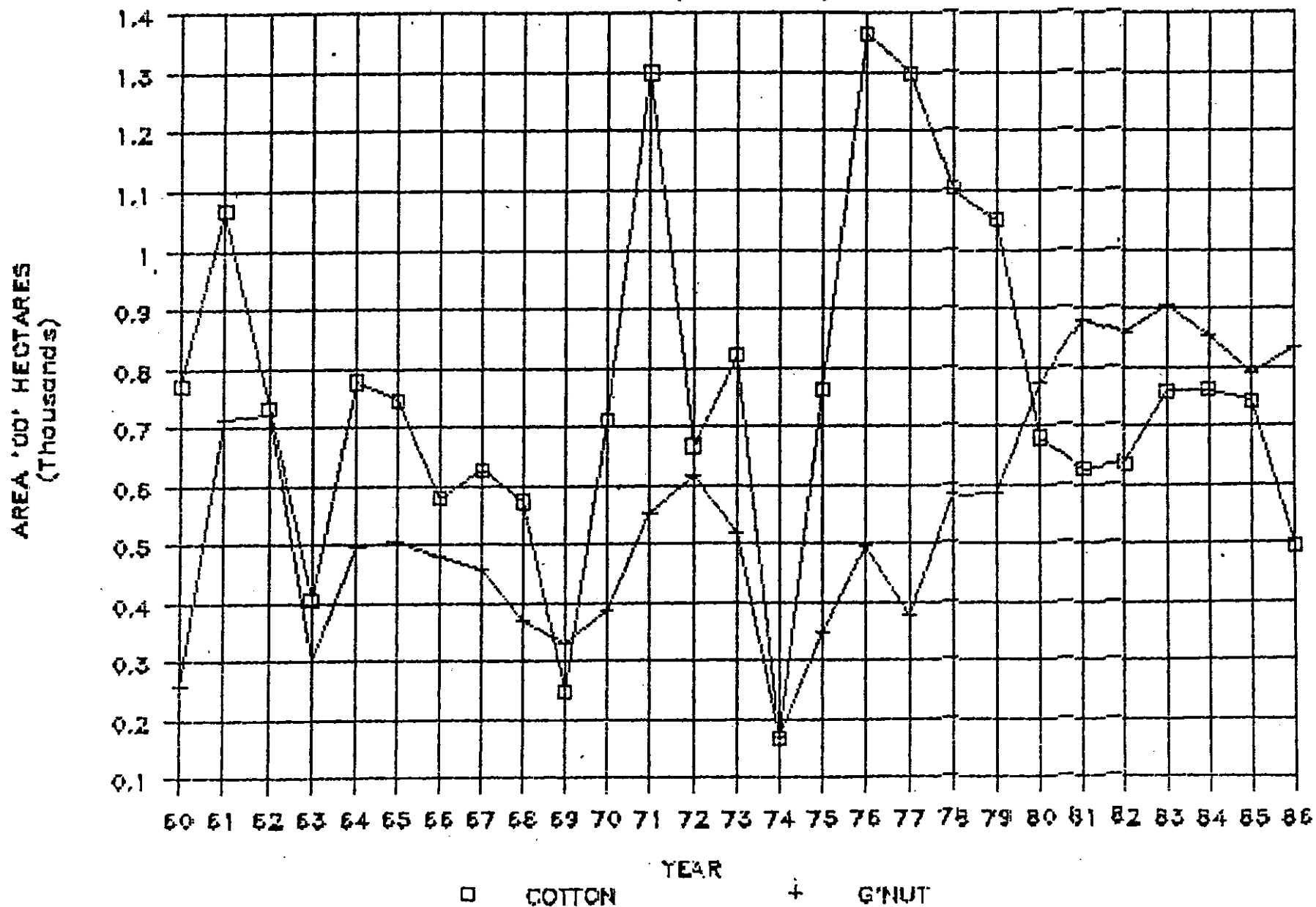


693

NO. 54

AREA UNDER COTTON, G'NUT

GUJARAT (KUCHCHH)

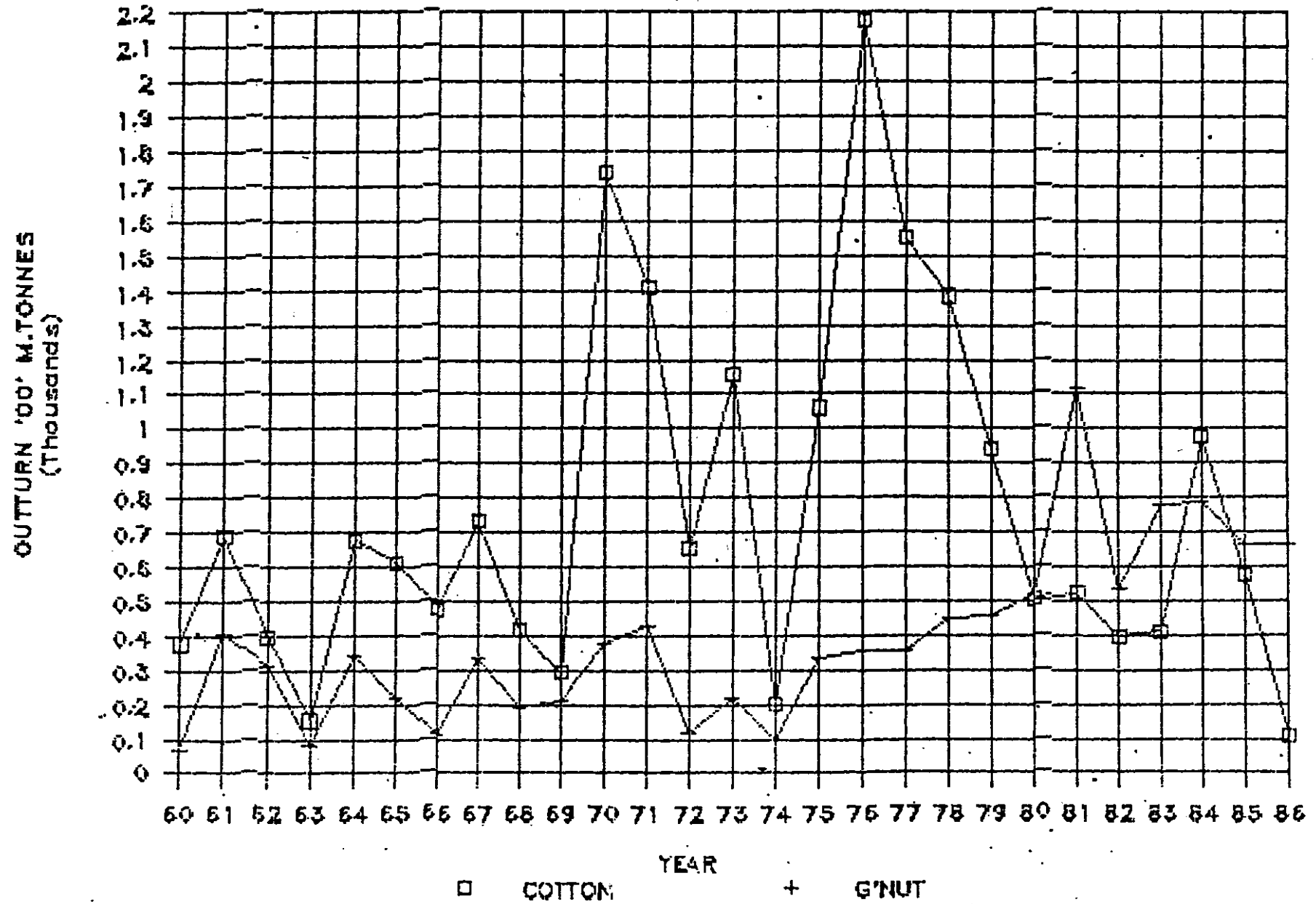


694

NO.55

PROD. UNDER COTTON, G'NUT

GUJARAT (KUCHCHH)



695

NO. 56

Optimum Land Use Model For Maharashtra

Equations of constraints in the model --

Land constraints:

