

Planning and Management of Surface Irrigation in Drought Prone Areas

Ashok K. Mitra

**INSTITUTE OF POLITICS AND ECONOMICS
PUNE 411004**

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**PLANNING AND MANAGEMENT OF SURFACE IRRIGATION
IN DROUGHT PRONE AREAS**

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FOREWORD

Irrigation projects have to be planned and operated to meet the national goal relating to efficient and equitable water supply from the system keeping in view the socio-economic, environmental and other relevant factors. In keeping with this broader objective, there is a need for laying stress on economic efficiency in planning, implementation and management of irrigation projects so that the projected benefits are actually realised by the agriculturists. It is against this background that the Steering Committee appointed by the Government of India in May 1981, to consider modernisation and improvement in the existing surface irrigation system, decided to carry out specific studies into the problem areas in the existing irrigation projects in operation.

The study of Mula Irrigation Project in Maharashtra was entrusted to the Water and Land Management Institute, Aurangabad. The study entrusted was in the nature of an evaluation study envisaged to identify the problems of irrigation planning and management involving both technical, technological aspects of irrigation development as well as socio-economic aspects of such a development. The present study was undertaken by the Institute at the instance of the Water and Land Management Institute, Aurangabad as a part of the total evaluation study. We are grateful to them for financial and other support provided to us for this study.

The study enquires into the aspects of planning and implementation for the fuller and timely development of the irrigation system as well as the aspect of management of water distribution and its use for fuller and efficient utilisation of the potential created under the system.

The study points out that the extent of under-utilisation is overestimated by the conventional procedure of estimating it by expressing area actually irrigated as a percentage of potential irrigable area based on project cropping pattern. Taking into account the water actually released during the year, it shows that while water available for irrigation is more or less entirely used up, the area actually irrigated is much smaller than what was expected to be irrigated based on project cropping pattern.

Improvement in the management of water distribution is sought to be brought about through the introduction of the Rotational Water Supply. The study shows that for the Rotational Water Supply to be successful not only is a technically sound distribution network necessary, but effective organisations of the irrigators below the outlet are also necessary for operating such a system.

Long gestation period in developing full potential of the system because of inadequate planning has led to cost

escalation which could have been avoided. A cost benefit exercise carried out for the project shows that extending irrigation over wider area in the canal command by growing seasonal crops instead of sugarcane on more than stipulated area, may not only increase the gross area irrigated, spread over wider area under canal command, but may also improve the benefit-cost ratio of the project.

The study highlights how the delay in the construction of distribution network even after full storage had been created not only led to cost escalation but also to a lop-sided irrigation development, because distribution network only in the upper reaches of the main canal was completed. This resulted into a lower benefit-cost ratio and also encouraged the farmers in the upper reaches of the main canal to grow heavy water using perennial crops like sugarcane and to use water wastefully, contrary to the objective of the project which was to provide protective irrigation over as wide an area as possible.

The conclusions arrived at in the study are of considerable relevance to the planning and management of surface irrigation in water scarce regions like Maharashtra and it is hoped that the study would be found useful in evolving some guidelines in modernisation of the existing new systems and in undertaking future projects.

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V.S. Chitre
Director

2 November, 1987

PREFACE

Fuller and timely development of any irrigation system and its fuller and efficient utilisation, based on the objectives with which the irrigation project is undertaken, are the most important aspects of planning, implementation and management of the irrigation projects.

Timely and fuller development of irrigation system implies development of the full storage (head works) and that of the entire distribution net work within the stipulated period. The obvious consequences of long gestation period are that in the interval between initiation and completion the cost of construction and operation are likely to increase well beyond what was planned and that in the interval the original objectives may be lost sight of.

Fuller and efficient utilisation of irrigation potential developed implies bringing the entire irrigable command area under irrigation based on the stipulated cropping pattern. Again, the obvious consequences of underutilisation of irrigation potential may not only be the adverse effect on the projected benefits from the irrigation system but may also be less than full realisation of the objectives of extending the benefit of irrigation to as large a number of farmers as possible.

For timely and fuller development of an irrigation project proper planning and implementation are the most important aspects and for fuller and efficient utilisation of the potential created proper management of the water distribution and its use are the most important aspects.

In our study we have looked into and analysed both these aspects with a view to examine the nature and extent of the adverse consequences of long gestation period and of underutilisation of irrigation potential, if any, as well as to examine the manner in which water is supplied and used and the factors that determine these and may be responsible for such consequences.

