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A STUDY OF THE UTILISATION OF IRRIGATION POTENTIAL OF THE PURNA IRRIGATION PROJECT

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A STUDY OF THE UTILISATION OF IRRIGATION POTENTIAL OF THE PURNA IRRIGATION PROJECT

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CHAPTER I

STATEMENT OF THE PROBLEM

1.1 Need for Irrigation

Next to air, water is most vital for plant and animal life. It is not only essential for the sustenance of life but is essential in myriads of human activities. It is no wonder that civilisations grew around and flowered and perished on people's capability to make proper use of water.

In India, the production of both food and fibre has to be increased to meet the needs of an ever increasing population. There is only limited scope for bringing additional land under cultivation.

The total geographical area of the country is 328 million hectares of which 175 million hectares are arable.[1] It is estimated that 142 million hectares were under cultivation at the end of the Fourth Plan.[2] Land use statistics indicate that the increase in the net sown area has not been significant in recent years. While the addition was 10 million hectares during the First Plan period, the addition in the succeeding 18 years was less than 13 million hectares.

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1 Report of the Irrigation Commission, Vol. I, 1972. Ministry of Irrigation and Power, Government of India, New Delhi, p. 42.

2 Draft Fifth Five Year Plan 1974-79, Part II. Planning Commission, Government of India, New Delhi, p. 105.

Considering the tremendous increase in the population of the country and its growing pressure on land, this fact indicates that, perhaps, the upper limit in respect of new land capable of being brought under the plough is being approached. New areas could not be brought under crops without encroaching further upon India's already inadequate and depleted forest resources.

The desired increase in agricultural production has, therefore, to come largely from multiple cropping and an increased level of productivity of land. There has been a revolutionary change in the agricultural technology in recent years, specially in hybrid and high yielding varieties of seeds and in the use of fertilisers and pesticides. However, to be able to derive the optimum benefits from these advances an assured supply of water is one of the most essential prerequisites. The rainfall in the country is confined mostly to a few monsoon months in the year and there are great variations in its incidence from year to year. Moreover, the rainfall in a large part of the country is low and uncertain in its distribution. Even where the rainfall is high the available soil moisture in the winter and summer months is not adequate to support multiple cropping. These vagaries of the weather frequently give rise to drought and scarcity. There is, therefore, an increased need for providing assured supplies of water through construction of irrigation projects. The need for irrigation arises because of lack of natural precipitation when needed

by crops in sufficient amounts with enough frequency and appropriate intensity. The amount of precipitation should be sufficient to replace moisture depleted from the root-zone of crops. The frequency should be enough to replenish the soil moisture before plants suffer from lack of it. The intensity should be low enough to allow the soil to absorb water. Lack of precipitation meeting these requirements has resulted in the need for irrigation in the country.

1.2 Water Resources of the Country

The principal water resources are surface resources through rivers, streams and groundwater. All fresh water resources are ultimately derived from precipitation of rainfall. Rainfall in the country varies from place to place but the annual average for its total area of 328 Mha. is about 120 cm.[3] The average annual precipitation of rainfall is thus of the order of 400 million hectare metres (Mham). However, on account of the limitations of topography, physiography, dependability, quality and the present state of technology only a part of this is utilisable. It has been estimated that altogether the utilisable surface flows aggregate to about of 70 Mham. and groundwater about 35 Mham.[4] All of this water would not be available for irrigation alone as there would be demands

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3 Report of the National Commission on Agriculture, Part V. Ministry of Agriculture and Irrigation, Government of India, New Delhi, 1976, p. 3.

4 Ibid., p. 9.

for other purposes like municipal, industrial and thermal power generation.

1.3 Review of Irrigation Development

Irrigation is not new in India. Historical records bear testimony to the existence of a number of old irrigation works in different parts of the country. However, the efforts were sporadic. It was with the advent of the British rule in the country that irrigation attained great importance. Along with a number of new works to harness the waters of major rivers, improvement and repairs of some of the important old irrigation works were undertaken. The partition of undivided India into India and Pakistan brought about the division of irrigation water which was uneven. At the time of partition, the net sown area in the undivided India was 116.8 Mha. Out of this 28.2 Mha. area was irrigated. On partition 18.3 Mha. net sown area, of which 8.8 Mha. was irrigated, went to Pakistan and India was left with 98.5 Mha. net sown area with only 19.4 Mha. of irrigated land. As a result India became an importer of foodgrains. Hence, in the development Plans, which India launched since 1950-51, irrigation received a high priority. A number of projects were taken up which included the giant schemes like the Bhakra-Nangal, The Damodhar Valley and the Hirakud. Nearly Rs. 800 million had already been spent on these projects before First Plan in which many more projects, major and medium, were included. Including the pre-Plan schemes, there were in all about 267 schemes under implementation in the First Plan,

of which 27 were major projects. Irrigation schemes taken up in the Second Plan included 195 new works. Of these, 25 belonged to the category of major works. Due to carry over of a large number of schemes, great emphasis was placed on their completion in the Third Plan and only nine new major schemes were undertaken. During the triennium of three Annual Plans (1966-69), excepting Maharashtra State, which launched six new schemes, all the States were preoccupied with the on-going irrigation schemes. Provision for an early completion of a large number of incomplete major and medium schemes was made in the Fourth Plan. The Fourth Plan also suggested taking up some new schemes, most of them in the latter part of the Plan. About 230 on-going projects including 75 major projects spilled over into the Fifth Plan. With the proposed outlay of Rs. 1210 crores, all the continuing medium projects and 64 major projects were expected to be completed during the Fifth Plan. In addition to this outlay for continuing schemes, an outlay of Rs. 1191 crores was proposed for new major and medium irrigation projects including investigation and research. Table 1.1 indicates the position regarding the creation of potential and its utilisation as obtained at the end of the Fourth Plan (1973-74), the beginning of the Fourth Plan (1968-69), the beginning of the planned development (1950-51) and in the first two years (1974-76) of the Fifth Plan.

Table 1.1 : Development of Irrigation Potential

(Area in million hectares)

Item	Ultimate Potential	1950-51		1968-69		1973-74		1974-75		1975-76	
		Potential	Utilisation	Potential	Utilisation	Potential	Utilisation	Potential	Utilisation	Potential	Utilisation
1. Surface Water											
a) Major and Medium	57	9.7	9.7	18.1	17.0	21.4	19.6	21.4	19.4	22.4	20.2
b) Minor	15	6.4	6.4	7.0	7.0	7.5	7.5	7.7	7.7	8.0	8.0
Total	72	16.1	16.1	25.1	24.0	28.9	27.1	29.1	27.1	30.4	28.2
2. Groundwater	35	6.5	6.5	12.0	12.0	16.0	16.0	16.6	16.6	17.2	17.2
Grand Total	107	22.6	22.6	37.1	36.0	44.9	43.1	45.7	43.7	47.6	45.4

Source: 1) Draft Fifth Five Year Plan 1974-79, Part II, op.cit., p. 105.

2) "Research and Statistics," Eastern Economist, Vol. 69(5), July 29, 1977, p. 233.

1.4 Progress in the Creation and Utilisation of the Irrigation Potential

The Planwise progress in the creation and utilisation of irrigation potential from major and medium irrigation schemes is given in Table 1.2. It can be seen therefrom that the percentage utilisation of the irrigation potential shows a steady rise and now is as much as 84.3 per cent. While the rise in the national average is encouraging 52 per cent of the lag in the utilisation noticed at the end of the Fourth Plan has occurred in eight major projects in the country, viz., Kosi, Chambal, Gandak, Kakrapar, Tungabhadra, Rajasthan Canal, Kangasbati and Mahi Stage I.[5]

Table 1.2 : Major and Medium Schemes: Irrigation Benefits from Plan Schemes

(Million hectares)

To the end of	Cumulative irrigation potential created by plan projects	Cumulative utilisation from plan projects	Percentage utilisation
First Plan	2.48	1.48	59.7
Second Plan	4.63	3.35	72.4
Third Plan	6.86	5.47	79.7
Three Annual Plans	8.43	7.00	83.0
Fourth Plan	11.69	9.85	84.3

Source: Y.K. Murthy, "Utilisation of Irrigation Facilities," Bhagirath, Vol. XXII(1), 1975, p. 5.

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5 Y.K. Murthy, "Utilisation of Irrigation Facilities," Bhagirath, Vol. XXII(1), 1975, p. 5.

Irrigation potential with the completion of major and medium irrigation schemes was 21.4 Mha. at the end of the Fourth Plan. The level of actual utilisation of the irrigation potential till the end of Fourth Plan was, however, 19.6 Mha. thus giving a lag of 1.8 Mha. in the utilisation. At the end of 1975-76 as against the potential of 22.4 Mha., utilisation of 20.2 Mha. was achieved (Table 1.1).

Underutilisation of the available irrigation facilities is not a new problem. But the problem at present has got added significance because of the paradoxical situation in the country in which on one hand huge amounts of public money are being invested in the creation of irrigation facilities and on the other hand available irrigation facilities are not used to the fullest extent. Several high level bodies and research workers have examined the reasons for underutilisation of the irrigation facilities. A brief review of literature on causes of underutilisation of the created irrigation potential is presented in the next paragraph.

Since the commencement of the First Plan in 1950-51 a large Public Sector investment of about Rs. 3500 crores[6] has been made upto the end of Fourth Plan in major and medium irrigation projects in the country i.e. on an average an investment of Rs. 1636 per hectare of created potential. A lag of the order of 1.8 Mha. would correspond to a locked up

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6 Report of the Finance Commission, 1973. Ministry of Finance, Government of India, New Delhi, p. 58.

capital of Rs. 294.5 crores. This highlights the need for the optimum utilisation of the irrigation potential created in as short a period as possible.

1.5 Review of Literature on Causes of Underutilisation

The National Council of Applied Economic Research[7] (1959) in a case study of the Sarda Canal System in Uttar Pradesh observed that, even 25 years after the completion of the canal, full use was not being made of the available irrigation facilities and the utilisation came only to a little over 50 per cent. The factors responsible for underutilisation were found to be irregular and insecured water supplies, tail end difficulties and high water rates. The bad condition of the Sarda guls (small channels or water courses) was also a major factor responsible for inadequate utilisation of the canal water.

With a view to obtaining an objective appraisal of the utilisation of the irrigation potential created under the plan projects and to suggest steps that should be taken to accelerate the utilisation of the potential, Ministry of Irrigation and Power, Government of India appointed Dildar Hussain and D.V. Rao[8] (1960) as Special Officers to examine and report on

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7 National Council of Applied Economic Research. Criteria for Fixation of Water Rates and Selection of Irrigation Projects. Bombay : Asia Publishing House, 1959, pp. 88-95.

8 Dildar Hussain and D.V. Rao, "Project Water Utilisation," Bhagirath, Vol. VI(9), 1960, pp. 343-45.

the problems relating to the creation and utilisation of the irrigation potential under the major and medium irrigation projects in the Northern and Southern Zones. They observed that the utilisation upto the end of March 1958, compared with the potential created at the end of March 1957, was 91 per cent and in general there was no lag in the utilisation, although the utilisation on some of the major and medium projects was somewhat halting. They indicated low population density in ayacuts, poor economic condition of the ryots, lack of requisite knowledge on the part of the peasants to change from dry farming to irrigated agriculture and of crop rotations, high water rates, price fluctuations of agricultural commodities, lack of transport facilities and non-provision of field channels as some of the factors coming in the way of speedy development of irrigation.

The Central Board of Irrigation and Power[9] (1961) while observing that the water facilities provided have not been adequately utilised recommended several measures to accelerate the utilisation of water resources; these are: introduction of a system of compulsory levy in the form of 'irrigation cess' to ensure utilisation of the available supplies, provision of adequate distribution channels, supply of agricultural credit, better seeds and fertilizers, provision of warehousing

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9 Central Board of Irrigation and Power. Report on Measures to Accelerated utilisation of Irrigation Water, Part I. Publication No. 71, 1961, pp. 6-17.

and storage facilities and adequate system of rural communication, free supply of irrigation water or supply at concessional rates for all seasonal crops for a short period, establishment of research and demonstration farms in the command area of the project, encouraging growth of multipurpose societies and training to young irrigation officers in timely distribution of water supplies, apportionment, sanction, assessment of water rates and penal assessment.

M.V. Gadgil[10] (1961) in a study of water use under some irrigation tanks in Bombay Deccan reported several reasons responsible for underutilisation of the tank water, important among them being: unlevelled land, water refused due to defaulting of water rates, unsatisfactory distribution of water from the tank, high water rates, disputes over water courses, inadequate bullock and complementary resources, irrigation water not required due to adequate rainfall and unsuitable soils.

H.B. Shivamaggi[11] (1961) indicated that the utilisation of the irrigation potential of Tungabhadra project in the year 1957-58, five years after the completion of the project, was 75 per cent in Bellary district. Irrigation water of the

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10 M.V. Gadgil. A Study of Water Use Under Some Irrigation Tanks in Bombay Deccan. A thesis submitted to the University of Poona for Ph.D. Degree, 1961, p. 350 (unpublished).

11 H.B. Shivamaggi, "Credit Problems of Farmers in Newly Irrigated Canal Areas," Indian Journal of Agricultural Economics, Vol. XVI(3), 1961, pp. 52-53.

project was made available to Kurnool district in 1954-55; but till 1957-58 only 27 per cent of the irrigation potential was utilised. Lack of bullock power, inadequate manures, resistance on the part of the agriculturists to get their lands levelled by bulldozing, shortage of manpower, large size of holdings and lack of adequate finance, were reported to be responsible for the failure to utilise the available irrigation facilities.

C.S. Shah, Mrs Tara Shukla and T.K. Meti[12] (1961) in two research studies carried out in Gujarat have highlighted the reasons for underutilisation of the irrigation facilities as being absence of field channels, unsuitability of land and lack of complementary resources and funds to buy them were restricted in their supplies.

The Maharashtra State Irrigation Commission[13] (1962) reported that certain management practices and the lack of proper planning of some aspects of irrigation schemes were mainly responsible for the delayed utilisation of the irrigation potential of various projects in the State. The Commission recommended the following measures to accelerate the pace of development of irrigation: construction of field

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12 C.H. Shah, Mrs Tara Shukla and T.K. Meti, "Problems of Irrigation," Indian Journal of Agricultural Economics, Vol. XVI(4), 1961, pp. 29-34.

13 Report of the Maharashtra State Irrigation Commission. Government of Maharashtra, 1962, pp. 152-56.

channels, levelling of fields, change in the management practices, planning of utilisation in different seasons, providing credit and marketing facilities, establishing processing factories and demonstration farms and arranging transport and communication facilities in the command of the project.

Baleshwar Nath[14] (1965) observes that major irrigation schemes have suffered a setback because of poor utilisation of the new potential created. The two most important reasons for it are lack of coordination among different agencies and unpreparedness of cultivators to change from dry to wet farming.

Baljit Singh and Shridhar Mishra[15] (1965) estimated that under the Sarda canal out of the potential that was created since 1943 only 50 per cent was utilised although of the old potential 64 per cent was utilised by 1943 indicating that the new extensions were not yet fully matured and even on the old system nearly one-third of the potential remained unutilised. Inadequate and ill maintained field channels, inadequate facilities for communication and transport, primitive farming practices and cropping pattern adopted by the cultivators, poverty, illiteracy and lack of skill and efficiency among the farming community were identified to be the causes of underutilisation of the irrigation facilities.

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14 Baleshwar Nath, "Major, Medium, Minor All Irrigation Projects Have Some Problems and Should be Brought Under One Agency," Yojana, Vol. IX(4), 1965, p. 7.

15 Baljit Singh and Shridhar Mishra. Benefit Cost Analysis of the Sarda Canal System. Bombay : Asia Publishing House, 1965, p. 46.

Nasim Ansari[16] (1968) in a survey undertaken in two States of Punjab and Uttar Pradesh aimed at gauging the nature and direction of benefits accruing to the peasantry from irrigation in selected regions and the extent, nature and causes of underutilisation of irrigation capacity in these regions reports that the utilisation of irrigation potential of Bhakra canals in the Hissar district since 1958-59 has remained under 65 per cent. Underutilisation of the potential of the Bhakra canals was also noted in the Karnal district. Insufficient supplies of water, defective distribution system, lack of feeder channels, unstable and insecure supplies and lack of satisfactory warabandi (time distribution) were found to be the chief obstacles in the way of better utilisation of irrigation potential of the project. Betterment levy also seemed to impede better utilisation of the canal potential.

Jaykumar Anagol[17] (1969) holds that non-synchronisation in construction, lack of field channels, lack of land shaping, lack of research, training to farmers and demonstrations, absence of communication and other facilities, lack of warehousing and marketing facilities and lack of long-term and short-term credit have been the causes for the gap in the

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16 Nasim Ansari. Economics of Irrigation Rates. Bombay : Asia Publishing House, 1968, pp. 229-271.

17 Jaykumar Anagol, "A Strategy for Ayacut Development Under Major Irrigation Projects," Economic and Political Weekly, Vol. IV(26), 1969, pp. 111-113.

creation and utilisation of irrigation water under the Tungabhadra project command.

N.D. Gulhati[18] (1969) while commenting on the slow development on new projects observes that the change over from unirrigated to irrigated agriculture is of a fundamental nature and calls for expert technical supervision. In many parts of the country it also requires large investment in land preparation as a prerequisite to irrigated farming and requires increased working expenses. The habits of the people and their ways of living are to undergo a radical change. The cultivators lack the technical skill and financial means for the change.

N.V. Khursale and P.R. Gandhi[19] (1969) observe that the non-utilisation of the irrigation potential is particularly noticeable in the case of kharif seasonals due to the general tendency of the irrigators to wait for rains in the case of seasonal crops and when they fail then to rush to Irrigation Department for supply of irrigation water for kharif seasonals. Apathy of the irrigators to excavate the water courses, failure of the irrigators to appreciate the increase in their produce by utilising irrigation facilities, lack of finance and storage and marketing facilities are some other reasons for underutilisation of the irrigation potential.

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18 N.D. Gulhati, "Problems of Indian Agriculture," Symposium on Management of Irrigation Waters. New Delhi : Central Board of Irrigation and Power, Publication No. 92, 1969, p. 13.

19 N.V. Khursale and P.R. Gandhi, "Management of Irrigation Waters in Maharashtra," Symposium on Management of Irrigation Waters, op.cit., pp. 28-29.

According to Donald C. Taylor[20] (1971) the argument that if irrigation water rates are raised farmers will be less motivated to exploit the full irrigation potential may have a certain limited validity during the initial transition stages of an irrigation project. But the obstacles to fuller utilisation of the irrigation potential may more importantly be due to such factors as inadequate availability of water to farmers' fields, inadequate research on locally adopted irrigated crops and cropping patterns, inadequate knowledge on techniques and improper equipment for levelling and shaping land, inadequate dissemination of information, inadequate quantities and inaccessibility to farmers of improved inputs and credit and deficiencies in the system for marketing the products which farmers raise.

V.V. Borkar and M.D. Padhye[21] (1972), in their study on 'Purna River Valley Project' maintain that the very low degree of utilisation of irrigation facilities is attributable to the lack of motivation and know-how among the cultivators and the necessary physical facilities and inputs, the absence of both will and ability. There exists even strong disincentives. This is because of the failure of the Government to think ahead and anticipate the problems connected with the full use of irriga-

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20 Donald C. Taylor, "Price Policy With Special Reference to Major Irrigation Projects," Indian Journal of Agricultural Economics, Vol. XXIV(4), 1971, p. 388.

21 V.V.Borkar and M.D. Padhye. Purna River Valley Project. Aurangabad : Marathwada University, 1972, p. 199.

tion facilities once they are available on a hitherto unknown scale to a dry farming area unfamiliar with the methods and practices of wet cultivation.

The Irrigation Commission[22] (1972) has called for a series of coordinated measures for ensuring rapid utilisation of the irrigation potential such as fixing of command area of a project in advance, carrying out soil surveys, adoption of realistic cropping pattern suited to local soil and climatic conditions, consolidation of holdings, levelling of land and excavation of field channels, strengthening of supply of inputs, gearing up the research and extension activities and provision of infrastructure facilities like roads, transport and communication, markets, storages and warehouses.

N.D. Rege[23] (1972) identifies absence of field distribution system - water courses, field channels and drainage facilities, failure to get land levelled or shaped so as to make the water spread evenly, absence of other infrastructure facilities such as provision of roads, marketing credit, etc., lack of proper extension services, lack of group activity, failure to reduce seepage losses from distribution systems, lack of coordination between Departments of Irrigation and Agriculture at the time of formulation of the projects, failure to carry out

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22 Report of the Irrigation Commission, Vol. I, 1972. Op.cit., p. 132.

23 N.D. Rege, "Soil and Water Management Problems in India," Indian Farming, Vol. XXII(2), 1972, p. 13.

soil surveys and classification of soils and land to determine their suitability for irrigation and failure to formulate cropping patterns based on availability of water and soil characteristics to be the primary reasons for poor utilisation and management of irrigation water.

The Committee of Official and Non-official Members[24] (1972) to investigate the causes of underutilisation of the irrigation potential of the Purna project revealed that the cultivators were reluctant to avail irrigation facilities even though sufficient irrigation potential was created in the year 1966-67. The Committee put forth the following factors chiefly to be responsible for the underutilisation of the project potential: lack of ayacut development, lack of adequate credit facilities to purchase the required inputs like improved seeds, fertilizers and pesticides, lack of infrastructure facilities, lack of improved implements, traditional outlook of the cultivators and absence of distribution system and storage facilities.

V.S. Gopalkrishnan[25] (1973) identified the following factors responsible for underutilisation of irrigation potential: lack of coordination between Departments of Irrigation and

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24 Report of the Committee of Official and Non-Official Members to Find out the Causes of Underutilisation of Irrigation Potential of Purna Project (in Marathi). Bombay : Government of Maharashtra, 1972, p. 4.

25 V.S. Gopalkrishnan, "Organization for Command Area Administration in India," Indian Journal of Public Administration, Vol. XIX(2), 1973, p. 178.

Agriculture, lack of land development in the command area i.e. land levelling and land shaping, absence of well designed field distribution system consisting of water courses, field channels, etc., lack of adoption of proper cropping patterns based on water availability and soil characteristics, lack of adequate soil surveys, lack of proper extension service, seepage losses in the distribution system, untimely supply of input facilities, poor infrastructure facilities in the manner of roads, markets, etc., and incomplete work in the consolidation of land holdings.

The Committee of Ministers[26] (1973) on underutilisation of created irrigation potential estimated that by March 1972 a potential of 9.61 Mha. was created by the major and medium irrigation projects in the country and the corresponding utilisation stood at 8.01 Mha., thus giving a lag of 1.6 Mha. in the utilisation. The principal reasons for lag in the utilisation are identified to be: lack of or inadequate field channels, inadequate drainage facilities, seepage, impeded drainage, absence of field drainage channels and water logging, inadequate preparation of land for irrigated agriculture - land shaping and levelling and bunding, crop patterns and water allowances anticipated under the project not being realised, lack of adequate agricultural research, demonstration farms and

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26 Report of the Committee of Ministers on Underutilisation of Created Irrigation Potential. Ministry of Irrigation and Power, Government of India, New Delhi, 1973, pp. 8-15.

education, training and extension facilities to cultivators inadequate water supply, wasteful use of water, maldistribution of available water and tail-end difficulties for water, lack of adequate credit, inputs and infrastructure, operation and maintenance of irrigation and drainage system being neglected, lack of proper coordinating agency or deficiencies in its functioning, need for proper legislative measures to ensure full use of water and inadequate funds to undertake ayacut development measures.

The Planning Commission[27] (1974) has observed non-construction of water courses and field channels; the need for land levelling and shaping and other farm works; the non-existence of proper drainage systems leading to the problems of water-logging, salinity and alkalinity; the practice of doing field to field irrigation; the non-adoption of rostering system of irrigation as well as irrigation during night and the inadequacy of infrastructure and inputs to be the principal aspects which have led to the underutilisation of the irrigation potential in case of a large number of projects and indicates that these need urgent attention.

V.N. Asopa and B.L. Tripathi[28] (1975) report that the irrigation potential created in Gujarat State through major and

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27 Draft Fifth Five Year Plan 1974-79, Part II. Op.cit., p. 111.

28 V.N. Asopa and B.L. Tripathi. Irrigation Agriculture in Gujarat: Problems and Prospects. Ahmedabad : Indian Institute of Management, 1975, pp. 27-62.

medium projects by the end of Fourth Five Year Plan was 10.96 lakh hectares. The corresponding proportion of water actually utilised was only 8.08 lakh hectares i.e. about 74 per cent of the potential created. A host of factors such as the lack of field channels, unlevelled land and unshaped land, water losses, faulty method of irrigation, inequitable distribution of water, absence of agricultural support programmes and lack of inputs and credit and infrastructure are reported to be responsible for the less than efficient utilisation of the created irrigation potential in the State.

In a pilot survey to find out the causes of underutilisation of irrigation water under the command of a medium project in Amravati district, A.R. Kasture[29] (1975) found that against a target of 40 per cent the actual utilisation of the irrigation potential stood at 8 per cent. Ill-maintenance and mismanagement of water courses and field channels, tail-end difficulties in getting adequate irrigation water, lack of easy and adequate supply of inputs like better seeds, fertilizers and insecticides, unsuitable interval between two roations, absence of demonstration farms, hesitancy of the farmers to shift from dry farming to irrigated farming, Government levy and land ceiling Rules were coming in the way of full utilisation of irrigation potential.

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29 A.R. Kasture, "Underutilisation of Irrigation Potential in Maharashtra," Yojana, Vol. XIX(5), 1975, p. 15.

K. Nazeer Hussain[30] (1975) in a study on Tungabhadra project found that in the year 1972-73 the non-intensive utilisation (in which water is utilised without even proper reclamation of land) of irrigation potential was to the extent of 226.26 thousand hectares as against the created potential of 271.95 thousand hectares (83 per cent utilisation). He indicated that the full intensive utilisation may take more than twice the time needed for non-intensive utilisation or more than 36 years after creation of full potential if the present trend continued. He has analysed the reasons for non-full utilisation of the irrigation potential as unfit lands for irrigation (in the form of unlevelled lands), lack of strong and systematic extension efforts and large holdings becoming unmanageable for irrigated agriculture.

J.R. Pawar and C.S. Kadam[31] (1975) in an investigation into the extent and causes of underutilisation of the irrigation potential of the Ghod irrigation project have found that there existed a gap between the irrigation potential created and utilised. In the year 1971-72 the utilisation of the potential of the project was to the tune of 61 per cent. The problem of underutilisation is reported to be more serious in kharif season when 70 to 75 per cent of the potential remained unutilised.

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30 K. Nazeer Hussain, "Tungabhadra Project: Utilisation of Irrigation Potential," Financial Express, Vol. XV(223), 16th September 1975.

31 J.R. Pawar and C.S. Kadam, "Underutilisation of Canal Water," The Economic Times, Vol. XV(185), 10th September 1975.

They report untimely availability of irrigation water in kharif season, long interval between two rotations, lack of adequate credit, inputs and infrastructure, unsuitable land and defects in the irrigation supply system to be the causes of the underutilisation of the created irrigation potential.

C. Gopinath[32] (1976) observes that the utilisation of irrigation resources from the major and medium surface reservoirs continues to be poor and the chief reasons for poor utilisation of the irrigation potential are: lack of coordination between Departments of Irrigation and Agriculture at the project formulation stage, failure to carry out adequate soil surveys and assess suitability of land and soils for irrigation, failure to minimise conveyance losses and associated problems of water-logging and soil salinity, absence of field distribution system, water control structures and farm drainage facilities, failure to formulate cropping patterns based on availability of water and soil characteristics, failure to get land shaped and levelled, absence of other infrastructure facilities like roads, marketing credit, etc., and lack of proper extension service.

R. Ghosh[33] (1976) has identified the following reasons leading to underutilisation of the irrigation potential and has

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32 C. Gopinath, "Problems and Concepts in Irrigation Use," Role of Irrigation in the Development of India's Agriculture. The Indian Society of Agricultural Economics, Bombay, and the Institute for Social and Economic Change, Bangalore, Seminar Series XIII, 1976, p. 12.

33 R. Ghosh, "Utilisation of Potential in Command Areas of Irrigation Projects," Role of Irrigation in the Development of India's Agriculture, op.cit., p. 66.

suggested remedial measures to the same: (a) deficiencies in the irrigation system i.e. unsatisfactory creation of CPCCP (Chak Periphery Cultural Command Potential), (b) deficiencies in the field channels and plot characteristics or creation of PPCCP (Plot Periphery Cultural Command Potential), (c) unrealistic cropping pattern and water allowances, and (d) deficiencies in agricultural and infrastructure facilities.

The National Commission on Agriculture[34] (1976) maintains that irrigation water can be put to a satisfactory productive use only if the command area is fully ready to receive the supplies. For this, it adds further, the land has to be properly formed, fields preferably laid out in proper sizes, water courses and field channels constructed to carry water to individual fields, field drains provided to remove unwanted water which may affect the crops, farm roads provided for easy access to fields for transporting inputs and produce and dispersed fields of individual farmers consolidated into one or two operational holdings. Besides the above measures, adequate and timely supply of inputs has to be ensured and marketing and other infrastructure facilities provided so that the farmer is able to derive maximum benefit from raising irrigated crops.

V.K. Srinivasan[35] (1976) views that the inadequate

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34 Report of the National Commission on Agriculture, Part V. Op.cit., p. 107.

35 V.K. Srinivasan, "Return from Investment: An Area of Increasing Concern," Role of Irrigation in the Development of India's Agriculture. Op.cit., p. 113.

utilisation of the irrigation potential created and the slow phase of ayacut development have been found to be the result of: (a) lags in construction of distributaries and water courses owing to inadequate planning by budgetary reasons, (b) inadequacy of structure or policies to bring about speedy development in project areas where new settlements have to be established, (c) insufficient preparation and effort in respect of experimental work on the part of the agricultural agencies in the introduction of new crops and provision of technical guidance and information to farmers, (d) insufficient arrangements to provide credit, and (e) inadequacy of special arrangements required for reclamation, levelling and other works, requiring machinery or large labour force than could be provided by farmers.

1.6 Integrated Command Area Development Approach

The various steps which have been considered necessary for prompt utilisation of irrigation potential created and its efficient use on the field encompass the activities of several Government Departments like Irrigation, Agriculture, Revenue, and Cooperation. No single department would be in a position to take all the requisite measures. It is only through an interdepartmental approach that the measures required for prompt and efficient use of irrigation facilities can be ensured. Such an approach, known as command area approach, has been introduced recently in some major irrigation projects by constituting special administrative agencies for this purpose.

Command area development seeks to accelerate the process of utilisation of irrigation potential created and improve the efficiency to achieve the end objective of agricultural production through a multidisciplinary approach. Construction of field channels, land levelling and shaping, farm drainage, adjustments in cropping patterns, provision of infrastructure facilities for storage, marketing and transport, medium-term credit for farm development works and short-term credit for farm operations, supply of good seeds, balanced fertilizers, pesticides, etc., are the necessary measures.

An appraisal during the Third Plan period brought home that without a reasonable investment on ayacut development the pace of utilisation of irrigation waters would remain slow. A decision to make such an investment was taken in 1964-65, but little progress was made in the Third Plan. During the period covered by the three Annual Plans (1966-69) a package of approaches to ayacut development was formulated comprising soil surveys, land levelling and shaping, determination of proper irrigation practices and drainage requirements, cropping patterns, consolidation of holdings, provision of inputs like credit, seeds, fertilizers, pesticides and agricultural machinery, building up of an adequate research base, extension and farmers' education and training, rural roads, marketing and storage and processing industries. Though it was intended to launch the scheme as a joint venture of the States and the Centre on 50:50 basis, this scheme never got off the ground.

When, however, the Fourth Plan was formulated, it was agreed that all these developments were necessary. Accordingly, a beginning was made on such a programme in the Fourth Plan on a few selected major projects located in different States and an initial provision of Rs. 15 crores was made in the Central Sector for strengthening the infrastructure facilities for marketing and communication in ten selected commands, subject to the State Governments agreeing to meet the cost of other essential services and inputs out of their normal State Plan provisions. As a result of the mid-term appraisal an additional provision of Rs. 10 crores was made which was utilised for increasing the outlays in the ten commands already selected and also for taking up the work in seven new commands.

The Draft Fifth Five Year Plan envisaged an integrated command area development programme as one of the principal elements in the strategy for increasing agricultural production. It was proposed to set up development authorities in areas covering about 15 million hectares in the commands of 50 major projects. Included in these projects were those already taken up in the Fourth Plan. The actual programme would vary from project to project and State to State depending on the developments that have already taken place.

The Government of Maharashtra observes in its Resolution[36]

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36 See Resolution No. IPM 1074-I(5)-CADA, Irrigation and Power Department, Government of Maharashtra, Sachivalaya, Bombay, dated 15th April 1974.

that the returns by way of increased agricultural production from the completed irrigation projects have not been satisfactory due to underutilisation of irrigation potential. The inadequate utilisation is particularly distressing in the context of low per acre availability of water resources in Maharashtra and comparatively higher costs of construction and maintenance of irrigation projects. The Government, therefore, in consultation with the Government of India set up in the State, Command Area Development Authorities for the following projects or group of projects with a view to expeditious development of the command areas:

1) Purna and Jayakwadi Projects
2) Ghod and Bhima Projects including Pawna command area
3) Girna and Upper Tapi (Hatnur) Projects
4) Bagh, Itiadoh and Pench Projects and
5) Krishna Project.

1.7 Objects of the Study

It was known that there existed a gap between the irrigation potential created and utilised by the Purna irrigation project in Parbhani district of Maharashtra State. It was, therefore, felt that it would be instructive to undertake an investigation into the causes of underutilisation of the irrigation potential created by the Purna command. The specific objectives of the study are three-fold as follows: Firstly, to study the extent of utilisation of the irrigation potential

of the Purna project. Secondly, to find out the causes of underutilisation of the irrigation facilities, and, Thirdly, to study the economic consequences of the underutilisation.

1.8 Significance of the Study

Evaluation of the extent of utilisation and the causes responsible for underutilisation of the potential would serve an important purpose. In the first place it would indicate the extent to which the project waters are being underutilised. Secondly, it would throw light on the bottlenecks which hinder full utilisation of the potential created. This would suggest ways and means for exploiting the available irrigation facilities to the fullest extent.

CHAPTER II

THE PURNA PROJECT

2.1 Marathwada

It is proposed here to take a review of the socio-economic and political conditions in the Marathwada region, in which the Purna project is located, in order to have a proper perspective of the irrigation development in the region.

The Aurangabad Division of Maharashtra State, popularly known as Marathwada region, consists of five districts viz. Aurangabad, Nanded, Parbhani, Bhir and Osmanabad. The total geographical area of the region is 64,525 sq.kilometres and the population according to the Census of 1971 is 80,58,347. The region accounts for 20.97 per cent of the total geographical area and 15.98 per cent of the total population of the State. The average density of population in the region is 125 persons per sq.km. as against 164 persons per sq.km. for the State as a whole.

The five districts of the present Marathwada region were a part of the old princely Hyderabad State until it was annexed to the Indian Union in 1948. This long subjection to a feudal regime has left a deep stamp on the socio-economic life of the region. As a result of the reorganisation of States in 1956 the Marathwada region was joined to the erstwhile

bilingual Bombay State which consisted of the present Maharashtra and Gujarat States. Subsequently, in the middle of 1960 it became a part of the present Maharashtra State.

The eastern extension of the Satmala range from the Nasik district lies in the north of Aurangabad district and is known as the Ajanta range. This extends further in the Vidarbha region separating the Godavari and the Tapi basins. The Balaghat Range cuts across the Bhir district from east to west. A branch of this range extends into the south-west and southern parts of the Osmanabad district dividing the Manjara catchment of the Godavari basin and Sina catchment of the Krishna basin.

The river Godavari is the only major river flowing through the region. Rising in the Western Ghats it winds its way through Nasik and Ahmednagar districts and through four districts of Marathwada namely, Aurangabad, Nanded, Bhir, and Parbhani, and then enters Andhra Pradesh. The river Godavari along with its tributaries drains the major portion of the region lying between the Satmala range in the north and the Balaghat range in the south forming the Godavari valley. Purna, the biggest tributary of Godavari is another important river of the region. The other important rivers are Shivana, Dheku, Sindphana in Bhir district, Manjara and Terna in Osmanabad district, Painganga, Manyad, Ashna, Lendi in Nanded district and Kayadhoo, Kapra, Dudhana in Parbhani.

The rainfall is unevenly distributed throughout the year

and the major portion of it occurs during the four rainy months of June, July, August and September. Consequently, while the streams and rivers are in flood during the monsoons they dwindle to almost nothing by December. Parbhani and Nanded districts are considered to be the areas with assured rainfall and the annual precipitation ranges between 700 and 900 mm. In other districts the annual rainfall varies between 600 and 750 mm. Vaijapur and Gangapur talukas in Aurangabad district, Ashti, Patola, Bhir and Geori talukas in Bhir district and Parenda, Bhoom, Kalamb and Osmanabad talukas in Osmanabad district are identified as drought affected areas.

Most of the region is covered with black cotton soil or 'regur' derived from the Deccan trap volcanic rock. There are, however, variations in depth and texture. Soils along the river banks and nallas are deep and very fertile. The soils are coarse, shallow and relatively poor along the hill slopes and at the foot of the hills. Major portion of the region is having medium black soils.

In the Marathwada region kharif and rabi crops are predominantly grown under unirrigated conditions. Kharif crops consist of crops like cotton, jowar, bajra, pulses and groundnut. In the rabi season wheat, jowar, gram and safflower are grown. Kharif crops are sown at the onset of monsoons while the rabi crops are grown at the end of monsoons. Rabi crops are generally grown in heavy soils so that the residual moisture and the occasional light showers received in November

and December come to be utilised. The cropping pattern in all the districts in the region is dominated by foodgrain crops. A sizable portion of the cropped area is put to the cultivation of a variety of pulses. Among the non-food crops the most important are cotton and oilseeds.

As per the latest year[1] for which information is available the net sown area in the region is 49.40 lakh hectares which works to about 77 per cent of the total geographical area of the region. The land under current fallow constitute as much as 5.45 per cent of the geographical area. Permanent pastures and grazing land form 4.1 per cent and less than 4.0 per cent is under forest. The gross cropped area in the region is about 52.67 lakh hectares and the area sown more than once is 3.26 lakh hectares. The net area irrigated is 3.23 lakh hectares which works to 6.5 per cent of the net sown area. The percentage of gross irrigated area to gross cropped area is about 7.5.