Kharif season

$$\begin{aligned}
 1) & X_{P,S}^{K,D} + X_{N,S}^{K,D} + X_{BL,S}^{K,D} + X_{BH,S}^{K,D} + X_{JL,S}^{K,D} + X_{JH,S}^{K,D} \\
 & + X_{OC,S}^{K,D} + X_{T,S}^{K,D} + X_{M,S}^{K,D} + X_{U,S}^{K,D} + X_{OP,S}^{K,D} + X_{GNL,S}^{K,D} \\
 & + X_{GNH,S}^{K,D} + X_{SF,S}^{K,D} + X_{OO,S}^{K,D} + X_{O,S}^{K,D} + X_{R,S}^{K,D} \\
 & + X_{V,S}^{K,I} + X_{V,S}^{K,D} \leq 55820 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 2) & X_{P,M}^{K,D} + X_{P,M}^{K,I} + X_{N,M}^{K,D} + X_{BL,M}^{K,D} + X_{BH,M}^{K,D} \\
 & + X_{BH,M}^{K,I} + X_{JL,M}^{K,D} + X_{JH,M}^{K,D} + X_{JH,M}^{K,I} + X_{OC,M}^{K,D} \\
 & + X_{OC,M}^{K,I} + X_{T,M}^{K,D} + X_{M,M}^{K,D} + X_{M,M}^{K,I} + X_{U,M}^{K,D} \\
 & + X_{U,M}^{K,I} + X_{OP,M}^{K,D} + X_{OP,M}^{K,I} + X_{GNL,M}^{K,D} + X_{GNH,M}^{K,D} \\
 & + X_{GNH,M}^{K,I} + X_{SF,M}^{K,D} + X_{SF,M}^{K,I} + X_{OO,M}^{K,D} + X_{OO,M}^{K,I} \\
 & + X_{C,M}^{K,D} + X_{C,M}^{K,I} + X_{R,M}^{K,D} + X_{V,M}^{K,I} + X_{S,M}^{K,I} \\
 & + X_{B,M}^{K,I} + X_{OR,M}^{K,I} + X_{V,M}^{K,D} \leq 80600 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 3) & X_{P,D}^{K,D} + X_{P,D}^{K,I} + X_{N,D}^{K,D} + X_{BH,D}^{K,D} + X_{BH,D}^{K,I} + X_{JL,D}^{K,D} \\
 & + X_{JH,D}^{K,D} + X_{JH,D}^{K,I} + X_{OC,D}^{K,D} + X_{OC,D}^{K,I} + X_{T,D}^{K,D} + X_{M,D}^{K,D} \\
 & + X_{M,D}^{K,I} + X_{U,D}^{K,D} + X_{U,D}^{K,I} + X_{OP,D}^{K,D} + X_{OP,D}^{K,I} + X_{GNL,D}^{K,D} \\
 & + X_{GNH,D}^{K,D} + X_{GNH,D}^{K,I} + X_{SF,D}^{K,D} + X_{SF,D}^{K,I} + X_{OO,D}^{K,D} + X_{OO,D}^{K,I} \\
 & + X_{C,D}^{K,D} + X_{C,D}^{K,I} + X_{R,D}^{K,D} + X_{V,D}^{K,I} + X_{S,D}^{K,I}
 \end{aligned}$$

$$+ X_{B,D} + X_{OR,D} + X_{V,D} = 55550 \text{ (0000)}$$

$$4) X_{P,L}^{K,D} + X_{N,L}^{K,D} + X_{JL,L}^{K,D} + X_{OC,L}^{K,D} + X_{T,L}^{K,D} + X_{M,L}^{K,D} \\ + X_{V,L}^{K,D} + X_{OP,L}^{K,D} + X_{GNL,L}^{K,D} + X_{GNH,L}^{K,D} + X_{OO,L}^{K,D} \\ \leq 4550 \text{ (00Ha)}$$

$$5) X_{P,H}^{K,D} + X_{N,H}^{K,D} + X_{BL,H}^{K,D} + X_{JL,H}^{K,D} + X_{OC,H}^{K,D} + X_{T,H}^{K,D} \\ + X_{M,H}^{K,D} + X_{V,H}^{K,D} + X_{OP,H}^{K,D} + X_{GNL,H}^{K,D} + X_{GNH,H}^{K,D} + X_{OO,H}^{K,D} \\ + X_{C,H}^{K,D} \leq 6658 \text{ (00Ha)}$$

$$6) X_{P,C}^{K,D} \leq 367 \text{ (00Ha)}$$

$$7) X_{P,Y}^{K,D} + X_{P,Y}^{K,I} + X_{JL,Y}^{K,D} + X_{OC,Y}^{K,D} + X_{OC,Y}^{K,I} + X_{T,Y}^{K,D} \\ + X_{V,Y}^{K,D} + X_{V,Y}^{K,I} + X_{OP,Y}^{K,D} + X_{OP,Y}^{K,I} + X_{GNL,Y}^{K,D} + X_{GNH,Y}^{K,D} \\ + X_{GNH,Y}^{K,I} + X_{OO,Y}^{K,D} + X_{OO,Y}^{K,I} + X_{R,Y}^{K,D} \leq 9148 \text{ (00Ha)}$$

Rabi Season

$$8) X_{JL,S}^{R,D} + X_{JH,S}^{R,D} + X_{WH,S}^{R,D} + X_{OC,S}^{R,D} + X_{G,S}^{R,D} \\ + X_{OP,S}^{R,D} + X_{SF,S}^{R,D} + X_{OO,S}^{R,D} + X_{V,S}^{R,I} \leq 55820 \text{ (00Ha)}$$

$$9) X_{JL,M}^{R,D} + X_{JH,M}^{R,D} + X_{JH,M}^{R,I} + X_{WL,M}^{R,D} + X_{WL,M}^{R,I} + X_{WH,M}^{R,D} \\ + X_{WH,M}^{R,I} + X_{OC,M}^{R,D} + X_{OC,M}^{R,I} + X_{G,M}^{R,D} + X_{G,M}^{R,I} + X_{OP,M}^{R,D} \\ + X_{SF,M}^{R,D} + X_{SF,M}^{R,I} + X_{OO,M}^{R,D} + X_{OO,M}^{R,I} + X_{V,M}^{R,I} \\ + X_{JL,M}^{R,I} + X_{S,M}^{A,I} + X_{B,M}^{A,I} + X_{OR,M}^{A,I} \leq 80600 \text{ (00Ha)}$$

$$\begin{aligned}
 10) & X_{JL,D}^{R,D} + X_{JH,D}^{R,D} + X_{JH,D}^{R,I} + X_{WL,D}^{R,D} + X_{WL,D}^{R,I} + X_{WH,D}^{R,D} \\
 & + X_{WH,D}^{R,I} + X_{G,D}^{R,D} + X_{G,D}^{R,I} + X_{OP,D}^{R,D} + X_{SF,D}^{R,D} \\
 & + X_{SF,D}^{R,I} + X_{OO,D}^{R,D} + X_{OO,D}^{R,I} + X_{VI,D}^{R,I} + X_{S,D}^{A,I} \\
 & + X_{JL,D}^{R,I} + X_{B,D}^{A,I} + X_{OR,D}^{A,I} \leq 33330 \text{ ('00Ha)}
 \end{aligned}$$

$$11) X_{JL,L}^{R,D} + X_{WL,L}^{R,D} + X_{G,L}^{R,D} \leq 276 \text{ ('00Ha)}$$

$$12) X_{JL,H}^{R,D} + X_{WL,H}^{R,D} + X_{WH,H}^{R,D} + X_{G,H}^{R,D} \leq 2194 \text{ ('00Ha)}$$

$$\begin{aligned}
 13) & X_{JL,Y}^{R,D} + X_{WL,Y}^{R,D} + X_{WH,Y}^{R,D} + X_{WL,Y}^{R,I} + X_{WH,Y}^{R,I} \\
 & + X_{G,Y}^{R,D} + X_{G,Y}^{R,I} + X_{OO,Y}^{R,D} + X_{OO,Y}^{R,I} + X_{JL,Y}^{R,I} \leq 1716 \text{ ('00Ha)}
 \end{aligned}$$

Summer Season

$$14) X_{GNH,S}^{S,I} \geq 200 \text{ ('00Ha)}$$

$$\begin{aligned}
 15) & X_{GNH,M}^{S,I} + X_{V,M}^{S,I} + X_{C,M}^{S,I} + X_{M,M}^{S,I} + X_{S,M}^{A,I} \\
 & + X_{B,M}^{A,I} + X_{OR,M}^{A,I} \leq 80600 \text{ ('00Ha)}
 \end{aligned}$$

$$\begin{aligned}
 16) & X_{GNH,D}^{S,I} + X_{VI,D}^{S,I} + X_{C,D}^{S,I} + X_{M,D}^{S,I} + X_{S,D}^{A,I} \\
 & + X_{B,D}^{A,I} + X_{OR,D}^{A,I} \leq 33330 \text{ ('00Ha)}
 \end{aligned}$$

$$17) X_{P,L}^{S,I} \leq 90$$

$$18) X_{P,Y}^{S,I} \leq 240$$

699

(Perennial)

$$19) X_{S,M}^{A,I} + X_{S,D}^{A,I} + X_{B,M}^{A,I} + X_{B,D}^{A,I} + X_{OR,M}^{A,I} + X_{OR,D}^{A,I} \leq 5000 \text{ ('00Ha)}$$