The study was undertaken at the instance of the Water and Land Management Institute (WALMI), Aurangabad. We are grateful to the WALMI for extending financial and other supports to carry out this study.

In completing this study I have had the benefit of receiving detailed comments and suggestions on the earlier draft from Professor Nilakantha Rath. I record my sincere thanks to him for sparing his time for this purpose.

I have also benefited from the discussions I had with Shri H.V. Dhamdhere, (the then) Director of the WALMI. I also express my sincere thanks to Shri P.V. Purandare of the WALMI for extending full support and cooperation at every stage of the work. His contribution in explaining

some of the technical details has been of immense value in preparing this study.

My thanks are also due to Shri N.D. Kamble for carrying out the field work in time and to Shri S.S. Kulkarni for timely help with the tabulation work.

I am also grateful to the concerned officers and staff of the Irrigation Department for their unstinted cooperation and help.

Lastly I owe a debt of gratitude to the Administrative Staff for typing the study report in time and making it available for circulation.

Ashok K. Mitra

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Irrigation in Drought Prone Areas

Ashok K. Mitra

CHAPTER I

INTRODUCTION

1. INTRODUCTION

1.1 Investment in irrigation forms a major part of the strategy of increased agricultural production and rural development in the successive five year plans. This calls for greater efforts on preparation of basinwise regional plans for optimum development of water and related resources, within the national policy framework. There is a greater need for laying stress on economic efficiency in planning, implementation and management of irrigation projects so that the projected benefits to the farmers are achieved. Irrigation planning and management pose problems which are extremely complex. It needs a comprehensive interdisciplinary approach drawing insights and skills from many fields to tackle these complex problems.

1.2 Besides, there is also a need for the development of irrigation technology for the future and for systematic approach to modernisation of irrigation projects which would be serving the needs up to the year 2000 A.D. and beyond. It is against this background that the Steering Committee appointed by the Government of India decided to carry out specific studies into the problem areas in the existing irrigation projects in operation. The study of the Mula Irrigation Project in Maharashtra was entrusted to the Water and Land Management Institute (WALMI), Aurangabad. The study entrusted is in the nature of an evaluation study envisaged to identify the problems of irrigation management and to suggest solutions thereof. Performance evaluation and diagnostic analysis of the project is expected to be useful to assess the practice adopted in planning, design construction and maintenance of the project. Performance evaluation has two aspects; one is the technical and technological aspects of irrigation development and the other is the socio-economic aspect of such a development. The present study, then termed as, Socio-Economic Evaluation

of Mula Irrigation Project, was undertaken by the Gokhale Institute at the request of the WALMI, Aurangabad, as a part of the total evaluation study.

2. THE PRESENT STUDY

2.1 For timely and fuller development of an irrigation project proper planning and implementation are the most important aspects and for fuller and efficient utilisation of the potential created proper management of the water distribution and its use are the most important aspects.

2.2 In our study of the Mula Irrigation System we propose to look into and analyse both these aspects with a view to examine the nature and extent of the adverse consequences of long gestation period and of underutilisation of irrigation potential, if any, as well as to examine the manner in which water is supplied and used and the factors that determine these and may be responsible for such consequences.

2.3 More specifically the study envisages to include the following:

- i) A major question in the economics of irrigation project is the time taken in the construction of the project and the consequent gestation period in commissioning the project. The ultimate cost of the project is very significantly affected by this. In view of this it is proposed to examine this question in detail in regard to the Mula Project.
- ii) The second question relates to the actual availability and use of water under the system, as against the projected coverage and use. This is important in not only working out the economics of the project, but also in examining in detail the question of underuse or misuse of water and in finding out the reasons for divergence, if any, for the purpose of corrective action as well as for guidance in formulation of other such schemes.
- iii) The third question relates to the resulting cropping pattern as against the project cropping pattern in order to examine whether this pattern is the best under the existing state of technological information and market conditions. If it is not so and a hypothetical exercise suggests that a different cropping pattern would be more beneficial, it would be necessary to ask the question why the farmers do not presently follow such crop pattern and practices. Moreover, the manner of supply of water and its application may turn out to be wasteful, thereby affecting the economics of the project. It may also affect the decision of the farmer in regard to the choice of crops and intensity of application of inputs under irrigated

conditions. The size of the farms, and more specifically the area of farm under irrigation command may be another factor influencing the farmers' decision about choice of irrigated crops. And, finally, the prevailing social attitudes of farmers may be relevant factor in influencing such decisions. It would be necessary to raise and try to answer these questions in order to estimate the actual social benefits and the possible alternative benefits, if the necessary policy measures are followed.