2.2 Growth of Irrigation in Marathwada

Upto 1940 the only source of irrigation in the region was wells and about 2.5 per cent of the cultivable area was irrigated in this manner. In general, water levels in wells vary from 7.50 to 9.0 m. and about one hectare per season is irrigated under a well. Besides, a few hundred acres have been under irrigation for centuries under minor irrigation tanks

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1 Season and Crop Report, Maharashtra State, 1974-75. Government of Maharashtra, Bombay, pp. 50-55.

in Nanded district along the border of Andhra Pradesh. Yet another historical and sizable source of irrigation has been an infiltration gallery in Bhir district whose water is collected and brought to the surface through a covered deep cut to irrigate about 200 hectares by flow. It was the belief of the former Hyderabad Government that there were no sites in the Marathwada area for building storage reservoirs and that the cultivators would not be interested in irrigated farming. It was as a famine relief work that the first irrigation project was taken up in 1940 to irrigate 1619 hectares (4000 acres) in drought affected area of the Ashti taluka of Bhir district. This was the only irrigation work executed in more than a century prior to 1940. The potential created came to be utilised soon after the completion of the project. This work is known as the Rooty project. Encouraged by the experience of the Rooty project, a few medium and minor irrigation schemes were taken up for investigation during the First Five Year Plan period by the Popular Government of the former Hyderabad State. Eight medium projects - six storage tanks and two bandharas - were included in the Plan. It was, however, possible to complete only two of these works namely, Bendsura and Khasapur projects in the First Plan period. Work on Talwar and Kamli projects was started during the First Plan but was completed during the Second Plan. The work on other projects spilled into the Second Plan without a start in the First Plan. A potential of 7285 hectares (18000 acres) was created by the

end of First Plan and an expenditure of Rs. 110.10 lakhs was booked on account of the works completed and in progress. Although no major project was included in the First Plan, a good beginning was made in their investigations and preparation of the project reports. A project report of the Purna multipurpose project was prepared and submitted to the Central Water and Power Commission. A preliminary report was also sent to the Commission on the Godavari project after some reconnaissance.

The small beginning that was made in the First Plan towards the development of irrigation in the region, developed in the Second Five Year Plan to a sizable extent. The Government allocated about 25 per cent of the State's expenditure in this Plan on irrigation works in Marathwada. In comparison to total negligence of irrigation in this region, this was surprising. The Second Plan included one major project namely, the Purna multipurpose project, 15 medium projects and a small sum for minor projects, besides the six medium projects spilled from the First Plan of which the two, namely, the Kamli and Talwar projects, were in progress while the others were not started till then. It was proposed to spend an amount of Rs. 1108.14 lakhs on irrigation works and an irrigation potential of 70,420 hectares (1,74,000 acres) was planned to be achieved by the end of the Second Plan period. However, considerable revision in the plan proposals was made after the reorganisation of States in January 1956.

Further investigations were carried out and out of 15 new projects ten were finally taken up. The scopes of three medium projects were changed and they were included in minor irrigation programme. Three new works were taken up in place of five medium projects that were dropped. Thus there were in all 13 medium projects. But, work on these projects could not be started till 1961-62 due to various procedural and organisational reasons. Work on ten of the thirteen projects was started in 1961-62. They were programmed to be completed by the end of the Third Plan. Work on the remaining three was suspended in September 1961 for further investigations and re-started in October 1963. These projects were to spill over to the Fourth Plan. Only one major project, namely, the Purna project, was included in the Second Plan. But on detailed investigations, the scope of one of the medium projects, namely, Manar project, was increased and was approved as a major project.

Very few new irrigation schemes could be included in the Third Plan due to a large spill over of major, medium and minor projects from the Second Plan. All the projects spilled over from the Second Plan were, however, programmed to be completed with an outlay of Rs. 21.64 crores. Of the new major irrigation projects included in the Plan mention may be made of Kayadhu and Jayakwadi Stage I projects. Two major projects viz. Purna and Manar Stage I were completed during this period.

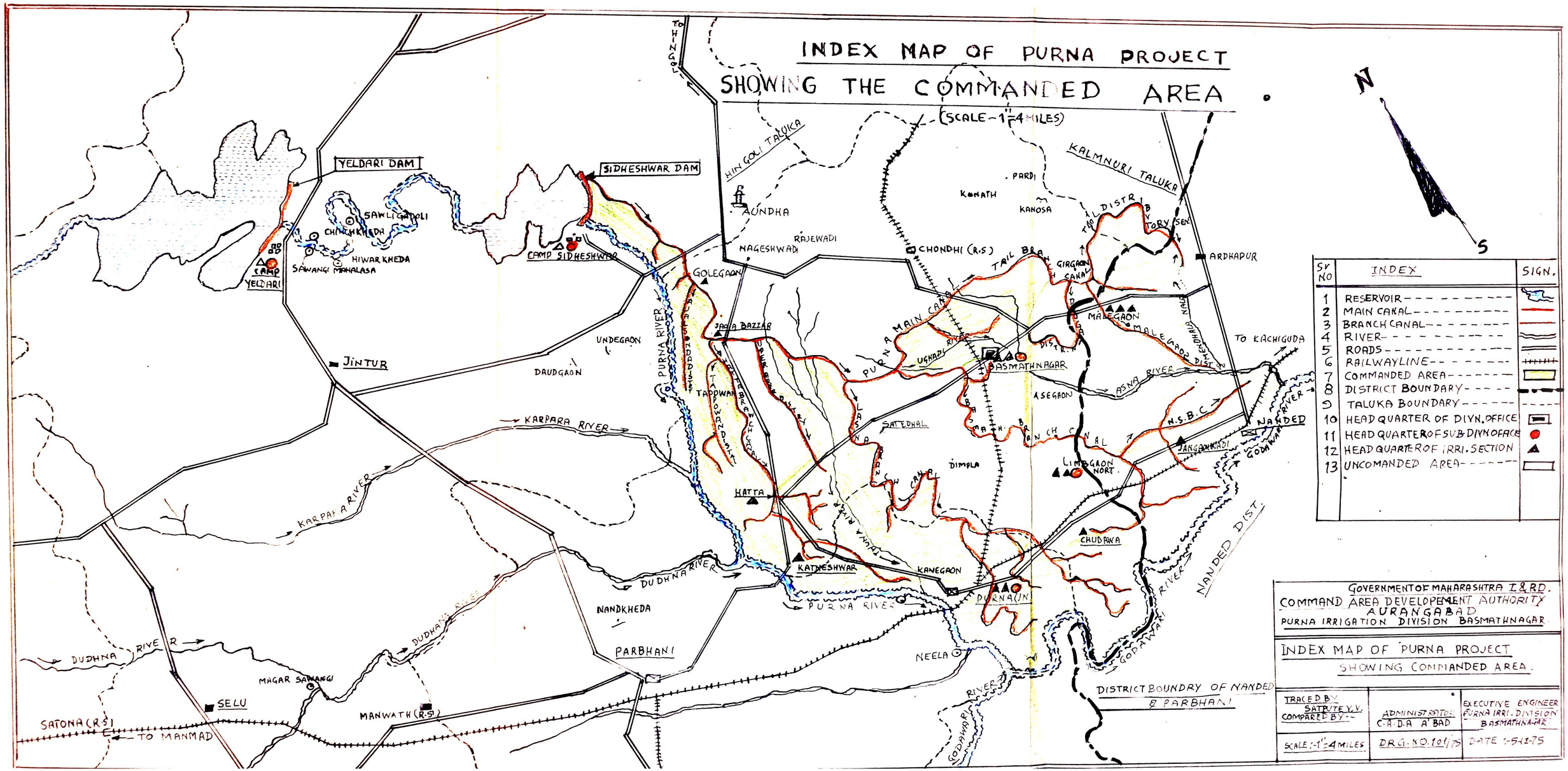
There was again a large spill over in the Fourth Five

Year Plan due to non-completion of five medium projects from the Third Plan and non-execution of all the four major projects. Among the major irrigation projects taken up during the Fourth Plan period, mention may be made of Jayakwadi Stage II project.

2.3 Genesis of the Purna Project

The Purna project constitutes the most important and the largest single investment scheme ever to be undertaken in the region. The project is located in Parbhani district of Aurangabad Division, commonly known as Marathwada region, of Maharashtra State. Its command area is spread over Parbhani and Nanded districts, the major portion of which lies in the former district. The project is conceived as a multipurpose river valley project designed to provide irrigation as well as power. The project was first conceived as far back as 1921 when a scheme to that effect was formulated by Public Works Department of the ex-Hyderabad Government. However, the scheme did not make any progress until 1934. The scheme was then taken up for a general review and that too was limited to a scheme of partial development. The work of survey and preparation of project design for the scheme of partial development as conceived in 1934 was being undertaken when the Second World War broke out in 1939. This resulted in suspension of work. After the War was over it was soon realised, when the scheme was again taken up for further consideration, that fresh survey of the project was necessary due to a change in the economic

INDEX MAP OF PURNA PROJECT
SHOWING THE COMMANDED AREA.
(SCALE - 1" = 4 MILES)



SR NO	INDEX	SIGN.
1	RESERVOIR	
2	MAIN CANAL	
3	BRANCH CANAL	
4	RIVER	
5	ROADS	
6	RAILWAYLINE	
7	COMMANDED AREA	
8	DISTRICT BOUNDARY	
9	TALUKA BOUNDARY	
10	HEAD QUARTER OF DIVN. OFFICE	
11	HEAD QUARTER OF SUB-DIVN OFFICE	
12	HEAD QUARTER OF IRRI. SECTION	
13	UNCOMANDED AREA	

GOVERNMENT OF MAHARASHTRA I & RD.
COMMAND AREA DEVELOPEMENT AUTHORITY
AURANGABAD
PURNA IRRIGATION DIVISION BASMATHNAGAR

INDEX MAP OF PURNA PROJECT
SHOWING COMMANDED AREA.

TRACED BY SATPUTE V.V. COMPARED BY:-	ADMINISTRATOR C.A.D.A A'BAD	EXECUTIVE ENGINEER PURNA IRRI. DIVISION BASMATHNAGAR
SCALE:- 1" = 4 MILES	DRG. NO. 101/75	DATE :- 5-12-75

the carrying capacity of the irrigation canal. This was responsible for an upward revision of the estimated cost.

2.4 The River Purna

The river springs in the Ajanta hills in Aurangabad district, flowing through the southeast of Buldhana district in the Vidarbha region, it re-enters the Marathwada region through the north-west of Parbhani district. It meets the Godavari river on the borders of Nanded district as its major tributary. The river with a long winding course of about 250 miles also has five tributaries of its own. They are Anjan, Girja and Khelna in the early course of its flow in Aurangabad district and Kapra and Dudhana in the later course in Parbhani district. The river drains a total area of 5870 sq. miles covering three districts, major portion of which falls in Parbhani district.

2.5 Salient Features of the Project

The storage reservoir on river Purna is located at Yeldari village in Jintoor taluka of Parbhani district. The diversion dam is located downstream of Yeldari at a distance of 40 miles along the river near village Sidheshwar in Hingoli taluka of Parbhani district. The main components of the project are: (i) a reservoir at Yeldari with gross storage capacity of 33,000 m.c.ft., (ii) a power-house at the toe of the Yeldari dam with an installed capacity of 22,500 K.W., (iii) a diversion dam at Sidheshwar with gross storage capacity of 8859 m.c.ft., and (iv) a main canal 44 km. in

length taking off from left bank of Sidheshwar dam along with its branches and distribution system. The canal is designed to carry a discharge of 2000 cusecs at head to irrigate 61,540 hectares of land and the whole of it is lined. The work of the project was completed in 1968. The principal features of the project are given below:

Particulars	Yeldari Reservoir	Sidheshwar Reservoir
1) Longitude	76°-0'-45"	76°-57'-30"
2) Latitude	19°-0'-43"	19°-0'-20"
3) Catchment area	2830 sq.miles	3000 sq.miles
4) Maximum flood discharge	3,70,000 cusecs	3,81,000 cusecs
5) Maximum height of dam	51.21 metres	38.25 metres
6) Length of dam	4431.80 metres	6658.32 metres
7) Storage capacity at F.R.L.	33,000 m.c.ft.	8,859 m.c.ft.
8) Live storage	31,460 m.c.ft.	2,850 m.c.ft.
9) Gross command area	-	1,86,644 acres (75,532 hectares)
10) Culturable command area	-	1,69,462 acres (68,575 hectares)
11) Irrigable command area	-	1,52,000 acres (61,540 hectares)
12) Cost of the project	Rs. 1961.265 lakhs	
i) Irrigation part	Rs. 1693.978 lakhs	
ii) Power part	Rs. 267.287 lakhs	

2.6 Climate and Rainfall

The State of Maharashtra has been divided into nine well defined agro-climatic zones. The command area of Purna project lies in zone VII 'assured rainfall with kharif cropping' and zone VIII 'moderate to moderately high rainfall'. The former is bound on western side by 700 mm and eastern side by 900 mm isohyet while the latter is bound on the western side by 900 mm and on eastern side by 1250 mm isohyet. Major part of the precipitation is received from south-west monsoon from the end of June to mid-October. Light showers from north-east monsoon are received in November, the extent of which is, however, very little. Temperature ranges between 15.5°C and 45°C. The conditions are suitable for crop growth throughout the year and favourable for growing fruit crops, vegetables, cereals, pulses and fibre crops.

2.7 The Soils

The soils of the entire command area are derived from disintegrated basalt of various shades ranging from brown to black and consist of light, medium-deep to deep soils under the general category of black cotton soils. A soil survey of the command area was carried out by the Soil Survey Division of the Department of Irrigation and Power, Poona, and the soils have been classified on the basis of the depth of soil cover. The gross area of 2,28,505 acres (92,475 hectares) covered by this survey has been classified as under.

Table 2.1 : Soil Classification of the Command Area of Purna Project

Type	Area (hectares)	Percentage
Light soils	7,097	7.67
Medium soils	45,116	48.79
Deep soils	40,262	43.54
Total	92,475	100.00

Source: Government of Maharashtra, Irrigation and Power Department. Report of the Soil Survey of the Areas Commanded by Purna Left Bank Canal in the Marathwada Areas of Maharashtra State, Vol. I, 1964, p. 7.

The light soils being excessively drained are considered unsuitable for irrigation. Medium soils are considered well suited for perennial and other irrigation while deep soils are considered suitable for seasonal irrigation and limited perennial irrigation. The light soils have a depth between 0" and 18" while the medium soils range between 18" and 8' in depth. Deep soils have a depth of more than 8 feet. The sub-types are Kharbad, Kali I and II, and Chopan, and can be described as under:

i) Kharbad soils: These are generally found on high lying and sloping lands. These are a shallow type of sandy loam to loam, brown to brownish in colour underlain with murum derived from the parent basalt rock.

ii) Kali I (Clay Soils): These soils are found along

the banks of nallas, streams and rivers. These are clayey in texture, brownish dark to dark in colour, very hard and cloddy on drying and sticky to rather impervious when wet.

iii) Kali II (Clay loam): These soils are found in gently undulating and flatter tracts in the valley. These are clay loam to clayey in texture, black to deep black in colour, fairly rich in lime reserves and are having a high water holding capacity.

iv) Chopan soils: Certain areas in the narrow belts are found to be covered with alkaline soils, reddish to brownish dark in colour, very hard and cloddy when dry and sticky and impervious when wet. These are known as chopan soils which have an impervious stratum.

Soil samples from 576 profiles in medium soils and 417 profiles in deep soils were examined during the soil survey in respect of total soluble salts by conductivity, pH value, saturation moisture, shrinkage, mechanical analysis, capillary rise in distilled water and sodium chloride solution. The results indicated that in medium soils adverse conditions occurred in 10 per cent cases and in deep soils to the extent of 45 per cent. Clay percentage was observed to be ranging between 39 and 55 per cent.

2.8 Topography

Topographical survey of the command area of the project showed that barring the high level tracts which are out of

command, the general topography of the culturable command was of gently undulating type. The classification of land with regard to percentage slope of the surveyed area is given in Table 2.2.

Table 2.2 : Topography of the Command Area of Purna Project

Sr. No.	Particulars	Area (hectares)	Percentage
1.	Flat land and upto 1% slope	48,088	46.96
2.	1 to 2 per cent slope	41,288	40.32
3.	2 to 3 per cent slope	9,466	9.25
4.	More than 3 per cent slope, ravine and cut up lands	3,253	3.18
5.	Rocky, hilly lands, unfit for cultivation	298	0.29
	Total	1,02,393	100.00

Source: Department of Agriculture, Maharashtra State, "Purna Project," Bulletin No. 836, 1969, p. 22.

2.9 Surface Drainage

The nallas are the natural carriers of excess water, drained through soils. The command area of Purna project is divided into fourteen sub-catchments drained by ten nallas and three rivers namely, Purna, Godavari and Asna. The total length of the nallas is 65 miles and of the rivers is 90 miles. Thus the total length of drainage is 155 miles for 235 sq.miles of the irrigated areas. The area drained per mile length of the nalla or river varies from 0.9 sq.miles to 1.6 sq.miles.

2.10 Approved Cropping Pattern of the Project

In the initial stages when full data regarding soil survey were not available, it was contemplated to adopt cropping pattern which would find favour with the cultivators under the command introducing heavy and other perennials.

Table 2.3 : Cropping Pattern of Purna Project

Sr. No.	Name of crop	Area (ha.)	Percentage
1.	Sugarcane and Banana	6,478	10.53
2.	Other Perennials	3,036	4.93
3.	Kharif rice	6,154	10.00
4.	Kharif seasonals	4,453	7.24
5.	Rabi seasonals	21,255	34.54
6.	Hot-weather seasonals	3,644	5.92
7.	Two seasonals	4,048	6.58
8.	L.S. Cotton	11,338	18.42
9.	Hybrid crops in hot-weather seasonals	1,134	1.84
	Total	61,540	100.00

The original cropping pattern mentioned in the project report, therefore, gave priority to crops like sugarcane, banana, sweet orange, guava, orange and chikoo, allowing perennial irrigation to the extent of 25 per cent of the total irrigable command. When the details of the soil survey became available, a more realistic crop pattern to suit the soil conditions was thought of. Priority was given to two seasonals and kharif seasonals rather than perennials. Further changes were

proposed in the cropping pattern of the Irrigation Department in February 1967. These changes were suggested taking into consideration the different soil types and also the high yielding hybrid varieties which had become available recently. The cropping pattern which is presently in vogue is given in Table 2.3. In the revised cropping pattern emphasis is given on rabi seasonals and hot-weather seasonals by a reduction in the area under two-seasonals.

2.11 Attachment with Command Area Development Authority

The Purna project is attached to the Command Area Development Authority for Purna and Jayakwadi projects with effect from 1-8-1974. Various activities for the development and acceleration of the utilisation of the irrigation potential of the project are undertaken by the C.A.D.A.

CHAPTER III

MANAGEMENT AND ADMINISTRATION OF CANAL IRRIGATION WATER

3.1 Irrigation Acts

The State of Maharashtra, as at present constituted consists of Western Maharashtra, being a part of old Bombay State, Marathwada being a part of the erstwhile Hyderabad State and Vidarbha being a part of the Central Provinces. In general irrigation works continue to be governed and administered under the Acts which were applicable to them when they formed part of the parent Province or State. Hence irrigation works in different parts of Maharashtra were being administered under different Acts and Rules as under:

1) The Bombay Irrigation Act of 1879: Irrigation works in Western Maharashtra region which formed part of the old Bombay State were being administered under this Act and the Bombay Canal Rules of 1934 thereunder.

2) The Hyderabad Irrigation Act No. XXIV of 1357 Fasli: The erstwhile Hyderabad State passed an Irrigation Act in 1948 as Hyderabad Irrigation Act XXIV of 1357 Fasli. The Act and the Rules thereunder continued to apply to such irrigation works as lied in Marathwada region.

3) The Central Provinces Irrigation Act of 1931: The

Act, as amended from time to time was applicable to all the irrigation works in Vidarbha region.

In order to have uniformity in all the regions regarding the administration and management of irrigation works in the State, the Government of Maharashtra subsequently decided to have a uniform Irrigation Act for all the three regions. Accordingly, the State Government passed an Act in August 1976 to unify and amend the law relating to irrigation in the State of Maharashtra called Maharashtra Act No. XXXVIII of 1976. However, during the period under study the old irrigation Act continued to apply to the project command.

The provisions in the Hyderabad Irrigation Act are broadly comparable to those in the Bombay Irrigation Act of 1879 and the Bombay Canal Rules of 1934 have been made applicable to the irrigation works in Marathwada region under Section 67 of the Hyderabad Irrigation Act No. XXIV of 1357 Fasli.

3.2 Provisions of the Act*

The provisions made under some important sections of the Bombay Irrigation Act of 1879 are reproduced below:

Section 4 : This Section defines an Irrigation Officer's powers.

Section 5 : Whenever the water from any river or

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* See, Legal Department, Government of Bombay. The Bombay Code, Vol. I, 6th Edition, 1958, p. 513.

stream flowing in a natural channel of any lake or any other natural collection of water is required for irrigation or for non-irrigation purposes, the said water is notified in the Gazette.

Section 9: This provides power for entry in any land for enquiry as well as exercising power for notification under the provisions of Section 4 of the Land Acquisition Act and for setting up water gauges, etc.

Section 14 : It gives powers to a Canal Officer to remove the cause of obstruction in canal as defined under Section 3.

Section 21 : It is regarding construction and maintenance of water courses.

Section 26 : This is regarding the settlement of disputes about mutual rights and liabilities of a person interested in a water course.

Section 27 : This is regarding the requirement of giving a written application to have supply of water from a canal to the Canal Officer in a prescribed form.

Section 28 : This Section deals with the provisions regarding the supply of water.

Section 30 : This is regarding the transfer of the agreement for supply of water with the property. This Section is very important in the transfer of water permission.

Section 31 : This Section deals with the compensation

awarded in cases of ascertainable substantial damage.

Section 44 : Determination of rates for the supply of canal water is done under this Section.

Sections 45 and 46 : In case of canal irrigation waste and unauthorised use of water is many times noticed. These Sections deal with the subject of penalty in such cases.

Section 49 : This is regarding the levy of betterment charges.

Section 58 : In case of emergencies sometimes difficulty is experienced in obtaining labour for carrying out repairs to the canal. Under these circumstances unless a Canal Officer is adequately empowered to collect forced labour it will be difficult to carry out repairs and avoid consequent loss of life and wealth. Necessary powers are provided under this Section to a Canal Officer.

Section 61 : Any act of damage to the canal is required to be punishable as the offence of such nature is not forgivable. This Section empowers a Canal Officer to produce the offender before a Magistrate.

Section 70 : The Government is required to frame rules for canal system from time to time or cancel them. Rules framed by the Government, modifications and cancellations, therefore, have the force of law under this Section.

All the officers in the management circle act as Canal Officers under the different Sections of the Irrigation Act.

3.3 Field Organisation

Under a management circle, generally there are four to five Divisions of irrigation management. Each Division is entrusted with a mixed irrigation of about one lakh acres. An Executive Engineer is incharge of the Division. There are four Sub-Divisions under the Executive Engineer. A Deputy Engineer is incharge of a Sub-Division. Each Sub-Division commands irrigation in about 25,000 to 30,000 acres. In each Sub-Division there are 3 to 4 Sections dealing with about 5,000 acres of irrigated tract. The Sectional Officer is generally an overseer and is an Irrigation Officer under certain Sections of the Act. There are eight to ten Canal Inspectors under the Sectional Officer each managing irrigation in about 500 acres.

The Canal Inspector is the last link in the management dealing with the actual distribution of supplies. The duties of a Canal Inspector are multifarous and consist mainly of supply of irrigation water to irrigators as per the share list, detection of unauthorized irrigation, dating of passes, preparation of pali patrak, booking offences of pani nash, etc., and assisting measurers in crop measurements. He is also oftenly required to prepare demand statements. He has to maintain a list of wells in the area under his command and detect misuse of water by the irrigators. It is evident that the Canal Inspector has a pivotal role in the successful management of canal waters. He is the official in direct contact of the irrigators and on his ability and tact depends the smooth

functioning of the irrigation management. Needless to say, proper supervision by higher officers is necessary.

3.4 Sanction to Applications for Irrigation Water

Unlike in Western Maharashtra, the system of giving long-term sanctions and blocks, commonly known as block system of irrigation, does not prevail in Marathwada region and sanction is given for every crop season.

Cultivators requiring irrigation supplies have to apply to the Executive Engineer, Purna Irrigation Division, Basmathnagar in the prescribed form (Form No. VII) on or before the dates fixed and notified. This form is used for all crops for which 'block system' is not applied and is meant for irrigation in each season. The Executive Engineer incharge of the Division invites application for irrigation water by giving a public notice in Marathi. The public notice is to be got approved from the Superintending Engineer and is issued well in advance, say one month before the commencement of the season. The date before which the water applications are to be tendered by intending irrigators is so fixed as to have sufficient time for processing the applications and giving sanctions. Such notices of inviting applications are given wide publicity by endorsing copies to various authorities such as the District Collectors, Tahsildars, District Agricultural Officers, members of the Canal Advisory Committee, etc. Copies of the notification are also displayed in the 'chawadi' (office of the

Sarpanch, Grampanchayat) of each village under the command. The applications are normally received in the Sectional Office. However, there is no objection to receiving them in higher offices also in which case they are sent to the Sectional Office concerned. The Sectional Clerk (Karkoon), after scrutinising the applications, acknowledges the applications in a prescribed printed form. After due scrutiny such as whether the form is properly filled or not, the applications are submitted by the Sectional Officer to the Sub-Divisional Officer concerned who again scrutinizes the applications as per Rules.

Full details of the field numbers, total area and the crops for which irrigation supplies are required and the outlet from which the area is to be irrigated are required to be given in the application form. If any details are missing, the Sectional Officer points out the deficiency and returns the application form to the irrigator. If due to any reason the application is rejected the reasons thereof are stated and the same is returned to the applicant. If the application is complete in all the aspects and submitted in time, sanction is accorded to the irrigator, subject to the availability of irrigation supplies. Each application received in the office of the Sectional Officer is entered serially in a register and the Sectional Clerk puts his signature and date on the application form. If there are more applications than the available water, the applications, which are received after the demand

is fulfilled according to the availability of water, are rejected. The form of application is supplied free of cost to the irrigators and can be sent by post or delivered personally in the office concerned. Before giving sanctions, following points are taken into account:

a) evidence showing that the irrigator has title to the land for which irrigation supplies are required

b) all the details such as name of the village, survey number, distributary, minor are recorded,

c) field channels are in proper condition,

d) there is no mixing of canal and well waters,

e) the field for which irrigation supplies are required is not far away from other fields requiring irrigation supplies.

If an applicant is in arrears of water rates, the application may be summarily rejected. The recovery of the water rates is done by the Revenue Officers of the Revenue Department and often it is found that they do not intimate the names of the defaulters of water charges to the concerned officer of the Irrigation Department. Hence, in practice, irrigation supplies are sanctioned to all irrespective of whether one is a defaulter or otherwise so long as a properly filled application form is received in time. The Sub-Divisional Officer scrutinises the applications regarding the above-mentioned points and if he is satisfied that all the requirements are met, he gives sanction to the irrigation supplies within

fifteen days of the last date of receipt of application forms.

When an application for use of irrigation supplies is sanctioned, a pass* is issued to the irrigator indicating therein the area and the crop for which irrigation supplies are sanctioned, the sources from which and the period for which the irrigator would get the supplies. The powers to issue passes are delegated to the following officers according to the crops irrigated:

a) Sectional Officer : For seasonal crops

b) Sub-Divisional Officer : For two-seasonal crops

c) Divisional Officer : For perennials crops.

Sanction to perennials is given only to that area which is passed for taking perennials i.e. M_1 and D_2 soils.@

There are certain general Rules regarding giving sanctions as follows:

i) Sanction is not given for irrigating an area within ten feet of a well, cart-tract or road boundary.

ii) Sanction is not given to the area less than 0.20 ha. (0.50 acre) and is accorded in the multiple of 0.20 ha.

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* See form of pass given in the Appendix as Appendix A.

@ Soils classified as M_1 and D_2 are sanctioned for taking perennial crops - soils with good drainage capacity.

M_1 Soils: Medium soils which drain directly into some natural drainage.

D_2 Soils: Deep soils within a belt of 1/2 mile along the rivers Purna, Godavari and Asna taken as well drained.

iii) Sanction would not be accorded to an area if the Canal Officer apprehends that water would go waste.

The irrigator has to take supplies only when the Canal Inspector marks the date on the pass issued to him. Dating of the pass is done for every rotation i.e. every watering. The irrigator or his representative is required to be present in the field when irrigation supplies are given and should possess the pass. The irrigation supplies are required to be taken during night if the rotation happens to fall during night.

When the crop sustains damage or loss on account of inadequacy of the discharge, closure of canals for sudden repair during irrigation, remission of the whole or part of the irrigation charges is admissible subject to the proviso that the outturn is not more than twenty-five per cent of the normal yield. Such remission is admitted after proper certification following a panchanama and only when application to that effect is made to the concerned Divisional Engineer within one month from the date of such loss.

3.5 Distribution of Irrigation Water

The distribution network in an irrigation system consists of the main canal, branch canal, distributary, minor, sub-minor, water courses and field channels. On major and medium irrigation projects a distinction is made between a water course and a field channel. The former is built at Government expense to carry water from an outlet to a 40 ha. block (100

acres). Beyond the water courses, the farmers have to construct field channels to serve the several fields within the block. The responsibility for maintenance of both water courses and field channels lies with the beneficiaries.

It would be impossible for all the cultivators to take the irrigation supplies on the same day and at the same time. With a view to ensuring proper distribution of the supplies, irrigation water is given starting from tail-end towards the head of a canal. In this way it is ensured that all the irrigators would get irrigation supplies in sufficient quantities within the time limit and water would not run to waste or flood nearby fields. If it is found that an irrigator at upper reaches is taking irrigation supplies when the tail-end irrigator is irrigating his fields it constitutes an unauthorized use and becomes liable to penalty under the Rules. Similarly, if an irrigator takes irrigation supplies twice in a rotation, it is treated as an offence. A cultivator has to irrigate the area and the crop for which he is entitled. An irrigator has to take irrigation supplies during night according to his turn and if it is detected that water is not utilised and allowed to run to waste, the concerned irrigator then becomes liable for penal action. It is called 'pani nasacha panchanama'.

As per the provisions of the Act, the irrigators are required to maintain their field channels in proper condition. It is further provided in the Act that an irrigator is required

to maintain the field channels even if he does not avail of irrigation supplies. The Act makes adequate provisions for construction of field channels by Government at the cost of the irrigator when the latter is unable or fails to do so by giving a prior notice and the expenditure on account of this is recovered from the concerned irrigator.

3.6 Irrigation Year

The irrigation year starts on 1st July and closes on 30th June. It is divided into three cropping seasons as indicated below:

(i)	Kharif	: 1st July to 14th October	106 days
(ii)	Rabi	: 15th October to 28/29 February	137/138 days
(iii)	Hot-weather	: 1st March to 30th June	122 days

The interval at which crops require irrigation differs in different seasons. The rotation period i.e. interval between two waterings, is, therefore, different in each of the three seasons. It is of 18 days (12 days flow period and 6 days closure) in kharif season. In rabi and hot-weather seasons it is 21 days (14 days flow period and 7 days closure) and 10-11 days (8 days flow period and 2 days closure) respectively.* The Executive Engineer incharge of the project prepares an irrigation rotation programme called 'pani pali-patrak' well in

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* See Pani-Pali-Patrak prepared by the Executive Engineer, Purna Irrigation Division, Basmathnagar, appended as Appendix B, C and D.

advance of each season and notifies it to the beneficiaries. According to this programme water is let into the main canal from the reservoir. Details regarding the rotation period, period during which the main canal is open and the period of closure of the main canal are indicated in the pani-pali-patrak. The beneficiaries have to ascertain from the Canal Inspector or Patkari the details of letting water into the main canal. A copy of the rotation programme is displayed on the notice-board in the office of the Sectional Officer and the Sub-Divisional Officer as well as in the chawadi of each village under the command.

The following crop classification is recognised for the irrigated area under the command:

i) Heavy perennials	: Sugarcane and Banana
ii) Other perennials	: Sweet Oranges, Guava, Chikoo, Oranges, and perennial fodder
iii) Two seasonals	: Chillies, long-staple Cotton, Turmeric, Ginger, Vegetables and Potato
iv) Kharif seasonals	: Paddy, Hybrid Jowar, Hybrid Bajara, Hybrid Maize, and Vegetables
v) Rabi seasonals	: Wheat, Hybrid Jowar, Hybrid Maize, Gram, local improved Jowar and Vegetables
vi) Hot-weather seasonals	: Groundnut, Vegetables, Fodder and Mung.

In growing these crops certain crop rotations are essential to maintain soil fertility. Crop rotations may be of one year, two years or three years.

3.7 Crop Measurements

In order to know whether the irrigators have availed irrigation facilities for the sanctioned crops, to the extent of the sanction in the specified survey number, it is necessary to measure the areas of crops for which irrigation supplies are availed by the cultivators. The work of measurement of area under each crop is done by the measurers before the end of each season. This gives an idea of irrigation done on any canal system. The record of measurements of areas of crops is taken in a field book called 'tippen book'. A list of irrigators with the sanctioned area is supplied by the Canal Inspector to the measurers. Check measurements (nimtans) are done by the Sectional Officer, Sub-Divisional Officer and Executive Engineer to ascertain the correctness of crop measurements done by the measurers. It is expected that the irrigator concerned is present while measurements are being taken. The measurer takes his signature or thumb impression in the measurement book if the irrigator is present. Excess areas are exempted as per slab given below taking it as bonafide excess:

Area sanctioned		Excess exempted
i) Upto 0.61 ha.	(1.50 ac.)	0.01 ha. (0.025 ac.)
ii) 0.61 to 1.82 ha.	(1.50 to 4.50 ac.)	0.02 ha. (0.050 ac.)
iii) 1.82 to 3.64 ha.	(4.50 to 9.00 ac.)	0.03 ha. (0.075 ac.)
iv) 3.64 to 6.07 ha.	(9.00 to 15.00 ac.)	0.04 ha. (0.100 ac.)
v) Above 6.07 ha.	(15.00 ac.)	0.05 ha. (0.125 ac.)

Any excess beyond the above is charged at penal rates. Water charges are levied even though the cultivator does not avail of irrigation supplies once a pass is issued to him. It is called 'pokal akarni'.

3.8 Penalties

For areas of unauthorized irrigation and the area beyond the sanction, a penalty is imposed generally three times of the seasonal rates. For offences of misuse of water like unauthorized irrigation (bin arjee), out of turn of irrigation (bigarpali), waste of water (pani nash), etc., panchanamas are held by the Canal Inspector as soon as the offence is detected by him. The Canal Inspector then makes an entry of the offence immediately in the panchanama form and issues a slip to the concerned irrigator or his representative on which a remark to the effect that the irrigator should put up complaints within five days is printed. A panchanama is said to be completed when all the entries regarding details of the offence, Canal Inspector's statement, statements of witnesses and the statement

of the irrigator are recorded. In case the irrigator or his representative is absent, the duplicate copy of panchanama slip is pasted to the hands of the irrigator in the presence of two witnesses. If the irrigator refuses to give statement or in case his statement cannot be obtained, the panchanama is got completed from village officers. The powers to hold panchanama are given to the following Irrigation Officers to the extent indicated:

i) Canal Inspector	:	0.61 ha.
ii) Sectional Officer	:	1.00 ha.
iii) Sub-Divisional Officer	:	5.00 ha.
iv) Divisional Officer	:	10.00 ha.

3.9 Irrigation Revenue

The Rules under the Act prescribe water rates to be charged for different crops and the charges are assessed accordingly. After taking measurements of the area irrigated an assessment statement showing the cropped area actually irrigated by a cultivator, water rate and the actual charges to be assessed is prepared by the Sectional Officer. This is called demand statement and is prepared in Form No. XII. The demand statements are prepared villagewise. The amount charged on account of water charges is made known to the irrigators by the beat of drum in every village under the command and signature or thumb impression of every irrigator to that effect is obtained. This is known as 'kulrujwat'. The demand statements prepared by the Sectional Officer are submitted to the Sub-Divisional

Officer for scrutiny. The Sub-Divisional Officer after due scrutiny transmits the same to the Executive Engineer or Divisional Engineer. The annual demand statement in Form No. XIII is prepared by the Executive Engineer and a copy of the same is sent to the District Collector, Superintending Engineer and the Dy. Accountant General. The Revenue Officers (Tahsildars of the concerned tahsils) are responsible for the recovery of the charges. The Tahsildars have to intimate the progress of the recovery in Form No. XV to the Executive Engineer. But recently the Government of Maharashtra has made Irrigation Department responsible for the recovery of water charges.*

3.10 Water Rates

There was no uniform system of charging water rates in the Marathwada region till recently. In most cases it was a consolidated assessment and the water rates were inclusive of land revenue and a uniform water rate of Rs.12.00 per acre was charged under some tanks for irrigating either kharif or rabi crops. If a rabi crop was irrigated from the tank after irrigating kharif crop in the same land an additional charge of Rs.6.00 per acre (totalling to Rs.18.00 per acre) was recovered. The maximum charge for wet cultivation of paddy or perennial crops like sugarcane or banana was Rs.24.00 per acre inclusive of land revenue. Under some tanks water rates were charged on the area for which water was actually utilised, but in the case

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* See, Government of Maharashtra, Irrigation Department Notification No. IRA 1075/1119 13(214) dated 29th May, 1976.

of others the ayacut was fixed and water rates were charged to all the area included in it irrespective of whether water was taken by the cultivators or otherwise.

In order to bring uniformity in the water rates the Government of Maharashtra had prescribed provisionally water rates for all the existing works as well as for all the newly constructed works viz. major, medium and minor, with effect from 15-2-1963 (vide G.R. No. Revenue and Forests Department, Government of Maharashtra WTR 1065/45463-C dated 5-5-1965). The Commissioner of the Division was empowered to fix the rates on individual holdings according to the rates prescribed in the Resolution. The water rates were subsequently revised and came into force with effect from 1-7-1974 and are now in vogue. The same are produced in Appendix E. In addition to the water rates leviable under the provision of the Irrigation Act, an amount of Rs.0.20 per rupee is charged as local cess fund presently. The levy of betterment charges is, however, suspended.

3.11 Water Management

A canal is designed to carry water for irrigation of a maximum area required to be irrigated in a single rotation. The area actually required to be irrigated in each rotation from the beginning of a cropping season to its end is not the same due to differences in sowing dates on account of variations in farm operations. Therefore, the discharge required to be released from the diversion work into the canal in a cropping

season varies from rotation to rotation. The discharge required to be released at the head of a distributary and at the head of a canal is computed on the basis of the commitments made by way of issue of passes and the demand received for irrigation water from the passholders and water is admitted into the canal accordingly.

The discharge released into the main canal and into the distributaries from the main canal is measured by a simple measuring device known as 'standing wave flume' which is constructed in masonry or cement concrete at the head of the main canal and branches and at the head of every distributary through which the released water passes. A gauge is fixed at an appropriate place in the standing wave flume structure known as the gauge chamber. The gauge reading indicates the discharge passing through the flume. The water level in the gauge chamber, read at least twice in a day at fixed times, is reported by a canal telegram to the controlling officer controlling the canal discharges. At the head of each distributary there is a gated head regulator and the required water for irrigation of the area on the distributary in each rotation is regulated and released into the distributary from the branch canal by manipulating the gates on the regulator.