Dry Land constraints -
(shallow)

$$20) X_{P,S}^{K,D} + X_{N,S}^{K,D} + X_{BL,S}^{K,D} + X_{BH,S}^{K,D} + X_{JL,S}^{K,D} + X_{JH,S}^{K,D} + X_{OC,S}^{K,D} + X_{T,S}^{K,D} + X_{M,S}^{K,D} + X_{U,S}^{K,D} + X_{OP,S}^{K,D} + X_{GNL,S}^{K,D} + X_{GNH,S}^{K,D} + X_{SF,S}^{K,D} + X_{OO,S}^{K,D} + X_{C,S}^{K,D} + X_{R,S}^{K,D} + X_{JL,S}^{R,D} + X_{JH,S}^{R,D} + X_{WH,S}^{R,D} + X_{OC,S}^{R,D} + X_{G,S}^{R,D} + X_{OP,S}^{R,D} + X_{SF,S}^{R,D} + X_{OO,S}^{R,D} + X_{V,S}^{K,D} \leq 55820 \text{ ('00Ha)}$$

21) (Medium, kharif)

$$X_{P,M}^{K,D} + X_{N,M}^{K,D} + X_{BL,M}^{K,D} + X_{BH,M}^{K,D} + X_{JL,M}^{K,D} + X_{JH,M}^{K,D} + X_{OC,M}^{K,D} + X_{T,M}^{K,D} + X_{M,M}^{K,D} + X_{U,M}^{K,D} + X_{OP,M}^{K,D} + X_{GNL,M}^{K,D} + X_{GNH,M}^{K,D} + X_{OO,M}^{K,D} + X_{C,M}^{K,D} + X_{R,M}^{K,D} + X_{V,M}^{K,D} + X_{SF,M}^{K,D} \leq 58000 \text{ ('00Ha)}$$

22) (Deep Black, kharif)

$$X_{P,D}^{K,D} + X_{N,D}^{K,D} + X_{BH,D}^{K,D} + X_{JL,D}^{K,D} + X_{JH,D}^{K,D} + X_{OC,D}^{K,D} + X_{T,D}^{K,D} + X_{M,D}^{K,D} + X_{U,D}^{K,D} + X_{OP,D}^{K,D} + X_{GNL,D}^{K,D} + X_{GNH,D}^{K,D} + X_{SF,D}^{K,D} + X_{OO,D}^{K,D} + X_{C,D}^{K,D} + X_{R,D}^{K,D} + X_{V,D}^{K,D} \leq 24000 \text{ ('00Ha)}$$

23) (Medium, Rabi)

$$\begin{aligned}
 & X_{JL,M}^{R,D} + X_{JH,M}^{R,D} + X_{WL,M}^{R,D} + X_{WH,M}^{R,D} + X_{OC,M}^{R,D} + X_{G,M}^{R,D} \\
 & + X_{OP,M}^{R,D} + X_{SF,M}^{R,D} + X_{OO,M}^{R,D} \leq 40,000 \text{ ('00 Ha)}
 \end{aligned}$$

24) (Deep Black, Rabi)

$$\begin{aligned}
 & X_{JL,D}^{R,D} + X_{JH,D}^{R,D} + X_{WL,D}^{R,D} + X_{WH,D}^{R,D} + X_{G,D}^{R,D} + X_{OP,D}^{R,D} \\
 & + X_{SF,D}^{R,D} + X_{OO,D}^{R,D} \leq 18,000 \text{ ('00 Ha)}
 \end{aligned}$$

25)

$$\begin{aligned}
 & X_{P,M}^{K,D} + X_{P,M}^{K,I} + X_{N,M}^{K,D} + X_{BL,M}^{K,D} + X_{BH,M}^{K,D} \\
 & + X_{BH,M}^{K,I} + X_{JL,M}^{K,D} + X_{JH,M}^{K,D} + X_{JH,M}^{K,I} + X_{OC,M}^{K,D} + X_{OC,M}^{K,I} \\
 & + X_{T,M}^{K,D} + X_{M,M}^{K,D} + X_{M,M}^{K,I} + X_{U,M}^{K,D} + X_{U,M}^{K,I} + X_{OP,M}^{K,D} \\
 & + X_{OP,M}^{K,I} + X_{GNL,M}^{K,D} + X_{GNH,M}^{K,D} + X_{GNH,M}^{K,I} + X_{SF,M}^{K,D} \\
 & + X_{SF,M}^{K,I} + X_{OO,M}^{K,D} + X_{OO,M}^{K,I} + X_{C,M}^{K,D} + X_{C,M}^{K,I} + X_{V,M}^{K,I} \\
 & + X_{R,M}^{K,D} + X_{S,M}^{A,I} + X_{B,M}^{A,I} + X_{OR,M}^{A,I} + X_{V,M}^{K,D} \\
 & \leq 80,600,00 - X_{GNH,M}^{S,I} - X_{V,M}^{S,I} - X_{M,M}^{S,I} - X_{C,M}^{S,I}
 \end{aligned}$$

26)

$$\begin{aligned}
 & X_{P,D}^{K,D} + X_{P,D}^{K,I} + X_{N,D}^{K,D} + X_{BH,D}^{K,D} + X_{BH,D}^{K,I} + X_{JL,D}^{K,D} \\
 & + X_{JH,D}^{K,D} + X_{JH,D}^{K,I} + X_{OC,D}^{K,D} + X_{OC,D}^{K,I} + X_{T,D}^{K,D} + X_{M,D}^{K,D} \\
 & + X_{M,D}^{K,I} + X_{U,D}^{K,D} + X_{U,D}^{K,I} + X_{OP,D}^{K,D} + X_{OP,D}^{K,I} + X_{GNL,D}^{K,D} \\
 & + X_{GNH,D}^{K,D} + X_{GNH,D}^{K,I} + X_{SF,D}^{K,D} + X_{SF,D}^{K,I} + X_{OO,D}^{K,D} + X_{OO,D}^{K,I} \\
 & + X_{C,D}^{K,D} + X_{C,D}^{K,I} + X_{V,D}^{K,I} + X_{R,D}^{K,D} + X_{S,D}^{A,I} + X_{B,D}^{A,I} \\
 & + X_{OR,D}^{A,I} + X_{V,D}^{K,D} \leq 3333000 - X_{GNH,D}^{S,I} - X_{V,D}^{S,I} \\
 & \quad - X_{M,D}^{S,I} - X_{C,D}^{S,I}
 \end{aligned}$$

27) (Shallow)

$$\begin{aligned}
& X_{P,S}^{K,D} + X_{N,S}^{K,D} + X_{BL,S}^{K,D} + X_{BH,S}^{K,D} + X_{JL,S}^{K,D} + X_{JH,S}^{K,D} + X_{OC,S}^{K,D} \\
& + X_{T,S}^{K,D} + X_{M,S}^{K,D} + X_{U,S}^{K,D} + X_{OP,S}^{K,D} + X_{GNL,S}^{K,D} + X_{GNH,S}^{K,D} \\
& + X_{SF,S}^{K,D} + X_{OO,S}^{K,D} + X_{C,S}^{K,D} + X_{R,S}^{K,D} + X_{V,S}^{K,D} + X_{V,S}^{K,I} \\
& \leq 5582000 - X_{JL,S}^{R,D} - X_{JH,S}^{R,D}
\end{aligned}$$

28) (Medium)

$$\begin{aligned}
& X_{P,M}^{K,D} + X_{P,M}^{K,I} + X_{N,M}^{K,D} + X_{BL,M}^{K,D} + X_{BH,M}^{K,D} + X_{BH,M}^{K,I} \\
& + X_{JL,M}^{K,D} + X_{JH,M}^{K,D} + X_{JH,M}^{K,I} + X_{OC,M}^{K,D} + X_{T,M}^{K,D} + X_{M,M}^{K,D} \\
& + X_{M,M}^{K,I} + X_{U,M}^{K,D} + X_{U,M}^{K,I} + X_{OP,M}^{K,D} + X_{OP,M}^{K,I} + X_{GNL,M}^{K,D} \\
& + X_{GNH,M}^{K,D} + X_{GNH,M}^{K,I} + X_{SF,M}^{K,D} + X_{SF,M}^{K,I} + X_{OO,M}^{K,D} + X_{OO,M}^{K,I} \\
& + X_{C,M}^{K,D} + X_{C,M}^{K,I} + X_{R,M}^{K,D} + X_{V,M}^{K,I} + X_{S,M}^{A,I} + X_{B,M}^{A,I} \\
& + X_{OR,M}^{A,I} + X_{V,M}^{K,D} + X_{OC,M}^{K,I} \leq 80,600,00 - X_{JL,M}^{R,D} - X_{JH,M}^{R,D}
\end{aligned}$$

29) (Deep Black)

$$\begin{aligned}
& X_{P,D}^{K,D} + X_{P,D}^{K,I} + X_{N,D}^{K,D} + X_{BH,D}^{K,D} + X_{JL,D}^{K,D} + X_{JH,D}^{K,D} \\
& + X_{JH,D}^{K,I} + X_{OC,D}^{K,D} + X_{OC,D}^{K,I} + X_{T,D}^{K,D} + X_{M,D}^{K,D} + X_{M,D}^{K,I} \\
& + X_{U,D}^{K,D} + X_{U,D}^{K,I} + X_{OP,D}^{K,D} + X_{OP,D}^{K,I} + X_{GNL,D}^{K,D} + X_{GNH,D}^{K,D} \\
& + X_{GNH,D}^{K,I} + X_{SF,D}^{K,D} + X_{SF,D}^{K,I} + X_{OO,D}^{K,D} + X_{OO,D}^{K,I} + X_{C,D}^{K,D} \\
& + X_{C,D}^{K,I} + X_{V,D}^{K,I} + X_{R,D}^{K,D} + X_{S,D}^{A,I} + X_{B,D}^{A,I} + X_{OR,D}^{A,I} \\
& + X_{V,D}^{K,D} + X_{BH,D}^{K,I} \leq 3333000 - X_{JL,D}^{R,D} - X_{JH,D}^{R,D}
\end{aligned}$$

$$\begin{aligned}
30) & X_{JL,M}^{R,D} + X_{JH,M}^{R,D} + X_{JH,M}^{R,I} + X_{WL,M}^{R,D} + X_{WL,M}^{R,I} \\
& + X_{WH,M}^{R,D} + X_{WH,M}^{R,I} + X_{OC,M}^{R,D} + X_{OC,M}^{R,I} + X_{G,M}^{R,D} \\
& + X_{G,M}^{R,I} + X_{OP,M}^{R,D} + X_{SF,M}^{R,D} + X_{SF,M}^{R,I} + X_{OO,M}^{R,D} + X_{OO,M}^{R,I} \\
& + X_{V,M}^{R,I} + X_{S,M}^{A,I} + X_{B,M}^{A,I} + X_{OR,M}^{A,I} + X_{JL,M}^{R,I} \\
& \leq 80,600,00 - X_{C,M}^{K,I} - X_{P,M}^{K,I}
\end{aligned}$$

$$\begin{aligned}
31) & X_{JL,D}^{R,D} + X_{JH,D}^{R,D} + X_{JH,D}^{R,I} + X_{WL,D}^{R,D} + X_{WL,D}^{R,I} \\
& + X_{WH,D}^{R,D} + X_{WH,D}^{R,I} + X_{G,D}^{R,D} + X_{G,D}^{R,I} + X_{OP,D}^{R,D} + X_{SF,D}^{R,D} \\
& + X_{SF,D}^{R,I} + X_{OO,D}^{R,D} + X_{OO,D}^{R,I} + X_{V,D}^{R,I} + X_{S,D}^{A,I} + X_{B,D}^{A,I} \\
& + X_{JL,D}^{R,I} + X_{OR,D}^{A,I} \leq 33,330,00 - X_{C,D}^{K,I} - X_{P,D}^{K,I}
\end{aligned}$$

$$\begin{aligned}
32) & X_{JL,M}^{R,D} + X_{JH,M}^{R,D} + X_{JH,M}^{R,I} + X_{WL,M}^{R,D} + X_{WL,M}^{R,I} \\
& + X_{WH,M}^{R,D} + X_{WH,M}^{R,I} + X_{OC,M}^{R,D} + X_{OC,M}^{R,I} + X_{G,M}^{R,D} + X_{G,M}^{R,I} \\
& + X_{OP,M}^{R,D} + X_{SF,M}^{R,D} + X_{SF,M}^{R,I} + X_{OO,M}^{R,D} + X_{OO,M}^{R,I} + X_{V,M}^{R,I} \\
& + X_{S,M}^{A,I} + X_{B,M}^{A,I} + X_{OR,M}^{A,I} + X_{JL,M}^{R,I} \\
& \leq 80,600,00 - X_{JL,M}^{K,D} - X_{JH,M}^{K,D}
\end{aligned}$$

$$\begin{aligned}
33) & X_{JL,D}^{R,D} + X_{JH,D}^{R,D} + X_{JH,D}^{R,I} + X_{WL,D}^{R,D} + X_{WL,D}^{R,I} + X_{WH,D}^{R,D} \\
& + X_{WH,D}^{R,I} + X_{G,D}^{R,D} + X_{G,D}^{R,I} + X_{OP,D}^{R,D} + X_{SF,D}^{R,D} + X_{SF,D}^{R,I}
\end{aligned}$$

$$\begin{aligned}
 & X_{00,D}^{R,D} + X_{00,D}^{R,I} + X_{V,D}^{R,I} + X_{S,D}^{A,I} + X_{B,D}^{A,I} + X_{OR,D}^{A,I} \\
 & + X_{JL,M}^{R,I} \leq 33330,00 - X_{JL,D}^{K,D} - X_{JH,D}^{K,D}
 \end{aligned}$$

$$\begin{aligned}
 34) & X_{JL,S}^{R,D} + X_{JH,S}^{R,D} + X_{WH,S}^{R,D} + X_{OC,S}^{R,D} + X_{G,S}^{R,D} + X_{OP,S}^{R,D} \\
 & + X_{SF,S}^{R,D} + X_{00,S}^{R,D} + X_{V,S}^{R,I} \leq 55,820,00 - X_{JL,S}^{K,D} - X_{JH,S}^{K,D}
 \end{aligned}$$

$$35) \sum_i X_{i,M}^{R,D} + \sum_i X_{i,M}^{R,I} \leq 80,600,00 - X_{C,M}^{K,D}$$

$$36) \sum_i X_{i,D}^{R,D} + \sum_i X_{i,D}^{R,I} \leq 33,330,00 - X_{C,D}^{K,D}$$

$$37) \sum_i X_{i,S}^{R,D} + X_{V,S}^{R,I} \leq 55,820,00 - X_{C,S}^{K,D}$$

$$\begin{aligned}
 38) & X_{OC,M}^{R,D} + X_{OC,M}^{R,I} + X_{G,M}^{R,D} + X_{G,M}^{R,I} + X_{OP,M}^{R,D} + X_{SF,M}^{R,D} \\
 & + X_{SF,M}^{R,I} + X_{00,M}^{R,D} + X_{00,M}^{R,I} + X_{V,M}^{R,I} + X_{S,M}^{A,I} + X_{B,M}^{A,I} \\
 & + X_{OR,M}^{A,I} \leq 80,600,00 - X_{BH,M}^{K,I} - X_{JH,M}^{K,I} - X_{GNH,M}^{K,I}
 \end{aligned}$$

$$\begin{aligned}
 39) & X_{JL,M}^{R,D} + X_{JH,M}^{R,D} + X_{JH,M}^{R,I} + X_{OC,M}^{R,D} + X_{OC,M}^{R,I} + X_{G,M}^{R,D} \\
 & + X_{G,M}^{R,I} + X_{OP,M}^{R,D} + X_{SF,M}^{R,D} + X_{SF,M}^{R,I} + X_{00,M}^{R,D} + X_{00,M}^{R,I} \\
 & + X_{V,M}^{R,I} + X_{S,M}^{A,I} + X_{B,M}^{A,I} + X_{OR,M}^{A,I} + X_{JL,M}^{R,I} \\
 & \leq 80,600,00 - X_{JH,M}^{K,I}
 \end{aligned}$$

$$\begin{aligned}
 40) & X_{G,D}^{R,D} + X_{G,D}^{R,I} + X_{OP,D}^{R,D} + X_{SF,D}^{R,D} + X_{SF,D}^{R,I} + X_{OO,D}^{R,D} \\
 & + X_{OO,D}^{R,I} + X_{V,D}^{R,I} + X_{S,D}^{A,I} + X_{B,D}^{A,I} + X_{OR,D}^{A,I} \\
 & \leq 33,330,00 - X_{BH,D}^{K,I} - X_{JH,D}^{K,I} - X_{GNH,D}^{K,I}
 \end{aligned}$$

$$\begin{aligned}
 41) & X_{JL,D}^{R,D} + X_{JH,D}^{R,D} + X_{JH,D}^{R,I} + X_{G,D}^{R,D} + X_{G,D}^{R,I} + X_{OP,D}^{R,D} \\
 & + X_{SF,D}^{R,D} + X_{SF,D}^{R,I} + X_{OO,D}^{R,D} + X_{OO,D}^{R,I} + X_{V,D}^{R,I} + X_{S,D}^{A,I} \\
 & + X_{B,D}^{A,I} + X_{OR,D}^{A,I} + X_{JL,D}^{R,I} \leq 33,330,00 - X_{JH,D}^{K,I}
 \end{aligned}$$