The Canal Inspector submits a statement of requirement of water for each rotation for each channel to the Sectional Officer. The Sectional Officer, after scrutinising the same, compiles the requirements of all the Canal Inspectors and

submits his combined requirement for the rotation to the Sub-Divisional Officer. The Sub-Divisional Officer incharge of a major canal is entrusted with the overall control of letting out water from storage in a day to day working and it is his responsibility to see that each canal gets its due share in each rotation as per the requirement. The Sub-Divisional Officer prepares a combined programme of daily draw off of each canal for the whole canal system. He lets out water from the storage in such a way that it does not go to waste due to overflowing of the weir. The Divisional Officer does not interfere in the day to day management except exercising his check on the draw off from the storage in each rotation.

Dependent on the area to be irrigated by each irrigator, the Sectional Officer determines in advance the day and time from and to in which each irrigator is entitled to receive water in each of the rotation and notifies it by a notice known as 'share list' or 'pali-patrak'. Pali patrak is prepared only once at the beginning of the irrigation season. The share list is exhibited well in time in the Sectional Office and the contents are communicated to each irrigator through the Canal Inspector who actually supervises the use of water released for irrigation and ensures that each irrigator takes irrigation supplies on the proper day and during the specified time of his entitlement.

The system of issue of irrigation water by measurement in some form or the other was practised on the Deccan Canals

in the British regime. Today water is issued on volumetric basis to the State Farming Corporation. But the issue of water is not controlled in a similar way so far as the individual irrigators are concerned. At present the irrigator is supposed to have levelled his field and constructed a low bund along the boundary of the area entitled to irrigation water. The irrigator is allowed to flood his field and take as much water as he pleases without breaching the surrounding bund. As soon as one irrigator completes irrigation of his field known as 'bharna' the water is diverted to the field of next irrigator. Practically no control is exercised on the height of the earth bund surrounding the irrigated area and the tendency of irrigators is to construct a bund of greater height than prescribed and take more water than allowed. This leads to over-irrigation and reduction in the area irrigated per unit of water and a lower irrigation efficiency. Over-irrigation also affects yields adversely as crops suffer if the soil moisture status is maintained at the field capacity for a longer time than the crop can tolerate. Besides, if more water is applied than required for the plant, the excess percolates to the ground-water-table thereby dissolving and washing away some essential nutrients which are needed for plant growth. This also leads to conditions of waterlogging which hampers soil aeration important for plant growth and anerobic activities of the soil. Over-irrigation also sets in reductive processes whereby assimilable plant nutrients viz., nitrates, sulphates, phosphates, ferric and magnetic salts, are reduced to unassimiable

and sometimes toxic substances which instead of aiding actually retard plant growth and yield.

3.12 Role of Institutions in Irrigation Management

Canal Advisory Committee: It is a body appointed by Government for giving advice to it in matters concerning irrigation. It consists of Executive Engineer as the chairman, Members of Legislative Assembly of the area, District Agricultural Officer and two or three irrigators as members. The Sub-Divisional Officer acts as the Secretary of the Committee. The tenure of the Committee is of three years and is reorganized after the expiry of the period excepting the official members.

Pani Panchayat Committee: There is a Pani Panchayat Committee generally in every village under the command. Along with official members there are members from the irrigators. The functions of this Committee are to assist the Irrigation Department by detecting and preventing encroachment on canal lands, by preventing damage to irrigation works, etc. It also settles disputes and on the whole sees that discipline is maintained in the distribution of irrigation supplies.

However, during the course of the survey it was noted that in many villages the Committees did not function properly. Meetings of the Committees were not convened regularly and they did not play significant role in the successful management of the irrigation waters.

CHAPTER IV

EXTENT OF UTILISATION OF THE PROJECT POTENTIAL

One of the objectives of the present study is to estimate the progress in the utilisation of the irrigation potential on the Purna irrigation project from the year of its creation. As a preliminary we shall first describe certain practices and terms used in the operation and management of irrigation works.

4.1 Volume of Water

If one foot depth of water were put on one acre of land the quantity of water put on the land would be described as one acre foot of water. One acre is equal to 43560 sq.feet. Accordingly, one acre foot would be equal to 43560 cubic feet. When a crop in one acre of land is given six waterings of two inches each i.e. 12 inches or one foot in all, the quantity of irrigation water applied is described as one acre foot.

The quantity of water stored in a storage reservoir on a river is either measured in acre feet or in million cubic feet (m.c.ft.). Sometimes when the quantity is very large it is measured in million acre foot (M.A.F.) or in thousand million cubic feet (T.M.C.).

1 million cubic feet	= 22.96 acre feet
1 T.M.C.	= 22957 acre feet = 0.023 M.A.F.
1 M.A.F.	= 43.56 T.M.C.

4.2 Rate of Flow

One cusec stands for one cubic foot per second. If one cusec of water is delivered for 60 seconds or one minute the quantity of water delivered would be 60 cubic feet. Similarly, one cusec delivered for one full day of 24 hours is called a 'cusec day'.

1 cusec day	= 0.0864	m.c.ft.
	= 1.98	acre feet
	= 0.54	million gallons
1 imperial gallon	= 0.16	c.ft. of water

In Maharashtra, the irrigation year is divided into three cropping seasons viz. kharif, rabi and hot-weather. The period covered by each cropping season is of 106 days, 137 days and 122 days in kharif, rabi and hot-weather seasons respectively. Taking into consideration these periods:

1 cusec in kharif	= 9.16	m.c.ft.	= 209.88	acre feet
1 cusec in rabi	= 11.84	m.c.ft.	= 271.26	"
1 cusec in hot-weather	= 10.54	m.c.ft.	= 241.56	"
1 cusec year	= 31.54	m.c.ft.	= 723.97	"

4.3 Duty and Delta

The term duty of a crop connotes the area of a crop which can be brought to maturity by one cusec of irrigation water delivered during its life time in which water is required to be given to the crop, called its base period. The term delta means the total depth of irrigation water required by a crop till it matures. The terms duty and delta are thus interrelated. If duty or delta for a crop is given, the other can be found from

from the following:

$$\Delta = \frac{1.98 \times B}{D}$$

where Δ = Delta i.e. total depth of irrigation water given to a crop in feet

B = Base period in days

and D = Duty of the crop expressed in acres.

Given the delta for rice, for instance, as 4 feet and base period as 120 days, we have:

$$4 = \frac{1.98 \times 120}{D}$$

$$\therefore 4D = 1.98 \times 120$$

$$\therefore D = 1.98 \times 30$$

$$= 59.4 \text{ acres}$$

Duty of a crop is generally expressed at distributary head. Since the length of distributaries as well as of minors and water courses differs very widely the loss of water in transit, from the distributary, etc., to the field, differs from one distributary to another. Therefore, the duty at distributary head obtained on one distributary would differ from that obtained on another. The duty obtained on a distributary of short length would be more while that obtained on a distributary of long length would be less. For the purpose of assessment of water requirements of crops proposed to be irrigated on various distributaries it, therefore, becomes necessary to strike an average and adopt average duty for the canal system as a whole. Since duties for a new canal system cannot be known beforehand average duties at distributary head

on comparable canal system in operation are adopted for estimation of water needs on the new canal system.

Duty of a crop and the area under it helps in the assessment of the total water requirement of the crops proposed to be irrigated. Crop duty depends upon factors like season, rainfall, type of soil, kinds of crops, condition of the channels, conveyance losses, etc.

For the sake of convenience in estimating the seasonal average discharge required for irrigating the crops in each of the three cropping seasons the term seasonal duty of a crop is used.

A crop may stand in ground in all the three cropping seasons and may require irrigation water in all of them as in the case of sugarcane, banana, etc. Or it may stand in the ground for two cropping seasons and require irrigation water in the two seasons as in the case of chillies, ordinary cotton, etc. A crop like long staple cotton, which is sown by the middle of May (15 to 25 April in Deccan Irrigation Circle) in hot-weather and harvested in rabi, may stand in the ground in a part of each of the three cropping seasons. The finer varieties of paddy, which are sown in kharif and receive irrigation water in kharif and part of rabi, stand in the ground for one cropping season and a part of the following season. The irrigation practice in Maharashtra is to determine the seasonwise water requirement of all crops and add up the requirement on a season basis. The term seasonal duty, therefore, refers to

the area of a crop which can be irrigated in a cropping season by a discharge of one cusec delivered at the distributary head. This is the duty of the crop for the particular cropping season. The seasonal water requirements of different crops differ from one another and are reflected in their seasonal duties. The seasonal duties of crops grown on canals of Purna project are given in a tabular form in Appendix F.

The seasonal duty described above is the duty in acres of crops irrigated by one cusec of water delivered at distributary head. Transit losses are added to arrive at the discharge required at the canal head.

4.4 Rotation

After receiving the first irrigation watering a subsequent watering is required to be given on the same area after an interval of some days dependent on the crop, water holding capacity of the soil, depth of root zone of the crop and the rate of daily evapo-transpiration at that time. Some crops need irrigation water at every 10 to 12 days interval while some others can tolerate a break of 15 to 20 days between two waterings. This interval between two waterings is known as rotation. The rotation period or simply a rotation can, therefore, be defined as the interval between two consecutive waterings given to a crop. In hot-weather season the rate of evapo-transpiration being higher water is required to be given to the crops at a shorter interval than given in the other two seasons.

4.5 Transit Losses

Utilisation of irrigation water is affected by the extremely high water loss during storage and transit, particularly in flow irrigation. In unlined channels only a portion of the water supplied at the canal head reaches the farmer's field, the rest of it being lost in transit. There is also a substantial loss in the field itself and only a fraction of the supply reaching the farmer's field is actually utilised by the crops. Some of these losses are unavoidable. Many of them can, however, be avoided by suitable measures. Losses in channels arise from percolation, evaporation and transpiration from weeds in the channels and on the banks. Little can be done to save the evaporation loss in channels, which in any case is small. Losses due to transpiration through bank vegetation can, however, be reduced by keeping the banks clear of weeds. The main loss is through percolation, depending on the permeability of the bed and bank material of the channels. In Maharashtra the canal losses in the main canal and branches are estimated at 25 per cent of the water delivered into the distributaries for a 100 mile long canal. If the length of the canal is 50 miles the percentage loss is reduced proportionately to 12.5 per cent. The losses in distributaries are taken at 10 per cent of the discharge released at their head and those in the water courses at 20 per cent of the water released at the head of the water courses.

4.6 The Concept of Irrigation Potential

The term irrigation potential created by an irrigation project is the aggregate gross area that can be irrigated annually by the amount of water which could be made available by all connected and completed works including and upto the end of water courses or the last point in the water delivery system upto which the Government is responsible for construction. According to this definition it can be seen that potential is deemed to have been created only after water could be made available upto the end of water courses. It goes without saying that as a pre-condition enough water must be available at the storage or diversion point to satisfy the needs of the lands that can be served by the completed portion of the canal system.

The term gross irrigated area would include all the cropped area which will get irrigation water facilities whether in kharif, rabi or hot-weather. The irrigated area under sugarcane or other perennial crops or two-seasonal crops is counted once but area covered by two or three crops in a year is counted twice or thrice as the case may be.

The term irrigation potential utilised connotes the total gross cropped area actually irrigated by a project during the year under consideration. As the utilisation of irrigation potential created can take place only in the year following the creation of such potential, the irrigation potential utilised

in a particular year should be related to the potential created upto the end of the preceding year.

The parameters which determine the creation of annual potential are:

(i) Yield of water in the catchment area with a certain dependability such as 50 per cent, 75 per cent, etc.: The total rainfall in the catchment area of the dam determines the quantity available for utilisation. The rainfall in the catchment areas of rivers and streams varies from year to year. Hence there is a variation in the quantity of surface flow available in the rivers and streams from year to year. It, therefore, becomes necessary to know the range of variation in the quantity of flow available in a river during a period of years. This would enable one to forecast, with a fair degree of accuracy, the extent to which one can depend on obtaining a specified quantity of water from the flow, from year to year. This is called the degree of dependability. The dependability or percentage dependability of available water represents the percentage number of years in which a specified quantity of water is available in full and in the remaining years the availability is less in varying degrees.

For working out the percentage dependability normally a minimum of 60 years' data are required. The annual flow data are also called the "run-off series". The annual run-off data in respect of Mutha river gauged at Khadakwasla for a period of 49 years are given in a tabular form in Appendix G. The

data are arranged in a chronological order as well as in the descending order of magnitude. It will be seen from the table that a run-off of 48,350 m.c.ft. was available at Khadakwasala for 50 per cent of the years for which the data are recorded. This quantity is known as 50 per cent dependable supplies. Similarly, the run-off of 37,271 m.c.ft. available at Khadakwasala for 75 per cent of the years is said to be 75 per cent dependable supplies. At present irrigation projects are designed to utilise flows with 75 per cent dependability. It is evident that the higher the dependability, the less the quantity of water available for utilisation.

The requirement of 75 per cent dependable flow for irrigation projects puts a severe limitation on the total area that could be supplied with irrigation water. The Maharashtra State Irrigation Commission (1962) considered it desirable to harness flows of lesser dependability. The Commission recommended that in the planning of irrigation projects in future the aim should be to utilise 50 per cent dependable flows; especially in the basins of the Bhima, the Godavari (excluding Wainganga) and the Tapi, where water resources of 75 per cent dependability are extremely inadequate.[1]

(ii) Out of the estimated yield of water that would be available, decision regarding how much to use in the kharif and how much to use in the fair weather season, i.e. rabi and hot-

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1 Report of the Maharashtra State Irrigation Commission, 1962, op.cit., p. 45.

weather seasons: The quantity of water which is desired to be kept for the rabi and hot-weather seasons constitutes another factor for kharif utilisation. The water utilisation in rabi and hot-weather seasons is known as the fair-weather utilisation. It depends on the quantity of water which is stored in the reservoir feeding the canals and is available for use after the cessation of monsoon. There is a certain amount of flow in the river, in the upper reaches of the dam, after the cessation of monsoon. This flow is known as 'post-monsoon flow' and the quantity of water so available is referred to as 'river-gains'. Naturally, in rabi and hot-weather seasons the quantity of water available in the reservoir and the post-monsoon flow in the river both are relevant.

(iii) Evaporation losses in the storage: The water stored in the reservoir may either be utilised fully in the rabi season or may partly be used in rabi and partly in hot-weather season. However, utilisation of stored water in hot-weather season involves larger evaporation losses.

(iv) Canal capacities needed for the designed use: For irrigation in the kharif season all that is required is to direct the water from the river into the canals without necessarily storing it in the reservoir. The area irrigated with the quantity of water that is available in the kharif season, therefore, depends on the available canal capacity. Since the canal capacity is fixed it is a limiting factor for the creation of irrigation potential.

(v) Transit losses on account of (a) evaporation, (b) seepage.

The term irrigation potential of an irrigation project is generally taken to mean the area which the project is designed to irrigate under various crops on full development as envisaged in the project cropping pattern. The irrigation water requirement varies from crop to crop and from season to season. Naturally with a given quantity of water available in kharif season and in fair-weather season a variety of crops with different water requirements could be grown. An irrigator is free to make his own choice regarding the crops to be grown and irrigated depending on the availability of water, resources at his command and the prevalent commodity prices. Obviously, therefore, even though the entire available water may be utilised, the cropping pattern obtained could be different from that designed in the project cropping pattern and since the water requirements of crops differ from one another the area actually irrigated could vary from the area designed to be irrigated in the project i.e. from the irrigation potential of the project. Utilisation of the irrigation potential of a project is often assessed by merely comparing the area actually irrigated in a given year with that put down in the project. Such a comparison would not be valid unless both the figures of areas are converted to a common base.[2] Without such conversion it would appear that even on the canals, where the

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2 See, ibid., p. 152.

entire available water resource is fully booked, there may appear underutilisation. The method by which the utilisation of a project potential is presently assessed does not, therefore, appear to be appropriate.

In order that the comparison should be meaningful, potential and utilisation has to be expressed in terms of the quantity of water either directly or in terms of a standard or base crop. There are two alternative ways, namely (a) comparison of the actual quantity of water in m.c.ft. utilised in a given year by various crops during kharif, rabi and hot-weather seasons with the quantity of water available for utilisation in that year and (b) expressing the physical area irrigated under various crops in a given year in terms of a base crop to which all the crops are reduced in consideration of their water requirements as compared to the base crop and comparing these figures with the figures of the base crop under project cropping pattern obtained by giving the same treatment.

The second method is simpler and is followed here. The areas irrigated under various crops in a given year can be readily reduced to a base crop area in proportion and consideration of the duties adopted in the project report. This would enable us to bring all the area irrigated under various crops in a given year on the same footing. The area designed to be irrigated under various crops in the approved cropping pattern of the project would also be subjected to the same treatment. Rabi seasonals are usually taken as the base crop for this

purpose. A comparison between the two figures would yield percentage utilisation of the irrigation potential of the project in a given year unless the particular year is a bad year with less than projected water available.

4.7 Irrigation Potential of the Project

In Purna project the ultimate irrigation potential to irrigate 61,540 hectares was created from the year 1968-69. The stages in which irrigation potential was created are shown in the following table.

Table 4.1 : Stages of Creation of Irrigation Potential

Year	Potential created (hectares)
1962-63	3,239
1963-64	5,263
1964-65	5,972
1966-67	24,049
1967-68	40,486
1968-69	61,540

In Table 4.2 is given cropwise break-up of the area to be irrigated under the project.

Data on physical area irrigated under various crops during the years 1968-69 to 1975-76 were collected from the project authorities and are given in Appendix H. As explained earlier, in order to find the extent of utilisation, the area designed to be irrigated under various crops in the approved

Table 4.2 : Cropwise Break-up of the Area to be Irrigated

Sr.No.	Crops	Area (hectares)
1.	Sugarcane and Banana	6,478
2.	Other Perennials	3,036
3.	Kharif Seasonals	4,453
4.	Kharif Rice	6,154
5.	Long Staple Cotton	11,338
6.	Other Two-Seasonals	4,048
7.	Rabi Seasonals	21,255
8.	Hot-weather Seasonals	3,644
9.	Hybrid Crops in Hot Weather	1,134
	Total	61,540

cropping pattern of the project was converted into a base crop area, taking rabi seasonals as the base crop, as a norm for comparison. Following the same procedure the physical area irrigated under various crops during the years under study was also converted into equivalent area of rabi seasonals. Areas of equivalent rabi seasonals thus obtained are then compared with that obtained under project cropping pattern in order to find the percentage utilisation of the project potential. Appendices I to Q show details of the conversion of areas irrigated under various crops into equivalent area under rabi seasonals. The results obtained are presented in Table 4.3 and Figures 1 and 2.

It can be seen that the utilisation of the irrigation

Table 4.3 : Utilisation of the Project Potential

(Area in hectares)

Season	Base crop area to be irrigated as per the approved cropping pattern of the project	1968-69		1969-70		1970-71		1971-72		1972-73		1973-74		1974-75		1975-76	
		Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation	Base crop area irrigated	% utilisation
Kharif	45962.41	6011.16	13.08	8391.90	18.26	7734.16	16.83	18266.12	39.74	21492.60	46.76	9194.53	20.00	10615.18	23.10	36441.31	79.29
Rabi	58041.48	12744.44	21.96	11386.90	19.62	14359.11	24.74	21206.77	36.54	19939.87	34.35	16071.00	27.69	17966.27	30.95	32082.57	55.28
Hot Weather	54184.74	7187.93	13.27	8880.30	16.39	12291.56	22.68	22401.51	41.34	-	-	17236.43	31.81	16669.42	30.76	25057.73	47.35
Total	158188.63	25943.53	16.40	28659.10	18.12	34384.83	21.74	61874.40	39.11	41432.47	39.84	42501.96	26.87	45250.87	28.61	94181.61	59.54

FIGURE I

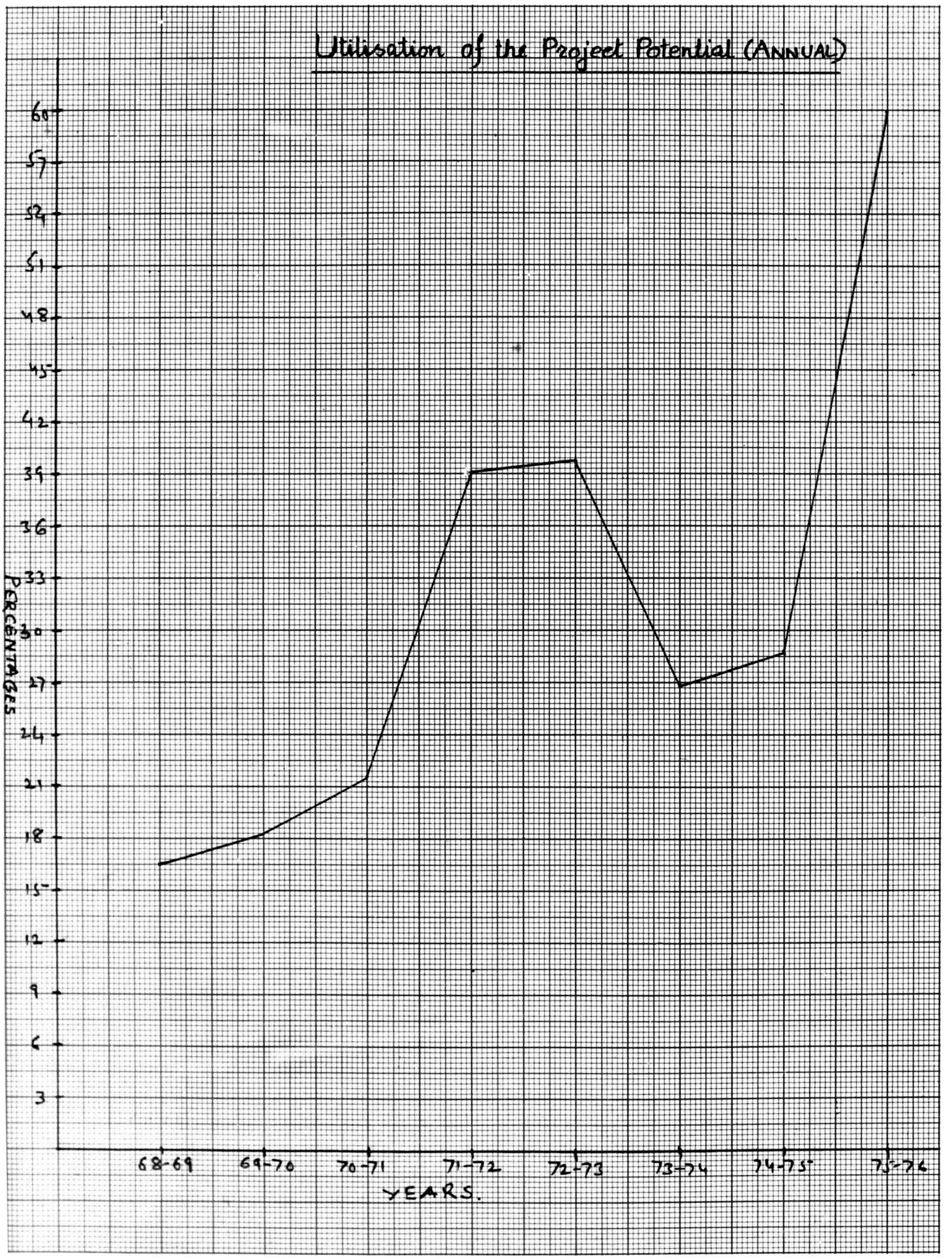

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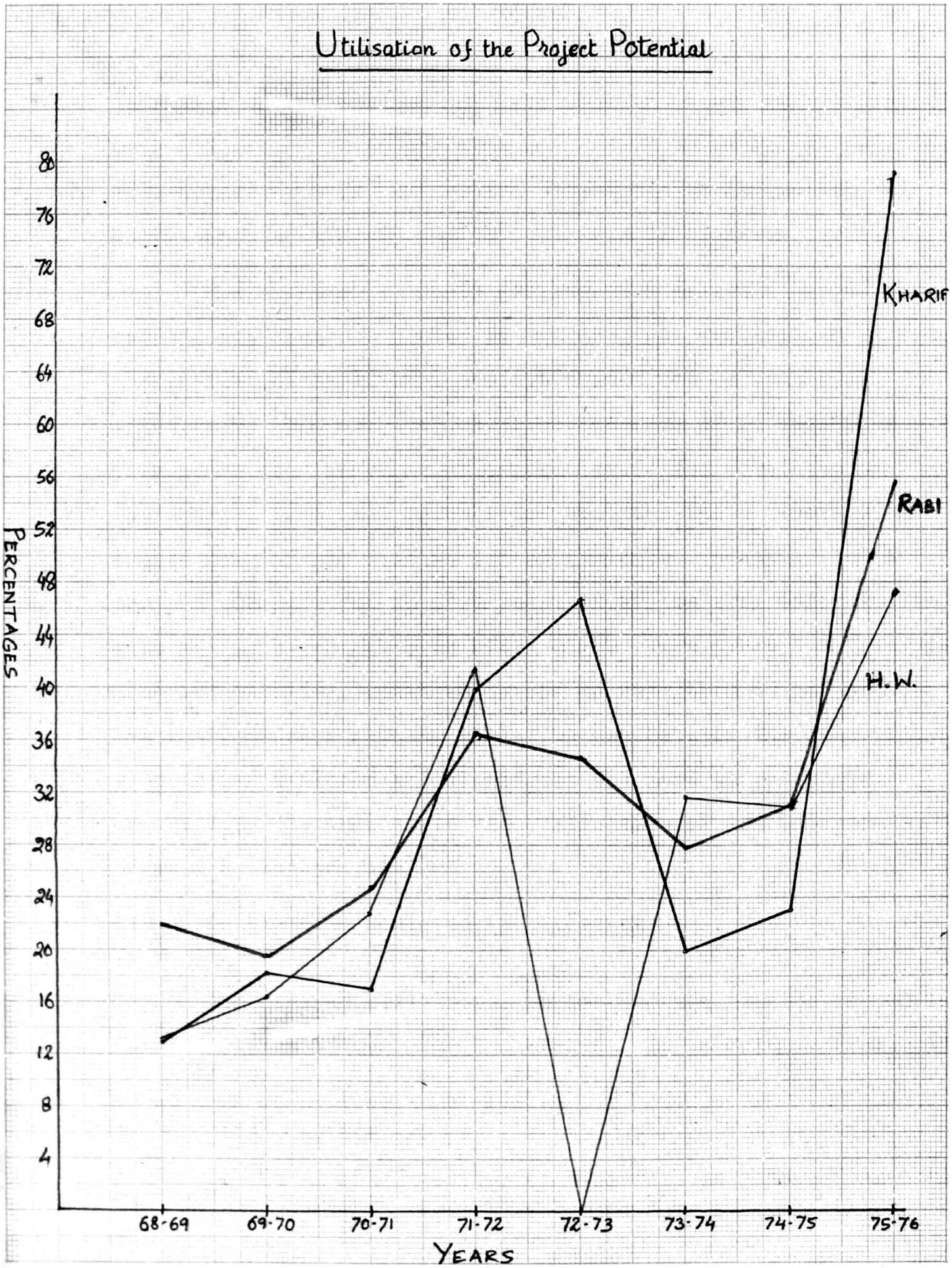
FIGURE 2



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potential of the project improved from 16.40 per cent in the year 1968-69 to 59.54 per cent in 1975-76, substantial improvement occurring only in 1975-76. There was no irrigation in hot-weather of 1972-73 due to reservoir limitations.

The Maharashtra State Irrigation Commission[3] (1962) has recommended that the period to achieve full utilisation of the irrigation potential of a project should not be more than eight years from starting construction work or it should be five years from starting of irrigation. The Committee of Ministers[4] (1973) has recommended that the State Governments should aim at full utilisation of irrigation potential of a project within three to five years after its creation. In the case of Purna project even after eight years since the development of potential, utilisation was no more than 60 per cent. The analysis thus reveals a glaring gap between the potential created and utilised and highlights the need to undertake urgent steps to accelerate the utilisation of the potential created by the project.

4.8 Utilisation Achieved in Different Cropping Seasons

The maximum utilisation achieved during kharif season is fairly high at 79 per cent in 1975-76. It is evident from the

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3 Ibid., p. 192.

4 Report of the Committee of Ministers on Underutilisation of Created Potential, 1973, op.cit., p. 42.

table that for the first three years after creation of full potential the utilisation of the kharif potential remained below 20 per cent. During the next two years 1971-72 and 1972-73 it rose to 40 per cent and 47 per cent respectively only to register a fall in the following two years. The rise in the utilisation from 23 per cent in the year 1974-75 to 79 per cent in 1975-76 may be due to the efforts of the Command Area Development Authority, to which the project is attached since August 1974.

The utilisation of the potential during rabi season of the various years under study is highest at 55 per cent in 1975-76. The progress in the utilisation in this season is uneven. From 22 per cent in 1968-69 the utilisation slightly decreased to 19.6 per cent in 1969-70. It increased to 24.7 per cent and 36.5 per cent in the next two years. Thereafter during the period since 1972-75 it registered a fall.

There was a progressive increase in the utilisation of the project potential in the hot-weather season. During the initial period of four years it increased from 13.3 per cent in 1968-69 to 41.3 per cent in 1971-72. It may be due to higher percentage of sugarcane and hot-weather seasonals irrigated during the year. The irrigation potential in the hot weather of 1972-73 declined since the year was a bad year with little storage available. The utilisation in hot-weather season of 1973-74 and 1974-75 fluctuated around 31 per cent and rose to 47.40 per cent in 1975-76, the highest percentage utilisation ever achieved during that season.

CHAPTER V

FARM BUSINESS OF THE SAMPLE OF FARMERS

In this and the following three chapters we shall present the results of the field investigation based on a sample of 100 farms. We shall first discuss the method of selecting the sample farms and then present the general economic features of the selected farms such as their land use and cropping pattern, value of output and net returns.

5.1 The Need for a Survey

The need for a survey arose from the object of studying the causes of underutilisation of the irrigation facilities provided under the Purna command. Data relating to the creation and utilisation of the irrigation potential, financial returns of the project and the related aspects were collected by personally visiting the project authorities several times. The information concerning the extent of utilisation of the irrigation facilities, factors responsible for non-full utilisation of these facilities and some aspects of farm business, which form the core of the study, could be collected only through conduct of a special survey for the purpose.

5.2 Character of the Study

The first problem in the initial stages of the survey was drawing a sample of villages and the cultivators benefiting

from the canal waters. The coverage of the whole enquiry was to be planned taking into account the available resources and the time available for the study. At the time of planning this work it was found that not more than five to six months could be devoted to the work of data collection both at the cultivator's level as well as project level. Hence in view of the resources and time constraints it was decided to restrict the sample to 100 cultivators selected from a sample of 20 villages. The survey is extended over the entire command area of the project. A two-stage stratified sample design with villages as first-stage units and the cultivators as the second-stage units has been adopted for the survey. The method of selecting the villages and cultivators is described in the following sections.

5.3 Selection of Villages

Information regarding the number of villages coming under the command of the project and the number of cultivator benefiting from the canal waters in the villages in the talukas of Parbhani and Nanded districts, over which the command area is spread, was obtained from the project authorities. The number of villages coming under the command is 216. Out of these, ten villages, one in Jintoor taluka, four in Hingoli taluka and five in Kalamnuri taluka of Parbhani district were left out. Out of the remaining 206 villages a sample of 20 villages—about 10 per cent of the total—was selected at random with probability proportionate to the number of benefited

cultivators. The villages were arranged serially according to the number of cultivators benefiting in the village, written in ascending order giving cumulative total at the end. The number of benefited cultivators was a little more than 15,000. Having decided to select 20 villages, this meant we had to select one village per 750 benefited cultivators. The village corresponding to the figure after every 750 cultivators was marked. The village falling in the middle of such marked villages was selected for the survey. The number of villages selected talukawise is given in Table 5.1.

Table 5.1 : Proportion and Number of Villages Selected from Each Taluka

Taluka	District	No.of villages under the command	Percentage	No.of benefiting cultivators	Percentage	No.of villages selected	Percentage
Parbhani	Parbhani	23	11.17	1,902	12.51	2	10.00
Basmath	Parbhani	107	51.94	7,659	50.37	12	60.00
Nanded	Nanded	76	36.89	5,643	37.12	6	30.00
Total		206	100.00	15,204	100.00	20	100.00

5.4 Selection of Cultivators

A list of cultivators entitled to get canal water from the selected villages was obtained from the Sectional Officer of the Irrigation Department under whose command the village

Table 5.2 : List of Twenty Sample Villages

Sr. No.	Village	Taluka	District	No. of cultivators selected
1.	Bhanpur	Nanded	Nanded	5
2.	Warona	Nanded	Nanded	5
3.	Somthana	Basmath	Parbhani	5
4.	Pandhri	Basmath	Parbhani	5
5.	Gunj	Basmath	Parbhani	5
6.	Pimpalgaon (Hajam)	Parbhani	Parbhani	5
7.	Degaon	Nanded	Nanded	5
8.	Palasgaon	Basmath	Parbhani	5
9.	Sonkhed	Basmath	Parbhani	5
10.	Mahtargaon	Basmath	Parbhani	5
11.	Mahagaon	Basmath	Parbhani	5
12.	Ranjana	Basmath	Parbhani	5
13.	Taroda (Bk.)	Nanded	Nanded	5
14.	Nandgaon	Parbhani	Parbhani	5
15.	Dhanora	Basmath	Parbhani	5
16.	Chudava	Basmath	Parbhani	5
17.	Kasarkheda	Nanded	Nanded	5
18.	Sawangi (Bk.)	Basmath	Parbhani	5
19.	Ajalsonda	Basmath	Parbhani	5
20.	Malegaon	Nanded	Nanded	5
	Total			100

is situated. Five cultivators from each of the 20 selected villages were chosen randomly for the survey. For this, they were written serially in alphabetical order and with the help of Table XXXIII of Random Numbers from the Statistical Tables for Biological, Agricultural and Medical Research by Fisher and

Yates, five cultivators were selected. The villages selected along with the taluka and the district are given in Table 5.2.

5.5 Method of Enquiry and the Schedule

Survey method was followed for collection of the necessary data. Each selected sample cultivator of the study was interviewed for the purpose. Information from the individual cultivators was collected in the specially designed schedule for the survey. The schedule canvassed among the cultivators is reproduced in full in Appendix R. The schedule covered such aspects as land ownership, operational holding, physical irrigable area, availability of well water, cropping pattern, number of irrigations given from canal as well as from well water, land preparation and levelling, availability, use and deficiency of farmyard manure and inorganic fertilizers, availability of credit and reasons for deficiency, information on items of cost of production, use of improved seeds and pesticides, output of crops and quantity sold and reasons for not availing canal irrigation facilities. The schedule was finalised after testing the same in one of the villages under the command of the project. The data thus collected pertain to the sample of 100 cultivators benefited by the project.

5.6 Response to the Schedule

Judging by the number of schedules actually filled as a proportion of the target set for the study, the survey may be deemed to have been successful. The quality of the response

of the respondents on the whole was quite satisfactory. To secure as much accuracy as possible special measures were adopted. For instance, before canvassing the schedule in any village enquiries were first made about the character of the season and harvests, position regarding communication and transport facilities, timely availability of credit and inputs, attitude of the farmers towards canal irrigation water, adequacy of canal water, relations between the farmers and the irrigation staff, enforcement of Canal Rules, etc. The normal output obtained per acre of a specified crop in the year was ascertained by making enquiries with some of the enlightened cultivators. Method of selling and marketing centres were enquired into. When any respondent stated his output of crop, which markedly deviated from the normal, attempts were made to enquire into the special reasons leading to the marked deviation. Information on the attitude and behaviour of the canal irrigation staff with the irrigators, prevailing harvest prices, marketing and processing of agricultural products was also sought with a discussion with the village Sarpanch (head of the Village Panchayat) and other educated and progressive farmers. In this way all possible care was taken to arrive at as much accurate information as possible.

The attitude of the cultivators towards the survey was in the first instance one of suspicion that the enquiries were being made with a view to recovering the defaulted loans taken from the cooperative society. Most of them felt that the

purpose of the enquiry was to collect data to be ultimately used for raising irrigation water rates and imposing some kind of levy. Some of the cultivators were reluctant to give information because they felt that if they divulged information they would face trouble with the irrigation staff and other influential cultivators in the village. After prolonged persuasion with the help of the village officers, however, the fears of the respondents were dispelled. In some of the villages the response was spontaneous. In a few of the villages, a larger number of irrigators gathered around the author stating their difficulties and asking solutions for them. One cultivator from village Ranjana refused to cooperate. This cultivator was replaced by the cultivator next in the list. Barring this exception, the work of the survey proceeded smoothly. The cooperation given by the cultivators was, by and large, satisfactory and cases of deliberate misreporting were rare.

5.7 Internal Consistency Checks in the Schedule

The schedule provides some internal consistency checks. For instance, the area sown under a crop must be consistent with the quantity of seed sown. Other items bearing a mutual relation and, therefore, checks for internal consistency include size of area under the crop and human and bullock labour employed, area under the crop and the output obtained, total quantity of farmyard manure available and actually used.

5.8 Time Required for Canvassing the Schedule

The data relating to the estimation of the extent of utilisation of the irrigation potential of the project, financial returns of the project and information required for planning the survey were collected in five visits to the office of the project authorities. During these visits discussions regarding the management and utilisation of the canal waters with the officers of the Irrigation Department of the State ranging from the rank of Executive Engineer to the Section Karkoon (Clerk) and Canal Inspectors were held. With a view to have a complete picture of the field management of the canal waters the author accompanied Deputy Engineers and Section Officers during their tours to villages and attended meetings held by them in the villages for promoting utilisation of the canal waters and achieving the target set forth. This was helpful in understanding the management and utilisation of the canal waters in its right perspective. Spot observations were made wherever possible. The information given in respect of items like availability of credit and inputs, land levelling, water courses and field channels, outlets, etc., was referred to the officials concerned and clarification obtained wherever possible. Verbatim notes were prepared during these visits based on the information collected through discussions and personal observations. These proved useful in the final analysis. The schedule required to be answered by the respondents was filled up in one visit to them. The field survey

to fill up all the hundred schedules lasted for about two and a half months starting from November 1976.

The author did not employ any assistant for executing the field work except that the Canal Inspector of the concerned village used to accompany him to the village with a view to introducing him to the cultivators and village officers. The Canal Inspector's visit to the village conformed to his normal duty essential for proper management and distribution of canal water to the beneficiaries. He used to be busy with his work while the author interviewed the cultivators and established rapport with the village officers and other progressive farmers. In this way the entire field work was conducted by himself. Though it was an arduous task it was not without its use. Personal conduct of the survey made it possible for him to acquire a firsthand knowledge of the irrigation management, to enquire into certain problems relevant to the study but not included in the schedule and prepare notes based on the discussions with the cultivators and knowledgeable people in the village. These have been of great help in analysing the problem.

5.9 Reference Period

The data pertaining to the utilisation of the irrigation potential at the project level relate to the agricultural year July-June. Similarly, the data in respect of the field survey of the cultivators pertain to the agricultural year 1975-76.

The information in respect of the financial returns of the project relates to the financial year.