Water Requirements :- (Kharif)

$$\begin{aligned}
 42) & [X_{P,M}^{K,I} + X_{P,D}^{K,I} + X_{P,Y}^{K,I}] 0.40 + [X_{BH,M}^{K,I} + X_{BH,D}^{K,I}] 0.15 \\
 & + [X_{JH,M}^{K,I} + X_{JH,D}^{K,I}] 0.25 + [X_{OC,M}^{K,I} + X_{OC,D}^{K,I} + X_{OC,Y}^{K,I}] 0.25 \\
 & + [X_{M,M}^{K,I} + X_{M,D}^{K,I}] 0.25 + [X_{U,M}^{K,I} + X_{U,D}^{K,I} + X_{U,Y}^{K,I}] 0.25 \\
 & + [X_{OP,M}^{K,I} + X_{OP,D}^{K,I} + X_{OP,Y}^{K,I}] 0.25 + [X_{GNH,M}^{K,I} + X_{GNH,D}^{K,I} \\
 & + X_{GNH,Y}^{K,I}] 0.30 + [X_{SF,M}^{K,I} + X_{SF,D}^{K,I}] 0.25 + [X_{OO,M}^{K,I} \\
 & + X_{OO,D}^{K,I} + X_{OO,Y}^{K,I}] 0.25 + [X_{C,M}^{K,I} + X_{C,D}^{K,I}] 0.25 \\
 & + [X_{V,S}^{K,I} + X_{V,M}^{K,I} + X_{V,D}^{K,I}] 0.60 + [X_{S,M}^{A,I} + X_{S,D}^{A,I}] 0.75 \\
 & + [X_{B,M}^{A,I} + X_{B,D}^{A,I}] 0.25 + [X_{OR,M}^{A,I} + X_{OR,D}^{A,I}] 0.50 \\
 & \leq 13,80,000 \text{ (Ha-metre)}
 \end{aligned}$$

43) Summer

$$\begin{aligned} & \left[X_{GNH,S}^{S,I} + X_{GNH,M}^{S,I} + X_{GNH,D}^{S,I} \right] 1.00 + \left[X_{P,L}^{S,I} + X_{P,Y}^{S,I} \right] 1.00 \\ & + \left[X_{V,M}^{S,I} + X_{V,D}^{S,I} \right] 1.00 + \left[X_{C,M}^{S,I} + X_{C,D}^{S,I} \right] 0.60 + \left[X_{M,M}^{S,I} \right. \\ & \left. + X_{M,D}^{S,I} \right] 0.55 + \left[X_{S,M}^{A,I} + X_{S,D}^{A,I} \right] 1.25 + \left[X_{B,M}^{A,I} + X_{B,D}^{A,I} \right] 1.75 \\ & + \left[X_{OR,M}^{A,I} + X_{OR,D}^{A,I} \right] 0.80 \leq 900000 \text{ (Ha-metre)} \end{aligned}$$

44) Rabi

$$\begin{aligned} & \left[X_{JH,M}^{R,I} + X_{JH,D}^{R,I} \right] 0.45 + \left[X_{WL,M}^{R,I} + X_{WL,D}^{R,I} + X_{WL,Y}^{R,I} \right] 0.45 \\ & + \left[X_{WH,M}^{R,I} + X_{WH,D}^{R,I} + X_{WH,Y}^{R,I} \right] 0.55 + \left[X_{OC,M}^{R,I} \right] 0.35 \\ & + \left[X_{G,M}^{R,I} + X_{G,D}^{R,I} + X_{G,Y}^{R,I} \right] 0.35 + \left[X_{SF,M}^{R,I} + X_{SF,D}^{R,I} \right] 0.35 \\ & + \left[X_{OO,M}^{R,I} + X_{OO,D}^{R,I} + X_{OO,Y}^{R,I} \right] 0.35 + \left[X_{V,S}^{R,I} + X_{V,M}^{R,I} \right. \\ & \left. + X_{V,D}^{R,I} \right] 1.00 + \left[X_{S,M}^{A,I} + X_{S,D}^{A,I} \right] 1.50 + \left[X_{B,M}^{A,I} + X_{B,D}^{A,I} \right] 2.00 \\ & + \left[X_{OR,M}^{A,I} + X_{OR,D}^{A,I} \right] 1.00 + \left[X_{JL,M}^{R,I} + X_{JL,D}^{R,I} + X_{JL,Y}^{R,I} \right] 0.45 \\ & \leq 2530000 \text{ (Ha-meters)} \end{aligned}$$

45) Jowar

$$\begin{aligned} & \left[X_{JL,S}^{K,D} + X_{JL,M}^{K,D} + X_{JL,D}^{K,D} + X_{JL,L}^{K,D} + X_{JL,H}^{K,D} + X_{JL,Y}^{K,D} \right] 575 \\ & + \left[X_{JH,S}^{K,D} + X_{JH,M}^{K,D} + X_{JH,D}^{K,D} \right] 1330 + \left[X_{JH,M}^{K,I} + X_{JH,D}^{K,I} \right] 2000 \\ & + \left[X_{JH,S}^{R,D} + X_{JH,M}^{R,D} + X_{JH,D}^{R,D} \right] 700 + \left[X_{JH,M}^{R,I} + X_{JH,D}^{R,I} \right] 2000 \\ & + \left[X_{JL,S}^{R,D} + X_{JL,M}^{R,D} + X_{JL,D}^{R,D} + X_{JL,L}^{R,D} + X_{JL,H}^{R,D} + X_{JL,Y}^{R,D} \right] 400 \\ & \geq 6444880000 \text{ kg} \end{aligned}$$

46) Pulses

$$\begin{aligned}
& \left[X_{T,S}^{K,D} + X_{T,M}^{K,D} + X_{T,D}^{K,D} + X_{T,L}^{K,D} + X_{T,H}^{K,D} + X_{T,Y}^{K,D} \right] 600 \\
& + \left[X_{M,S}^{K,D} + X_{M,M}^{K,D} + X_{M,D}^{K,D} + X_{M,L}^{K,D} + X_{M,H}^{K,D} \right] 300 + \left[X_{M,M}^{K,I} \right. \\
& \left. + X_{M,D}^{K,I} \right] 1000 + \left[X_{U,S}^{K,D} + X_{U,M}^{K,D} + X_{U,D}^{K,D} + X_{U,L}^{K,D} + X_{U,H}^{K,D} \right. \\
& \left. + X_{U,Y}^{K,D} \right] 350 + \left[X_{U,M}^{K,I} + X_{U,D}^{K,I} + X_{U,Y}^{K,I} \right] 1000 + \left[X_{OP,S}^{K,D} + X_{OP,M}^{K,D} \right. \\
& \left. + X_{OP,D}^{K,D} + X_{OP,L}^{K,D} + X_{OP,H}^{K,D} + X_{OP,Y}^{K,D} \right] 300 + \left[X_{OP,M}^{K,I} + X_{OP,D}^{K,I} \right. \\
& \left. + X_{OP,Y}^{K,I} \right] 900 + \left[X_{G,S}^{R,D} + X_{G,M}^{R,D} + X_{G,D}^{R,D} + X_{G,L}^{R,D} + X_{G,H}^{R,D} \right. \\
& \left. + X_{G,Y}^{R,D} \right] 430 + \left[X_{G,M}^{R,I} + X_{G,D}^{R,I} + X_{G,Y}^{R,I} \right] 800 + \left[X_{OP,S}^{R,D} \right. \\
& \left. + X_{OP,M}^{R,D} + X_{OP,D}^{R,D} \right] 300 + \left[X_{M,M}^{S,I} + X_{M,D}^{S,I} \right] 1000 \\
& \geq 1749300,000 \text{ kg}
\end{aligned}$$

47) Oilseeds

$$\begin{aligned}
& \left[X_{GNL,S}^{K,D} + X_{GNL,M}^{K,D} + X_{GNL,D}^{K,D} + X_{GNL,L}^{K,D} + X_{GNL,H}^{K,D} + X_{GNL,Y}^{K,D} \right] 700 \\
& + \left[X_{GNH,S}^{K,D} + X_{GNH,M}^{K,D} + X_{GNH,D}^{K,D} + X_{GNH,L}^{K,D} + X_{GNH,H}^{K,D} + X_{GNH,Y}^{K,D} \right] 1000 \\
& + \left[X_{GNH,M}^{K,I} + X_{GNH,D}^{K,I} + X_{GNH,Y}^{K,I} \right] 1300 + \left[X_{SF,S}^{K,D} + X_{SF,M}^{K,D} \right. \\
& \left. + X_{SF,D}^{K,D} \right] 500 + \left[X_{SF,M}^{K,I} + X_{SF,D}^{K,I} \right] 1100 + \left[X_{OO,S}^{K,D} + X_{OO,M}^{K,D} \right. \\
& \left. + X_{OO,D}^{K,D} + X_{OO,L}^{K,D} + X_{OO,H}^{K,D} + X_{OO,Y}^{K,D} \right] 400 + \left[X_{OO,M}^{K,I} + X_{OO,D}^{K,I} \right. \\
& \left. + X_{OO,Y}^{K,I} \right] 900 + \left[X_{SF,S}^{R,D} + X_{SF,M}^{R,D} + X_{SF,D}^{R,D} \right] 600 + \left[X_{SF,M}^{R,I} \right. \\
& \left. + X_{SF,D}^{R,I} \right] 1200 + \left[X_{OO,S}^{R,D} + X_{OO,M}^{R,D} + X_{OO,D}^{R,D} + X_{OO,Y}^{R,D} \right] 350 \\
& + \left[X_{OO,M}^{R,I} + X_{OO,D}^{R,I} + X_{OO,Y}^{R,I} \right] 1000 + \left[X_{GNH,S}^{S,I} + X_{GNH,M}^{S,I} \right]
\end{aligned}$$

$$+ X_{GNH,D}^{S,I}] 1380 \geq 15340,00,000 \text{ Kg}$$

48) Sugarcane

$$[X_{S,I,M}^{A,I} + X_{S,I,D}^{A,I}] 100,00,0 \geq 100,440,00,000 \text{ Kg}$$

Individual crop constraints:-

Kharif - (Dry)

49) Paddy dry

$$X_{P,S}^{K,D} + X_{P,M}^{K,D} + X_{P,D}^{K,D} + X_{P,L}^{K,D} + X_{P,H}^{K,D} + X_{P,C}^{K,D} + X_{P,Y}^{K,D} \\ \leq 136,83,60 \text{ Ha}$$

50) Nagli

$$X_{N,S}^{K,D} \geq 49300 \text{ Ha}$$

$$51) X_{N,L}^{K,D} \geq 1100,00 \text{ Ha}$$

$$52) X_{N,H}^{K,D} \geq 767,00 \text{ Ha}$$

$$53) X_{N,S}^{K,D} + X_{N,M}^{K,D} + X_{N,D}^{K,D} + X_{N,L}^{K,D} + X_{N,H}^{K,D} \\ \leq 2880,00 \text{ Ha}$$

54) Bajra Local dry

$$X_{BL,S}^{K,D} \geq 5160,00 \text{ Ha}$$

$$55) X_{BL,M}^{K,D} \geq 1135,00 \text{ Ha}$$

$$56) X_{BL,H}^{K,D} \geq 660,00 \text{ Ha}$$

$$57) X_{BL,S}^{K,D} + X_{BL,M}^{K,D} + X_{BL,H}^{K,D} \leq 834600 \text{ Ha}$$

Bajra Hybrid Dry

$$58) X_{BH,S}^{K,D} \geq 730600 \text{ Ha}$$

$$59) X_{BH,M}^{K,D} \geq 255600 \text{ Ha}$$

$$60) X_{BH,D}^{K,D} \geq 70800 \text{ Ha}$$

61) Jowar Local Dry

$$X_{JL,S}^{K,D} + X_{JL,M}^{K,D} + X_{JL,D}^{K,D} + X_{JL,L}^{K,D} + X_{JL,H}^{K,D} + X_{JL,Y}^{K,D} \\ \geq 700000 \text{ Ha}$$

62) Jowar Hybrid Dry

$$X_{JH,S}^{K,D} + X_{JH,M}^{K,D} + X_{JH,D}^{K,D} \leq 2486900 \text{ Ha}$$

63) Other Cereals

$$X_{OC,S}^{K,D} + X_{OC,M}^{K,D} + X_{OC,D}^{K,D} + X_{OC,L}^{K,D} + X_{OC,H}^{K,D} + X_{OC,Y}^{K,D} \\ \leq 258960 \text{ Ha}$$

Pulses

$$64) X_{T,S}^{K,D} + X_{T,M}^{K,D} + X_{T,D}^{K,D} + X_{T,L}^{K,D} + X_{T,H}^{K,D} + X_{T,Y}^{K,D} \\ \leq 950560 \text{ Ha}$$

$$65) X_{M,S}^{K,D} + X_{M,M}^{K,D} + X_{M,D}^{K,D} + X_{M,L}^{K,D} + X_{M,H}^{K,D} \leq 676000 \text{ Ha}$$

$$66) X_{U,S}^{K,D} + X_{U,M}^{K,D} + X_{U,D}^{K,D} + X_{U,L}^{K,D} + X_{U,H}^{K,D} + X_{U,Y}^{K,D} \\ \leq 61100 \text{ Ha}$$

$$67) X_{OP,S}^{K,D} + X_{OP,M}^{K,D} + X_{OP,D}^{K,D} + X_{OP,L}^{K,D} + X_{OP,H}^{K,D} + X_{OP,Y}^{K,D} \\ \leq 708500 \text{ Ha}$$

Groundnut

68) Local + HYV dry

$$X_{GNL,S}^{K,D} + X_{GNL,M}^{K,D} + X_{GNL,D}^{K,D} + X_{GNL,L}^{K,D} + X_{GNL,H}^{K,D} + X_{GNL,Y}^{K,D} \\ + X_{GNH,S}^{K,D} + X_{GNH,M}^{K,D} + X_{GNH,D}^{K,D} + X_{GNH,L}^{K,D} + X_{GNH,H}^{K,D} \\ + X_{GNH,Y}^{K,D} \leq 735240 \text{ Ha}$$

69) Local, HYV (Dry + irrigated)

$$X_{GNL,S}^{K,D} + X_{GNL,M}^{K,D} + X_{GNL,D}^{K,D} + X_{GNL,L}^{K,D} + X_{GNL,H}^{K,D} + X_{GNL,Y}^{K,D} \\ + X_{GNH,S}^{K,D} + X_{GNH,M}^{K,D} + X_{GNH,D}^{K,D} + X_{GNH,L}^{K,D} + X_{GNH,H}^{K,D} + X_{GNH,Y}^{K,D} \\ + X_{GNH,H}^{K,I} + X_{GNH,D}^{K,I} + X_{GNH,Y}^{K,I} \geq 7000,00 \text{ Ha}$$

70) Local Dry

$$X_{GNL,S}^{K,D} + X_{GNL,M}^{K,D} + X_{GNL,D}^{K,D} + X_{GNL,L}^{K,D} + X_{GNL,H}^{K,D} + X_{GNL,Y}^{K,D} \\ \geq 2000,00 \text{ Ha}$$

71) Sunflower

$$X_{SF,S}^{K,D} + X_{SF,M}^{K,D} + X_{SF,D}^{K,D} \leq 177060 \text{ Ha}$$

72) Other oilseeds

$$X_{00,S}^{K,D} + X_{00,M}^{K,D} + X_{00,D}^{K,D} + X_{00,L}^{K,D} + X_{00,H}^{K,D} + X_{00,Y}^{K,D} \leq 683020 \text{ Ha}$$

73) Cotton

$$X_{C,S}^{K,D} + X_{C,M}^{K,D} + X_{C,D}^{K,D} + X_{C,H}^{K,D} \leq 3482660 \text{ Ha}$$

Kharif Irrigated74) Bajra Hybrid

$$X_{BH,M}^{K,I} + X_{BH,D}^{K,I} \geq 600,00 \text{ Ha}$$

75) Moong

$$X_{M,M}^{K,I} + X_{M,D}^{K,I} \geq 2500 \text{ Ha}$$

76) Udid

$$X_{U,M}^{K,I} + X_{U,D}^{K,I} + X_{U,Y}^{K,I} \geq 1000 \text{ Ha}$$

77) Other pulses

$$X_{OP,M}^{K,I} + X_{OP,D}^{K,I} + X_{OP,Y}^{K,I} \geq 5000 \text{ Ha}$$

Rabi78) Jowar Local Dry

$$X_{JL,S}^{R,D} + X_{JL,M}^{R,D} + X_{JL,D}^{R,D} + X_{JL,L}^{R,D} + X_{JL,H}^{R,D} + X_{JL,Y}^{R,D} \leq 24000,00 \text{ Ha}$$

79) Jowar Local Irrigated

$$X_{JL,M}^{R,I} + X_{JL,D}^{R,I} + X_{JL,Y}^{R,I} \geq 2000,00 \text{ Ha}$$

80) Jowar Hybrid Dry

$$X_{JH,S}^{R,D} + X_{JH,M}^{R,D} + X_{JH,D}^{R,D} \geq 9000,00 \text{ Ha}$$

81) Jowar Hybrid Irrigated

$$X_{JH,M}^{R,I} + X_{JH,D}^{R,I} \geq 2500,00 \text{ Ha}$$

82) Wheat (Total)

$$\begin{aligned} & X_{WL,M}^{R,D} + X_{WL,D}^{R,D} + X_{WL,L}^{R,D} + X_{WL,H}^{R,D} + X_{WL,Y}^{R,D} + X_{WL,M}^{R,I} \\ & + X_{WL,D}^{R,I} + X_{WL,Y}^{R,I} + X_{WH,S}^{R,D} + X_{WH,M}^{R,D} + X_{WH,D}^{R,D} + X_{WH,H}^{R,D} + X_{WH,Y}^{R,D} \\ & + X_{WH,M}^{R,I} + X_{WH,D}^{R,I} + X_{WH,Y}^{R,I} \geq 1183200 \text{ Ha} \end{aligned}$$