The normal rainfall in the area to be served by the project is 39.3* inches (983 mm). Table 5.3 shows rainfall data for the year 1975-76 relating to the three talukas selected for the study.

Table 5.3 : Data on Rainfall in Parbhani, Basmath and Nanded Talukas

(mm)

Sr. No.	Month and	Year	Parbhani	Basmath	Nanded
1.	June	1975	235.5	81.9	88.6
2.	July	1975	350.5	461.3	353.1
3.	August	1975	407.1	185.7	158.1
4.	September	1975	414.5	486.4	578.4
5.	October	1975	118.4	182.0	75.4
6.	November	1975	1.0	N.R.	N.R.
7.	December	1975	N.R.	N.R.	N.R.
8.	January	1976	N.R.	N.R.	N.R.
9.	February	1976	N.R.	N.R.	N.R.
10.	March	1976	N.R.	N.R.	1.5
11.	April	1976	3.0	N.R.	8.2
12.	May	1976	N.R.	N.R.	N.R.
	Total		1530.0	1397.3	1263.3

Note: N.R. = No Rains.

Source: Records of the Statistician, Department of Agriculture, Maharashtra State, Pune.

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* Report dated 31st March 1964 by N.D. Gulhati, Consultant, Water Resources Development, on Purna Project, p. 1.

Taking into account the normal rainfall the year under reference appears to be a good year. Irrigation water was, therefore, applied to the crops by the cultivators as and when it was required.

5.10 Land Utilisation Pattern

In Table 5.4 is given distribution of farms according to the size of farms.

Table 5.4 : Groupwise Distribution of Cultivators according to Their Operational Holding

(ha.)

Size-Group (Hectares)	No.of farms in the group	Total area of the farms	Average area of the farms
I (0 to 2.00)	17	23.71	1.39
II (2.01 to 4.00)	28	81.78	2.92
III (4.01 to 6.00)	26	125.59	4.83
IV (6.01 and above)	29	254.10	8.76
Total	100	485.18	4.85

In general land use pattern of the selected farmers for the year 1975-76 is given in Tables 5.5 and 5.6.

It will be seen therefrom that of the total area of the farms about 5 per cent of the area is reported to be permanently fallow on account of unculturable land, land under canals and wells and land under huts and dwellings. In 1975-76 there was no current fallow. The total gross cropped area is 646.94 hectares and the intensity of cropping works out to 133.34 per

Table 5.5 : Land Utilisation for the Year 1975-76

(Area in hectares)

Sr. No.	Classification	Size Group				
		0 to 2.00	2.01 to 4.00	4.01 to 6.00	6.01 & above	All Farms
1.	Total area of the farms	24.34	85.45	131.24	269.57	510.60
2.	Permanent fallow (waste and unculturable)	0.63	3.67	5.65	15.47	25.42
3.	Net cultivable area	23.71	81.78	125.59	254.10	485.18
4.	Current fallow	-	-	-	-	-
5.	Area sown more than once	9.81	34.72	55.82	61.41	161.76
6.	Gross cropped area	33.52	116.50	181.41	315.51	646.94
7.	Gross cropped area as percentage of net cultivated area	141.37	142.46	144.45	124.17	133.34

Table 5.6 : Percentage Area Under Irrigated and Unirrigated Crops

(Area in hectares)

Sr. No.	Classification	Size Group				
		0 to 2.00	2.01 to 4.00	4.01 to 6.00	6.01 & above	All Farms
1.	Area under irrigated crops	18.77	61.07	101.31	115.00	296.15
	a) Irrigated from wells	0.70	3.03	7.89	8.27	19.89
	b) Irrigated from the canal	18.07	58.04	93.42	106.73	276.26
2.	Area under unirrigated crops	14.75	55.43	80.10	200.51	350.79
3.	Area under irrigated crops as percentage of gross cropped area	56.00	52.42	55.85	36.45	45.78
4.	Area under unirrigated crops as percentage of gross cropped area	44.00	47.58	44.15	63.55	54.22

cent. The intensity of cropping is highest in size-group III and lowest in size-group IV of holding. The gross cropped area irrigated from both the sources viz. canal and wells is 296.15 hectares and forms 46 per cent of the gross cropped area. The gross cropped area under unirrigated crops is 350.79 hectares and forms 54 per cent of the gross cropped area. The percentage of gross cropped area under unirrigated crops to the gross cropped area is highest at 64 in size-group IV of holding.

In Table 5.7 is given physical irrigable area from the canal and wells.

Table 5.7 : Physical Irrigable Area

(Area in hectares)

Classification	Size-group (0 to 2.00)	Size-group (2.01 to 4.00)	Size-group (4.01 to 6.00)	Size-group (6.01 and above)	All farms
Area irrigable by the canal	19.94	58.67	87.18	142.30	308.09
Area irrigable by wells	-	1.02	1.62	1.41	4.05
Mixed irrigable area	1.42	4.05	9.35	14.16	28.98

Of the total irrigable area of 312.14 hectares area commanded by the canal and wells is 308.09 hectares and 4.05 hectares respectively. An area of 28.98 hectares is found to be mixed irrigable area i.e. area which can be irrigated both from the canal as well as wells.

5.11 Cropping Pattern

Crops grown by the sample of farmers on the unirrigated or irrigated lands are given in Tables 5.8 and 5.9 respectively. It will be seen that among the unirrigated crops Sorghum (60.80 per cent), Cotton (14.00 per cent), Green gram (8.91 per cent), Gram (6.63 per cent) and Linseed (4.46 per cent) were the important crops.

Sorghum is cultivated both in kharif and rabi seasons. The Sorghum varieties locally known as Piwala and Varhadi for kharif season and Talki for rabi season are grown extensively. Area under improved hybrid varieties of sorghum was negligible. Reportedly, the farmers preferred the local varieties to the improved hybrid varieties because of consumer preferences and also higher yields of fodder. The local varieties can be grown under unirrigated conditions and preference for them constitutes an important reason for underutilisation of the irrigation facilities.

Among the irrigated crops wheat was by far the most important crop accounting for 37 per cent of the total cropped area. Other important irrigated crops were Paddy (28.75 per cent), Groundnut (10.63 per cent), Sugarcane (7.30 per cent), Sorghum (5.05 per cent), and Cotton (3.82 per cent). In each of the size group of holding the predominance of cereals is obvious. Oilseeds come next in importance.

Table 5.10 gives cropping pattern under canal and under wells respectively.

Table 5.8 : Unirrigated Cropping Pattern

(Area in hectares)

Sr. No.	Crops	Size-group (0 to 2.00)		Size-group (2.01 to 4.00)		Size-group (4.01 to 6.00)		Size-group (6.01 and above)		All Farms	
		Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage
I.	Cereals	10.89	73.83	33.09	59.70	47.64	59.48	126.91	63.29	218.53	62.30
1)	Paddy	-	-	-	-	0.61	0.76	2.62	1.31	3.23	0.92
2)	Sorghum	10.89	73.83	33.09	59.70	47.03	58.72	122.27	60.98	213.28	60.80
3)	Wheat	-	-	-	-	-	-	2.02	1.00	2.02	0.58
II.	Pulses	2.65	17.97	11.40	20.57	17.97	22.43	30.00	14.96	62.02	17.68
1)	Green gram	0.81	5.49	7.97	14.38	8.89	11.10	13.57	6.77	31.24	8.91
2)	Black gram	-	-	0.61	1.10	-	-	0.81	0.40	1.42	0.40
3)	Pigeon pea	-	-	0.60	1.08	4.30	5.37	-	-	4.90	1.40
4)	Chickling vetch	-	-	0.40	0.72	-	-	0.81	0.40	1.21	0.34
5)	Gram	1.84	12.48	1.82	3.29	4.78	5.96	14.81	7.39	23.25	6.63
III.	Fibres	1.21	8.20	6.09	10.98	9.56	11.94	32.47	16.20	49.33	14.06
1)	Cotton	1.21	8.20	6.09	10.98	9.56	11.94	32.27	16.10	49.13	14.00
2)	Sannhemp	-	-	-	-	-	-	0.20	0.10	0.20	0.06
IV.	Oilseeds	-	-	4.85	8.75	4.93	6.15	11.13	5.55	20.91	5.96
1)	Linseed	-	-	4.04	7.29	4.93	6.15	6.68	3.33	15.65	4.46
2)	Groundnut	-	-	0.81	1.46	-	-	3.84	1.92	4.65	1.32
3)	Niger	-	-	-	-	-	-	0.41	0.20	0.41	0.12
4)	Safflower	-	-	-	-	-	-	0.20	0.10	0.20	0.06
	Total Cropped Area	14.75	100.00	55.43	100.00	80.10	100.00	200.51	100.00	350.79	100.00

Table 5.9 : Irrigated Cropping Pattern

(Area in hectares)

Sr. No.	Crops	Size-group (0 to 2.00)		Size-group (2.01 to 4.00)		Size-group (4.01 to 6.00)		Size-group (6.01 and above)		All Farms	
		Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage	Area	Percentage
	I. Cereals	14.42	76.82	44.40	72.71	65.75	64.90	85.10	74.00	209.67	70.80
	1) Paddy	6.09	32.44	19.84	32.49	26.03	25.69	33.17	28.84	85.13	28.75
	2) Sorghum	0.20	1.07	2.22	3.64	3.44	3.40	9.11	7.92	14.97	5.05
	3) Wheat	8.13	43.31	22.34	36.58	36.28	35.81	42.82	37.24	109.57	37.00
	II. Pulses	-	-	2.22	3.64	0.40	0.39	1.61	1.40	4.23	1.43
	1) Gram	-	-	2.22	3.64	0.40	0.39	1.61	1.40	4.23	1.43
	III. Oilseeds	1.98	10.55	4.05	6.63	17.59	17.36	7.85	6.83	31.47	10.63
	1) Groundnut	1.98	10.55	4.05	6.63	17.59	17.36	7.85	6.83	31.47	10.63
	IV. Fibres	-	-	2.42	3.96	5.07	5.01	4.25	3.70	11.74	3.96
	1) Cotton	-	-	2.42	3.96	4.66	4.60	4.25	3.70	11.33	3.82
	2) Sannhemp	-	-	-	-	0.41	0.41	-	-	0.41	0.14
	V. Sugars	0.85	4.53	5.04	8.25	5.35	5.28	10.38	9.02	21.62	7.30
	1) Sugarcane	0.85	4.53	5.04	8.25	5.35	5.28	10.38	9.02	21.62	7.30
	VI. Fruits	0.91	4.85	1.43	2.34	2.11	2.08	2.21	1.92	6.66	2.25
	1) Banana	0.91	4.85	1.43	2.34	2.11	2.08	2.21	1.92	6.66	2.25
	VII. Vegetables	-	-	0.41	0.67	0.78	0.77	1.37	1.19	2.56	0.86
	1) Onions and carrot	-	-	0.41	0.67	0.78	0.77	1.37	1.19	2.56	0.86
	VIII. Fodder	0.10	0.53	-	-	0.81	0.80	-	-	0.91	0.31
	1) Sorghum for fodder	0.10	0.53	-	-	0.81	0.80	-	-	0.91	0.31
	IX. Condiments and Spices	0.51	2.72	1.10	1.80	3.45	3.41	2.23	1.94	7.29	2.46
	1) Turmeric	0.51	2.72	1.10	1.80	3.45	3.41	2.23	1.94	7.29	2.46
	Total Cropped Area	18.77	100.00	61.07	100.00	101.31	100.00	115.00	100.00	296.15	100.00

Table 5.10 : Cropping Pattern Under Canal and Under Wells

(Area in hectares)

Sr. No.	Crop	Size-group (0 to 2.00) Area irrigated from		Size-group (2.01 to 4.00) Area irrigated from		Size-group (4.01 to 6.00) Area irrigated from		Size-group (6.01 and above) Area irrigated from		All Farms Area irrigated from	
		Canal	Wells	Canal	Wells	Canal	Wells	Canal	Wells	Canal	Wells
1.	Paddy	6.09 (33.70)	-	19.84 (34.18)	-	24.61 (26.34)	1.42 (17.99)	32.77 (30.70)	0.40 (4.84)	83.31 (30.16)	1.82 (9.15)
2.	Wheat	8.13 (44.99)	-	22.34 (38.49)	-	35.47 (37.17)	0.81 (10.27)	42.41 (39.74)	0.41 (4.96)	108.35 (39.22)	1.22 (6.13)
3.	Sugarcane	0.60 (3.32)	0.25 (35.71)	3.43 (5.91)	1.61 (53.14)	2.62 (2.80)	2.73 (34.60)	5.65 (5.29)	4.73 (57.19)	12.30 (4.45)	9.32 (46.86)
4.	Banana	0.61 (3.38)	0.30 (42.86)	0.21 (0.36)	1.22 (40.26)	0.60 (0.64)	1.51 (19.14)	0.40 (0.37)	1.81 (21.89)	1.82 (0.66)	4.84 (24.33)
5.	Turmeric	0.36 (1.99)	0.15 (21.43)	0.90 (1.55)	0.20 (6.60)	2.64 (2.83)	0.81 (10.27)	1.72 (1.61)	0.51 (6.16)	5.62 (2.03)	1.67 (8.40)
6.	Vegetables	-	-	0.41 (0.70)	-	0.17 (0.18)	0.61 (7.73)	1.37 (1.29)	-	1.95 (0.71)	0.61 (3.07)
7.	Sorghum	0.20 (1.11)	-	2.22 (3.83)	-	3.44 (3.68)	-	8.70 (8.15)	0.41 (4.96)	14.56 (5.27)	0.41 (2.06)
8.	Cotton	-	-	2.42 (4.17)	-	4.66 (4.99)	-	4.25 (3.98)	-	11.33 (4.10)	-
9.	Groundnut	1.98 (10.96)	-	4.05 (6.98)	-	17.59 (18.83)	-	7.85 (7.36)	-	31.47 (11.39)	-
10.	Sorghum for fodder	0.10 (0.55)	-	-	-	0.81 (0.87)	-	-	-	0.91 (0.33)	-
11.	Gram	-	-	2.22 (3.83)	-	0.40 (0.43)	-	1.61 (1.51)	-	4.23 (1.53)	-
12.	Sannhemp	-	-	-	-	0.41 (0.44)	-	-	-	0.41 (0.15)	-
	Total	18.07 (100.00)	0.70 (100.00)	58.04 (100.00)	3.03 (100.00)	93.42 (100.00)	7.89 (100.00)	106.73 (100.00)	8.27 (100.00)	276.26 (100.00)	19.89 (100.00)

Note: Figures in the parentheses indicate percentage to total.

The soils of the Purna command are divided into five categories viz. M_1, M_2, D_1, D_2, and shallow soils. Soils classified as M_1 and D_2 are approved for growing perennials. Cultivation of perennials outside this sanction i.e. growing perennials in the soils other than M_1 and D_2, constitutes an offence. Farmers whose area is not sanctioned for growing perennials have, therefore, to rely upon their wells for growing perennials. It will be seen from the Table that more than 70 per cent of the area irrigated from the wells has been devoted for the cultivation of perennials.

5.12 Expenditure on Various Items of Cultivation

In Tables 5.11 and 5.12 is given expenditure incurred on various items of cultivation per hectare of cropped area in respect of unirrigated and irrigated crops respectively. While considering the expenditure the family labour is not included. Items included are hired human labour, owned and hired bullock labour, seed, manures and fertilizers, land revenue, irrigation and plant protection. The valuation of human labour is done at the actual wages paid to the casual labour and at the prevailing wage rate of an adult male in the case of a permanent servant. Bullock labour is valued at the prevailing hire charges of a bullock pair in the case of owned bullock labour and actual charges paid in the case of hired bullock labour. In case of purchased seed the actual price paid by the farmer is considered while in the case of home produced seed its cost at

Table 5.11 : Per Cropped Hectare Expenditure on Various Items in respect of Unirrigated Crops

(Amount in Rs.)

Size-group (ha.)	Average gross cropped area (ha.)	Human labour	Bullock labour	Seed	Manures and fertilizers	Insecticides and Pesticides	Land Revenue	Total
I (0 to 2.00)	0.87	36.56 (7.70)	275.60 (58.01)	59.56 (12.54)	92.69 (19.51)	4.07 (0.86)	6.57 (1.38)	475.05 (100.00)
II (2.01 to 4.00)	1.98	47.39 (12.67)	235.40 (62.92)	54.02 (14.44)	27.94 (7.47)	3.08 (0.82)	6.28 (1.68)	374.11 (100.00)
III (4.01 to 6.00)	3.08	64.49 (15.74)	235.71 (57.53)	69.27 (16.91)	30.12 (7.35)	4.03 (0.98)	6.08 (1.49)	409.70 (100.00)
IV (6.01 and above)	6.91	65.71 (16.46)	212.56 (53.24)	63.96 (16.02)	43.60 (10.92)	7.01 (1.76)	6.42 (1.60)	399.26 (100.00)
All Farms	3.51	61.31 (15.29)	224.10 (55.91)	63.42 (15.82)	40.11 (10.01)	5.59 (1.39)	6.33 (1.58)	400.86 (100.00)

Note: Figures in the parentheses indicate percentage to the total.

Table 5.12 : Per Cropped Hectare Expenditure on Various Items in respect of Irrigated Crops

(Amount in Rs.)

Size-group (ha.)	Average gross cropped area (ha.)	Human labour	Bullock labour	Seed	Manures and Fertilizers	Insecticides and Pesticides	Irrigation	Land Revenue	Total
I (0 to 2.00)	1.10	109.40 (7.88)	303.41 (21.85)	301.65 (21.72)	474.31 (34.15)	-	193.50 (13.93)	6.48 (0.47)	1388.75 (100.00)
II (2.01 to 4.00)	2.18	96.19 (6.66)	310.63 (21.50)	306.96 (21.25)	524.68 (36.32)	12.23 (0.85)	187.68 (12.99)	6.18 (0.43)	1444.55 (100.00)
III (4.01 to 6.00)	3.90	123.21 (8.98)	286.89 (20.92)	296.93 (21.65)	462.29 (33.71)	12.97 (0.95)	183.19 (13.36)	5.85 (0.43)	1371.33 (100.00)
IV (6.01 and above)	3.97	145.81 (10.07)	294.91 (20.37)	306.73 (21.18)	499.95 (34.53)	16.19 (1.11)	177.90 (12.29)	6.54 (0.45)	1448.03 (100.00)
All Farms	2.96	125.54 (8.86)	295.95 (20.88)	303.10 (21.39)	490.54 (34.61)	13.25 (0.93)	182.72 (12.89)	6.22 (0.44)	1417.32 (100.00)

Note: Figures in the parentheses indicate percentage to the total.

the prevailing market price is taken into account. Farmyard manure produced on the farm is valued according to the prevalent market rate. In the case of purchased farmyard manure, fertilizers, and insecticides and pesticides the actual cost paid is considered. The irrigation charges represent the actual water charges due to Government in case of the canal irrigated crops and the actual expenditure incurred on irrigation in the case of well irrigated crops. Land revenue includes the actual cess paid by the farmers.

It will be seen from Table 5.11 that on an average an amount of Rs.400.86 per cropped hectare is spent on the cultivation of unirrigated crops. It will be noticed that the per hectare expenditure is relatively high in the smallest size group of holding. This is in spite of the fact that in these holdings the per hectare expenditure on hired human labour is comparatively small. The expenditure on bullock labour and manures and fertilizers on these farms is comparatively large.

The principal items of expenditure are bullock labour (56 per cent), seed (16 per cent), human labour (15 per cent), and manures and fertilizers (10 per cent).

In larger size holdings there is no systematic trend.

The per cropped hectare expenditure in respect of irrigated crops (Table 5.12) is Rs. 1417.32 and is thus more than three times that of the unirrigated crops. The following shows where the major increases in expenditure come from.

Items	Per hectare Expenditure (Rs.)	
	Unirrigated Crops	Irrigated Crops
Human labour	61.31	125.54
Seed	63.42	303.10
Manures and Fertilisers	40.11	490.54
Irrigation	-	182.72

The major items of expenditure are manures and fertilizers (34.61 per cent), seed (21.39 per cent), bullock labour (20.88 per cent) and irrigation (12.89 per cent).

The differences in the per hectare expenditure in different size groups of holding are not systematic.

5.13 Value of Output and Net Returns

Table 5.13 shows per cropped hectare value of output obtained by the farmers from the cultivation of unirrigated and irrigated crops and the net returns therefrom.

It can be seen from the Table that the farmers on an average have obtained gross returns of Rs.1125.12 per cropped hectare of unirrigated crops. The net returns work out to Rs. 724.26 per hectare.

In respect of irrigated crops the farmers on an average have obtained Rs. 2583.31 from per hectare and the net returns are Rs. 1166. As in the case of unirrigated crops, the net returns per hectare are relatively large in the smallest size group of holding.

Table 5.13 : Per Cropped Hectare Value of Output and Net Returns

Size groups (ha.)	Unirrigated Crops			Irrigated Crops		
	Cropped area (ha.)	Per Cropped Hectare		Cropped area (ha.)	Per Cropped Hectare	
		Value of Output (Rs.)	Net Returns (Rs.)		Value of Output (Rs.)	Net Returns (Rs.)
I (0 to 2.00)	14.75	1472.20	997.15	18.77	2950.71	1561.96
II (2.01 to 4.00)	55.43	1208.69	834.58	61.07	2697.10	1252.55
III (4.01 to 6.00)	80.10	1154.24	744.54	103.31	2411.04	1039.71
IV (6.01 & above)	200.51	1064.85	655.59	115.00	2614.67	1166.64
All Farms	350.79	1125.12	724.26	296.15	2583.31	1165.99

Though the per cropped hectare expenditure in respect of irrigated crops was more than three times that of the unirrigated crops the per hectare returns from irrigated crops are not in that proportion. The analysis indicates that the farmers derived returns of Rs. 2.81 per rupee invested in the cultivation of unirrigated crops, while the returns per rupee invested in the cultivation of irrigated crops work out to Rs. 1.82.

CHAPTER VI

IRRIGATED AGRICULTURE

We shall present in this chapter various aspects relevant to irrigated agriculture such as preparation of land for irrigated farming, level of application of manures and fertilizers, application of plant protection measures, use of improved seeds and yield performance of the crops.

6.1 Land Preparation

Before actual application of water to the new lands to be brought under irrigation two basic operations connected with land viz. levelling and bunding are necessary. Where lands are undulating they have to be levelled to ensure uniform spread of water. Bunds are required to be raised to store water in the field. Land levelling and bunding thus become as important as water conveyance.

Information relating to the expenditure on land preparation during the last five years was collected from the farmers. In Table 6.1 we give expenditure on various items of land preparation during the preceding five years period.

Land levelling appears to be an important item in land preparation. The total area levelled during the five year period was reported to be 17.08 hectares and the expenditure per hectare of levelled land works out to Rs. 445. The per

Table 6.1 : Expenditure on Land Preparation

Items	Number reporting	Expenditure per reporting farmer (Rs.)
Land levelling	23	326.78
Bunding	28	111.11
Field channels	29	134.52
Drainage channels	16	293.53
Per hectare expenditure on land preparation	-	61.38

hectare expenditure on all items of land preparation works out to Rs. 61.38.

Questions were asked regarding the area remained to be levelled and the reasons thereof, if the entire land of the farmers coming under the command of the canal was not levelled. It was reported that an area of 15.84 hectares (5.14 per cent of the physical irrigated area) belonging to 18 farmers was yet to be levelled. In Table 6.2 we give reasons for not levelling the land.

The work of levelling the land requiring levelling with mechanical equipment like a bulldozer is entrusted to the Department of Agriculture of the State. The Department of Agriculture through the Soil Conservation Wing undertakes surveying and mapping of the areas needing levelling with mechanical equipment. The work of levelling is then taken up

Table 6.2 : Frequency Distribution of Farmers according to the Reasons for Not Levelling

Sr. No.	Reasons	Number reporting	Percentage
1.	Could not get a bulldozer for levelling operation	5	27.78
2.	Lack of finance	2	11.11
3.	Work done by the bulldozer not proper	1	5.56
4.	Work suspended due to breakdown of bulldozer	3	16.66
5.	Absence of field channels	1	5.56
6.	Lack of manpower	2	11.11
7.	Indifferent attitude of the farmer	3	16.66
8.	No reason given	1	5.56
	Total	18	100.00

by the bulldozer unit of the Department. It may be seen that twenty-eight per cent of the farmers reporting to have unlevelled land could not get a bulldozer for levelling operation. Reportedly, the farmers could not get the bulldozer for the work even after repeated requests and applications. An enquiry with the concerned officials regarding three out of five cases revealed that the work was being taken up turn by turn due to shortage of the equipments. Breakdown of the bulldozer caused the work of levelling to be suspended and the work was not resumed. This was reported by three farmers. An enquiry with a few other farmers in the villages and an Agricultural Supervisor in one case confirmed the reason advanced by the farmers. Another farmer reported that the levelling

operation was not done well. About 20 per cent of the farmers reporting to have unlevelled land were apathetic about the need to get their land levelled. Lack of finance for undertaking the land levelling operation is reported by two farmers. Reportedly, the farmers did not need a bulldozer for levelling due to comparatively flat terrain. They could have levelled the land with bullock labour. The farmers, however, lacked finance for hiring the bullocks to level the lands. One farmer did not level his land because field channels to take water to his field were not constructed. Lack of manpower as a reason for not levelling the land is reported by two farmers. One of the two lacked sufficient manpower to look after irrigated farming and hence did not care. The other farmer was in service and could not pay sufficient attention to farming. One farmer could not advance any specific reason for his unlevelled land.

The distribution of unlevelled land, along with the reasons therefor, according to the holding size class is given in Table 6.3.

It will be seen from the Table that about 53 per cent of the unlevelled land is owned by the largest size group of holding, the smallest size group contributing 11.5 per cent. The percentage of the unlevelled land to the area in the holding size group works out to 9.13 and 5.88 in the smallest and largest size groups respectively. It is evident that 53 per cent of the unlevelled land is on account of the reasons

Table 6.3 : Size of Farm and the Area Remained to be Levelled
(Area in hectares)

Sr. No.	Reasons	I (0 to 2.00)	II (2.01 to 4.00)	III (4.01 to 6.00)	IV (6.01 and above)	All Farms
1.	Could not get a bulldozer for levelling operation	0.61	1.41	-	1.50	3.52 (22.22)
2.	Lack of finance	-	-	1.21	1.21	2.42 (15.28)
3.	Work done by the bulldozer not proper	-	-	-	1.21	1.21 (7.64)
4.	Work suspended due to breakdown of bulldozer	-	-	2.02	1.62	3.64 (22.98)
5.	Absence of field channels	1.01	-	-	-	1.01 (6.38)
6.	Lack of manpower	0.20	-	-	1.21	1.41 (8.90)
7.	Indifferent attitude of the farmers	-	1.01	-	0.81	1.82 (11.49)
8.	No reason given	-	-	-	0.81	0.81 (5.11)
	Total	1.82 (11.49)	2.42 (15.28)	3.23 (20.39)	8.37 (52.84)	15.84 (100.00)

Note: Figures in the parentheses indicate percentage to total.

concerning to levelling with a bulldozer. Fifteen per cent of the unlevelled land is on account of lack of finance and 11.5 per cent due to indifferent attitude of the farmers.

6.2 Use of Improved Seed

It is now universally accepted that the improved and

hybrid seeds have great production potential if combined with other inputs like irrigation, fertilizers and pesticides. Experimental data collected in the Coordinated Agronomic Trial Scheme[1] show that in case of Wheat, Maize, Jowar and Paddy by using balanced doses of fertilizers and high yielding varieties as compared with local varieties the yield per acre is doubled.

It is found during the survey that all the wheat growers have used improved varieties viz. S-227 (HDM 1593) and S-308 (HDM 1553). In case of Groundnut all the farmers growing the crop have used the recommended variety (SB 11) of the crop. All the farmers growing crops like Jowar (CSH-1), Banana (Basrai) and Cotton (H-4) have used improved varieties of seeds. Two out of forty-six farmers growing Sugarcane have used local variety of the crop. Out of 86 farmers growing Paddy only 6 (7 per cent) have used improved varieties, the rest sticking to the local varieties. For Gram and Turmeric all the farmers have used local varieties of seeds.

6.3 Use of Manures and Fertilizers

Irrigated agriculture requires large quantities of manures and fertilizers per hectare, expenditure on them being Rs. 490 in irrigated agriculture compared to Rs. 40 in unirrigated agriculture. In the course of the interview of the

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1 J.S. Kanwar. "New Dimensions in Water Management Technology," Indian Farming, Vol. XIX, No. 3, 1969, p. 11.

selected farmers it was noticed that there was complete unanimity among the farmers that irrigation and fertilizers were complementary inputs. Artificial watering of crops accelerates the process of absorption of plant food nutrients available in the soil and unless care is taken to restore the soil fertility through adding adequate manures and fertilizers the land becomes unproductive after some years.

The major or primary nutrients* required by plants are nitrogen (N), phosphorus (P) and potassium (K). They can be provided through manures. Manures can be of two types viz. organic and inorganic. Organic manures by their decomposition bring about microbiological activities and increase humus. These are responsible for helping to maintain the organic status of the soil besides supplying food elements to the crop. Organic manures are classified into bulky, concentrated and miscellaneous organic wastes. Farmyard manure, compost from farm and town refuse and green manure are included in bulky manures. In concentrated organic manures are included oil cakes, blood meal, fish manures, bone meal and animal meal. Miscellaneous organic wastes include crop residues and animal refuse.

Inorganic manures are generally called chemical fertilizers and are of three kinds viz. nitrogenous, phosphatic and

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* There are secondary nutrients such as calcium, magnesium and sulphur and micronutrients such as chlorine, boron, copper, molybdenum, iron, manganese, and zinc as well.

potassic. They are called simple fertilizers if they contain only one nutrient and complex fertilizers if more than one nutrient.

Organic manures are prepared out of the farm by-products which otherwise would go waste. Besides they improve the physical condition of the soil. They also supply many minor nutrients and ensure balanced fertilisation. They are in fact 'complete fertilizers'. In whatever quantity they may be applied they would not produce the undesirable effects observed when a straight chemical fertilizer is applied in heavy doses or over a prolonged period. It is generally agreed that the performance of chemical fertilizers in the soil is not fully realised in the absence of an adequate amount of organic matter. In fact maximum benefits from irrigation, improved seeds or any other organic practice can be obtained only when combined with the application of manures and fertilizers. One may say that they are mutually complementary.

The most commonly used manure is farmyard manure. Farmyard manure consists of dung and urine of farm animals along with the litter (bedding material) and left-over materials of roughages or fodder fed to the cattle. The average composition of farmyard manure is 0.84 per cent N, 0.69 per cent P and 1.36 per cent K.[2] This composition, however, varies according to

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2 Composition of Important Organic Manures and Fertilizers. Department of Agriculture, Maharashtra State, Pune, Research Bulletin No. 12, 1968, p. 3.

the kind of food that the animals eat, the proportion of dung and urine used, nature of litter and the manner in which dung is stored. The quality of the farmyard manure prepared by the farmers is far below the average since they do not adopt any scientific method for preparing the same.

Fertilizers like Ammonium Sulphate, Urea, Superphosphate and fertilizer mixtures are widely used by the farmers.

Among the irrigated crops gram, vegetables, sannhemp and fodder were not applied any manure or fertilizer. In the case of other crops the quantity reportedly used by the sample of farmers may be compared with that recommended by the Department of Agriculture, Maharashtra State. In the case of nitrogenous fertilizers the level of application to the various crops varies between 49.7 per cent and 84.5 per cent of the recommended level of doses. In the case of phosphatic fertilizers it ranged from 17.6 to 48.2 per cent of the recommended doses. In case of potassic fertilizers it ranged from 4.43 per cent to 23.5 per cent of the recommended doses. The use of farmyard manure was merely 2.8 per cent of the recommended dose.

Besides less than recommended use of fertilizers in general, the relative preference for nitrogenous fertilizers over phosphatic and potassic may be noted. This is contrary to the importance of a balanced fertilization. The I.A.D.P. experience has revealed that for the attainment of maximum potential yield balanced nutrition is of the utmost import-

ance.[3] Nitrogen alone does not give the desired response. Under the All India Coordinated Agronomic Experiments Schemes[4] it has been found that the interaction between nitrogen and phosphorus is significant at a number of centres and was generally positive, resulting in higher yields. Trials conducted on cultivators' fields[5] showed that both hybrid and local maize responded to N but the response is better in the presence of a balanced NPK fertilisers. According to the experiments conducted on cultivators' fields[6] on wheat at Allahabad and Ambala on alluvial soils and in Jabalpur district on black soils best results were obtained with a balanced application of N50 P25 K25. While nitrogen is essential for rapid vegetative growth, phosphorus is required for root formation, hastening maturity and making plants more drought resistant and winter-hardy. Potassium promotes formation of carbohydrates and has a marked effect on the development of leaves and woody parts of the stem. When potassium is deficient the stems are weak and brittle, leaves do not have normal colour and show a tendency to die earlier. The growth of flowers is delayed when there is a large supply of nitrogen and too little

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3 Report of the National Commission on Agriculture, Part X, 1976, op.cit., pp. 58-59.

4 Ibid., p. 59.

5 Ibid., p. 111.

6 Ibid., pp. 111-112.

phosphorus and potassium. While nitrogenous fertilisers alone can be expected to increase the yields of most crops in India, when superphosphate is added along with the nitrogen the yields are usually increased even more.[7] When 200 pounds of superphosphate was applied in addition to 150 pounds of ammonium sulphate, the yield of rice was increased to 789 pounds or an additional 275 pounds per acre due to the addition of superphosphate.[8] In case of banana, while there would be no increase in its yield due to the application of potassium, there is an improvement in its quality which ultimately would give additional net returns by fetching good price.

The imbalance in the application of the nutrients to plants may be due, among other reasons, to ignorance. Many farmers seemed to believe that nitrogen was the only plant nutrient required by the plants.

The application of farmyard manure and fertilizers in respect of individual crops is discussed in the following paragraphs.

Paddy: The level of application of nitrogenous fertilizers is fairly high at 84.5 per cent of the recommended dose (Table 6.4). The doses of phosphorus and potassium applied stand at 12.02 kg. and 6.78 kg. per hectare as against the

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7 L.S.S. Kumar et al. Agriculture in India, Vol. I. (First Edition). Bombay : Asia Publishing House, 1963, p. 195.

8 Ibid., p. 196.

Table 6.4 : Doses of Fertilizers Applied to Paddy

Size groups (ha.)	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	FYM (cts./ha.)
Recommended dose	60	30	30*	25
I (0 to 2.00)	42.65	3.86	2.87	10.84
II (2.01 to 4.00)	52.77	13.76	7.81	10.69
III (4.01 to 6.00)	53.86	13.52	7.11	8.18
IV (6.01 and above)	48.38	11.31	6.63	9.29
All Farms	50.67	12.02	6.78	9.39
Per cent of Recommended dose	84.45	40.06	22.60	37.56

* As per requirements.

Figures of recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Intensive Cultivation of High Yielding Varieties of Paddy," (Marathi), Information Bulletin No. 600, April 1976, p. 24.

recommended doses of 30 kg. per hectare respectively. The use of farmyard manure was 38 per cent of the recommended dose. The differences between size groups of holding are not very systematic except that the use of fertilizers particularly of P and K appear somewhat low in the smallest size group.

Wheat: The data on levels of application of fertilizer doses to wheat crop are given in Table 6.5.

It will be seen from the Table that the quantity of N applied amounts to 62.4 per cent of the recommended dose. The application of P and K stands at 40 per cent and 23 per cent

Table 6.5 : Doses of Fertilizers Applied to Wheat

Size groups (ha.)	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	FYM (cts./ha.)
Recommended dose	100	50	50*	25-40
I (0 to 2.00)	61.81	11.69	6.77	0.37
II (2.01 to 4.00)	68.35	15.98	9.18	0.45
III (4.01 to 6.00)	61.38	23.54	12.47	1.65
IV (6.01 and above)	60.37	20.45	12.38	0.07
All Farms	62.44	19.91	11.34	0.69
Per cent of Recommended dose	62.44	39.82	22.68	2.76-1.73

* As per requirements.

Figures of recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Intensive Cultivation of High Yielding Varieties of Wheat," (Marathi), Information Bulletin No. 602, 1976, p. 6.

of the recommended doses respectively. The use of farmyard manure is insignificant. Application of P and K seems to be little higher in case of large size holdings.

Hybrid Jowar: The data on level of application of fertilizer doses in respect of Hybrid Jowar (Table 6.6) show that the doses do not exceed 63 per cent, 25 per cent and 13.5 per cent of the recommended doses in case of NPK respectively. There is no application of NPK in the smallest size group. There is no systematic trend in the level of application in different size groups.

Table 6.6 : Doses of Fertilizers Applied to Hybrid Jowar

Size groups (ha.)	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	FYM (cts./ha.)
Recommended dose	75	62	62*	12-25
I (0 to 2.00)	N.A.	N.A.	N.A.	N.A.
II (2.01 to 4.00)	42.47	12.16	6.76	0.90
III (4.01 to 6.00)	57.56	23.84	10.74	9.30
IV (6.01 and above)	45.61	13.50	8.23	8.34
All Farms	47.29	15.50	8.35	7.35
Per cent of Recommended dose	63.05	25.00	13.47	61.25-29.4

* As per requirements. N.A. = Not applied.

Figures of the recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Intensive Cultivation of Hybrid Varieties of Jowar," (Marathi), Information Bulletin No. 599, 1976, pp. 7-8.

Groundnut: It will be seen from Table 6.7 that the level of application of fertilizer doses to Groundnut crop does not exceed 50 per cent of the recommended doses of N and P. The level of application in different size groups of holding does not differ very much though in case of P the level of application is highest at 58 per cent of the recommended dose in the smallest size group. Though no K is recommended, there is application of it in little quantity. This is due to the application of fertilizer mixtures of NPK.

Table 6.7 : Doses of Fertilizers Applied to Groundnut

Size groups (ha.)	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	FYM (cts./ha.)
Recommended dose	25	50	-	-
I (0 to 2.00)	11.36	28.79	-	-
II (2.01 to 4.00)	12.22	18.77	-	-
III (4.01 to 6.00)	13.53	23.81	3.41	-
IV (6.01 and above)	10.32	23.95	2.55	-
All Farms	12.42	23.51	2.54	-
Per cent of Recommended dose	49.68	47.04	-	-

Figures of recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Irrigated Crops Under Purna Project," (Marathi), Information Bulletin No. 415, 1971, pp. 11-12.

Cotton: It is an important cash crop in the area. The application of N is fairly high at 78 per cent of the recommended dose. The application of other two nutrients - P and K - is however, quite poor at 30 per cent and 17 per cent of the recommended doses respectively. The use of farmyard manure stands at 21 per cent. There seems to be no systematic trend in the application of fertilizer doses as between different size groups of holding though the level of application is somewhat low in the case of holdings of 2.01 to 4.00 hectares.