83) Gram (Total)

$$\begin{aligned} & X_{G,S}^{R,D} + X_{G,M}^{R,D} + X_{G,D}^{R,D} + X_{G,L}^{R,D} + X_{G,H}^{R,D} + X_{G,Y}^{R,D} + X_{G,M}^{R,I} \\ & + X_{G,D}^{R,I} + X_{G,Y}^{R,I} \leq 593880 \text{ Ha} \end{aligned}$$

84) Other pulses

$$X_{OP,S}^{R,D} + X_{OP,M}^{R,D} + X_{OP,D}^{R,D} \leq 240000 \text{ Ha}$$

85) Sunflower

$$X_{SF,S}^{R,D} + X_{SF,M}^{R,D} + X_{SF,D}^{R,D} + X_{SF,M}^{R,I} + X_{SF,D}^{R,I} \leq 68760 \text{ Ha}$$

86) Other oilseeds

$$\begin{aligned} & X_{OO,S}^{R,D} + X_{OO,M}^{R,D} + X_{OO,D}^{R,D} + X_{OO,M}^{R,I} + X_{OO,D}^{R,I} + X_{OO,Y}^{R,D} \\ & + X_{OO,Y}^{R,I} \leq 979560 \text{ Ha} \end{aligned}$$

$$\begin{aligned}
 87) & X_{P,S}^{K,D} + X_{N,S}^{K,D} + X_{BL,S}^{K,D} + X_{BH,S}^{K,D} + X_{JL,S}^{K,D} + X_{JH,S}^{K,D} \\
 & + X_{OC,S}^{K,D} + X_{T,S}^{K,D} + X_{M,S}^{K,D} + X_{U,S}^{K,D} + X_{OP,S}^{K,D} + X_{GNL,S}^{K,D} \\
 & + X_{GNH,S}^{K,D} + X_{SF,S}^{K,D} + X_{OO,S}^{K,D} + X_{C,S}^{K,D} + X_{R,S}^{K,D} + X_{V,S}^{K,I} \\
 & + X_{V,S}^{K,D} \geq 41548 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 88) & X_{P,M}^{K,D} + X_{P,M}^{K,I} + X_{N,M}^{K,D} + X_{BL,M}^{K,D} + X_{BH,M}^{K,D} + X_{BH,M}^{K,I} \\
 & + X_{JL,M}^{K,D} + X_{JH,M}^{K,D} + X_{JH,M}^{K,I} + X_{OC,M}^{K,D} + X_{OC,M}^{K,I} + X_{T,M}^{K,D} \\
 & + X_{M,M}^{K,D} + X_{M,M}^{K,I} + X_{U,M}^{K,D} + X_{U,M}^{K,I} + X_{OP,M}^{K,D} + X_{OP,M}^{K,I} \\
 & + X_{GNL,M}^{K,D} + X_{GNH,M}^{K,D} + X_{GNH,M}^{K,I} + X_{SF,M}^{K,D} + X_{SF,M}^{K,I} + X_{OO,M}^{K,D} \\
 & + X_{OO,M}^{K,I} + X_{C,M}^{K,D} + X_{C,M}^{K,I} + X_{R,M}^{K,D} + X_{V,M}^{K,I} + X_{S,M}^{A,I} \\
 & + X_{B,M}^{A,I} + X_{OR,M}^{A,I} + X_{V,M}^{K,D} \geq 56047 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 89) & X_{P,D}^{K,D} + X_{P,D}^{K,I} + X_{N,D}^{K,D} + X_{BH,D}^{K,D} + X_{BH,D}^{K,I} + X_{JL,D}^{K,D} \\
 & + X_{JH,D}^{K,D} + X_{JH,D}^{K,I} + X_{OC,D}^{K,D} + X_{OC,D}^{K,I} + X_{T,D}^{K,D} + X_{M,D}^{K,D} \\
 & + X_{M,D}^{K,I} + X_{U,D}^{K,D} + X_{U,D}^{K,I} + X_{OP,D}^{K,D} + X_{OP,D}^{K,I} + X_{GNL,D}^{K,D} \\
 & + X_{GNH,D}^{K,D} + X_{GNH,D}^{K,I} + X_{SF,D}^{K,D} + X_{SF,D}^{K,I} + X_{OO,D}^{K,D} + X_{OO,D}^{K,I} \\
 & + X_{C,D}^{K,D} + X_{C,D}^{K,I} + X_{R,D}^{K,D} + X_{V,D}^{K,I} + X_{S,D}^{A,I} + X_{B,D}^{A,I} + X_{OR,D}^{A,I} \\
 & + X_{V,D}^{K,D} \geq 22830 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 90) & X_{P,Y}^{K,D} + X_{P,Y}^{K,I} + X_{JL,Y}^{K,D} + X_{OC,Y}^{K,D} + X_{OC,Y}^{K,I} + X_{T,Y}^{K,D} \\
 & + X_{U,Y}^{K,D} + X_{U,Y}^{K,I} + X_{OP,Y}^{K,D} + X_{OP,Y}^{K,I} + X_{GNL,Y}^{K,D} + X_{GNH,Y}^{K,D} \\
 & + X_{GNH,Y}^{K,I} + X_{OO,Y}^{K,D} + X_{OO,Y}^{K,I} + X_{R,Y}^{K,D} \geq 5993 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 91) & X_{JL,S}^{R,D} + X_{JH,S}^{R,D} + X_{WH,S}^{R,D} + X_{OC,S}^{R,D} + X_{G,S}^{R,D} + X_{OP,S}^{R,D} \\
 & + X_{SF,S}^{R,D} + X_{OO,S}^{R,D} + X_{V,S}^{R,I} \geq 12890 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 92) & X_{JL,M}^{R,D} + X_{JH,M}^{R,D} + X_{JH,M}^{R,I} + X_{WL,M}^{R,D} + X_{WL,M}^{R,I} \\
 & + X_{WH,M}^{R,D} + X_{WH,M}^{R,I} + X_{OC,M}^{R,D} + X_{OC,M}^{R,I} + X_{G,M}^{R,D} + X_{G,M}^{R,I} \\
 & + X_{OP,M}^{R,D} + X_{SF,M}^{R,D} + X_{SF,M}^{R,I} + X_{OO,M}^{R,D} + X_{OO,M}^{R,I} + X_{V,M}^{R,I} \\
 & + X_{JL,M}^{R,I} + X_{S,M}^{A,I} + X_{B,M}^{A,I} + X_{OR,M}^{A,I} \geq 33030 \text{ ('00 Ha)}
 \end{aligned}$$

$$\begin{aligned}
 93) & X_{JL,D}^{R,D} + X_{JH,D}^{R,D} + X_{JH,D}^{R,I} + X_{WL,D}^{R,D} + X_{WL,D}^{R,I} + X_{WH,D}^{R,D} \\
 & + X_{WH,D}^{R,I} + X_{G,D}^{R,D} + X_{G,D}^{R,I} + X_{OP,D}^{R,D} + X_{SF,D}^{R,D} + X_{SF,D}^{R,I} \\
 & + X_{OO,D}^{R,D} + X_{OO,D}^{R,I} + X_{V,D}^{R,I} + X_{S,D}^{A,I} + X_{JL,D}^{R,I} + X_{B,D}^{A,I} \\
 & + X_{OR,D}^{A,I} \geq 14739 \text{ ('00 Ha)}
 \end{aligned}$$

$$94) X_{JL,Y}^{R,D} + X_{WL,Y}^{R,D} + X_{WH,Y}^{R,D} + X_{WL,Y}^{R,I} + X_{WH,Y}^{R,I} + X_{G,Y}^{R,D}$$

$$+ X_{G,Y}^{R,I} + X_{OO,Y}^{R,D} + X_{OO,Y}^{R,I} + X_{JL,Y}^{R,I} \geq 1430 \text{ (00 Ha)}$$

$$95) X_{P,S}^{K,D} + X_{P,M}^{K,D} + X_{P,D}^{K,D} + X_{P,L}^{K,D} + X_{P,H}^{K,D} \\ + X_{P,C}^{K,D} + X_{P,Y}^{K,D} \geq 912240 \text{ Ha}$$

$$96) X_{N,S}^{K,D} + X_{N,M}^{K,D} + X_{N,D}^{K,D} + X_{N,L}^{K,D} + X_{N,H}^{K,D} \geq 192000 \text{ Ha}$$

$$97) X_{BL,S}^{K,D} + X_{BL,M}^{K,D} + X_{BL,H}^{K,D} \geq 556400 \text{ Ha}$$

$$98) X_{JH,S}^{K,D} + X_{JH,M}^{K,D} + X_{JH,D}^{K,D} \geq 1339100 \text{ Ha}$$

$$99) X_{OC,S}^{K,D} + X_{OC,M}^{K,D} + X_{OC,D}^{K,D} + X_{OC,L}^{K,D} + X_{OC,H}^{K,D} \\ + X_{OC,Y}^{K,D} \geq 172640 \text{ Ha}$$