Table 6.8 : Doses of Fertilizers Applied to Cotton

Size groups (ha.)	N (kg/ha.)	P (kg./ha.)	K (kg./ha.)	FYM (Cts./ha.)
Recommended dose	100	50	50*	50
I (0 to 2.00)	No crop	No crop	No crop	No crop
II (2.01 to 4.00)	65.91	11.16	6.20	14.88
III (4.01 to 6.00)	82.08	19.31	10.73	8.80
IV (6.01 and above)	81.53	12.71	7.06	9.65
All Farms	78.42	15.09	8.38	10.41
Per cent of Recommended dose	78.42	30.18	16.76	20.82

* As per requirements.

Figures of the recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Cultivation of Irrigated H-4 Cotton," (Marathi), Information Bulletin No.593, 1976, pp. 1-2.

Turmeric: Table 6.9 shows doses of fertilizers and farmyard manure applied to Turmeric crop. It will be seen that though the quantity of N applied to the crop is significant at 64 per cent, the quantity of P and K applied amount only to 22 per cent and 10 per cent of the recommended doses respectively. The use of farmyard manure is fairly high at 67 per cent. While there is no application of P and K, the application of N stands at 53 per cent of the recommended dose in case of the smallest size group. The level of application of fertilizer doses seems to be better in the

Table 6.9 : Doses of Fertilizers Applied to Turmeric

Size groups (ha.)	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	FYM (Cts./ha.)
Recommended dose	125	62.5	62.5	50-75
I (0 to 2.00)	66.18	N.A.	N.A.	27.45
II (2.01 to 4.00)	96.14	41.82	13.64	44.55
III (4.01 to 6.00)	88.70	10.43	5.80	29.28
IV (6.01 and above)	63.57	8.07	4.48	36.32
All Farms	80.56	13.72	6.17	33.61
Per cent of Recommended dose	64.45	21.95	9.87	67.22-44.81

N.A. = Not applied.

Figures of recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Irrigated Crops Under Purna Project," (Marathi), Information Bulletin No. 415, 1971, pp. 9-10.

holding size group 2.01 to 4.00 as compared to other groups.

Sugarcane: This being a long duration crop, adequate provision of nutrients is essential for the production of quality cane with high tonnage of yield. Table 6.10 shows the fertilizer doses and farmyard manure applied to this crop by the sample farmers.

It will be seen from the Table that the farmers' performance is better in the application of nitrogen with 75 per cent of the recommended dose. The quantity of P and K applied

Table 6.10 : Doses of Fertilizers Applied to Sugarcane

Size groups (ha.)	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	FYM (Cts./ha.)
Recommended dose	170	115	115	50
I (0 to 2.00)	190.59	84.71	47.06	3.53
II (2.01 to 4.00)	136.61	55.56	28.77	7.34
III (4.01 to 6.00)	113.04	65.61	22.43	12.90
IV (6.01 and above)	123.65	47.78	26.97	9.63
All Farms	126.68	55.46	27.06	9.67
Per cent of Recommended dose	74.52	48.23	23.53	19.34

Figures of recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Intensive Cultivation of Sugarcane," (Marathi), Information Bulletin No. 610, July 1976, pp. 4-7.

is to the extent of 48 per cent and 24 per cent of the recommended levels respectively. The use of farmyard manure stands at 19 per cent of the recommended dose. It is interesting to note that the farmers of the smallest size group of holding have applied a fertilizer dose of N in excess of the recommended dose. The quantity of P and K applied by them is also more than quantity applied by the farmers of the rest of the size groups.

Banana: Table 6.11 gives fertilizer doses applied to Banana. The quantity of nitrogen applied stands at 60 per cent of the recommended dose. The doses of phosphorus and

Table 6.11 : Doses of Fertilizers Applied to Banana

Size groups (ha.)	N (grams/ plant)	P (grams/ plant)	K (grams/ plant)	FYM (Cts./ ha.)
Recommended dose	100	100*	200*	50-100
I (0 to 2.00)	71.05	11.84	6.58	18.68
II (2.01 to 4.00)	55.65	13.63	8.87	25.87
III (4.01 to 6.00)	56.99	19.04	10.84	20.85
IV (6.01 and above)	62.16	21.53	7.95	29.86
All Farms	60.33	17.60	8.86	24.62
Per cent of Recommended dose	60.33	17.60	4.43	49.24-24.62

* As per requirements.

Figures of the recommended doses are adopted from Department of Agriculture, Maharashtra State, Pune. "Cultivation of Banana," (Marathi), Information Bulletin No. 476, May 1973, pp. 10-11.

potassium applied stand at 18 and 4 per cent of the recommended doses respectively. The use of farmyard manure was about 50 per cent of the recommended dose. Excepting N, the application of P and K appear to be somewhat low in the smallest size group.

The broad picture which emerges from the foregoing analysis is that the level of application of manures is very low. The level of application of fertilizers is particularly low as far as the phosphatic and potassic fertilizers are

concerned and the imbalance in the fertilization is evident.

Questions were asked regarding the reasons for low levels of manures and fertilizer applied by the farmers. The respondents were asked whether the quantity of manures and fertilizers used by them was sufficient. Thirty-four per cent of the farmers agreed that their application of farmyard manure was insufficient. Lack of supplies was reported to be the reason for the insufficient use of farmyard manure. The farmers reported that the manure was not available. The practice of using dung as a fuel seriously limits the available quantity of farmyard manure. The farmers were asked whether they used dung as fuel and to state the proportion of dung used by them as fuel if they did so. Sixty-four per cent of the farmers reported to be using dung as fuel and the proportion of dung used as fuel ranged between one-fifth and one-half of the cattle dropping. This is because of shortage of alternative fuel.

There are other alternatives for farmyard manure such as compost prepared by village panchayat, other organic manures and green manuring. None of the farmers have used concentrated organic manures; use of such manures may be encouraged. In the following is given price per kilogram of N obtainable from farmyard manure, groundnut cake and castor cake and Ammonium Sulphate and Urea.

Kind	N Content (%)	Price (Rs./Qt.)	Price of N/kg. (Rs.)
Farmyard manure	0.84	14.30	17.02
Groundnut cake	6.96	160.00	22.99
Castor cake	4.55	68.00	14.95
Ammonium Sulphate	20.00	95.00	4.75
Urea	45.00	175.00	3.89

Concentrated organic manures besides supplying plant nutrients supply organic matter to the soil. Green manuring consists of growing a quick maturing nitrogenous crop and ploughing it into the soil. Green manuring increases the nitrogen and humus contents of the soil. But only 16 per cent of the farmers followed the practice. A large number of farmers (57 farmers) lacked knowhow while 23 farmers did not follow the practice because of competition for space from other crops.

In respect of fertilizers 48 per cent of the farmers reported that the quantity of fertilizers used by them was not sufficient. Lack of purchasing capacity as a reason for low level of application was reported by 44 per cent of them. Untimely supply of fertilizers was reported by 4 per cent of the farmers. The farmers complained that it often happened that whenever they went to the centre where the fertilizers were stored to lift the quota sanctioned to them by the co-operative society, they would find that no stock was available

or whatever stock was available was inadequate.

The cropwise inadequacy of fertilizers and farmyard manure as indicated by the farmers is given in Table 6.12.

Table 6.12 : Cropwise Deficiency of Fertilizers and F.Y.M.

Sr. No.	Crops	N (kg./ha.)	P (kg./ha.)	K (kg./ha.)	F.Y.M. (Cts./ha.)
1	Paddy	5.66	6.21	0.66	15.29
2	Wheat	17.62	7.24	2.08	18.80
3	Jowar	9.07	5.70	0.76	10.80
4	Groundnut	7.72	23.55	0.83	-
5	Cotton	10.37	10.96	2.69	21.70
6	Turmeric	10.01	9.30	-	26.42
7	Sugarcane	16.74	15.22	2.92	35.37
8	Banana	3.86*	0.41*	-	47.22

Note: * Grams per plant.

An estimation of the total deficient quantity of N, P and K is attempted in Table 6.13. The deficiency of N, P and K per hectare of gross cropped area works out to 28.82 kg., 36.90 kg. and 52 kg. respectively.

6.4 Use of Plant Protection Chemicals

The luxuriant growth of plants induced by the use of fertilizers and irrigation have created serious pests and disease problems. In the absence of control measures the

Table 6.13 : Estimation of Total N, P and K Deficiency

Sr. No.	Particulars	Paddy			Wheat			Jowar			Groundnut			Cotton		
		N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
1.	Recommended dose (kg./ha.)	60.00	30.00	30.00	100.00	50.00	50.00	75.00	62.00	62.00	25.00	50.00	-	100.00	50.00	50.00
2.	Actual application (kg./ha.)	50.67	12.02	6.78	62.44	19.91	11.34	47.29	15.50	8.35	12.42	23.51	2.54	78.42	15.09	8.38
3.	Deficient quantity (kg./ha.) (1-2)	9.33	17.98	23.22	37.56	30.09	38.66	27.71	46.50	53.65	12.58	26.49	-	21.58	34.91	41.62
4.	Area under the crop (ha.)	85.13			109.57			14.97			31.47			11.33		
5.	Total deficient quantity (kg.)(3x4)	794.26	1530.64	1976.72	4115.45	3296.96	4235.98	414.82	696.11	803.14	395.89	833.64	-	244.50	395.53	471.55
6.	Deficiency per hectare of gross cropped area (kg.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sr. No.	Particulars	Turmeric			Sugarcane			Banana			Total (All Crops)			
		N	P	K	N	P	K	N	P	K	Area(ha.)	N	P	K
1.	Recommended dose (kg./ha.)	125.50	62.50	62.50	170.00	115.00	115.00	100.00*	100.00*	200.00*	-	-	-	-
2.	Actual application (kg./ha.)	80.56	13.72	6.17	126.68	55.46	27.06	60.33*	17.60*	8.86*	-	-	-	-
3.	Deficient quantity (kg./ha.) (1-2)	44.44	48.78	56.33	43.32	59.54	87.94	39.67*	82.40*	191.14*	-	-	-	-
4.	Area under the crop (ha.)	7.29			21.62			6.66 (27,100 plants)			288.04	-	-	-
5.	Total deficient quantity (kg.) (3x4)	323.97	355.61	410.65	936.58	1287.25	1901.26	1075.06	2233.04	5179.89	-	8300.48	10628.78	14979.14
6.	Deficiency per hectare of gross cropped area (kg.)	-	-	-	-	-	-	-	-	-	-	28.82	36.90	52.00

Note : * Grams per plant.

yield of crop may vary from poor harvest to none at all. According to an estimate made by the National Council of Applied Economic Research[9] (NCAER) the maximum loss due to pests recorded was on Cotton (40.3 per cent) and other crops like Paddy, Jowar, Sugarcane, Potato recorded losses ranging from 8.8 to 12.1 per cent, the lowest being 2.8 per cent in Wheat. Unlike Fertilizers, pesticides do not increase yield but only prevent losses.

In order to know the level of adoption of plant protection by the farmers questions were asked regarding the reasons for not adopting any plant protection measures or for not following the recommended schedule. Thirty per cent of the farmers replied that there was no necessity of plant protection measures. In Table 6.14 are given the reasons for not using any plant protection chemicals or for not following the recommended schedule.

Farmers mostly lack the knowledge about the kind and quantity of pesticides and insecticides to be used, the manner of application and the stage of growth of the pest and the crop. Lack of knowhow was the major constraint in the non-adoption of plant protection measures. Eighteen per cent of the farmers lacked finance for purchasing pesticides. Fifteen per cent of the farmers refrained from using pesticides because

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9 Quoted in Report of the National Commission on Agriculture, Part X, 1976, op.cit., p. 157.

Table 6.14 : Reasons for Non-Adoption of Plant Protection Measures

Sr. No.	Reasons	Number reporting	Percentage
1.	Lack of knowhow	27	27.00
2.	Lack of purchasing capacity	18	18.00
3.	Pesticides are costly	15	15.00
4.	Lack of appliances	6	6.00
5.	Lack of labour	2	2.00
6.	Did not want to apply	2	2.00
7.	Plant protection measures not necessary	30	30.00
	Total	100	100.00

of their costliness. The plant protection chemicals are generally costly, but because the amounts to be applied are usually small and the saving of crops is almost assured, the benefits accruing from the use of such chemicals outweigh their costs. The benefit-cost ratios vary from 1.5 to 16 depending on the nature of crop. It is reported that[10] the ratios in the case of food crops and vegetables are lower, namely, 3 to 7.2 and 2.8 to 4.7 respectively than in the case of cash crops like Cotton (2 to 13.5), Sugarcane (3.4 to 14), and Oilseeds (1.4 to 44); in the case of Jute and Coconut the ratios are 4 and 2 respectively. Lack of appliances as a reason for non-adoption of plant protection measures was

10 Ibid., p. 175.

reported by 6 per cent of the farmers. Lack of labour was reported by two farmers.

6.5 Yield Performance of the Crops

In Table 6.15 we give the per hectare yields obtained by the farmers along with the expected yields according to the Department of Agriculture of Maharashtra State. It will be

Table 6.15 : Per Hectare Yields of Irrigated Crops

(Quintals per hectare)

Sr. No.	Size groups (ha.)	Wheat	Paddy	Cotton	Turmeric	Groundnut	Jowar	Sugarcane *
1.	Expected yield	40	30	25	38	11.2	30	100
2.	I (0 to 2.00)	15.38	11.25	No crop	21.57	8.59	24.00	61.76
3.	II (2.01 to 4.00)	17.12	10.85	8.88	22.86	8.64	11.71	55.26
4.	III (4.01 to 6.00)	15.46	11.83	7.30	18.70	7.53	13.37	43.36
5.	IV (6.01 and above)	16.02	10.06	6.88	24.73	10.73	13.94	45.28
6.	All Farms	16.01	10.87	7.48	21.37	8.54	13.61	47.78
7.	Per cent of expected yield	40.02	36.23	29.92	56.24	76.25	45.37	47.78

Note: * Yield in Tons per hectare.

seen that the yields of all the crops were below the expected yields and that except for Groundnut and Turmeric they were less than 50 per cent of expected yields. In the case of Cotton the yield obtained was as low as 30 per cent of the expected yield. In the case of Jowar and Sugarcane the smallest size group of holding has obtained the maximum yields. In larger size holdings there appears no systematic trend in obtaining yields.

Banana crop needs a separate mention. It is a common practice in the study area to sell the standing crop. The bagwans (a community of traders having a monopoly in the trade of Banana) visit the fields and taking into consideration the development of Banana bunch they purchase the whole yield on the basis of price per plant. Hence in the absence of data on physical yields it is not possible to judge the yield performance of the crop.

CHAPTER VII

WATER REQUIREMENTS AND SUPPLY

The water requirements of a crop are determined by evapotranspiration which is a physical process involving conversion of water into vapour with the aid of energy derived from the sun. The evapotranspiration is thus governed primarily by metereological factors like sunshine, temperature, humidity and wind velocity. As a consequence the water requirements of various crops are determined largely by the length of their periods of growth and the seasonal changes in climate. The nature of soil affects only the frequency and depth of irrigation water. Shallow soils require greater number of light waterings whereas deep soils can do with fewer but more intensive waterings. In either case the total amount of water required by crops remains the same, provided climatic conditions are identical. The ability of a plant to draw water from the soil depends on its root system as also on the nature of the soil.

The water requirement of crops consists of (i) consumptive use of water by crops which is the quantity of water lost in evaporation, transpiration and that used by a plant in metabolic activities, and (ii) other unavoidable losses such as leaching through soils, percolation, etc., and is expressed as depth in mm or cm.

The irrigation requirements of a crop in the field is the quantity of water which needs to be applied to it for its successful growth, exclusive of any contribution from effective rainfall.* It includes unavoidable losses in the application of water in the field, both as surface runoff and deep percolation. To these, however, have to be added transit losses to determine the quantity of water that has to be made available from the source.

7.1 Frequency and Depth of Watering

Moisture in the soil supplies the water required by crops. The availability of moisture in the soil depends upon its depth and water holding capacity. The finer the texture of the soil the greater is its water holding capacity. The depth and texture of the soil thus govern the depth and interval of irrigation and in consequence the scheduling of irrigation water. The soil moisture gradually gets depleted due to evaporation and transpiration till it becomes so low that the crop is unable to draw sufficient amount and ultimately wilts. Irrigation is needed much before this stage since yield of the crop is affected much earlier and the damage caused is irrepairable. The damage done cannot be repaired by any subsequent copious watering. The interval at which irrigation water should be applied to crops depends

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* That part of the rainfall which is lost by runoff and by deep percolation is ineffective and it is only the balance which makes a useful contribution to the plant growth.

chiefly upon the evaporation caused by the climate. The frequency of watering is also influenced by its depth. The depth of watering normally ranges between 5 and 10 cm. The depth of irrigation required by a crop depends upon the soil moisture deficit in the effective root zone of the crop. Knowledge of the water holding properties of soils and the rooting of crops is necessary to estimate the quantity of water to be applied at each watering.

7.2 Irrigation in Relation to Critical Stages of Growth

It is now well recognised that there are some critical stages of growth in the life period of a crop when it must get irrigation water. Three stages are universally recognised to be the critical stages of growth viz. growth period, flowering stage and seed formation. Table 7.1 shows the critical stages of growth of some important crops.

If irrigation water is not supplied at these stages there is retardation in the growth of the crop. Moisture deficiency at these stages adversely affects the process of formation of earheads and grain weight which in consequence reduce the yield of the crop substantially.

7.3 Irrigation in Relation to Agro-Climatic Zones

The irrigation requirement varies from crop to crop and differs from season to season and is governed by agro-climatic conditions. Temperature, soil type and the nature of rainfall together determine the most suitable crops that can be grown

Table 7.1 : Critical Stages of Growth of Crops

Crops	Critical stage of growth	Approximate period from sowing (days)
Sugarcane	1. Tillering stage	90
	2. Initial stage of growth period	120
	3. Grand growth period	150
Cotton	1. Flowering stage	100
	2. Fruit setting (boll formation)	120
Paddy	1. Tillering stage	60
	2. Flowering stage	90
	3. Seed or grain formation	100
Hybrid Jowar	1. Initial stage of grand growth	25
	2. Flag leaf stage	55
	3. Flowering stage	75
	4. Seed formation	105
Wheat	1. Crown root development	20
	2. Tillering stage	60
	3. Jointing stage	75
	4. Flowering stage	90
	5. Milk formation in seeds	105

Source: Department of Agriculture, Maharashtra State, Pune. Water Requirement of Crops in Different Agro-Climatic Zones, Agricultural Bulletin No. 574, 1975, p. 19.

in an area. For instance, while wheat is best grown in cool and dry climate, Paddy thrives well in warm and humid climate. Similarly, while wheat does well in loam and sandy loam, paddy requires clayey soils which have low permeability. But apart of consideration of temperature and soil type, natural preci-

pitation is the principal factor that determines crops suitable for a region. It is the rainfall that normally meets the basic water requirement of a crop grown, irrigation water being used only to make up the deficiencies in the rainfall. It is for this reason that for each region the crops in an irrigation command are best chosen from amongst those which are natural to the area under rainfed conditions and their yields increased with assured irrigation supplies.

As already noted the command area of the Purna project lies in Agro-climatic zone VII 'Assured rainfall area' and zone VIII 'Zone of moderate to moderately high rainfall'. The Department of Agriculture of Maharashtra has given recommendations regarding the water requirements of crops in different agro-climatic zones of the State. The figures relevant to Purna command area are given in Table 7.2.

Table 7.2 : Recommended Number of Waterings To Be Applied to Crops Under Purna Command

Sr.No.	Crops	No.of waterings
1.	Sugarcane (Plant)	28-29
2.	Banana	56-60
3.	Cotton: Long Staple (Pre-monsoon)	6
4.	Cotton: Long Staple (June sowing)	2
5.	Turmeric	16
6.	Kharif Paddy (drilled)	2
7.	Kharif Hybrid Jowar	1
8.	High Yielding Wheat	7
9.	Groundnut (Hot-weather)	12

Source: Water Requirement of Crops in Different Agro-Climatic Zones, 1975, op.cit., p. 23.

Most of the experiments have indicated that light and frequent irrigations are more conducive to higher yields than heavy irrigation at long intervals, total delta remaining the same within a certain range.[1] Recent results of experiments on Crowfoot millet (Ragi) obtained at Siruguppa[2] showed that nine irrigations gave more yield than seven irrigations, the delta remaining the same as 450 mm. The results obtained by Dastane and Singh[3] (1966) showed that the grain yield of wheat, irrespective of variety, increased with the number of irrigations even though the different varieties gave significantly different yields. In an another experiment[4] on rice it was found that the practice of giving small quantities of water at short intervals - 5.1 cm (2 inches) irrigation at three days interval - seemed to be more beneficial than giving more quantity of water at longer intervals.

Deficiency in maintaining the regularity in interval between two consecutive waterings leads to missing the critical

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1 N.G. Dastane. New Concepts, Practices and Techniques in the Field of Water Use and Management. Symposium on Soil and Water Management, Indian Council of Agricultural Research, New Delhi, 1972, p. 121.

2 N.G. Dastane. "New Concepts in Irrigation," Economic and Political Weekly, Vol. IV, No. 13, 1969, p. A-29.

3 Quoted in A Review of Soil and Water Research in India in Retrospect and Prospect. Indian Council of Agricultural Research, New Delhi, Technical Bulletin No. 22, January 1971, p. 283.

4 Quoted by M.S. Chaudhari, and R.S. Singh. Irrigation Requirements of Rice Crop—A Review. Symposium on Optimum Requirements and Utilisation of Water for Irrigated Crops. Central Board of Irrigation and Power, New Delhi, Publication No. 94, 1969, p. 25.

stages of growth of plants. According to Singh et al, Ghosh and Bhattacharjee, Dutta and Sen, Vamdevan and Dastane and Chaudhari and Pandey lack of adequate moisture at the critical stages of growth during the plant life reduces the yield even upto the extent of 50 per cent.[5] Experiments have shown that a faulty irrigation schedule can reduce the yield of wheat by as much as 15 quintals per hectare or 29 per cent below the optimum evident from the following Table 7.3.

Table 7.3 : Response of Wheat (Sonora-64) to Four Irrigation Timings

Number of irrigations during crop-age (days)			Yield (Q/ha)	Relative yield
0-60	60-90	90-120		
-	2	2	37.0	100
1	1	2	44.0	119
2	1	1	51.3	140
2	-	2	52.3	141

Source: Report of the Irrigation Commission, 1972, Vol. I, op.cit., p. 107.

The table clearly shows that with the same quantity of irrigation water incorrect application can reduce the yields drastically. The high yielding varieties programme has also revealed that though the total quantity of water may be the same the time when it is applied to the crop is most critical.

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5 Quoted in A Review of Soil and Water Research in India in Retrospect and Prospect, op.cit., p. 280.

The Irrigation system, therefore, should supply irrigation water not only in the required quantity but also at the required time.

7.4 Supply of Irrigation Water

We may now examine how far these requirements were met by the farmers from the canal. The farmers were asked to give details regarding irrigation water applied to different crops from the canal as well as from other sources of irrigation. Information on such items like number of waterings given and interval between two waterings in different seasons was collected from the farmers. In Table 7.4 we give number of waterings applied to different crops.

Recommended water requirements in the case of crops like Paddy, Hybrid Jowar, L.S. Cotton and Turmeric were met by the farmers. The farmers reporting not to have given any watering to these crops or reporting to have applied less waterings than those required to meet the water requirements of the crops have done so on their own accord as they did not need canal water due to receipt of sufficient rainfall. The deficiency in case of water is more pronounced in case of Sugarcane and Banana. Out of 90 farmers growing wheat 19 farmers have reported to have given 6 waterings as against the recommended 7 waterings. In the case of Groundnut only 10 farmers out of 33 farmers growing the crop applied the recommended number of waterings. In the case of Sugarcane and Banana most of the farmers could not apply the recommended number of waterings. Reportedly, the

Table 7.4 : Number of Waterings Applied to Different Crops by Reporting Farmers Using Only Canal Water

Crops	Number of reporting farmers	Number of waterings applied
Paddy (Drilled)	75	No watering
	6	1
	4	2
Kharif Hybrid Jowar	13	No watering
Cotton (Long Staple)(Pre-monsoon)	6	5
	9	6
Turmeric	5	12
	14	15
Wheat	19	6
	71	7
Groundnut (Hot-Weather)	13	10
	10	11
	10	12
Sugarcane (Plant)	1	17
	2	20
	2	21
	8	22
	1	23
	4	24
	7	25
Banana	1	38
	4	40
	1	41

farmers could not get the recommended number of waterings because of mismanagement and maldistribution of the irrigation water and failure on the part of the irrigation staff to enforce the Irrigation Rules strictly.

The existing rotation is of 18 days in kharif, 21 days in rabi and 10 days in hot-weather season. Reportedly, the scheduled rotations are not strictly adhered to consequently there are long gaps between two consecutive waterings. Table 7.5 shows interval at which irrigation water was supplied to the farmers for different crops in the three cropping seasons. It is clear that there were long gaps between two consecutive waterings during rabi and hot-weather seasons than the scheduled rotations in case of all those crops which spread over these two seasons. There was no problem, it was reported, regarding the supply of irrigation water according to the scheduled rotation in kharif season. In rabi and hot-weather seasons there was competition for more water among the farmers and the more powerful and influential farmers took more than one turn of watering in one rotation thus disturbing the schedule.

It can be seen from the table that of the 15 farmers growing cotton 8 farmers reported that they received irrigation water for the crop in hot-weather season at an interval of 15-18 days as against the scheduled rotation of 10 days because of the failure of irrigation staff in maintaining discipline in the distribution of water. In the case of Turmeric three out of 19 farmers received canal water at an interval of 24 days in

Table 7.5 : Interval Between Two Waterings Applied to Different Crops

Crops	Number of reporting farmers	Season	Interval (days)
Cotton (Long Staple) (Pre-Monsoon)	15	Kharif	20-22
	8	Hot-weather	15-18
	7	"	10-11
Turmeric	19	Kharif	20-22
	16	Rabi	20-22
	3	"	20-24
	4	Hot-weather	15-18
	15	"	10-11
Wheat	42	Rabi	20-22
	38	"	24-25
	10	"	25-30
Groundnut (Hot-weather)	9	Hot-weather	10-11
	10	"	12-15
	7	"	15-18
	5	"	18-20
	2	"	25-28
Sugarcane	25	Kharif	20-25
	15	Rabi	20-22
	10	"	24-25-30
	10	Hot-weather	10-11
	10	"	12-15
	4	"	15-18
	1	"	18-30
Banana	6	Kharif	20-22
	2	Rabi	20-22
	4	"	24-25
	4	Hot-weather	10-11
	2	"	15-18

rabi season and four farmers at an interval of 15-18 days in hot-weather season. In the case of Wheat out of 90 farmers growing the crop 38 farmers could apply the water at an interval of 25 days and 10 farmers at an interval of 25-30 days. Twenty-four out of 33 farmers who cultivated Groundnut in hot-weather season reported to have lacked canal water at regular interval as per the schedule. While 10 of them irrigated their crop at an interval of 12-15 days, seven irrigated after a gap of 15-18 days. In the case of five farmers the gap was twice that of the scheduled rotation. Ten out of 25 farmers growing Sugarcane irrigated their crop in rabi season at an interval of 24-30 days in two waterings. In hot weather the interval was 12-30 days in case of 15 farmers. In the case of Banana 4 out of 6 farmers applied irrigation water in rabi season after a gap of 24-25 days and 2 farmers irrigated their crop after 15-18 days in hot-weather.

7.5 Application of Irrigation Water from Wells

The only other source of irrigation was wells. In Table 7.6 we give the number of irrigations given and the rotation followed in the case of crops irrigated from wells.

Almost all the farmers growing Sugarcane and Banana on canal irrigation indicated the need to modify the existing rotation since it does not commensurate with the requirements of the crops. Their argument was based on the rotation followed by the farmers growing these crops on well irrigation. The rotation followed by such farmers, as is seen from the Table,

Table 7.6 : Application of Irrigation Water from Wells

Crops	Number of reporting farmers	Number of waterings given	Rotation followed	
			Season	Interval (days)
Paddy	1	3	Kharif	20-22
Hybrid Jowar	1	Nil	-	-
Cotton (Long Staple)	Nil	-	-	-
Wheat	1	7	Rabi	20-22
Groundnut (Hot-weather)	Nil	-	-	-
Turmeric	5	15-20	Kharif	20-22
			Rabi	18-20
			Hot weather	10-12
Sugarcane	21	24-32	Kharif	15-20
			Rabi	12-15
			Hot weather	8-10
Banana	13	50-56	Kharif	12-15
			Rabi	8-10
			Hot weather	4-6

was of 15-20 days in kharif, 12-15 days in rabi and 8-10 days in hot-weather in respect of Sugarcane. The rotation was of 12-15 days in kharif, 8-10 days in rabi and 4-6 days in hot-weather in case of Banana. The rotation followed on canal irrigation in rabi and hot-weather seasons does not compare well with the rotation followed on well irrigation in the case of both the crops. As a result some farmers tend to break Canal Rules taking water out of turn denying water to other farmers.

7.6 Deficiency in the Quantity of Water Required and Yields Obtained

In order to examine the effect of deficient irrigation on yields, we may compare per hectare yields obtained by farmers who could apply the required number of waterings and by those who could not. In Tables 7.7 to 7.10 are given relevant data. It will be seen that deficiency in irrigation

Table 7.7 : Per Hectare Yield Obtained by the Farmers of Two Categories

Items	Wheat		Groundnut	
	a	b	a	b
Number of farmers reporting	19	71	23	10
Area (hectares)	25.34	83.01	21.96	9.51
Yield obtained (Quintals)	339.20	1391.00	174.00	94.75
Per hectare yield (Quintals)	13.39	16.76	7.92	9.96

Note: a = Those farmers who could not meet their requirement of water

b = Those farmers who could meet their requirement of water.

reduced the yield of Wheat by 3.37 quintals per hectare or 20.1 per cent. In the case of Groundnut it reduced the yield by 2.04 quintals per hectare or 20.5 per cent. In the case of Sugarcane the yield reduced to a large extent in case of those farmers who applied less number of waterings. The yield of Sugarcane obtained by the farmers growing the crop on well irrigation is more than the yield of the crop grown on canal irrigation. The increase in the yield in case of well irrigated crop may be

Table 7.8 : Number of Irrigations Applied and Yield Obtained in Case of Sugarcane

Number of irrigations applied	Number of reporting farmers	Area (ha.)	Yield (Tons)	Per hectare yield (Tons)
17-20	3	1.21	27.00	22.31
21-22	10	4.84	226.00	46.69
23-24	5	2.01	98.50	49.00
25	7	4.24	170.50	40.21
Total	25	12.30	522.00	42.44

Table 7.9 : Number of Irrigations Applied and Yield Obtained in Case of Sugarcane Grown on Well Irrigation

Number of irrigations applied	Number of reporting farmers	Area (ha.)	Yield (Tons)	Per hectare yield (Tons)
24-26	10	4.08	213.00	52.21
28	8	4.24	242.00	57.08
30-32	3	1.00	56.00	56.00
Total	21	9.32	511.00	54.83

Table 7.10 : Number of Irrigations Applied and Yield Obtained in Case of Banana

Sources of irrigation	Number of waterings applied	Number of reporting farmers	Area (ha.)	Total returns (Rs.)	Number of plants	Price per plant (Rs.)
Canal	38-41	6	1.82	25,200.00	7,100	3.55
Well	50-56	13	4.84	74,450.00	20,000	3.72

attributed to application of irrigation at the required time, at regular intervals and in the required number of waterings.

We have already mentioned that yields expressed in physical quantities are not available in the case of Banana since the crop is sold on the basis of price per plant. In Table 7.10 we give price per plant obtained in the case of Banana grown on canal and well irrigation. Since the number of farmers growing the crop on canal irrigation is small they are grouped together irrespective of number of waterings applied by them. The same is followed in the case of well irrigated Banana.

It will be seen that there is a reduction in price per plant by Rs. 0.17 in the case of canal irrigated Banana which may be due to deficient irrigation.

The above findings are only suggestive and not conclusive because they are based on only a few observations. Moreover, the yield of a crop depends on other inputs and not on irrigation alone.

CHAPTER VIII

EXTENT AND CAUSES OF UNDERUTILISATION OF CANAL WATER

8.1 Extent of Underutilisation

In relation to an individual farm the extent of underutilisation has to be assessed in relation to the irrigable area of the farm. The irrigable area of a farm is the area lying in the command of the canal, that is, that portion of the culturable area of a farm which is below the level of the canal and which can be irrigated therefrom by means of gravity flow without employing a lift. This may be called the physical irrigable area. However, in the years of short replenishment in the reservoir, when available supply of water is rationed out in order to achieve equitable distribution, water may not be available to the entire irrigable area of the farm. Similarly, in order to maintain the proportion of different crops in the project cropping pattern and distribute the supplies equitably, the physical irrigable area may be restricted and pass for cultivation of irrigated crops would not be issued. For estimating underutilisation the area for which water was actually available or might have been made available on demand is more important and this may be called the permissible irrigable area to distinguish the same from the physical irrigable area. Hence while estimating under-

utilisation of the irrigation facilities the following three distinctions will have to be made:

i) area not irrigated because not applied for getting irrigation supplies from the canal even though the land comes under the command of the canal (demand restricted)

ii) area not irrigated because a pass for the entitlement of the canal water was not issued (supply restricted)

iii) area not irrigated even though a pass was issued (demand restricted).

There are no cases of the second and third type. Hence we should focus our attention on how many farmers and why did they not apply for irrigation water even when their lands were under the command of the canal.

In Table 8.1 we give the data on the area applied for getting irrigation supplies, the area for which a pass was issued and the area actually irrigated by the sample farmers. Applications requiring irrigation supplies in kharif season for an area of 126.69 hectares comprising 116.61 hectares of seasonals and two-seasonals and 10.08 hectares of perennials were tendered. Of the area applied for, the whole of the seasonals and two-seasonals area and an area of 4.64 hectares of perennials was sanctioned for getting irrigation supplies by means of issuing passes. Similarly, during rabi and hot-weather seasons though sanction for whole of the area applied requiring irrigation supplies for seasonals and two-seasonals was accorded, sanction was not given to the full extent applied

Table 8.1 : Area Applied, Area for which a Pass Was Issued and the Area Actually Irrigated

(Area in hectares)

Sr. No.	Particulars	Kharif	Rabi	Hot-weather	Total
1.	Area applied	126.69	144.17	53.57	324.43
	i) Seasonals and two-seasonals	116.61	130.06	39.46	286.13
	ii) Perennials	10.08	14.11	14.11	38.30
2.	Area for which a pass was issued	121.25	137.53	46.93	305.71
	i) Seasonals and two-seasonals	116.61	130.06	39.46	286.13
	ii) Perennials	4.64	7.47	7.47	19.58
3.	Area actuall irrigated	126.69	144.17	53.57	324.43
	i) Seasonals and two-seasonals	116.61	130.06	39.46	286.13
	ii) Perennials	10.08	14.11	14.11	38.30

for perennials. This was because, it was reported, the area was not passed for taking perennials i.e. the area was not under M_1 and D_2 soils. Nevertheless, an area of 5.44 hectares in kharif season and 6.64 hectares in rabi and hot-weather seasons was thus irrigated without having an entitlement for it amounting to unauthorised irrigation. A provision of imposing a penalty, three times the normal water rates, has been made in the Irrigation Act. But in the present case the offences were condoned with a nominal penalty of Re. 1. The leniency has led many farmers to grow perennials outside the demarcated area.

For estimating underutilisation in the present case it is necessary to calculate the permissible irrigable area. The permissible irrigable area of the sample farms is calculated in the proportion in which the project cropping pattern is designed to be irrigated. We call this as area expected to be irrigated. Underutilisation then would be equal to the difference between the area expected to be irrigated and the area actually irrigated by the farmers. In Table 8.2 is given data on area expected to be irrigated, area actually irrigated and the extent of underutilisation. It is evident from the Table that the irrigation facilities provided to the farmers have not been utilised to the fullest extent. Considering the total annual irrigation it can be seen that the utilisation of the irrigation facilities is only 60 per cent. The utilisation in kharif was somewhat better (71.27 per cent) than in rabi season (62.39 per cent). In hot-weather season, only a small area was expected to be irrigated. But even that was not irrigated - actual area irrigated being only 41.75 per cent of the expected.

The performance of the farmers with different sizes of farms in respect of the utilisation of irrigation facilities shows that the differences between different size-groups of holding are not very systematic except that the underutilisation of irrigation appears largest in the highest size-group.

In order to see whether any relationship exists between the size of physical irrigable area and utilisation of the

Table 8.2 : Extent of Underutilisation of Irrigation by the Sample Farmers

Size Groups (ha.)	Physical irrigable area		Area (ha.) Expected to be irrigated	Actually irrigated	Under-utilisation
I (0 to 2.00)	19.94	Kharif	11.51	7.46 (64.81)	4.05 (35.19)
		Rabi	14.95	9.69 (64.82)	5.26 (35.18)
		Hot weather	8.30	3.29 (39.64)	5.01 (60.36)
		TOTAL	34.76	20.44 (58.80)	14.32 (41.20)
II (2.01 to 4.00)	58.67	Kharif	33.85	27.80 (82.13)	6.05 (17.87)
		Rabi	44.00	31.90 (72.50)	12.10 (27.50)
		Hot weather	24.44	9.08 (37.15)	15.36 (62.85)
		TOTAL	102.29	68.78 (67.24)	33.51 (32.76)
III (4.01 to 6.00)	87.18	Kharif	50.30	38.35 (76.24)	11.95 (23.76)
		Rabi	65.39	46.38 (70.93)	19.01 (29.07)
		Hot weather	36.31	23.25 (64.03)	13.06 (35.97)
		TOTAL	152.00	107.98 (71.04)	44.02 (28.96)
IV (6.01 and above)	142.30	Kharif	82.11	53.08 (64.64)	29.03 (35.36)
		Rabi	106.73	56.20 (52.66)	50.53 (47.34)
		Hot weather	59.27	17.95 (30.29)	41.32 (69.71)
		TOTAL	248.11	127.23 (51.28)	120.88 (48.72)
All Farms	308.09	Kharif	177.77	126.69 (71.27)	51.08 (28.73)
		Rabi	231.07	144.17 (62.39)	86.90 (37.61)
		Hot weather	128.32	53.57 (41.75)	74.75 (58.25)
		TOTAL	537.16	324.43 (60.40)	212.73 (39.60)

Note: Figures in the parentheses indicate percentage to the area expected to be irrigated.

Table 8.3 : Size of Physical Irrigable Area and Extent of Underutilisation

Size groups	No.of farms	Physical irrigable area (I.C.A.) (ha.)	Average I.C.A. (ha.)	Area (ha.)			Under-utilisation
					Expected to be irrigated	Actually irrigated	
I (0 to 2.00)	38	43.35	1.14	Kharif	25.01	19.20 (76.77)	5.81 (23.23)
				Rabi	32.52	24.31 (74.75)	8.21 (25.25)
				Hot weather	18.06	6.86 (37.98)	11.20 (62.02)
				TOTAL	75.59	50.37 (66.64)	25.22 (33.36)
II (2.01 to 4.00)	35	99.59	2.85	Kharif	57.46	49.93 (86.90)	7.53 (13.10)
				Rabi	74.69	52.47 (70.25)	22.22 (29.75)
				Hot weather	41.48	19.00 (45.81)	22.48 (54.19)
				TOTAL	173.63	121.40 (69.92)	52.23 (30.08)
III (4.01 and above)	27	165.15	6.12	Kharif	95.30	57.56 (60.40)	37.74 (39.60)
				Rabi	123.86	67.39 (54.41)	56.47 (45.59)
				Hot weather	68.78	27.71 (40.29)	41.07 (59.71)
				TOTAL	287.94	152.66 (53.02)	135.28 (46.98)
All Farms	100	308.09	3.08	Kharif	177.77	126.69 (71.27)	51.08 (28.73)
				Rabi	231.07	144.17 (62.39)	86.90 (37.61)
				Hot weather	128.32	53.57 (41.75)	74.75 (58.25)
				TOTAL	537.16	324.43 (60.40)	212.73 (39.60)

Note: Figures in the parentheses indicate percentage to the area expected to be irrigated.

Table 8.4 : Length of Period of Using Canal Water and Extent of Underutilisation

Length of period (years)	No.of farms	Physical irrigable area (I.C.A.) (ha.)	Average I.C.A. (ha.)		Area (ha.) Expected to be irrigated	Area (ha.) Actually irrigated	Under-utilisation
0 - 5	21	47.92	2.28	Kharif	27.65	13.98 (50.56)	13.67 (49.44)
				Rabi	35.94	17.37 (48.33)	18.57 (51.67)
				Hot weather	19.96	8.40 (42.08)	11.56 (57.92)
				TOTAL	83.55	39.75 (47.58)	43.80 (52.42)
6 - 9	63	213.27	3.39	Kharif	123.06	91.03 (73.97)	32.03 (26.03)
				Rabi	159.95	102.69 (64.20)	57.26 (35.80)
				Hot weather	88.83	42.54 (47.89)	46.29 (52.11)
				TOTAL	371.84	236.26 (63.54)	135.58 (36.46)
10 years and above	16	46.90	2.93	Kharif	27.06	21.68 (80.12)	5.38 (19.88)
				Rabi	35.18	24.11 (68.53)	11.07 (31.47)
				Hot weather	19.53	2.63 (13.47)	16.90 (86.53)
				TOTAL	81.77	48.42 (59.21)	33.35 (40.79)
All Farms	100	308.09	3.08	Kharif	177.77	126.69 (71.27)	51.08 (28.73)
				Rabi	231.07	144.17 (62.39)	86.90 (37.61)
				Hot weather	128.32	53.57 (41.75)	74.75 (58.25)
				TOTAL	537.16	324.43 (60.40)	212.73 (39.60)

Note: Figures in the parentheses indicate percentage to the area expected to be irrigated.

irrigation facilities the sample farms are classified by the size of their physical irrigable area into three size-groups. Relevant data are given in Table 8.3. It is clear from the Table that underutilisation is somewhat greater in farms with more than 4 hectares of physical irrigable area.

The period since when irrigation facilities are being utilised may have an effect on the extent of utilisation of these facilities since it takes time to adopt and develop irrigated agriculture. Table 8.4 shows analysis in this respect. It will be seen therefrom that except in hot-weather season the utilisation of irrigation water improves after a period of five years.

8.2 Causes of Underutilisation of the Irrigation Facilities

The sample farmers were asked regarding the area of their farm coming under the command of the canal waters and the reasons for not applying for getting irrigation supplies. The causes responsible for underutilisation of the irrigation facilities of the project as advanced by the sample farmers are enumerated in Table 8.5. Some of the respondents advanced more than one reason for underutilising the canal waters. Each reason is described in below paragraphs.

8.2.1 Competition from Wells in respect of Mixed Irrigable Area

Sixteen farmers reported to have used well irrigation water for irrigating their crops grown in the mixed irrigable

Table 8.5 : Number of Farmers Reporting Various Reasons for Underutilisation of Irrigation Water

Sr. No.	Reasons	Number of reporting farmers
1.	Competition from wells in respect of mixed irrigable area	16
2.	Causes relating to the distribution system	29
	i) Absence of outlets and field channels	5
	ii) Defective and ill-maintained distribution system	14
	iii) Disputes over field channels	4
	iv) Inadequate or lack of drainage channels and waterlogging	6
3.	Maldistribution of the available water and tail-end difficulties	11
4.	Lack of credit and inputs and infrastructure	33
5.	Inadequate preparation of land, inadequate man-power and inadequate draught power	22
6.	Traditional outlook of the farmers	16
7.	No reason given	7

area. The mixed irrigable area i.e. the area that can be irrigated both from the canal as well as a well, was mostly used for growing perennials. This was chiefly because the area was not passed for growing perennials excepting in the case of one farmer who had grown the perennials on well irrigation water even though his area was passed for taking perennials i.e. under M_1 and D_2 soils. When asked as to why he preferred well irrigation water to the canal irrigation water for growing

perennials he said that his crop of Banana in the past had completely failed when irrigated from canal irrigation water due to insecure supplies. This is why he preferred growing perennials on well irrigation water.

8.2.2 Causes Relating to the Distribution System

The Irrigation Act and the Rules thereunder in the State provide for the construction of field channels and outlets. According to the Irrigation Act field channel means a channel beyond an outlet from a point where it runs in its own command, either constructed by the holders or occupiers or constructed by the Appropriate Authority on their behalf and maintained by such holders or occupiers beyond the outlet. Similarly, an outlet means "an opening of a capacity not exceeding 30 litres per second to serve a block of land of approximately 40 hectares and which is constructed by the Appropriate Authority in a canal through which water is delivered into a field channel or directly on to any land". It is obligatory on the part of the farmers to excavate field channels to serve the various fields within the block and in the event they fail to do so, they are excavated on their behalf by the Government and expenditure on account of it is recovered from them. The maintenance of the field channels rests with the farmers. They are at present excavated by the Command Area Development Authority on behalf of the farmers and cost thereof is recovered from them.

It will be seen from the Table that lack of irrigation

supplies due to absence of distribution system like an outlet and field channels has been responsible for underutilisation of the irrigation facilities in case of five farmers. One farmer from village Chudava was denied irrigation water since an outlet was yet to be provided to supply canal water to his field. An enquiry with the concerned Canal Inspector and Section Officer revealed that a new outlet was sanctioned to supply canal water to the fields of the respondent and the fields of other nearby farmers and the work of construction was to start soon. Four farmers, two from village Nandgaon and one each from villages Taroda (Bk.) and Mahagaon reported absence of field channels to deliver water to their fields from the outlet. While the farmers from Nandgaon and Mahagaon had approached the project authorities several times for constructing field channels on their behalf, the farmer from village Taroda (Bk.) did not approach the project authorities for the purpose since he is a shepherd by occupation and mostly remains away from his farm. In the remaining cases, it was reported that, work was not done even after repeated requests. The statements of the farmers were verified, wherever possible, by an enquiry with the concerned Canal Inspector.

Six farmers have reported lack of irrigation supplies due to defective distribution system. Two farmers, one each from villages Gunj and Kasarkheda, said the defective position of the outlet to be responsible for that. The farmer in the village Gunj said that the position of the outlet was not

correct since the level of the outlet was much below the level of the fields to be irrigated from it. The concerned Canal Inspector, when enquired with, confirmed this and intimated that action to change the position of the outlet was being taken. Another farmer from village Kasarkheda also reported that the position of the outlet was defective and hence irrigation water is not available. The farmers whose lands come under the command of the outlet have already constructed field channels. The concerned Canal Inspector agreed with the farmers and informed that the position of the said outlet was changed a couple of years ago but this has not been useful. Four other farmers, one each from villages Somkhed, Kasarkheda, Dhanora and Mahagaon, reported lack of irrigation supplies due to defective construction of field channels. Their difficulty was common and related to the defective alignment of the field channels. While in case of three farmers the co-sharers were not ready to incur double expenditure on reconstruction of the field channels as per the correct alignment, the fourth farmer lacked requisite finance for undertaking realignment of the field channels.

A provision has now been made in the Irrigation Act empowering the Government to construct the field channels if the irrigators fail to do so and to recover the cost from them. But before such a provision was made the responsibility of constructing the field channels rested solely with the individual irrigator. As the irrigators do not have adequate technical knowledge for aligning the field channels, the

Irrigation Department extended technical help in the form of preparing blueprints showing alignments of the field channels in the villages. A copy of such blueprints used to be exhibited at a prominent place, like the village chawadi, from which the irrigators could know the alignment of the field channels and take up the work of excavation by themselves. This work was being executed by the Community and Rural Development Department (C. & R.D.D.) through the Block Development Officers. All technical help such as supply of alignment maps showing therein the alignment of field channels was extended to the Block Development Officer by the Irrigation Department. With the help of the maps the Block Development Officers through their subordinate staff got the work of excavation of field channels executed. The work was often defective because the work requiring technical knowledge and guidance was being executed and supervised by non-technical staff. The situation is now changed and the work of excavation of field channels is being executed by the project authorities under the Bombay Land Improvement Scheme Act, 1942, as amended from time to time and the charges thereof are recovered from the irrigators. But the old works seem not to have been corrected. A programme of re-designing and re-fashioning of the old field channels and outlets is required to be undertaken.

Eight farmers reported inadequate supply of water due to defective and ill-maintained distribution system. Two farmers from village Sawangi (Bk.) said that the water supply

was inadequate due to faulty canal construction. The level of the minor canal through which they get irrigation supplies is below the field level. The farmers have to construct a temporary cross bund across the canal to get the supplies but the flow is uncertain because of breaching of the bund by other influential farmers. Spot observation of the canal revealed that the statement of the farmers was true. The sub-minor canal which supplies irrigation water to two sample farmers in village Pimpalgaon is thoroughly silted and infested with weeds—what they locally call 'Pangawath'—thereby reducing the capacity of the canal and obstructing the flow. This was also verified by spot observation. The case of one farmer from village Wadhona was similar. The farmer reported that the field channels carrying water to the fields are silted and infested with thick weeds which has reduced their capacity. Other farmers sharing water from them do not come forward to clear and maintain them. Canal water was inaccessible to the field of our respondent in the village Pandhari due to the inadequate capacity of the outlet provided. The concerned Canal Inspector said that the work of remodelling the outlet was sanctioned. Two farmers, one each from villages Chudava and Gunj, were relectant to avail irrigation supplies due to the capricious nature of the canal water on account of the inadequate capacity of the sub-minor canal. The inadequate capacity has accentuated due to silting and weed growth. Mani[1]

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1 V.S. Mani. Research on Aquatic Weeds in India. Symposium on Soil and Water Management, op.cit., p. 278.

(1972) reports that the aquatic weeds in the Chambal Canals, Rajasthan, have been causing great damage. The canals are not functioning satisfactorily on account of rank growth of the submerged weeds. The discharge in the canal is far below than the one for which it was designed when the project was prepared and the reduced discharge has considerably affected the utilisation of the irrigation potential envisaged by the Chambal project.

In the present system of irrigation the State is responsible to supply the requisite quantity of water at the outlet head of the distribution system beyond which point the irrigators have to construct and maintain field channels. It is experienced that these field channels are sometimes blocked or breached by the irrigators thus preventing the flow to adjoining lands. This happens in many cases due to ill-will and family quarrels among them. Lack of water supply due to disputes over field channels caused underutilisation of the irrigation facilities in the case of four farmers. In the case of two farmers, one each from villages Pandhari and Palasgaon, irrigation water is not allowed to flow through the field channels due to disputes over the right of the land among the coparceners pending the decision of the court. Disputes over the field channels among the joint owners in the case of two farmers happened to be the cause for not allowing water to pass through the field channels to the fields of the respondents at lower reaches. The irrigators at upper reaches are

more influential and powerful and, therefore, the respondents thought it wise to cultivate the land without water than to enter into arguments with them. The aggrieved farmers had brought this to the notice of the irrigation staff. But, it was learnt, no action was taken.

It is not uncommon to come across such difficulties in the villages where the irrigators with influence and political support wield pressure on the irrigators at lower reaches as well as on the irrigation staff. The weaker farmers prefer to keep away from them rather than to enter into conflict with them.

Impeded drainage and waterlogged conditions are created in irrigation commands mainly due to interception of natural drainage lines by the embankments, canals, roads, railways, etc., seepage from irrigation system, delay in disposal of accumulated surface water, non-maintenance of natural drainage lines in the command, over irrigation and misuse of water. Studies[2] undertaken to see the behaviour of sub-soil water level as a result of the introduction of canal irrigation in a tract have shown that the level of groundwater invariably rose in all tracts after introduction of canal irrigation. Wilsdon and Sarathy[3] found from the examination of statistical

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2 Quoted by Jagir Singh and Rattan Singh in "Waterlogging in Punjab—Its Causes and Remedies," Symposium on Waterlogging—Causes and Measures for Its Prevention, Vol. II, 1972, p. 34. (Central Board of Irrigation and Power Publication No. 118.)

3 Ibid., p. 33.

data that one-third of the annual rise of water-table may be attributed to the leakage from the main canals and branches. Sally[4] attributes canal irrigation as the main cause for waterlogging.

An agricultural land is said to be waterlogged when the sub-soil water-table rises to an extent that the soil pores in the root-zone of a crop become saturated resulting in restriction of the normal circulation of air, decline in the level of oxygen and increase in the level of carbon dioxide. These conditions affect the growth and yield of a crop. In course of time such land turns saline and alkaline and ultimately becomes unfit for cultivation. While according to a Special Committee[5] of the Central Board of Irrigation the actual depth of water-table, when it starts affecting the yield of crop adversely, may vary over a wide range from zero for rice to about 1.5 metres for other crops, Uppal[6] maintains that a suitable water-table of 3.7 to 4.5 metres from the natural surface should be maintained. Anjaneyulu[7] views that

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4 H.L. Sally. Irrigation Planning for Intensive Cultivation. Bombay : Asia Publishing House, 1968, p. 124.

5 Quoted by the National Commission on Agriculture, Part V, 1976, op.cit., p. 180.

6 H.L. Uppal. "Serious Waterlogging in Punjab and Haryana—How Cured and Measures to Prevent Its Recurrence," Symposium on Waterlogging—Causes and Measures for Its Prevention, Vol. II, op.cit., p. 26.

7 B.S.R. Anjaneyulu. "Drainage Improvement for Reclamation and Preventing Waterlogging in Some Soils of Rajasthan Canal Area," Symposium on Waterlogging—Causes and Measures for Its Prevention, Vol. II, op.cit., p. 44.

water-table depths less than 3 metres (10 feet) are considered undesirable, specially when the groundwater is saline. Zende[8] holds that the harmful effects of the rise in water-table become noticeable when the sub-soil water level comes upto within 3 metres (10 feet) from the ground surface and damage to lands due to salt-efflorescence becomes apparent as the sub-soil water-table rises within 1.2 metres (4 feet) from the ground level. While defining waterlogging as a situation where water-table is so near the ground level that the pores are saturated, suffocating the roots of the vegetation, Pandya[9] classifies the waterlogged lands as given in the following:

Depth of water-table below ground level	Remarks
0 to 1.5 metres (0-5 feet)	Fully damaged
1.5 to 3 metres (5-10 feet)	Damaged
3 to 4.5 metres (10-15 feet)	Protected
More than 4.5 metres (15 feet)	Safe

Six farmers advanced waterlogged lands as a reason for not availing irrigation supplies. All the six farmers

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8 G.K. Zende. "Some Observations on the Performance of Crops Under Waterlogged Conditions, Periodical Fluctuations in Water-table and Efficacy of Cropping Patterns," Symposium on Waterlogging--Causes and Measures for Its Prevention, Vol. I, p. 152.

9 G.S. Pandya. "Waterlogging Causes and Measures for Its Prevention in Chambal Command of Madhya Pradesh," Symposium on Waterlogging--Causes and Measures for Its Prevention, Vol. II, op.cit., p. 53.

reported that the sub-soil water level in their fields has risen to very unsafe limits. While three of them reported a high water-table of 2-3 feet below the ground level, three others reported that the sub-soil water level in their lands was almost below the surface of the soil, that is 4 to 6 inches below the ground level. The case of village Ajalsonda is typical. The village is surrounded by canals from three sides viz. by Purna main canal on western side, Ajalsonda distributary on eastern side and Hatta branch canal on northern side. The village is in low lying areas. The soils are mostly deep, ill-drained with low permeability, prone to be exposed to the danger of waterlogging. Water percolating from these canals has damaged lands of the village to a high extent and there is always 1 to 2 feet of water standing in some lands which are fully infested with weeds. Many enlightened farmers of the village feared that their all culturable land would be rendered infertile due to the growing menace of waterlogging unless emergent steps are taken to arrest it. Three respondents from this village reported underutilisation of irrigation due to waterlogged lands. The case of two of them was acute because the lands have become almost barren due to high salinity and alkalinity. Spot observations revealed that salt incrustation was visible throughout the field prominently along field channels due to salt-efflorescence. Water level in an open well in the field was almost to the ground level and by mere piercing fingers in the soil one could strike water indicating that the sub-soil water level was within inches from the ground

level. The other farmer in the village also reported a high sub-soil water-table in his field rendering land unfit for irrigated agriculture. Water percolating from the Lasina branch canal has damaged land of one respondent from village Ranjana. The canal passes from just adjacent to the land and heavy seepage from the canal has damaged the low lying land. When the author visited the fields it was observed that the sub-soil water level was within 2 to 2.5 feet from the ground level which was evident from the water level in an open well. Another site which the author could visit was in Mahatargaon. Patches where water stagnated were clearly visible in the fields of the respondent. The water-table was within one to two feet from the ground level. This was evident from the level of water in the open well in the adjacent field. One respondent from village Nandgaon also reported waterlogged lands. Two respondents from village Ajalsonda have constructed field drains to drain out excess water. The field drains have not, however, been constructed properly as per the correct alignment, grade and depth. They said that they have excavated these field drains without any technical guidance. Another farmer from village Nandgaon has also constructed field drainage channels, but they were also of little use. The consensus of the farmers was that urgent steps are required to prevent further damage of lands due to waterlogging and expressed their desire to undertake reclamatory measures if the required technical guidance is forthcoming.

The behaviour of groundwater levels after the introduction of canal irrigation in a region has to be studied. The depth of the sub-soil water-table has to be observed in selected open wells distributed well in the command of the project. The observations are generally taken twice in a year, once in June and second time in October. This no doubt gives relative water levels in those months, but the objective to know the variations in the water levels from year to year would not be fulfilled in that case. It is the difference between two water levels in the month of June in two consecutive years that will give an idea of the variations in the water levels. It was learnt during a discussion with a leading educated farmer from village Kawatha that such observations were taken in the command of the Purna project by Mr N.D. Gulhati, Consultant, Water Resources Development, and that the observations were indicative of an alarming rise in the water-table in the command.

8.2.3 Maldistribution of the Available Water and Tail-end Difficulties

It can be seen from the Table that eleven farmers have advanced inadequate water supply due to maldistribution of the water and tail-end difficulties as a reason for not applying for the canal water. Efficient management of the canal water requires enforcement of the provisions made under the Irrigation Act and the Rules thereunder in order to ensure equitable distribution of the irrigation supplies. This is conducive for promoting irrigation development in the command area.

Sufficient provisions have been made in the Act to protect the tail-end farmers from exploitation at the hands of the farmers at upper reaches, so also to proceed against the farmers in case of unauthorised irrigation, out of turn irrigation, waste of water, etc., with a penal action. But these would not be of any use if they are not enforced scrupulously and the purpose for which they are made would be defeated.

A brief account of condition of management of the canal which the author could gather during the survey is given here. The author found that a picture of indiscipline and total neglect of the canal management persisted in the command. The provisions made under the Act were hardly enforced. It was learnt that the panchanamas in case of pani nash, out of turn irrigation, etc., were seldom held. The practice of taking irrigation supplies during night was uncommon. The irrigators were careless about closing the field channels after their irrigation is over thereby letting the water run to waste flooding the nearby fields, roads, cart-tracks or nallas. The author could see on many occasions water flowing out by the side of roads and forming ponds and ditches. Penal charges three times the normal water rates are provided in the Act which are hardly in practice levied. A nominal penalty of Re.1 is assessed from the defaulters. The Canal Inspector is expected to be present while delivering the irrigation supplies for equitable distribution and the irrigator has to get the dated signature of the Canal Inspector on the pass before he

actually avails the supplies. This practice was hardly heard to be followed and was also evident when the author had an occasion to see some of the passes. Instances of political interference and influence of big farmers and leaders in the villages were narrated.

Two farmers from village Pandhri encountered tail-end difficulties since the farmers at upper reaches took two to three waterings in one rotation allowing almost starvation dose of irrigation to the fields at lower reaches. Three farmers from village Bhanpur narrated that the quantity of water available for supply always falls short of the requirement because the farmers in the village Pawadewadi, a village at upper reaches of the minor canal through which the farmers in the village Bhanpur get irrigation supplies, do not allow water to pass in adequate quantity by resorting to out of turn irrigation and unauthorised irrigation. The concerned Canal Inspector as well as the Deputy Engineer on an enquiry confirmed the story of the farmers and expressed their inability to deal with the situation due to political interference. Two farmers, one each from villages Sonkhed and Chudava, were reluctant to avail the irrigation supplies on account of the uncertainty in getting adequate canal water at right time due to the farmers at upper reaches who took more than one waterings in one rotation. They being big and influential farmers, the aggrieved farmers avoided conflict with them. They said that often there are long gaps between two irrigations and whatever supply

they get is inadequate. The story of three farmers from village Degaon is similar. They get irrigation supplies from the Degaon Minor Canal which also supplies water to the irrigators in village Kasarkheda situated at upper reaches of the canal. The village Kasarkheda is well known for its notoriety among the irrigation staff and the staff avoid to confront with the irrigators of this village for there have been instances of assault on them in the past. The farmers in the village Degaon reported that the farmers in the other village misused water, over-irrigating their fields, taking out of turn irrigation for as many times as they wished. The result is that Degaon does not get its due share of water. The farmers maintained that a separate minor canal would solve their problem. Another farmer from village Palasgaon also faced tail-end difficulties.

8.2.4 Lack of Credit and Inputs and Infrastructure

Good irrigated agriculture is not possible without an adequate supply of inputs like better and improved seeds, fertilizers and pesticides. It becomes obvious that the farmers should have adequate finance to incur expenditure on these items. While a few of them can afford to meet such expenses from their own resources a majority of them need financial assistance.

Thirty-one farmers reported lack of credit and inputs for not availing irrigation supplies. The farmers reported that fresh loans were not sanctioned to them due to default.

An enquiry with the secretaries of the Cooperative Credit Societies revealed that no fresh loans were sanctioned to the defaulters. The names of the defaulters were referred to the secretaries of the societies for confirmation wherever possible.

Irrigated agriculture is market oriented. It creates large surpluses for sale. The initiative of the farmers would be lost if the farmers do not receive fair price for their produce. The markets should be located within easy distance of villages. The roads and transport system should permit vehicular traffic all the year round and each village in the command should have reasonable access to motorable road. The marketing centres should have adequate storage accommodation and arrangements to enable the farmers to obtain advances on stored produce. Development of agro-industries in the command area is equally important.

Two respondents advanced lack of infrastructure as a reason for underutilisation of the irrigation facilities. They reported that due to lack of proper roads transportation of inputs is very difficult so also they felt that they would get an incentive if a sugar factory and other processing units are started in the command area.

It was reported that approach roads were absent in most of the villages and those which existed were in bad condition. It was understood that excepting a few ginning and pressing factories and a couple of khandasari factories there was no

other type of processing factories in the command area. In the absence of transport facilities and an assured market Banana was sold to the local traders called Bagwans who due to monopoly over its purchase could dictate their price.

8.2.5 Inadequate Preparation of Land, Inadequate Manpower and Inadequate Draught Power

Apart from the construction of field channels, field drains where necessary, land forming is an important prerequisite for a change over from unirrigated to irrigated agriculture. The technique of land forming would vary from place to place depending on the configuration of the land and the thickness and nature of the soil. The purpose of the land forming is the creation of optimum environment for equalising moisture distribution in the seed bed and root zone for uniform plant growth. This may be accomplished by land levelling.

Eighteen farmers advanced unlevelled land to be the reason for underutilisation of the irrigation facilities. The extent of unlevelled land and the causes for that have been dealt separately in Chapter VI and hence are not dealt here to avoid repetition.

Irrigated agriculture requires better land preparation and timely farm operations. In the case of multiple cropping these operations are to be repeated after every cropping season. This necessitates alertness and promptness on the part of the farmer and also his personal supervision.

Three respondents in our study advanced lack of

adequate manpower as the reason for underutilisation of the canal irrigation water. Two of them were widows who availed irrigation supplies only to that extent which they could manage themselves properly. One of the two works as a wage farm labour. The third respondent from village Gunj reported that he was unable to look after the farm business as he was mostly ill. The responsibility of looking after the farm solely rested with his wife who could not venture to avail irrigation supplies fully.

Better soil preparation is prerequisite for irrigated agriculture. In multiple cropping the intervening period between two successive crops for soil and land preparation is short. Hence there is a need for adequate draught power or tractors or other machines. Lack of bullock power happened to be the cause of underutilisation of the irrigation supplies in case of one respondent. The farmer used to hire a bullock pair as and when it was required. He was unable to purchase a bullock pair due to lack of finance. He could not get finance from the cooperative society as he was a defaulter.

8.2.6 Traditional Outlook of the Farmers

Successful irrigated agriculture requires that the farmers in the command of a project are prepared for the change over from the traditional unirrigated agriculture to the new technology of irrigated agriculture. The farmers in the command do not come forward readily to take up to the new technology as they are not acquainted with the new technology.

Sixteen farmers were reluctant to avail irrigation supplies on account of their traditional outlook. The predominance of Jowar in the cropping pattern is quite obvious from the percentage it occupies in the cropping pattern. The farmers reported they preferred the local varieties of Jowar to the improved hybrid Jowar because of consumer preference. Moreover, these local varieties provided the fodder required for their cattle which they do not get from the high yielding hybrid varieties in the quantity which they can get from the local ones. The local varieties are cultivated under unirrigated conditions.

A brief account of what the author could gather during the course of the survey would also be helpful to understand the attitude of the farmers towards irrigated agriculture. It was reported by many Canal Inspectors and Section Officers that they have to pursue and persuade the farmers to tender their application forms for getting irrigation supplies. For this, the Canal Inspectors have to go to the farmers again and again, give them blank application forms and get them filled. Sometimes they have to go to the farmers again to collect them. The last date for receiving the application forms, therefore, is to be enhanced oftenly. The author could witness several occasions when the farmers were being pursued by the Canal Inspectors to tender their application forms for getting irrigation supplies. The initiative to get the irrigation supplies all the way starts from the management end rather than from

the farmers' end. This picture looks rather unrealistic when we think of the picture that prevails in the field of irrigated agriculture in Western Maharashtra. But it would be unfair to compare the picture in this regard prevalent in both the regions since irrigation in Western Maharashtra is quite old and well established. The socio-economic and political conditions prevalent in these two regions also differed to a large extent.

The farmers seem not to have shed their conviction to old, conservative farming practices and evince as much interest in the use of canal irrigation water as was expected of them. Dedicated as they are to unirrigated farming methods, they are required to be properly educated and guided. In cases, when the agriculturists stick to the old conventional pattern of crop, not because it is more suited for their economy, but due to the inertia of tradition, attempts to take over to a different cropping pattern, economically more profitable to them, is likely to fare better.[10]

8.2.7 No Reason Given

Seven farmers could not advance any specific reason for underutilisation of the irrigation facilities.

8.3 Remedial Measures

Urgent steps are required to be undertaken to accelerate

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10 R. Ghosh. Utilisation of Potential in Command Areas of Irrigation Projects, Role of Irrigation in the Development of India's Agriculture, op.cit., p. 76.

the utilisation of the irrigation facilities created at enormous public money which remains locked up due to a lag in the utilisation.

The difficulty in respect of absence of field channels and outlets can be removed by means of expediting the work of undertaking construction of field channels on behalf of the irrigators for which a provision is made in the Irrigation Act. New outlets are to be provided wherever they are lacking. The defects in the existing distribution system of outlets, field channels, etc., can be rectified by changing the positions of the outlets suitably and undertaking realignment of field channels. The expenditure on account of this may be borne by the Government partly or fully. Irrigation supplies in adequate quantity can be assured by remodelling the canals wherever possible and by resorting to desilting and clearing the aquatic weeds. Maintaining the canal banks by earthing up, proceeding with penal action against those who tamper with canal gates and locks, using chemicals to kill the weeds in the canals, lining of canals upto minors with appropriate lining material are some of the ways to assure adequate supply. The irrigators are required to be educated to take the irrigation supplies as per their turn. Provisions made in the Act should be scrupulously made use of in order to protect the tail-enders and to stop waste of water. The possibility of volumetric supply of irrigation water and the adoption of warabandi system of water distribution as adopted in Punjab

should be examined in this context. The Water Panchayat Committees should be strengthened to deal effectively with the various complaints of the irrigators. Distribution of irrigation supplies through water cooperatives* can be visualised to be an effective tool in the management of the canal waters.

Last but not the least important is the need to guide and educate the farmers in proper and wise use of the canal water. Rules and regulations can hardly make up for forbearance and understanding among the users of irrigation supplies. Such farmers make the task of internal field distribution of canal water a difficult problem indeed. A sizable contingent management staff has, therefore, to be maintained. The Irrigation Panchayats and Irrigation Department are required to inculcate a sense of responsibility among the irrigators so that canal offences are minimised. The irrigators should feel that the entire canal system is for their benefit alone and offences like breaching the canals or tampering with outlets harms them more than anybody else. Two types of approaches thus seem to be available for managing efficiently and counteracting the defaulters viz. financial penalties and educational persuasion.

Irrigated agriculture must be regarded as a highly

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* Working of such cooperatives has been spelt out by Asopa and Tripathi in their study Irrigation Agriculture in Gujarat: Problems and Prospects, op.cit., pp. 98-106.

specialised industry. This industry is, however, owned and managed by a very large number of farmers with inadequate technical knowledge and finance. A well laid out programme of educating the farmers in respect of different cultural and agronomic practices, use of improved seeds, methods of application of irrigation water, use of improved implements and appliances, etc., would go a long way in accelerating the utilisation of the irrigation facilities. The financial requirements of the farmers should be met by the rural co-operative credit societies. The main hindrance in obtaining a fresh loan from the cooperative society was default. It is required to take urgent steps to make the cooperatives again viable to advance the required finance to the farmers. For the development of irrigation in the command area of the project there should be in fact an integration of credit and services. In this connection plans to establish Farmers' Service Societies (FSS) enunciated by the National Commission on Agriculture in their report on 'Credit and Services' should be visualised.

Development of infrastructure facilities like roads, transport and communication, markets, storage and warehouses, establishment of processing and agro-based industries is equally important.

According to an unofficial source it was learnt that an area of about 6937 hectares has been damaged due to water-logging in the command of the project. Reclamation of damaged

land and steps to prevent further damage seem to be of vital importance to increase the degree of utilisation of the project potential. Anti-waterlogging measures in the affected tracts are essential. These include provision of field drainage system, conjunctive use of surface and groundwater, lining of canals. Drainage is like the kidney in a human body. It prevents waterlogging and salinity development and keeps the soil warm enough for good plant growth. To be effective the drainage system should extend to field drainage channels. In this connection it would be proper that the responsibility for construction and maintenance of field drains would correspond to that for field channels. The construction and maintenance of field drains may be left to the farmers who should be provided with guidance in the matter of alignment and design of drains. Farmers in the command area should be encouraged to dig wells and sink tube wells in order to make conjunctive use of surface and groundwater. This would help depress the groundwater table. Lining of channels assumes special significance in areas which are waterlogged or are prone to waterlogging. It is, therefore, required that this aspect should receive careful consideration. Besides reducing the percolation and seepage losses in channels, lining confers several other benefits. Unlined channels have to be designed with wide beds and flat slopes in order to make them stable. In a lined channel much higher velocities are permissible and a much deeper and narrower section is adopted. This results

in saving on land cost and earth work. Lining of channels has a good employment potential as well spread over a large rural area. There would be yet another way to take precautionary measures against waterlogging. This could be achieved by means of terminating the present practice of supplying the canal water in every rotation and resorting to supplying canal water in alternate rotation and supplying well water in between two canal rotations. This is called the alternate rotation system.* Besides conferring several other benefits this system would help depress the underground water-table and prevent waterlogging because in this system the water percolated in the ground in one rotation is lifted in the next rotation. This would help maintain the underground water-table at a safe distance.

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* This has been spelt out by Prof. V.M. Dandekar in an unpublished note "Pani Vatapachya Badalatya Paristhitit Maharashtrachya Samatol Vikasas (Gramin) Upayukta Pani Vatap Paddhati" (Marathi).

CHAPTER IX

ECONOMIC CONSEQUENCES OF UNDERUTILISATION

Steeply rising construction costs and rapid deterioration of working results of the irrigation projects have become important elements in planning infrastructure for the development of scientific agriculture in the country. The two sources of concern compelled the Sixth Finance Commission (1973) to observe, "the era of Planning which has witnessed a phenomenal increase in investment in irrigation projects has, however, been unfortunately marked by sharp and progressive deterioration in the working results of irrigation projects".[1] Whether one looked at the aggregate picture or at the individual irrigation projects there is an area of concern. The Finance Commission, while pointing out that the investment in irrigation projects rank only next to schemes for generation and transmission of power in terms of capital investment, estimated that the investment in major and medium irrigation projects would be of the order of Rs. 3,500 crores at the end of 1973-74 amounting to 16 per cent of the aggregate outlays of the State Plans.[2] The Irrigation Commission (1972) noted that since Independence there has been a progressive deterior-

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1 Report of the Sixth Finance Commission, op.cit., p. 58.

2 Ibid., p. 58.

ation in the Financial return from irrigation works and instead of a profit, the works have been showing increasing losses and imposing a burden on the general revenues of the States.[3] In Table 9.1 we give financial returns from public irrigation projects in the country over the Plan periods.

The Table strikingly brings out the steep rise in capital outlay and working expenses as also losses over the Plan periods. The losses which were of the order of Rs.48.40 million in 1955-56 increased to Rs. 144.80 million in 1960-61 and further to Rs. 536.00 million in 1965-66 and Rs. 569.10 million in 1966-67. The losses were about Rs. 566 million in 1967-68. While the area irrigated barely increased from 7.55 million hectares in 1955-56 to 14.40 million hectares in 1967-68, the losses increased nearly eleven times from Rs.48.40 million in 1955-56 to Rs. 566 million in 1967-68. The gross receipts slightly more than doubled from Rs. 161 million to Rs. 370 million during this period. But the working expenses registered a three-fold increase from Rs. 106 million in 1955-56 to Rs.330 million in 1967-68. Similarly, the interest which was Rs.103 million in 1955-56 shot up to Rs.607 million in 1967-68.

An analysis of the Statewise financial returns of irrigation projects for the year 1967-68[4] indicate that the gross

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3 Report of the Irrigation Commission, Vol. I, 1972, op.cit., p. 261.

4 Ibid., p. 263.

Table 9.1 : Financial Return of Public Irrigation Works

(Area in million hectares)
(Amount in million rupees)

Sr. No.	Particulars	End of First Plan 1955-56	End of Second Plan 1960-61	End of Third Plan 1965-66	1966-67	1967-68
1.	Area irrigated	7.55	9.33	12.72	12.87	14.40
2.	Capital outlay	3,932.00	6,643.60	13,759.70	14,388.80	15,181.40
3.	Accumulated interest	814.80	1,539.70	3,833.70	4,111.50	4,555.30
4.	Accumulated revenue	1,348.60	1,502.50	1,859.60	1,734.80	1,947.70
5.	Sum-at-charge	4,746.80	8,183.30	17,593.40	18,500.30	19,736.70
6.	Gross Receipts	160.90	223.50	348.50	319.40	370.40
7.	Working Expenses	105.90	161.70	295.80	310.80	329.80
8.	Revenue	55.00	61.80	52.70	8.60	40.60
9.	Interest	103.40	206.60	588.60	577.70	606.50
10.	Profit/Loss	(-)48.40	(-)144.80	(-)536.00	(-)569.10	(-)565.90

Source: Report of the Irrigation Commission, Vol. I, 1972, op.cit., p. 262.

revenue in seven States viz./Karnataka, Gujarat, Orissa, Jammu and Kashmir, Uttar Pradesh, Kerala and West Bengal, was not even sufficient to cover working expenses. In all the States, excepting Punjab and Madhya Pradesh, irrigation projects made a net loss ranging from Rs. 20 lakhs in Haryana to Rs. 1,037 lakhs in Uttar

Pradesh. The multipurpose projects covering more than one State also incurred heavy losses estimated at Rs.1,384 lakhs.

There has not been much improvement in the situation since 1967-68. The Finance Commission (1973) pointed out that as against the marginal loss of Rs. 58 lakhs in 1950-51, the State Governments sustained a loss of nearly Rs. 150 crores from major and medium projects in 1971-72. Excepting Andhra Pradesh, Haryana and Punjab no other State was able to cover even the working expenses. The Commission estimated that taking all the States together, the aggregate loss on irrigation projects including interest as projected during the Fifth Plan period would be well over Rs. 1,000 crores.[5]

The reasons for these mounting losses have been identified clearly. Analysing the contributory factors the Irrigation Commission observed, "Several factors have contributed to the deteriorating financial returns from irrigation works. Their construction costs have greatly increased as more and more expensive storage works with large dams had to be undertaken. Rising prices have also pushed up the cost of construction, maintenance and operation. Added to these have been the rising interest liabilities on investments not yet fully productive because of the lag in the utilisation of the potential created by new projects. All these required that the

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5 Report of the Finance Commission, 1973, op.cit., p. 58.

water rates should be raised to cover rising costs."[6] The Andhra Pradesh Irrigation Commission[7] maintained that this alarming state of affairs (net loss of irrigation works) was attributable to several factors, the more important among them being the tremendous increase in investment in the Plan periods, the time lag between the incurring of expenditure and the creation of potential, tardy progress of utilisation of the created potential due to bottlenecks in regard to ayacut development, the mounting costs of construction of the more complicated projects, the rising costs, inflationary pressures, increasing maintenance and operating expenses and the failure of the State Government to raise water rates to appropriate levels.

In this chapter, we shall examine the case of Purna project from this point of view.

9.1 Financial Returns of the Purna Project

The financial returns of Purna project are examined in this paragraph in order to find out its profitability. The analysis covers the period of eight years from 1968-69 to 1975-76. The data required for this purpose were collected from the Irrigation Administration Report of the Irrigation

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6 Report of the Irrigation Commission, Vol. I, 1972, op.cit., p. 264.

7 Quoted by V.K. Srinivasan in "Return from Investment: An Area of Increasing Concern," Role of Irrigation in the Development of India's Agriculture, op.cit., p. 106.

and Power Department of Maharashtra for the year 1968-69 and records of the Irrigation Department for the remaining years since the Annual Administration Reports for these years have not yet been published. In Table 9.2 we give financial returns of the project for the period specified above.