$$100) X_{T,S}^{K,D} + X_{T,M}^{K,D} + X_{T,D}^{K,D} + X_{T,L}^{K,D} + X_{T,H}^{K,D} \\ + X_{T,Y}^{K,D} \geq 658080 \text{ Ha}$$

$$101) X_{M,S}^{K,D} + X_{M,M}^{K,D} + X_{M,D}^{K,D} + X_{M,L}^{K,D} + X_{M,H}^{K,D} \geq 468000 \text{ Ha}$$

$$102) X_{U,S}^{K,D} + X_{U,M}^{K,D} + X_{U,D}^{K,D} + X_{U,L}^{K,D} + X_{U,H}^{K,D} \\ + X_{U,Y}^{K,D} \geq 423000 \text{ Ha}$$

$$103) X_{OP,S}^{K,D} + X_{OP,M}^{K,D} + X_{OP,D}^{K,D} + X_{OP,L}^{K,D} + X_{OP,H}^{K,D} \\ + X_{OP,Y}^{K,D} \geq 490500$$

$$104) X_{GNL,S}^{K,D} + X_{GNL,M}^{K,D} + X_{GNL,D}^{K,D} + X_{GNL,L}^{K,D} + X_{GNL,H}^{K,D} \\ + X_{GNL,Y}^{K,D} + X_{GNH,S}^{K,D} + X_{GNH,M}^{K,D} + X_{GNH,D}^{K,D} + X_{GNH,L}^{K,D} \\ + X_{GNH,H}^{K,D} + X_{GNH,Y}^{K,D} \geq 551430 \text{ Ha}$$

$$105) X_{SF,S}^{K,D} + X_{SF,M}^{K,D} + X_{SF,D}^{K,D} \geq 136200 \text{ Ha}$$

$$106) X_{OO,S}^{K,D} + X_{OO,M}^{K,D} + X_{OO,D}^{K,D} + X_{OO,L}^{K,D} + X_{OO,H}^{K,D} \\ + X_{OO,Y}^{K,D} \geq 525400 \text{ Ha}$$

$$107) X_{C,S}^{K,D} + X_{C,M}^{K,D} + X_{C,D}^{K,D} + X_{C,H}^{K,D} \geq 2685200 \text{ Ha}$$

$$108) X_{JL,S}^{R,D} + X_{JL,M}^{R,D} + X_{JL,D}^{R,D} + X_{JL,L}^{R,D} + X_{JL,H}^{R,D} \\ + X_{JL,Y}^{R,D} \geq 16000,00 \text{ Ha}$$

$$109) X_{G,S}^{R,D} + X_{G,M}^{R,D} + X_{G,D}^{R,D} + X_{G,L}^{R,D} + X_{G,H}^{R,D} \\ + X_{G,Y}^{R,D} + X_{G,M}^{R,I} + X_{G,D}^{R,I} + X_{G,Y}^{R,I} \geq 494900 \text{ Ha}$$

$$110) X_{OP,S}^{R,D} + X_{OP,M}^{R,D} + X_{OP,D}^{R,D} \geq 2000,00 \text{ Ha}$$

$$111) X_{SF,S}^{R,D} + X_{SF,M}^{R,D} + X_{SF,D}^{R,D} + X_{SF,M}^{R,I} + X_{SF,D}^{R,I} \geq 57300 \text{ Ha}$$

$$112) X_{OO,S}^{R,D} + X_{OO,M}^{R,D} + X_{OO,D}^{R,D} + X_{OO,M}^{R,I} + X_{OO,D}^{R,I} \\ + X_{OO,Y}^{R,D} + X_{OO,Y}^{R,I} \geq 816300 \text{ Ha}$$

Individual crop constraints
(For Irrigated crops with existing level of
cropping acrages)

Kharif

$$113) X_{P,M}^{K,I} + X_{P,D}^{K,I} + X_{P,Y}^{K,I} \geq 3810 \text{ ('00 Ha)}$$

$$114) X_{BH,M}^{K,I} + X_{BH,D}^{K,I} \geq 600 \text{ ('00 Ha)}$$

$$115) X_{JH,M}^{K,I} + X_{JH,D}^{K,I} \geq 950 \text{ ('00 Ha)}$$

$$116) X_{OC,M}^{K,I} + X_{OC,D}^{K,I} + X_{OC,Y}^{K,I} \geq 325 \text{ ('00 Ha)}$$

$$117) X_{M,M}^{K,I} + X_{M,D}^{K,I} \geq 25 \text{ ('00 Ha)}$$

$$118) X_{U,M}^{K,I} + X_{U,D}^{K,I} + X_{U,Y}^{K,I} \geq 10 \text{ ('00 Ha)}$$

$$119) X_{OP,M}^{K,I} + X_{OP,D}^{K,I} + X_{OP,Y}^{K,I} \geq 60 \text{ ('00 Ha)}$$

$$120) X_{GNH,M}^{K,I} + X_{GNH,D}^{K,I} + X_{GNH,Y}^{K,I} \geq 190 \text{ ('00 Ha)}$$

$$121) X_{OO,M}^{K,I} + X_{OO,D}^{K,I} + X_{OO,Y}^{K,I} \geq 30 \text{ ('00 Ha)}$$

$$122) X_{C,M}^{K,I} + X_{C,D}^{K,I} \geq 1300 \text{ ('00 Ha)}$$

$$123) X_{V,S}^{K,I} + X_{V,M}^{K,I} + X_{V,D}^{K,I} \geq 2300 \text{ ('00 Ha)}$$

$$124) X_{S,M}^{A,I} + X_{S,D}^{A,I} \geq 3593 \text{ ('00 Ha)}$$

$$125) X_{B,M}^{A,I} + X_{B,D}^{A,I} \geq 960 \text{ ('00 Ha)}$$

Summer

$$126) X_{GNH,S}^{S,I} + X_{GNH,M}^{S,I} + X_{GNH,D}^{S,I} \geq 985 \text{ ('00 Ha)}$$

$$127) X_{P,L}^{S,I} + X_{P,Y}^{S,I} \geq 290 \text{ ('00 Ha)}$$

Rabi

$$128) X_{JH,M}^{R,I} + X_{JH,D}^{R,I} \geq 1519 \text{ ('00 Ha)}$$

$$129) X_{WH,M}^{R,I} + X_{WH,D}^{R,I} + X_{WH,Y}^{R,I} \geq 6000 \text{ ('00 Ha)}$$

$$130) X_{OC,M}^{R,I} \geq 100 \text{ ('00 Ha)}$$

$$131) X_{G,M}^{R,I} + X_{G,D}^{R,I} + X_{G,Y}^{R,I} \geq 900 \text{ ('00 Ha)}$$

$$132) X_{SF,M}^{R,I} + X_{SF,D}^{R,I} \geq 20 \text{ ('00 Ha)}$$

$$133) X_{OO,M}^{R,I} + X_{OO,D}^{R,I} + X_{OO,Y}^{R,I} \geq 280 \text{ ('00 Ha)}$$

$$134) X_{V,S}^{R,I} + X_{V,M}^{R,I} + X_{V,D}^{R,I} \geq 652 \text{ ('00 Ha)}$$

$$135) X_{JL,M}^{R,I} + X_{JL,D}^{R,I} + X_{JL,Y}^{R,I} \geq 2781 \text{ ('00 Ha)}$$

GLOSSARY OF PLANTS

<u>Marathi/Hindi Name</u>	<u>Botanical Name</u>
Adulsa	Adhetoda vasica
Ain	Terminalia tomentosa
Amba/Mango	Mangifera 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

<u>Marathi/Hindi Name</u>	<u>Botanical Name</u>
Mahua	Madhuka indica
Munja	Secchrum munja
Mosambi	Citrus sinensis
Moth	Vigna aconitifolia
Nachani/Ragi	Eleusine coracana
Neem/Kadulimb	Azadirachta indica
Nirgudi	Vitex negundo
Palas	Butea monosperma
Pangara	Erythrina variegata
Papae	Carica papaya
Peroo/Guava	Psidium guajava
Phog	Callignum polygonoides
Ritha	Sapindus emarginatus
Rui	Calotropis procera
Saal	Boswellia serrata
Serpagandha	Rauwolfia serpentina
Sawa	Panicum miliare
Sawar	Bombax malabaricum
Shatawari	Asparagus racemosus
Shewari	Sesbania aegyptiaca
Shikekai	Acacia rugata
Shisam/Sissum	Dalbergia lalifolia
Shivan	Gmelina arborea
Siris	Albizzia lebbek
Sisoo	Dalbergia sissoo
Sitaphal/Custardapple	Anona squamosa
Subabhul	Leucaena leucocephala
Tendu	Diospyros embroyopteris
Vari	Panicum miliaceum
Vavding	Embelia tsjeriam

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