Originally the project was administratively approved for Rs. 5.55 crores. The project estimates were subsequently revised to Rs. 13.05 crores. The capital outlay including the direct and indirect charges at the end of the year 1967-68 amounted to Rs. 15.26 crores. Accumulated arrears of interest during that year were Rs. 3.74 crores. Thus the total capital investment (sum-at-charge) in the project at the end of 1967-68 stood at Rs. 19.00 crores.

The capital outlay since then has progressively increased every year and stands at Rs. 17.09 crores at the end of 1975-76. This includes direct capital expenditure on account of works comprising head works, main canals and branches, distributaries, drainage and protective works, water courses, etc., establishment, tools and plants and leave and pension charges and indirect charges due to capital account. The total capital invested in the project has also progressively increased from Rs. 20.06 crores at the end of 1968-69 to Rs. 29.60 crores at the end of 1975-76 on account of mounting arrears of interest since the project has not been able to yield a surplus revenue to clear off the interest on capital investment from year to year. The accumulated arrears of

Table 9.2 : Investment and Financial Returns of Purna Irrigation Project

(Area in hectares)
(Amount in Rupees)

Sr. No.	Particulars	Years							
		1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
1.	Area irrigated	11,466	9,921	13,268	25,628	23,815	20,251	22,720	50,355
2.	Capital outlay	15,47,84,354	15,70,22,000	16,03,63,000	16,29,16,000	16,54,78,000	16,73,44,000	16,99,91,000	17,08,55,000
3.	Accumulated arrears of interest	4,58,32,676	5,56,22,069	6,63,61,453	7,69,66,499	8,82,83,983	9,90,90,626	11,14,09,470	12,51,05,629
4.	Sum-at-charge (2+3)	20,06,17,030	21,26,44,069	22,67,24,453	23,98,82,499	25,37,61,983	26,64,34,626	28,14,00,470	29,59,60,629
5.	Revenue receipts	23,685	39,000	41,000	53,000	22,000	5,91,000	38,000	3,09,000
6.	Working expenses	6,31,613	23,66,000	26,94,294	25,86,555	30,03,035	39,04,610	44,88,368	45,11,676
7.	Net Revenue (5-6)	(-) 6,07,928	(-) 23,27,000	(-) 26,53,294	(-) 25,33,555	(-) 29,81,035	(-) 33,13,610	(-) 44,50,368	(-) 42,02,676
8.	Interest	78,60,229	79,96,000	81,69,000	83,51,000	85,09,000	86,45,000	87,87,000	89,00,000
9.	Profit/Loss (7-8)	(-) 84,68,157	(-) 1,03,23,000	(-) 1,08,22,294	(-) 1,08,84,555	(-) 1,14,90,035	(-) 1,19,58,610	(-) 1,32,37,368	(-) 1,31,02,676
10.	Percentage of net revenue to capital outlay	(-) 0.39	(-) 1.48	(-) 1.65	(-) 1.56	(-) 1.80	(-) 1.98	(-) 2.62	(-) 2.46
11.	Percentage of net revenue to Sum-at-charge	(-) 0.30	(-) 1.09	(-) 1.17	(-) 1.06	(-) 1.17	(-) 1.24	(-) 1.58	(-) 1.42

Source: 1. Irrigation Administration Report 1968-69, Part II. Irrigation and Power Department, Government of Maharashtra, Sachivalaya, Bombay.

2. Records of the Statistician, Irrigation Department, Government of Maharashtra, Sachivalaya, Bombay.

interest have increased from Rs. 4.58 crores in 1968-69 to Rs. 12.51 crores in 1975-76. There has thus been nearly three-fold increase in the accumulated interest charges which account for 42.3 per cent of the total capital invested in the project at the end of 1975-76.

In addition to the construction cost, the State has to incur operation and maintenance cost of irrigation works. Thus the total annual cost (financial) of an irrigation project is equal to the annual interest charges on the capital invested plus the working expenses incurred during the year. The working expenses are divided into direct and indirect in the administrative accounts of the State. Direct charges include extension and improvements, maintenance and repairs, compensation, establishment, tools and plants and share of collection charges. Indirect charges consist of capitalised abatement of land revenue, leave and pension allowances and audit and accounts establishment. It is evident from the Table that the working expenses have increased at a faster rate than the revenue receipts. From Rs. 6.32 lakhs in 1968-69 they shot up to Rs. 23.66 lakhs in the next year. The working expenses since then have continuously increased from Rs. 6.32 lakhs in 1968-69 to Rs. 45.12 lakhs in 1975-76. The revenue receipts, on the other hand, have lagged behind very badly. Excepting in years 1973-74 and 1975-76 they have remained under Rs. 1 lakh in all the years. The revenue receipts include direct receipts on account of irrigation charges, sale of water, water

supply to towns, other canal products, rent of buildings, etc., and indirect receipts on account of land revenue due to irrigation works and irrigation cess. When the working expenses are deducted from the revenue receipts the balance represents net revenue earned by a project during the year concerned. The annual interest constitutes another charge on a project. If the net revenue exceeds the interest charges during the year the project meets all the annual costs and earns a profit. But if the net revenue falls short of the interest charges, the project incurs a loss and thus there is an addition to the burden of interest charges outstanding against the project. Table 9.2 shows that in none of the years the revenue receipts met the working expenses. Taking into account interest during the year the project has thus incurred heavy losses every year. The losses which were of the order of Rs. 84.68 lakhs in 1968-69 increased to Rs. 114.90 lakhs in a period of five years. The losses at the end of 1975-76 amount to Rs. 131.03 lakhs. Incidentally, we may note that while the area irrigated increased barely five-fold from 11,466 hectares in 1968-69 to 50,355 hectares in 1975-76, the working expenses have increased more than seven times during this period.

Table 9.3 shows the percentage of working expenses to revenue receipts during each year under reference. Percentage of working expenses to revenue receipts obtained under some major irrigation projects in Western Maharashtra like Mula, Girna and Ghod are also given in the Table in order to have a

Table 9.3 : Percentage of Working Expenses to Revenue Receipts

Years	Irrigation Projects			
	Purna	Mula	Ghod	Girna
1968-69	2,666.72	N.A.	N.A.	N.A.
1969-70	6,066.51	N.A.	105.69	126.67
1970-71	6,571.45	N.A.	223.94	520.17
1971-72	4,880.29	140.51	43.47	133.77
1972-73	13,650.16	183.47	146.88	194.06
1973-74	660.68	162.94	50.45	82.08
1974-75	11,811.49	114.82	80.97	75.34
1975-76	1,460.09	108.05	58.24	62.44

Note: N.A. = Not Available.

Source: 1. Figures pertaining to the Purna project have been estimated from Table 9.2.

2. For rest of the projects records of the Irrigation Department.

comparative picture in this respect. There is only one other major irrigation project in the Marathwada region, namely the Jayakwadi project which, however, has started yielding receipts only from the year 1975-76 and hence has not been considered for comparison. From Table 9.3 we find that the percentage of working expenses to revenue receipts obtained under Purna project is as high as 13650 in 1972-73. It is the lowest at 660 in 1973-74 when the revenue receipts from the project were maximum. The figures obtained in this respect under other projects are too low to need any comments. Similar data on revenue receipts and working expenses during the year 1972-73,

the latest year for which the data are available, in respect of Kakrapar, Hathmati and Shetrunji projects in Gujarat show that the percentage of working expenses to revenue receipts for that year has been 475.78, 317.02 and 1201.93 respectively.[8] These figures compare very unfavourably with the figures obtained under the Purna project.

Table 9.4 : Working Expenses Per Hectare of Area Irrigated

(Amount in Rupees)

Years	Irrigation Projects			
	Purna	Mula	Ghod	Girna
1968-69	55.09	N.A.	N.A.	N.A.
1969-70	238.48	N.A.	47.09	20.43
1970-71	203.04	N.A.	43.35	92.07
1971-72	100.93	14.72	36.84	70.61
1972-73	126.10	10.69	41.02	88.11
1973-74	192.81	18.73	63.35	68.83
1974-75	197.55	28.99	135.27	153.89
1975-76	89.60	42.84	53.51	107.18

Note: N.A. = Not Available.

Source: 1. Figures pertaining to the Purna project have been estimated from Table 9.2.

2. For rest of the projects, Records of the Irrigation Department.

In Table 9.4 are given working expenses per hectare of

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8 Estimated from the Irrigation Administration Report, Parts I and II, 1972-73. Public Works Department, Government of Gujarat, Gandhinagar, 1975.

area irrigated during the years under reference. Data on working expenses per hectare of area irrigated under three major projects in Western Maharashtra are also given in the Table for comparison.

It will be seen that the working expenses per hectare of area irrigated are much higher in the case of Purna project excepting the year 1975-76 when they were slightly higher in the case of Girna project. It may be noted that the per hectare working expenses in the case of Purna project have reduced from Rs. 198 in 1974-75 to Rs. 90 in 1975-76 due to a more than double increase in the area irrigated even though there has been an increase in the total working expenses.

A break-up of the working expenses shows that establishment is the most important item of expenditure absorbing about 44 to 64 per cent of the total expenses. The expenditure on establishment is in the nature of a fixed cost which does not vary with the area irrigated and hence would be thinly distributed the more the area irrigated.

The Bombay Irrigation Inquiry Committee (1938)[9] made suggestions for reducing the working expenses under the major canals in the Deccan to 33-1/3 per cent of gross receipts. It appears, therefore, that the working expenses whether per hectare of area irrigated or relatively to gross receipts are exceedingly high under the Purna project.

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9 Report of the Irrigation Inquiry Committee appointed by Government of Bombay. Public Works Department, Government of Bombay, Central Press, 1938, p. 49.

Underutilisation of the created potential results in locking up the capital invested in creating the potential. Water resources projects are highly capital intensive with long gestation periods but they have very large indirect or secondary benefits that cannot be appreciated by private investors. Since resources for investment are limited, it is incumbent upon the State to take steps to accelerate the utilisation of the created potential in order to release the capital invested in a project which would enable it to undertake investment in new projects.

Data on the extent of underutilisation of the potential under the Purna project and the investment which remained unutilised due to it are given in Table 9.5.

Table 9.5 : Extent of Investment Unutilised

(Area in hectares)
(Cost in crores of rupees)

Years	Cost	Irrigation potential created	Actual utilisation	Percentage utilisation	Investment		
					Utilised	Unutilised	Total
1968-69	15.48	61,540	11,466	18.63	2.88	12.60	15.48
1969-70	15.70	61,540	9,921	16.12	2.53	13.17	15.70
1970-71	16.04	61,540	13,268	21.56	3.46	12.58	16.04
1971-72	16.29	61,540	25,628	41.64	6.78	9.51	16.29
1972-73	16.55	61,540	23,815	38.70	6.40	10.15	16.55
1973-74	16.73	61,540	20,251	32.91	5.51	11.22	16.73
1974-75	17.00	61,540	22,720	36.92	6.28	10.72	17.00
1975-76	17.09	61,540	50,355	81.82	13.98	3.11	17.09

It will be seen that every year large sums of investment remained unutilised due to underutilisation of the created potential. In 1975-76 the unutilised investment amounted to Rs. 3.11 crores. With the improvement in the utilisation of the potential the investment which remained unutilised has decreased over the years. In the year 1969-70 when the utilisation was minimum at 16.12 per cent, the investment unutilised amounted to Rs. 13.17 crores and in the year 1975-76 when the utilisation was maximum at 81.82 per cent the investment unutilised amounted to Rs. 3.11 crores.

Table 9.6 : Amount Spent Per Hectare of Irrigation Potential Created and Utilised

Years	Capital outlay (Crores of Rs.)	Irrigation potential created (ha.)	Actual utilisation (ha.)	Percentage utilisation	Amount spent per ha. of potential created (Rs.)	Amount spent per ha. of actual area irrigated (Rs.)
1968-69	15.48	61,540	11,466	18.63	2,515	13,501
1969-70	15.70	61,540	9,921	16.12	2,551	15,825
1970-71	16.04	61,540	13,268	21.56	2,606	12,089
1971-72	16.29	61,540	25,628	41.64	2,647	6,356
1972-73	16.55	61,540	23,815	38.70	2,689	6,949
1973-74	16.73	61,540	20,251	32.91	2,719	8,261
1974-75	17.00	61,540	22,720	36.92	2,762	7,482
1975-76	17.09	61,540	50,355	81.82	2,777	3,394

The gap between the per hectare capital cost incurred for creating certain potential and the per hectare cost of

actual area irrigated would be reduced with an improvement in the degree of utilisation of the potential. Table 9.6 gives data relating to the cost per hectare of irrigation potential created and actual area irrigated under the project. It will be seen that since the potential created was not fully utilised the cost per hectare of actual irrigation in every year was very much higher than the cost per hectare of potential created. When in the year 1975-76 maximum utilisation was attained the per hectare cost of area actually irrigated was the lowest at Rs. 3,394.

9.2 Value of Agricultural Production Forgone due to Underutilisation

The farmers in the command area of a project forgo additional agricultural production which otherwise they could have derived from the full utilisation of the available irrigation facilities. The full economic significance of underutilisation would, therefore, be better appreciated if an estimation of the value of agricultural production forgone could be made. This can be achieved by means of estimating the value of agricultural production from the irrigable land but unirrigated and the value of agricultural production that might have been available if it were irrigated. The difference between the two would yield the value of agricultural production forgone due to underutilisation. The former is estimated by assuming that the irrigable land was put to the cultivation of unirrigated crops in the same proportion as is obtained in the unirrigated cropping pattern of the

sample farms during the year under reference and multiplying the proportionate area under the crop by the average per hectare net returns obtained by the farmers from that crop. The latter, similarly, is estimated by assuming that had there been no underutilisation the irrigable land would have been put to the cultivation of irrigated crops in the same proportion as is obtained in the approved cropping pattern of the project and multiplying the proportionate area under the crop by the average per hectare net returns obtained by the farmers from that crop. The underutilisation was to the extent of 11,185 hectares during the year 1975-76. Tables 9.7 and 9.8 show estimation of the total value of agricultural production from unirrigated and irrigated crops respectively. In estimating the per hectare net returns from Sugarcane and Banana, the farmers which grew the crops on the canal irrigation water were only considered disregarding the farms growing the crops on well irrigation water since the per hectare net returns obtained in respect of these crops grown on well irrigation have been higher and since the number of such farms is quite large. In case of other crops which were cultivated both on canal as well as on well irrigation water such a distinction is not taken into account, number of farms being insignificant.

It will be seen from Table 9.7 that the total value of agricultural production obtained on account of putting the irrigable land to the cultivation of unirrigated crops amount to Rs. 81.02 lakhs. Had there been no underutilisation and

Table 9.7 : Estimation of the Value of Agricultural Production Obtained by Putting the Irrigable Land to the Cultivation of Unirrigated Crops

Sr. No.	Crops	Proportionate area (ha.)	Percentage	Per ha. receipts (Rs.)	Per ha. expenditure (Rs.)	Net Returns (5-6) (Rs.)	Value of the agricultural production (3 x 7) (Rs.)
1	2	3	4	5	6	7	8
1.	Paddy	102.90	0.92	734.21	449.57	284.64	29,289.46
2.	Black gram	44.74	0.40	908.45	432.55	475.90	21,291.77
3.	Green gram	996.58	8.91	1,206.95	434.87	772.08	7,69,439.49
4.	Sorghum	6,800.48	60.80	1,164.77	350.87	813.90	55,34,910.67
5.	Cotton	1,567.02	14.01	1,193.98	616.18	577.80	9,05,424.16
6.	Gram	741.57	6.63	843.95	361.36	482.59	3,57,874.27
7.	Linseed	498.85	4.46	960.22	206.86	753.36	3,75,813.64
8.	Groundnut	147.64	1.32	1,140.86	889.60	251.26	37,096.03
9.	Chickling vetch	38.03	0.34	541.32	409.61	131.71	5,008.93
10.	Pigeon Pea	156.59	1.40	896.94	443.04	453.90	71,076.20
11.	Wheat	63.76	0.57	450.50	515.72	(-) 65.22	(-) 4,158.43
12.	Safflower	6.71	0.06	1,000.00	496.70	503.30	3,377.14
13.	Niger	13.42	0.12	317.07	517.67	(-)200.61	(-) 2,692.19
14.	Sannhemp	6.71	0.06	-	331.50	(-)331.50	(-) 2,224.37
	Total	11,185.00	100.00	-	-	-	81,01,526.77

Table 9.8 : Estimation of the Value of Agricultural Production Obtainable by Putting the Irrigable Land to the Cultivation of Irrigated Crops

Sr. No.	Crops	Proportionate area (ha.)	Percentage	Per ha. receipts (Rs.)	Per ha. expenditure (Rs.)	Net Returns (Rs.)	Value of the agricultural production (3 x 7) (Rs.)
1	2	3	4	5	6	7	8
1.	Perennials	1,177.78	10.53	-	-	-	-
	a) Sugarcane	883.34	7.90	5,601.95	3,247.90	2,354.05	20,79,426.53
	b) Banana	294.44	2.63	13,846.15	4,400.56	9,445.59	27,81,159.52
2.	Other Perennials	551.42	4.93	-	-	2,477.00*	13,65,867.34
3.	Kharif Rice	1,118.50	10.00	1,633.32	1,072.91	560.41	6,26,818.59
4.	Kharif Seasonals (Hy. Jowar)	809.80	7.24	2,024.72	1,171.90	852.82	6,90,613.64
5.	Rabi Seasonals (Wheat)	3,863.30	34.54	2,084.59	1,127.52	957.07	36,97,448.53
6.	Hot Weather Seasonals (Groundnut)	662.15	5.92	1,899.55	1,083.80	815.75	5,40,148.86
7.	L.S. Cotton	2,060.28	18.42	2,551.35	1,934.01	617.34	12,71,893.26
8.	O.T. Seasonals (Turmeric)	735.97	6.58	4,943.45	3,085.41	1,858.04	13,67,461.70
9.	Hybrid crops in H.W. (Hy. Maize)	205.80	1.84	-	-	995.00*	2,04,771.00
	Total	11,185.00	100.00	-	-	-	1,46,25,608.97

Note: * Figures of net returns adopted from Government of Maharashtra. Report of the Fact Finding Committee for Survey of Scarcity Areas, Maharashtra State, Vol. I, 1973, p. 169.

the same irrigable land were put to the cultivation of irrigated crops the total value of agricultural production forthcoming would have been to the tune of Rs. 146.26 lakhs (Table 9.8). The total product which was forgone due to underutilisation thus works out to worth Rs. 65.24 lakhs.

9.3 Loss of Revenue to Government due to Underutilisation

Apart from the society being put to loss of agricultural production due to underutilisation there is another consequence of underutilisation of the available irrigation potential. The Government is also put to loss of additional revenue in the form of water charges that might have been realised had there been no underutilisation. An estimation of the revenue forgone by the Government in the year 1975-76 due to underutilisation is made in Table 9.9 assuming that if there were no underutilisation the irrigable land would have been utilised for the cultivation of irrigated crops in the same proportion as is obtained under the approved cropping pattern of the project.

Table 9.9 shows that the additional revenue forthcoming to the Government on account of water charges had there been no underutilisation comes to about Rs. 24.41 lakhs. This would have helped to a great extent to diminish the gap between the revenue receipts and the working expenses of the project during the year.

Table 9.9 : Estimation of Loss of Revenue to Government due to Underutilisation

Sr. No.	Crops	Proportionate Area (ha.)	Percentage	Water Rates per ha. (Rs.)	Total Water Charges (3 x 5) (Rs.)
1	2	3	4	5	6
1.	Sugarcane and Banana	1,177.78	10.53	750.00	8,83,335.00
2.	Other Perennials	551.42	4.93	500.00	2,75,710.00
3.	Kharif Rice	1,118.50	10.00	50.00	55,925.00
4.	Kharif Seasonals	809.80	7.24	50.00	40,490.00
5.	Rabi Seasonals	3,863.30	34.54	75.00	2,89,747.50
6.	H.W. Seasonals	662.15	5.92	250.00	1,65,537.50
7.	L.S. Cotton	2,060.28	18.42	250.00	5,15,070.00
8.	O.T. Seasonals	735.97	6.58	250.00	1,83,992.50
9.	Hybrid Crops in H.W.	205.80	1.84	150.00	30,870.00
	Total	11,185.00	100.00	-	24,40,677.50

9.4 Loss of Employment Opportunities

Irrigated agriculture requires more human and bullock labour on account of better land preparation, more number of intercultural operations, plant protection schedule, irrigation, etc., as compared to unirrigated agriculture. Underutilisation of the irrigation facilities, therefore, results in diminishing the opportunities of employment for hired labour as well as for the farmer's own labour. Quantification of loss of employment opportunities in terms of human and bullock labour days can be undertaken by means of estimating

the total employment in days available to human and bullock labour due to putting the irrigable land for the cultivation of unirrigated crops and the total employment in days that would have been available to human and bullock labour had there been no underutilisation. The difference between the two gives the loss of employment opportunities in days to human and bullock labour. On the assumption that the irrigable land was put to the alternative use of cultivation of unirrigated crops in the same proportion as is obtained under the unirrigated cropping pattern of the crops on sample farms, the former can be estimated by multiplying the proportionate area under the crop by the average number of per hectare human and bullock labour days required for the cultivation of the crop. Similarly, the latter can be estimated by multiplying the proportionate area under the crop by the average number of per hectare human and bullock labour days required for the cultivation of the crop, assuming that if there were no underutilisation the irrigable land would have been put to the cultivation of irrigated crops in the same proportion as is obtained in the approved cropping pattern of the project. Relevant data are presented in Tables 9.10 and 9.11. It will be seen from the Table that employment opportunities equivalent to 3,25,841 mandays, 6,75,003 woman days and 2,50,558 bullock days were available by putting the irrigable land for the cultivation of unirrigated crops (Table 9.10). If there were no underutilisation employment opportunities equivalent to

Table 9.10 : Estimation of Labour Required by the Unirrigated Crops

Sr. No.	Crops	Proportionate area (ha.)	Percentage	Per hectare labour required (days)			Total labour required (days)		
				Male	Female	Bullock	Male	Female	Bullock
1	2	3	4	5	6	7	8	9	10
1.	Paddy	102.90	0.92	28.95	71.52	19.66	2978.96	7359.41	2023.01
2.	Black gram	44.34	0.40	28.17	80.28	22.54	1260.33	3591.73	1008.44
3.	Green gram	996.58	8.91	30.07	86.04	21.62	29967.16	85745.74	21546.06
4.	Sorghum	6,800.48	60.80	29.26	47.24	23.60	198982.04	321254.68	160491.33
5.	Cotton	1,567.02	14.01	28.74	115.00	23.00	45036.15	180207.30	36041.46
6.	Gram	741.57	6.63	26.17	40.56	14.34	19406.89	30078.08	10634.11
7.	Groundnut	147.64	1.32	32.47	120.86	29.25	4793.87	17843.77	4318.47
8.	Linseed	498.85	4.46	27.16	25.05	17.06	13548.77	12496.19	8510.38
9.	Chickling vetch	38.03	0.34	50.41	38.02	19.01	1917.09	1445.90	722.95
10.	Pigeon pea	156.59	1.40	35.10	57.96	22.86	5496.31	9075.96	3579.65
11.	Wheat	63.76	0.57	25.74	60.89	17.82	1641.18	3882.35	1136.20
12.	Safflower	6.71	0.06	45.00	130.00	20.00	301.95	872.30	134.20
13.	Niger	13.42	0.12	29.27	73.17	21.95	392.80	981.94	294.57
14.	Sannhemp	6.71	0.06	17.50	25.00	17.50	117.43	167.45	117.43
	Total	11,185.00	100.00	-	-	-	325840.93	675003.10	250558.26

Table 9.11 : Estimation of Labour That Would Be Required by the Irrigated Crops

Sr.	Crops	Proportionate area (ha.)	Percentage	Per hectare labour required (days)			Total labour required (days)		
				Male	Female	Bullock	Male	Female	Bullock
1	2	3	4	5	6	7	8	9	10
1.	Perennials	1,177.78	10.53	-	-	-	-	-	-
	a) Sugarcane	883.34	7.90	116.46	190.08	26.59	102873.78	167905.27	23438.01
	b) Banana	294.44	2.63	222.80	287.91	45.33	65601.23	84772.22	13346.97
2.	O.P.[1]	551.42	4.93	116.46	190.08	26.59	64218.37	104813.91	14662.26
3.	Kharif Rice	1,118.50	10.00	49.10	91.51	31.18	54918.35	102353.94	34874.83
4.	Kharif Seasonals (Hy. Jowar)	809.80	7.24	57.21	123.38	35.57	46328.66	99913.12	28804.59
5.	Rabi Seasonals (Wheat)	3,863.30	34.54	45.72	85.08	26.86	176630.08	328689.56	103768.24
6.	H.W. Seasonals (Groundnut)	662.15	5.92	35.72	129.77	23.67	23652.00	85927.21	15673.09
7.	O.T. Seasonals (Turmeric)	735.97	6.58	137.17	259.67	50.34	100953.00	191109.33	37048.73
8.	L.S. Cotton	2,060.28	18.42	75.29	264.43	29.39	155118.48	544799.84	60551.63
9.	Hy. Crops[2] in H.W.	205.80	1.84	57.21	123.38	35.57	11773.82	25391.60	7320.31
	Total	11,185.00	100.00	-	-	-	802067.77	1735676.00	339538.66

Note: 1. Per hectare labour required in this case is taken to be as in the case of Sugarcane.
2. Per hectare labour required in this case is taken to be as in the case of Hy. Jowar.

8,02,068 mandays, 17,35,676 woman days and 3,39,539 bullock days would have been available (Table 9.11) for the cultivation of irrigated crops. The society was thus put to loss of employment opportunities equivalent to 4,76,227 man-days, 10,60,673 woman days and 88,981 bullock days on account of underutilisation of the available irrigation facilities.

Underutilisation of the irrigation facilities also results in forgoing many indirect benefits accruing from irrigation. These, however, would be difficult to quantify for lack of data in this respect.

9.5 Improving the Returns from the Project

Any improvement in the financial gains (or reduction in the losses) of a project can be achieved by means of reducing the costs and/or by increasing the revenues. In the absence of data no attempt is made to discuss the possible reduction in the annual costs of the project. The analysis thus boils down to an examination of sources of revenues. Two measures suggest themselves for increasing the current revenues from the project viz. enhancement of the present water rates and elimination of the underutilisation of the project potential.

The Sixth Finance Commission (1973) holds that an improvement in the working results of irrigation projects can be secured not through any economy in expenditure on maintenance but only through an enhancement of the present level of receipts. The Commission considered it imperative to fix

water rates at reasonable levels so as to eliminate recurring subsidies of a substantial nature from the general budget.[10] The Irrigation Commission (1972) also was emphatic about the need of raising the water rates to cover rising costs and observed that the State Governments, evidently for administrative and political reasons, have not raised the water rates adequately.[11] The Committee on Taxation of Agricultural Wealth and Income (headed by Prof. K.N. Raj) was even more specific in its observation that even though in many areas the rates vary with the nature of crops raised, in hardly any case do irrigation/water rates cover interest and provision for amortisation; in a large number of cases the amounts collected are not adequate to meet even the costs of maintenance and far from being a tax on agriculture irrigation rates carry an element of subsidy. The Committee felt that it is necessary to ensure that those who depend on private sources of irrigation are placed on par, for the purpose of taxation, with those who depend on public sources and advocated that water supplied by public irrigation projects is priced like any other input such as to cover costs since apart from the heavy burden that subsidising such inputs would involve underpricing of water encourages its wasteful use.[12]

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10 Report of the Sixth Finance Commission, 1973, op.cit., p. 59.

11 Report of the Irrigation Commission, Vol. I, 1972, op.cit., p. 264.

12 Report of the Committee on Taxation of Agricultural Wealth and Income. Ministry of Finance, Government of India, 1972, p. 99.

Two important justifications are advanced for an upward revision of water rates viz. the low proportion which the present water rates bear to the gross value of produce per hectare of the crop and the disparity existing between the price of water from public irrigation sources and private irrigation sources like tube wells or lift pumps. In Table 9.12 is given information on the proportion which the irrigation rates bear to the gross value per hectare in various States.

It will be seen that water rates for rice vary between 0.8 per cent to 1.6 per cent of the value of produce in Kerala to 7 per cent in Bihar. As for wheat the water rates as per cent of value of produce vary from 0.9 to 2.8 in Uttar Pradesh to 3.1 to 4.4 in Gujarat. It is clear from the above that water rates are very low and there is considerable scope for an enhancement in them.

An examination of what proportion the present water rates bear to the gross value of produce from a hectare of area in the command of the Purna project in the case of a few crops leads us to the information given in Table 9.13.

The Table shows that excepting in the case of Sugarcane and Groundnut the water rate as percentage of value of the produce varies between 2.47 in the case of Sorghum and 9.8 in the case of L.S. Cotton. In the case of Sugarcane and Groundnut water rate forms 13.39 and 13.16 per cent respectively of

Table 9.12 : Statewise Water Rates and Gross Value Per Hectare of Rice and Wheat

Sr. No.	Crops	Water Rate per ha. (Rs.)	Yield per ha. (Kg.)	Harvest price at farm level (Rs./Q.)	Value of produce per ha. (Rs.)	Percentage of Col. 3 to Col. 6
1	2	3	4	5	6	7
1.	Andhra Pradesh					
	Rice	37.5	1428	98.44	1406	2.6
2.	Bihar					
	Rice	37.5	926	59.63	553	7.0
	Wheat	22.5	940	87.02	818	2.7
3.	Gujarat					
	Rice	45 to 62.5	1358	101.39	1377	3.2 to 4.5
	Wheat	45 to 62.5	1529	92.69	1417	3.1 to 4.4
4.	Haryana					
	Rice	24.4	1433	53.96	773	3.1
	Wheat	14.5	1822	69.27	1262	1.1
5.	Kerala					
	Rice	12.5 to 25	1447	107.56	1556	0.8 to 1.6
6.	Maharashtra					
	Wheat	22.5	626	123.47	773	2.9
7.	Madhya Pradesh					
	Rice	25	1167	93.39	1090	2.3
	Wheat	10 to 25	970	81.59	791	1.2 to 3.1
8.	Mysore					
	Rice	40	1474	74.09	1092	3.6
9.	Punjab					
	Rice	24.4	1326	53.96	716	3.4
	Wheat	14.6	1953	69.27	1353	1.1
10.	Rajasthan					
	Wheat	13.1 to 25	1140	92.54	1055	1.2 to 2.3
11.	Tamil Nadu					
	Rice	40 to 50	1517	73.79	1120	3.5 to 4.4
12.	Uttar Pradesh					
	Rice	10 to 35	1483	52.69	781	1.2 to 4.4
	Wheat	10 to 30	1323	78.72	1041	0.9 to 2.8
13.	West Bengal					
	Rice	13.4 to 31.25	1824	128.32	1699	0.8 to 1.8

Source: Report of the Irrigation Commission, Vol. I, 1972, op.cit., pp. 271-272.

Table 9.13 : Water Rates as Percentage of Gross Value of Produce Under the Purna Command

Sr. No.	Crops	Water Rate per ha. (Rs.)	Gross Receipts per ha. (Rs.)	Percentage of Col. 3 to Col. 4
1	2	3	4	5
1.	Wheat	75	2085	3.60
2.	Sorghum	50	2025	2.47
3.	Gram	75	1154	6.50
4.	Groundnut	250	1900	13.16
5.	Sugarcane	750	5602	13.39
6.	Banana	750	13846	5.42
7.	Paddy	50	1633	3.06
8.	Turmeric	250	4943	5.06
9.	L.S. Cotton	250	2551	9.80

the gross value of produce from a hectare of land. It has been already seen under irrigated agriculture that the present level of productivity of all the crops has been very poor. The per hectare yield obtained in the case of Sugarcane compares very badly with that obtained in Western Maharashtra and there is wide scope for improving the yield performance of the crop. If there is an improvement in the yield levels of the crops the percentage which the water rates bear to the gross receipts would be still lower. The findings, therefore, indicate that there is scope for an upward revision of the existing water rates. Data for a single year would, however, be quite inadequate for implementing such a revision as fluctuations in yield levels are likely to occur.

The Irrigation Commission (1972) indicates[13] that assuming the project cost to be Rs. 2500 per hectare the water rate, if it is to cover interest liability of Rs. 163 per hectare at the rate of 6.5 per cent and costs on account of maintenance and operation at Rs. 15 per hectare, would work out to Rs. 178 per hectare. Such a rate is obtained only in the case of some commercial crops.

While bringing out the disparity between the costs of irrigation from private and public irrigation sources, the Irrigation Commission (1972) reports that for a 10 cm depth of water in the field the pump-owners charge Rs. 120 per hectare per watering and often pump-owners sell water on a crop-sharing basis taking one-third of the gross produce which is still more expensive.[14]

The foregoing analysis highlights the need for stepping up of the existing water rates for improving the financial returns from the irrigation project.

There has been much controversy over the criteria for fixation of water rates. The issue has been thoroughly thrashed out in the reports of the Indian Irrigation Commission of 1903 and 1972, Taxation Enquiry Committee of 1924-25, Taxation Enquiry Commission of 1953-54, Irrigation Rates Committee of Uttar Pradesh 1938-39 and 1948, Maharashtra State

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13 Report of the Irrigation Commission, Vol. I, 1972, op.cit., p. 269.

14 Ibid., p. 271.

Irrigation Commission of 1962 and the Committee to Suggest Ways and Means of Improving the Financial Returns from Irrigation Projects, 1964. The Irrigation Commission of Maharashtra suggested that water rates should be based on the annual cost (interest charges plus recurring expenses) and should be related to the level of average gross income obtained from the crop. The Commission after considering the costs and returns recommended that the range of percentage of gross incomes from the different crops which should be charged as water rate may be fixed from 6 per cent to 12 per cent.[15] The Committee to Suggest Ways and Means of Improving the Financial Returns from Irrigation Projects appointed by the Government of India in 1964 considered that the best way of fixing water rates is to base them on additional net benefit derived due to irrigation by the cultivators and recommended that the water rates may be fixed as a percentage ranging between 5 and 12 per cent of the gross income.[16] This range has been endorsed by the Irrigation Commission[17] (1972). The National Council of Applied Economic Research (NCAER) made a strong

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15 Report of the Irrigation Commission of Maharashtra State, 1962, op.cit., p. 74.

16 Report of the Committee to Suggest Ways and Means of Improving Financial Returns from Irrigation Projects, Parts I and II, 1964. Ministry of Irrigation and Power, Government of India, pp. 9-10.

17 Report of the Irrigation Commission, Vol. I, 1972, op.cit., p. 268.

plea that the only sound and justifiable basis for the irrigation rate should be the additional net benefit available to the cultivators from the use of water supplied. The Council suggested that the water rate in no case should exceed 50 per cent of the extra net benefit available to the cultivator and should vary between 20 and 50 per cent.[18]

Elimination of underutilisation of the available potential through a series of steps directed for that purpose would also contribute to larger current revenues. This point is too obvious to need any further elaboration.

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18 Criteria for Fixation of Water Rates and Selection of Irrigation Projects, op.cit., pp. 70-74.

CHAPTER X

SUMMARY AND CONCLUSIONS

Assured supply of water is one of the most essential prerequisites for increasing agricultural production and to derive the optimum benefits from the advances in agricultural technology. The rainfall in the country is confined mostly to a few monsoon months in the year and there are great variations in its incidence from year to year. Moreover, the rainfall in a large part of the country is low and uncertain in its distribution. Even where the rainfall is high the available soil moisture in the winter and summer months is not adequate to support multiple cropping. There is, therefore, an increased need for providing assured supplies of water through construction of irrigation projects. With this view considerable amounts have been spent on creating irrigation facilities by constructing several major and medium irrigation projects during the Five Year Plans in the country. But the pace of development of irrigation in the command areas of most of the new and old irrigation projects has been quite tardy. Underutilisation of the irrigation facilities is not a new problem. But the problem at present has got added economic significance because of the paradoxical situation in the country in which on one hand huge amounts of public money are being invested on creation of irrigation facilities and

on the other hand available irrigation facilities are not used to the fullest extent. Irrigation potential with the completion of major and medium schemes was 21.4 Mha. at the end of the Fourth Plan. The corresponding utilisation stood at 19.6 Mha., thus giving a lag of 1.8 Mha. in the utilisation. The lag in the utilisation of the potential was of the order of 2.2 Mha. at the end of 1975-76. Taking into account the investment made in the major and medium irrigation projects in the country since the commencement of the First Plan to the end of the Fourth Plan the lag in the utilisation of the created potential corresponds to a locked up capital of Rs. 294 crores.

It was known that there existed a gap between the irrigation potential created and utilised by the Purna irrigation project in Parbhani district of Maharashtra. It was, therefore, felt that it would be instructive to undertake an investigation into the causes of underutilisation of the irrigation potential created by the Purna Project. The data required for the study have been collected from two sources. The secondary data on irrigation potential created and utilised, financial returns of the project and the related aspects were collected from the project authorities and the Irrigation Department of the State by personally visiting their offices. The primary data at the farm level on the extent of underutilisation and the causes responsible for that were collected from a sample of 100 farmers selected from a

sample of 20 villages coming under the command of the project. The required data were collected in the specially designed questionnaire by personal interview method. The data relate to the agricultural year 1975-76. The following are the salient findings in brief.

1. The analysis reveals a glaring gap between the irrigation potential created and utilised even after eight years since the development of the potential. The utilisation of the potential is to the extent of 59.5 per cent in 1975-76. It was 16.4 per cent in 1968-69.

2. In kharif season the maximum utilisation at 79 per cent was achieved in 1975-76. For the first three years after creation of the potential the utilisation remained below 20 per cent. There is a spurt in kharif utilisation from 23 per cent in 1974-75 to 79 per cent in 1975-76 which may be attributable to the efforts of the Command Area Development Authority to which the project is attached since August 1974.

3. The progress in the utilisation during rabi season is uneven. From 22 per cent in 1968-69 the utilisation slightly decreased to 19.6 per cent in 1969-70. In the next two years there is an increase in it. The utilisation in this season is highest at 55 per cent in 1975-76.

4. The utilisation of the potential during hot weather season registers a progressive increase in it. The highest percentage utilisation achieved during this season is in 1975-76.

5. The intensity of cropping works out to 133.34 per cent. Among the unirrigated crops Sorghum (60.80 per cent) is the important crop. Other important crops are Cotton (14 per cent), Green gram (8.91 per cent) and Gram (6.63 per cent). Among the irrigated crops Wheat is the important crop accounting for 37 per cent of the total cropped area. Other important irrigated crops are Paddy (28.75 per cent), Groundnut (10.63 per cent) and Sugarcane (7.30 per cent).

6. More than 70 per cent of the area irrigated from the wells has been devoted for the cultivation of perennials since the farmers whose lands are not sanctioned under M_1 and D_2 soils have to rely upon their wells for growing perennials.

7. On an average an amount of Rs. 400.86 per cropped hectare is spent on the cultivation of irrigated crops. Similarly, the per cropped hectare expenditure in respect of irrigated crops is Rs. 1417.32. The net returns in respect of unirrigated crops work out to Rs. 724.26 while that in the case of irrigated crops they work out to Rs. 1166. The analysis shows that the farmers derived returns of Rs. 2.81 per rupee invested in the cultivation of unirrigated crops. The corresponding figure in respect of irrigated crops is Rs. 1.82.

8. An area of 15.84 hectares belonging to 18 farmers is yet to be levelled. Non-availability of bulldozer or suspension of levelling work due to the breakdown of bulldozer and lack of finance appear to be the important reasons for not levelling the land.

9. The level of application of manures and fertilisers in respect of irrigated crops is poor as compared to the recommended level of doses. Imbalance in the application of nutrients to plants is evident.

10. Use of improved seeds in respect of irrigated crops seems to be widespread excepting in the case Paddy, Gram and Turmeric.

11. Seventy per cent of the farmers advanced one or the other reason for not adopting any plant protection measures or for not following the recommended schedule. Lack of knowhow, lack of purchasing capacity and costliness of the pesticides appear to be the important reasons for that.

12. Excepting in the case of Groundnut and Turmeric the yield performance of the irrigated crops has remained below 50 per cent of the expected yield.

13. A large number of the farmers growing Sugarcane, Banana, Wheat and Groundnut could not give the recommended number of waterings to the crops. In rabi and hot weather seasons there was competition for more water among the farmers and the more powerful and influential farmers took more than one turn of watering in one rotation thereby disturbing the schedule. There were, therefore, long intervals between two waterings. Deficiency in the quantity of water required seems to have resulted in reduction in yield in the case of Wheat, Groundnut and Sugarcane.

14. The extent of underutilisation at the farm level works out to 40 per cent. The underutilisation during kharif season is less as compared to other two seasons. Underutilisation is somewhat greater in farms with more than 4 hectares of physical irrigable area. Excepting in the case of hot weather season utilisation improves after a period of five years since the beginning of availing irrigation facilities. Lack of credit and inputs, inadequate preparation of land, traditional outlook of the farmers, competition from the wells in respect of mixed irrigable area and defective distribution system appear to be the important reasons for underutilisation of the irrigation facilities.

15. An examination of the financial returns of the Purna project indicates that the project has incurred heavy financial losses in every year under study. Since the project has not been able to yield a surplus revenue to clear off the interest on capital investment from year to year the accumulated arrears of interest have increased from Rs. 4.58 crores to Rs. 12.51 crores during the period under consideration. The working expenses have continuously increased while the revenue receipts have lagged behind very badly. It is noted that while the area irrigated registered a bare five-fold increase in it the working expenses registered a seven-fold increase in them during the period under review.

16. The value of agricultural production forgone due to underutilisation of the irrigation facilities works out to

Rs.65.24 lakhs and the Government was put to loss of additional revenue to the extent of about Rs. 24.41 lakhs.

There is an urgent need to improve upon the financial position of the Purna project. An examination of the proportion which the present water rates bear to the value of produce from a hectare of land under the Purna command indicates that there is scope for an upward revision of the existing water rates. The present water rates, therefore, will have to be enhanced in order to increase the revenue receipts of the project and to meet the annual costs of the project. The bottlenecks which are found to hinder the full utilisation of the irrigation potential of the project also need to be removed in order to increase the revenue receipts of the project.

APPENDIX A

PASS

1. Pass Number :
2. Name of Irrigator :
3. Name of Village :
4. Taluka :
5. Mile No. Minor No. Block No.
6. Survey No. :
7. Plot No. :
8. Name of the Crop :
9. Area (Ac.) :
10. Period :
11. Date of issue :

Name of Crop Area (Acres)

Survey No.

Date of Watering	Area (Acres)	Signature of Canal Inspector

APPENDIX B

PURNA PROJECT: ROTATION PERIOD FOR KHARIF SEASON 1975-76 PERIOD FROM 1-7-1975 TO 14-10-1975

Sr. No.	Rotation Period			Main Canal Flow Period			Closure Period of Main Canal			Remarks
	From	To	No.of days	From	To	No.of days	From	To	No.of days	
1.	1- 7-75	18- 7-75	18	1- 7-75	12- 7-75	12	13- 7-75	18- 7-75	6	If demand is increased or there is occurrence of rains in the command area rotation will be changed.
2.	19- 7-75	5- 8-75	18	19- 7-75	30- 7-75	12	31- 7-75	5- 8-75	6	
3.	6- 8-75	23- 8-75	18	6- 8-75	17- 8-75	12	18- 8-75	23- 8-75	6	
4.	24- 8-75	10- 9-75	18	24- 8-75	4- 9-75	12	5- 9-75	10- 9-75	6	
5.	11- 9-75	28- 9-75	18	11- 9-75	22- 9-75	12	23- 9-75	28- 9-75	6	
6.	29- 9-75	14-10-75	16	29- 9-75	10-10-75	12	11-10-75	14-10-75	4	
	Total		106			72			34	

Basmatnagar
Dated: 27-6-75.
No. CB-Irrigation-2756

Sd/-
Executive Engineer
Purna Irrigation Division
Basmathnagar.

APPENDIX C

PURNA PROJECT: ROTATION PERIOD FOR RABI SEASON 1975-76 PERIOD FROM 15-10-1975 TO 29-2-1976

Sr. No.	Rotation Period			Main Canal Flow Period			Closure Period of Main Canal			Remarks
	From	To	No.of days	From	To	No.of days	From	To	No.of Days	
1.	15-10-75	4-11-75	21	15-10-75	28-10-75	14	29-10-75	4-11-75	7	
2.	5-11-75	25-11-75	21	5-11-75	18-11-75	14	19-11-75	25-11-75	7	
3.	26-11-75	16-12-75	21	26-11-75	9-12-75	14	10-12-75	16-12-75	7	
4.	17-12-75	6- 1-76	21	17-12-75	30-12-75	14	31-12-75	6- 1-76	7	
5.	7- 1-76	27- 1-76	21	7- 1-76	20- 1-76	14	21- 1-76	27- 1-76	7	
6.	28- 1-76	17- 2-76	21	28- 1-76	10- 2-76	14	11- 2-76	17- 2-76	7	
7.	18- 2-76	29- 2-76	12	18- 2-76	29- 2-76	12	1- 3-76	Closed	-	
	Total		138			96			42	

Basmatnagar
Dated: 8-10-1975
No. CB Irrigation 4521

Sd/-
Executive Engineer
Purna Irrigation Division
Basmathnagar.

APPENDIX D

PURNA PROJECT: ROTATION PERIOD FOR HOT-WEATHER SEASON 1975-76 PERIOD FROM 1-3-1976 TO 30-6-1976

Sr. No.	Rotation Period			Main Canal Flow Period			Closure Period of Main Canal			Remarks
	From	To	No.of days	From	To	No.of days	From	To	No.of days	
1.	1-3-76	11-3-76	11	1-3-76	8-3-76	8	9-3-76	11-3-76	3	If demand
2.	12-3-76	22-3-76	11	12-3-76	19-3-76	8	20-3-76	22-3-76	3	is in-
3.	23-3-76	1-4-76	10	23-3-76	30-3-76	8	31-3-76	1-4-76	2	creased
4.	2-4-76	11-4-76	10	2-4-76	9-4-76	8	10-4-76	11-4-76	2	the flow
5.	12-4-76	21-4-76	10	12-4-76	19-4-76	8	20-4-76	21-4-76	2	period of
6.	22-4-76	1-5-76	10	22-4-76	29-4-76	8	30-4-76	1-5-76	2	rotation
7.	2-5-76	11-5-76	10	2-5-76	9-5-76	8	10-5-76	11-5-76	2	will be
8.	12-5-76	21-5-76	10	12-5-76	19-5-76	8	20-5-76	21-5-76	2	changed.
9.	22-5-76	31-5-76	10	22-5-76	29-5-76	8	30-5-76	31-5-76	2	
10.	1-6-76	10-6-76	10	1-6-76	8-6-76	8	9-6-76	10-6-76	2	
11.	11-6-76	20-6-76	10	11-6-76	18-6-76	8	19-6-76	20-6-76	2	
12.	21-6-76	30-6-76	10	21-6-76	28-6-76	8	29-6-76	30-6-76	2	
	Total		122			96			26	

Basmatnagar
Dated: 27-2-1976
No. 1131

Sd/-
Executive Engineer
Purna Irrigation Division
Basmathnagar.

APPENDIX E

WATER RATES FOR SUPPLY OF CANAL WATER BY FLOW AND BY LIFT IN MARATHWADA

Schedule A

Sr. No.	Name of Crops	Water rates to be charged on flow irrigation			
		1st July 1974 to 30th June 1975 Rs.per hectare		1st July 1975 to 30th June 1976 Rs.per hectare	
1.	Sugarcane and Plantain	510	(204)	750	(300)
2.	Other Perennials	340	(136)	500	(200)
3.	Kharif Seasonals	37.50	(15)	50	(20)
4.	Rabi Seasonals	57.50	(23)	75	(30)
5.	Hot-weather Seasonals	112.50	(45)	150	(60)
6.	Hybrid Commercials:				
	(a) Kharif crops	37.50	(15)	50	(20)
	(b) Rabi Crops	57.50	(23)	75	(30)
7.	Hybrid Seed and Foundation:				
	(a) Kharif crops	75	(30)	100	(40)
	(b) Rabi crops	112.50	(45)	150	(60)
8.	Hot weather Cotton	170	(68)	250	(100)
9.	Hot weather Groundnut	170	(68)	250	(100)
10.	Pre-seasonal watering	55	(22)	75	(30)
11.	Post-seasonal watering to kharif crops in rabi season	15	(6)	20	(8)
12.	Post-seasonal watering to rabi crops in Hot weather season	20	(8)	25	(10)

Note: 1. The above rates are for all Government irrigation works where water supply is assured.

2. Government irrigation works where there is no assured water supply, 3/4 of the above water rates are to be charged.

3. The bracketed figures denote water rates per acre.

Schedule B : Water rates to be charged on lift irrigation:

1. Lift irrigation from canal : Full canal flow water rates for all crops.
2. Lift irrigation from back water of dam : 50% of the canal flow water rates for all crops.
3. Lift irrigation between dam and pick up weir : 50% of the canal flow water rates for all crops.

Sr. No.	Name of crops	1st July 1974 to 30th June 1975		1st July 1975 to 30th June 1976	
4.	Lift irrigation within back water zone of Bandhara water if released from storage in the Bandhara or dam:				
	i) Cane and Plantain	190	(76)	250	(100)
	ii) Other Perennials	145	(58)	175	(70)
	iii) Kharif crops	20	(8)	25	(10)
	iv) Rabi crops	27.50	(11)	37.50	(15)
	v) Hot-weather crops	57.50	(23)	75	(30)
5.	Lift irrigation downstream of pick up weir but not within canal command:				
	i) Cane and Plantain	152.50	(61)	187.50	(75)
	ii) Other Perennials	100	(40)	125	(50)
	iii) Kharif crops	12.50	(5)	12.50	(5)
	iv) Rabi crops	20	(8)	20	(8)
	v) Hot-weather crops	37.50	(15)	37.50	(15)
6.	Lift irrigation with back water zone of Bandharas where water is not supplemented from storage:				
	i) Cane and Plantain	142.50	(57)	187.50	(75)
	ii) Other Perennials	90	(36)	125	(50)
	iii) Kharif crops	12.50	(5)	12.50	(5)
	iv) Rabi crops	20	(8)	20	(8)
	v) Hot-weather crops	37.50	(15)	37.50	(15)
7.	Beyond back water zone of dam of first bandhara on nalla or river:				
	i) Cane and Plantain	47.50	(19)	62.50	(25)
	ii) Other Perennials	30	(12)	40	(16)
	iii) Kharif crops	-		-	
	iv) Rabi crops	12.50	(5)	12.50	(5)
	v) Hot-weather crops	12.50	(5)	12.50	(5)

Note: The bracketed figures denote water rates per acre.

Sd/-
Dy.Secretary to Government.

APPENDIX F

SEASONAL DUTIES CURRENTLY ADOPTED ON PURNA PROJECT

(ha.)

Crops	Kharif	Rabi	Hot weather
1) Sugarcane and Banana	32.38	28.33	20.23
2) Other Perennials	48.56	42.49	30.35
3) Kharif Seasonals	157.83	-	-
4) Kharif Rice	32.38	-	-
5) L.S. Cotton	169.97	84.99	60.70
6) Other Two-Seasonals	48.56	56.66	-
7) Rabi Seasonals	-	72.85	-
8) H.W. Seasonals	-	-	40.47
9) Hybrid Crops in H.W.	-	-	24.28

APPENDIX G

RUN-OFF SERIES AND RELIABLE YIELD OF THE MUTHA RIVER

Gauge Station: Khadakwasala Catchment Area: 196 sq.miles

Sr. No.	Arranged chronologically		Arranged in descending order		Degree of depend-ability
	Year	Discharge in m.c.ft.	Year	Discharge in m.c.ft.	
(1)	(2)	(3)	(4)	(5)	(6)
1.	1906	41,207	1914	78,821	
2.	1907	72,086	1907	72,086	
3.	1908	67,355	1946-47	72,015	
4.	1909	62,324	1908	67,355	
5.	1910	53,056	1931-32	63,233	
6.	1911	35,976	1909	62,324	
7.	1912	52,264	1933-34	60,274	
8.	1913	54,800	1945-46	58,156	
9.	1914	78,821	1942-43	57,530	
10.	1915	38,662	1938-39	56,261	
11.	1916	35,483	1954-55	56,124	
12.	1917	48,845	1926-27	55,313	
13.	1918	17,357	1913	54,800	
14.	1919	48,887	1944-45	53,966	
15.	1920	46,695	1910	53,056	
16.	1921	36,821	1912	52,264	
17.	1922	48,048	1953-54	52,203	
18.	1923-24	45,436	1930-31	50,778	
19.	1924-25	42,296	1932-33	50,396	
20.	1925-26	36,070	1937-38	49,760	
21.	1926-27	55,313	1943-44	49,756	
22.	1927-28	46,480	1919	48,887	
23.	1928-29	N.A.	1917	48,845	
24.	1929-30	28,832	1940-41	48,652 48,350	50 per cent
25.	1930-31	50,778	1922	48,048	

(continued)

(1)	(2)	(3)	(4)	(5)	(6)
26.	1931-32	63,233	1920	46,695	
27.	1932-33	50,396	1952-53	46,636	
28.	1933-34	60,274	1927-28	46,480	
29.	1934-35	45,369	1955-56	46,334 45,795	60 per cent
30.	1935-36	30,916	1923-24	45,436	
31.	1936-37	32,770	1934-35	45,369 42,757	65 per cent
32.	1937-38	49,760	1924-25	42,296	
33.	1938-39	56,261	1906	41,207	
34.	1939-40	36,426	1950-51	39,761	
35.	1940-41	48,652	1915	38,662	
36.	1941-42	36,009	1951-52	38,622 37,271	75 per cent
37.	1942-43	57,530	1921	36,821	
38.	1943-44	49,756	1939-40	36,426	
39.	1944-45	53,966	1925-26	36,070 36,058	80 per cent
40.	1945-46	58,156	1941-42	36,009	
31.	1946-47	72,015	1911	35,976	
42.	1947-48	35,623	1947-48	35,623	
43.	1948-49	25,279	1916	35,483	
44.	1949-50	26,324	1936-37	32,770 32,518	90 per cent
45.	1950-51	39,761	1935-36	30,916	
46.	1951-52	38,622	1929-30	28,832	
47.	1952-53	46,636	1949-50	26,324	
48.	1953-54	52,203	1948-49	25,279	
49.	1954-55	56,124	1918	17,357	
50.	1955-56	46,334			
	Total	23,12,287			
Annual average		47,190			

Source: Report of the Maharashtra State Irrigation Commission. Government of Maharashtra, 1962, pp. 324-325.

APPENDIX H

AREA IRRIGATED UNDER VARIOUS CROPS

(Area in hectares)

Crops	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76
1) Sugarcane and Banana	1,448.18	1,939.27	1,972.06	3,162.34	2,321.00	1,762.00	1,719.00	2,424.00
2) Other Perennials	184.21	164.77	207.69	58.71	31.00	39.00	18.00	101.00
3) Kharif Seasonals	384.21	393.93	21.05	1,937.65	1,452.00	403.00	467.00	6,012.00
4) Kharif Rice	418.62	887.45	259.52	3,069.23	6,196.00	1,420.00	2,214.00	10,083.00
5) L.S. Cotton	600.81	250.20	621.46	2,243.73	473.00	1,060.00	1,627.00	4,111.00
6) Other Two-Seasonals	733.20	997.16	1,417.00	1,534.41	913.00	891.00	551.00	2,409.00
7) Rabi Seasonals	7,246.96	4,621.06	6,577.33	9,078.14	12,339.00	9,419.00	11,412.00	19,055.00
8) Hot Weather Seasonals	449.80	667.21	2,191.90	4,544.13	-	5,205.00	4,711.00	5,607.00
9) Hybrid Crops in H.W.	-	-	-	-	-	52.00	1.00	553.00
Total	11,465.99	9,921.05	13,268.01	25,628.34	23,815.00	20,251.00	22,720.00	50,355.00

APPENDIX I

CONVERSION OF THE AREA UNDER VARIOUS CROPS IN THE APPROVED CROPPING PATTERN OF THE PROJECT INTO THE BASE CROP AREA

Crops	Area (hectares)	Duty	Base crop area (hectares)
(A) Kharif			
1. Sugarcane and Banana	6,478	32.38	14,574.50
2. Other Perennials	3,036	48.56	4,554.63
3. Kharif Seasonals	4,453	157.83	2,055.38
4. Kharif Rice	6,154	32.38	13,845.55
5. L.S. Cotton	11,338	169.97	4,859.52
6. Other Two-Seasonals	4,048	48.56	6,072.83
Total			45,962.41
(B) Rabi			
1. Sugarcane and Banana	6,478	28.33	16,658.04
2. Other Perennials	3,036	42.49	5,205.29
3. L.S. Cotton	11,338	84.99	9,718.48
4. Other Two-Seasonals	4,048	56.66	5,204.67
5. Rabi Seasonals	21,255	72.85	21,255.00
Total			58,041.48
(C) Hot Weather			
1. Sugarcane and Banana	6,478	20.23	23,327.84
2. Other Perennials	3,036	30.35	7,287.40
3. L.S. Cotton	11,338	60.70	13,607.47
4. Hot Weather Seasonals	3,644	40.47	6,559.56
5. Hybrid Crops in H.W.	1,134	24.28	3,402.47
Total			54,184.74

Kharif	45,962.41
Rabi	58,041.48
Hot Weather	54,184.74
Total	1,58,188.63

APPENDIX J

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1968-69

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	1,448.18	32.38	3,258.18
2.	Other Perennials	184.21	48.56	276.35
3.	Kharif Seasonals	384.21	157.83	177.34
4.	Kharif Rice	418.62	32.38	941.83
5.	L.S. Cotton	600.81	169.97	257.51
6.	Other Two-Seasonals	733.20	48.56	1,099.95
	Total			6,011.16
	Rabi			
1.	Sugarcane and Banana	1,448.18	28.33	3,723.96
2.	Other Perennials	184.21	42.49	315.83
3.	L.S. Cotton	600.81	84.99	514.99
4.	Other Two-Seasonals	733.20	56.66	942.70
5.	Rabi Seasonals	7,246.96	72.85	7,246.96
	Total			12,744.44
	Hot Weather			
1.	Sugarcane and Banana	1,448.18	20.23	5,215.02
2.	Other Perennials	184.21	30.35	442.16
3.	L.S. Cotton	600.81	60.70	721.07
4.	Hot Weather Seasonals	449.80	40.47	809.68
5.	Hybrid Crops in H.W.	Nil	24.28	-
	Total			7,187.93

		Percentage utilisation
Kharif	6,011.16	13.08
Rabi	12,744.44	21.96
Hot Weather	7,187.93	13.27
Total	25,943.53	16.40

APPENDIX K

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1969-70

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	1,939.27	32.38	4,363.06
2.	Other Perennials	164.77	48.56	247.19
3.	Kharif Seasonals	393.93	157.83	181.83
4.	Kharif Rice	887.45	32.38	1,996.63
5.	L. S. Cotton	250.20	169.97	107.24
6.	Other Two-Seasonals	997.16	48.56	1,495.95
	Total			8,391.90
	Rabi			
1.	Sugarcane and Banana	1,939.27	28.33	4,986.79
2.	Other Perennials	164.77	42.49	282.50
3.	L. S. Cotton	250.20	84.99	214.46
4.	Other Two-Seasonals	997.16	56.66	1,282.09
5.	Rabi Seasonals	4,621.06	72.85	4,621.06
	Total			11,386.90
	Hot Weather			
1.	Sugarcane and Banana	1,939.27	20.23	6,983.48
2.	Other Perennials	164.77	30.35	395.50
3.	L. S. Cotton	250.20	60.70	300.28
4.	Hot-Weather Seasonals	667.21	40.47	1,201.04
5.	Hybrid Crops in H.W.	Nil	24.28	-
	Total			8,880.30

		Percentage utilisation
Kharif	8,391.90	18.26
Rabi	11,386.90	19.62
Hot Weather	8,880.30	16.39
Total	28,659.10	18.12

APPENDIX L

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1970-71

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	1,972.06	32.38	4,436.83
2.	Other Perennials	207.69	48.56	311.58
3.	Kharif Seasonals	21.05	157.83	9.72
4.	Kharif Rice	259.52	32.38	583.88
5.	L. S. Cotton	621.46	169.97	266.36
6.	Other Two-Seasonals	1,417.00	48.56	2,125.79
	Total			7,734.16
	Rabi			
1.	Sugarcane and Banana	1,972.06	28.33	5,071.11
2.	Other Perennials	207.69	42.49	356.09
3.	L. S. Cotton	621.46	84.99	532.69
4.	Other Two-Seasonals	1,417.00	56.66	1,821.89
5.	Rabi Seasonals	6,577.33	72.85	6,577.33
	Total			14,359.11
	Hot Weather			
1.	Sugarcane and Banana	1,972.06	20.23	7,101.56
2.	Other Perennials	207.69	30.35	498.52
3.	L. S. Cotton	621.46	60.70	745.85
4.	Hot Weather Seasonals	2,191.90	40.47	3,945.63
5.	Hybrid Crops in H.W.	Nil	24.28	-
	Total			12,291.56

		Percentage utilisation
Kharif	7,734.16	16.83
Rabi	14,359.11	24.74
Hot Weather	12,291.56	22.68
Total	34,384.83	21.74

APPENDIX M

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1971-72

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	3,162.34	32.38	7,114.78
2.	Other Perennials	58.71	48.56	88.08
3.	Kharif Seasonals	1,937.65	157.83	894.37
4.	Kharif Rice	3,069.23	32.38	6,905.29
5.	L. S. Cotton	2,243.73	169.97	961.67
6.	Other Two-Seasonals	1,534.41	48.56	2,301.93
	Total			18,266.12
	Rabi			
1.	Sugarcane and Banana	3,162.34	28.33	8,131.89
2.	Other Perennials	58.71	42.49	100.66
3.	L. S. Cotton	2,243.73	84.99	1,923.23
4.	Other Two-Seasonals	1,534.41	56.66	1,972.85
5.	Rabi Seasonals	9,078.14	72.85	9,078.14
	Total			21,206.77
	Hot Weather			
1.	Sugarcane and Banana	3,162.34	20.23	11,387.86
2.	Other Perennials	58.71	30.35	140.92
3.	L. S. Cotton	2,243.73	60.70	2,692.85
4.	Hot Weather Seasonals	4,544.13	40.47	8,179.88
5.	Hybrid Crops in H.W.	Nil	-	-
	Total			22,401.51

		Percentage utilisation
Kharif	18,266.12	39.74
Rabi	21,206.77	36.54
Hot Weather	22,401.51	41.34
Total	61,874.40	39.11

APPENDIX N

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1972-73

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	2,321.00	32.38	5,221.89
2.	Other Perennials	31.00	48.56	46.51
3.	Kharif Seasonals	1,542.00	157.83	711.74
4.	Kharif Rice	6,196.00	32.38	13,940.04
5.	L. S. Cotton	473.00	169.97	202.73
6.	Other Two-Seasonals	913.00	48.56	1,369.69
	Total			21,492.60
	Rabi			
1.	Sugarcane and Banana	2,321.00	28.33	5,968.40
2.	Other Perennials	31.00	42.49	53.15
3.	L. S. Cotton	473.00	84.99	405.44
4.	Other Two-Seasonals	913.00	56.66	1,173.88
5.	Rabi Seasonals	12,339.00	72.85	12,339.00
	Total			19,939.87
	Hot Weather			
	No irrigation due to reservoir limitations in H.W.			

		Percentage utilisation
Kharif	21,492.60	46.76
Rabi	19,939.87	34.35
Hot Weather	-	-
Total	41,432.47	39.84

APPENDIX O

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1973-74

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	1,762.00	32.38	3,964.23
2.	Other Perennials	39.00	48.56	58.51
3.	Kharif Seasonals	403.00	157.83	186.01
4.	Kharif Rice	1,420.00	32.38	3,194.78
5.	L. S. Cotton	1,060.00	169.97	454.32
6.	Other Two-Seasonals	891.00	48.56	1,336.68
	Total			9,194.53
	Rabi			
1.	Sugarcane and Banana	1,762.00	28.33	4,530.95
2.	Other Perennials	39.00	42.49	66.87
3.	L. S. Cotton	1,060.00	84.99	908.59
4.	Other Two-Seasonals	891.00	56.66	1,145.59
5.	Rabi Seasonals	9,419.00	72.85	9,419.00
	Total			16,071.00
	Hot Weather			
1.	Sugarcane and Banana	1,762.00	20.23	6,345.12
2.	Other Perennials	39.00	30.35	93.61
3.	L. S. Cotton	1,060.00	60.70	1,272.17
4.	Hot Weather Seasonals	5,205.00	40.47	9,369.51
5.	Hybrid Crops in H.W.	52.00	24.28	156.02
	Total			17,236.43

		Percentage utilisation
Kharif	9,194.53	20.00
Rabi	16,071.00	27.69
Hot Weather	17,236.43	31.81
Total	42,501.96	26.87

APPENDIX P

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1974-75

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	1,719.00	32.38	3,867.52
2.	Other Perennials	18.00	48.56	27.00
3.	Kharif Seasonals	467.00	157.83	215.55
4.	Kharif Rice	2,214.00	32.38	4,981.16
5.	L. S. Cotton	1,627.00	169.97	697.34
6.	Other Two-Seasonals	551.00	48.56	826.61
	Total			10,615.18
	Rabi			
1.	Sugarcane and Banana	1,719.00	28.33	4,420.37
2.	Other Perennials	18.00	42.49	30.86
3.	L. S. Cotton	1,627.00	84.99	1,394.60
4.	Other Two-Seasonals	551.00	56.66	708.44
5.	Rabi Seasonals	11,412.00	72.85	11,412.00
	Total			17,966.27
	Hot Weather			
1.	Sugarcane and Banana	1,719.00	20.23	6,190.27
2.	Other Perennials	18.00	30.35	43.21
3.	L. S. Cotton	1,627.00	60.70	1,952.67
4.	Hot Weather Seasonals	4,711.00	40.47	8,480.27
5.	Hybrid Crops in H.W.	1.00	24.28	3.00
	Total			16,669.42

		Percentage utilisation
Kharif	10,615.18	23.10
Rabi	17,966.27	30.95
Hot Weather	16,669.42	30.76
Total	45,250.87	28.61

APPENDIX Q

CONVERSION OF THE AREA IRRIGATED UNDER VARIOUS CROPS INTO THE BASE CROP AREA : 1975-76

Sr. No.	Crops	Area Irrigated (ha.)	Duty	Base crop area (ha.)
	Kharif			
1.	Sugarcane and Banana	2,424.00	32.38	5,453.63
2.	Other Perennials	101.00	48.56	151.52
3.	Kharif Seasonals	6,012.00	157.83	2,274.97
4.	Kharif Rice	10,083.00	32.38	22,685.19
5.	L. S. Cotton	4,111.00	169.97	1,762.00
6.	Other Two-Seasonals	2,409.00	48.56	3,614.00
	Total			36,441.31
	Rabi			
1.	Sugarcane and Banana	2,424.00	28.33	6,233.27
2.	Other Perenndials	101.00	42.49	173.17
3.	L. S. Cotton	4,111.00	84.99	3,523.78
4.	Other Two-Seasonals	2,409.00	56.66	3,097.35
5.	Rabi Seasonals	19,055.00	72.85	19,055.00
	Total			32,082.57
	Hot Weather			
1.	Sugarcane and Banana	2,424.00	20.23	8,729.04
2.	Other Perennials	101.00	30.35	242.43
3.	L. S. Cotton	4,111.00	60.70	4,933.88
4.	Hot Weather Seasonals	5,607.00	40.47	10,093.15
5.	Hybrid Crops in H.W.	553.00	24.28	1,659.23
	Total			25,657.73

		Percentage utilisation
Kharif	36,441.31	79.29
Rabi	32,082.57	55.28
Hot Weather	25,657.73	47.35
Total	94,181.61	59.54

APPENDIX R

A STUDY OF THE UTILISATION OF IRRIGATION POTENTIAL OF THE PURNA IRRIGATION PROJECT

1) General Information of the Cultivator

Village : Name :

Taluka : District :

Sex : Age : Education:

Main occupation : Annual Income :

Subsidiary Occupation : Annual Income :

Distance of the village from pucca road :

Nearest Market : Distance :

Nearest Railway Station : Distance :

2) Particulars of holding (1975-76):

	Total Area (Ac.)	Irrigated Area (Ac.)	Unirrigated Area (Ac.)	Permanent Fallow (Ac.)	Current Fallow (Ac.)
1) Owned land					
Of which given on:					
i) Cash rent					
ii) Share rent					
2) Self cultivated:					
Land taken on :					
a) Cash rent					
b) Share rent					
3) Total cultivated holding					
4) Net cultivated holding					
5) Govt. land revenue on owned land (Rs.)					
6) Amount of share rent cash rent paid/received					

3) Area that can be irrigated (Physical Irrigated area)

	Area that can be irrigated out of the cultivated holding on the			Remarks Area unsuitable for irrigation
	Owned land (Ac.)	Leased in land (Ac.)	Total (Ac.)	(Ac.)
1) From Canal:				
a) Four-month crops				
b) Eight-month crops				
c) Perennials				
2) From Wells:				
a) Four-month crops				
b) Eight-month crops				
c) Perennials				
3) From Other Sources:				
a) Four-month crops				
b) Eight-month crops				
c) Perennials				
4) Total:				
a) Four-month crops				
b) Eight-month crops				
c) Perennials				

- -

No. of wells in the cultivated holding : In repair: Out of repair:

Mode of operation (Engine, mot, etc.) H.P.

Nature of ownership right: Full ownership: Part ownership:

Expenditure incurred on farm wells during the last 5 years:

No. constructed : Expenditure (Rs.) :

No. repaired, deepened etc. : Expenditure (Rs.) :

Quality of Water : Diameter of Well:

Depth of water column :

If a new well was constructed, give reasons:

In a year of unseasonal rains or of drought, which of the two, the canal or your well, is more dependable? Why?

4) Cropping Pattern (1975-76) 1-7-1975 to 30-6-1976

Season	Crops								Total cropped	Double cropped
	1	2	3	4	5	6	7	8		
1) Kharif										
a) Dry										
b) Irrigated										
c) Total										
2) Rabi										
a) Dry										
b) Irrigated										
c) Total										
3) Hot-Weather										
a) Dry										
b) Irrigated										
c) Total										

5) Details of Irrigation: (1975-76)

Particulars	Crops
Waterings given from:	
A) Canal	
1) Number	
2) Interval between two waterings	
B) Well	
1) Number	
2) Interval between two waterings	
C) Other Sources	
1) Number	
2) Interval between two waterings	

1) Since how long you have been using canal water?

2) Have you used the canal water each year during the last 5 years?

3) If yes, did you irrigate the whole irrigable area?

4) If not, state reasons therefor :

5) If you have never used the canal water during the last 5 years, state reasons therefor:

6) Did you get the canal water at the required time in required quantity (No. of waterings) during the year 1975-76? If not give details.

7) Was there enough moisture in the soil at the time of sowing?

8) If not, did you get canal water at the time of sowing?

9) Did you apply for the canal water at the proper time?

10) If yes, was a pass issued to you?

11) Did it happen that you did not avail canal water even though a pass was issued to you?

12) Were you in arrears of water charges?

13) Did you irrigate your fields during night time?

14) Indicate reasons for underutilisation or non-utilisation of irrigation facilities:

a) Lack of or inadequate field channels

b) Inadequate drainage channels and waterlogging

c) Inadequate preparation of land for irrigated agriculture (land shaping, land levelling and bunding)

d) Inadequate water supply, maldistribution of the available water and tail-end difficulties for water

e) Lack of adequate credit, inputs and infrastructure

f) Inadequate bullock power

g) Inadequate man-power

h) Soil unsuitable for irrigation

i) Water rates are very high

j) Disputes over water courses

k) Other (Specify)

15) Opinion of the cultivator regarding canal water

16) Are there any suggestions to make as to how, how much and when you should get the canal water?

6) Expenditure on land levelling, etc., during the last 5 years

Item	Year	Whether done with family labour? If yes, No.of man-days and bullock-days required	Cash expenditure	Remarks
1) Land levelling				
2) Bunding				
3) Field channels				
4) Drainage				

a) Is the entire area of your farm coming under the canal water levelled?

b) Area levelled during the last 5 years period (Ac.)

c) Area remained to be levelled (Ac.)

d) Reasons for not levelling

7) Manures and Fertilizers

1) State the quantity of F.Y.M. produced from your cattle during the year 1975-76: Value (Rs.):

2) State the proportion of dung used as fuel:

3) Did you buy any additional quantity of F.Y.M. during the year? If so, state the source of purchase: Quantity: Value (Rs.):

4) Did you sell any F.Y.M. during the year? If so, quantity sold: Price obtained:

5) Net quantity of F.Y.M. available:

6) Do you think that the quantity of F.Y.M. and fertilizers used by you for the crops of the year was sufficient? If not, indicate the extent of inadequacy cropwise and the reasons therefor:

Crops	Quantity of manures and fertilizers desired to be used			Reasons for inadequacy
	F.Y.M.	Ammonium Sulphate	Super-phosphate	
1)				
2)				
3)				
4)				
5)				
6)				
7)				
8)				

Do you practise green manuring? If not give reasons therefor:

8) Credit Needs

a) Did you experience any difficulty in securing adequate credit during the year 1975-76? If so, indicate the amount required but could not secure for:

Purpose	Amount (Rs.)
i) Current expenditure on cultivation	
ii) Capital expenditure on agriculture	
iii) Unproductive expenditure	
iv) Purchase of bullocks	
v) Others (specify)	

b) Did you try to secure loan?

c) Why could you not get loan?

d) How did you meet the need?

9) Cost of Production: (1975-76)

Crop: Area (Ac.) Season: Irrigated/Unirrigated (Canal/Well/Other)

Variety: Date of sowing: Method of irrigation:

Operation	No. of operations	Labour Requirement					
		Human labour (days)				Total human labour days	Bullock labour (days)
		Male		Female			
		Family	Hired	Family	Hired	Male Female	Total Of which hired
1) Ploughing							
2) Harrowing							
3) Manuring							
4) Sowing							
5) Weeding							
6) Hoeing							
7) Irrigation							
8) Fertiliser application							
9) Use of insecticides and pesticides							
10) Watch and ward							
11) Harvesting							
12) Threshing							
Total							

The information is to be collected for all the crops raised by the cultivator during the year 1975-76

Operation	Labour cost						Total cost of hired labour (M+F+B)	Other inputs				Total cost of operation
	Wages paid to hired labour							Expenditure on other inputs				
	Male		Female		Bullock (pair)			Home produced		Purchased		Cost in Rs.
	Rate (Rs./ day)	Total wages (Rs.)	Rate (Rs./ day)	Total wages (Rs.)	Rate (Rs./ day)	Total wages (Rs.)	(Rs.)	Qty. (kg.)	Value (Rs.)	Qty. (kg.)	Value (Rs.)	(Rs.)
1) Ploughing												
2) Harrowing												
3) Manuring												
4) Sowing												
5) Weeding												
6) Hoeing												
7) Irrigation												
8) Fertilizer application												
9) Use of Insecticides and pesticides												
10) Watch and ward												
11) Harvesting												
12) Threshing												
Total												

10) Improved Varieties of Seed

If you have sown local variety of seed, why did you not use improved variety of crops? Indicate reasons:

a) Did not know the variety

b) Did not know the agronomic and cultural practices which are to be followed

c) Could not obtain the seed

d) Had no adequate finance for purchasing the seed

e) Seed is costly

f) Others (specify)

11) Plant Protection Measures

If you have not adopted any plant protection measures or adopted but not according to the recommended schedule, indicate the reasons:

a) Had no adequate finance for purchasing

b) Costly

c) Were not available in time

d) Were not available locally and had to go a long distance to obtain them

e) Did not know how and when to apply

f) Others (specify)

12) <u>Output of Crops and Its Marketing</u>
(For irrigated and unirrigated crops separately.)

Particulars	Crops
1) Quantity produced (Qts.)	
a) Main product	
b) By-product	
2) Quantity sold (Qts.)	
a) Main product	
b) By-product	
3) Value received (Rs.)	
a) Main product	
b) By-product	
4) Where sold	
5) When sold	
6) To whom sold	
7) Transport cost (Rs.)	

APPENDIX S

GLOSSARY OF WORDS

Sr. No.	English Name	Botanical Name	Local (Marathi) Name
1.	Paddy (Rice)	Oryza sativa L.	Bhat
2.	Wheat	Triticum sativum L.	Gahu
3.	Sorghum	Sorghum vulgare Pers.	Jowar
4.	Black gram	Phaseolus mungo var. Radiatus Linn.	Udid
5.	Green gram	Phaseolus aureus Roxb.	Mung
6.	Chickling vetch	Lathyrus sativus L.	Lakh
7.	Gram	Cier arietinum L.	Harbara
8.	Pigeon pea	Cajanus cajan	Tur
9.	Groundnut	Arachis hypogaea L.	Bhuimug
10.	Linseed	Linum usitatissimum L.	Javas
11.	Safflower	Carthamus tinctorius L.	Kardi
12.	Sannhemp	Crotalaria juncea L.	Tag
13.	Sugarcane	Saccharum officinarum L.	Oos
14.	Carrot	Daucus carota L.	Gajar
15.	Onion	Allium cepa L.	Kanda
16.	Banana	Musa paradisiaca L.	Kele
17.	Turmeric	Curcuma longa	Halad
18.	Cotton	Gossypium spp.	Kapus
19.	Niger	Guizotia abyssinica Cass	Karal

Source: Appendix A and B, List of Cultivated Field, Garden and Plantation Crops. Handbook of Agriculture. Indian Council of Agricultural Research, New Delhi, 1966, pp. 796-847.

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