- iv) The actual returns to the social economy from this investment project have to be worked out for comparison with the costs mentioned earlier. For estimating the actual returns the concept of 'with' or 'without' irrigation is proposed to be made use of.

3. METHODOLOGY

Firstly the question of fuller and timely development of the irrigation system and its fuller and efficient utilisation has been discussed on the basis of the analysis of the time series data made available from the official records of the system under study. *Secondly* the question of fuller and efficient utilisation of irrigation water and related issues has also been discussed on the basis of the analysis of data collected from the beneficiaries of the scheme. It is expected that the discussion based on such analyses may bring in sharp focus the extent of the adverse consequences of long gestation period and of under utilisation of irrigation potential, if any, and the factors that determine these so as to suggest corrective actions.

The first aspect of such evaluation involves looking into and examining the modification the project underwent from time to time in terms of its location, storage capacity, command area, cropping pattern and consequent cost escalation.

The second aspect of this evaluation is an enquiry into the irrigation potential created and its utilisation over time.

The third aspect of the evaluation comprises the manner in which water is supplied and used both surface water and underground water and the factors that determine these.

The fourth aspect of such evaluation involves working and costs and returns considering the long gestation period and also considering the existing cropping pattern as against the project cropping pattern.

4. DATA NEED FOR THE STUDY

4.1 For the purpose of ascertaining the time taken in fuller development of the project and consequent cost escalation

the following data from the project records are used.

- i) Type of modification brought in the main dam and the distribution system from time to time.
- ii) Yearwise expenditure incurred on the construction of storage and distribution system.
- iii) Yearwise potential created against potential planned.
- iv) Periods over which full storage and distribution system are created against originally planned period.

4.2 For the purpose of ascertaining the *nature and extent* of utilisation of irrigation potential the following data from the project records are used.

- i) The area under different crops proposed to be irrigated as proportion of the total Irrigable Command Area (ICA), as per the project report.
- ii) The total volume of irrigation water proposed to be released as per the project report.
- iii) Yearwise area under different crops actually irrigated.
- iv) Yearwise total quantity of irrigation water actually released.
- v) Yearwise water content in the reservoir at different dates during the year.
- vi) Number of irrigation (rotation) provided and canal and distributory flow in each rotation during the past few years.

4.3 For the purpose of ascertaining the *availability* of water to the irrigators in the command, the *manner* of its use by them and the *costs and returns* from such uses we have collected the relevant data from the sample farmers selected from the cluster of villages falling in different reaches of the canal. The farm costs and returns data so collected have been supplemented by similar data obtained by other survey agencies for getting a surer basis of information. Relevant price data have been collected from the Regulated Market Centres.

4.4 For the purpose of examining the *change and improvement* that is sought to be brought about in the water distribution system through the introduction of RWS (Rotational Water Supply) relevant data have been collected from a sample of farms selected from a pilot scheme on RWS.

4.5 For the purpose of getting additional information on various factors influencing the choice of irrigated crops and level of application of inputs it has been necessary to make purposive selection of some cultivators using well irrigation.

5. SAMPLING FRAMEWORK

5.1 As mentioned earlier for ascertaining the availability of water to the irrigators, the manner of its use by them and the costs and returns from such uses, data have been collected from the irrigators in the command area.

5.2 The sample of irrigators is from the command area of the Mula Right Bank Canal (MRBC) and Branches I and II. The Mula Left Bank Canal (MLBC) has a small command, and we have ignored it for purposes of sampling. The sample of beneficiaries are selected on the basis of a stratified random sampling procedure with village as the primary unit and beneficiaries in the village as the ultimate unit of sampling. As the development of irrigation in the head, middle and tail reaches is likely to be different the villages from all the three reaches of the distribution system are represented in our sample.

5.3 The total number of around 120 villages in the command area of MRBC, Branch I and Branch II are classified into villages falling in the head, middle and tail reaches of the distribution system and then 4 villages from each reach of the distribution system are selected, making a total of 12 villages; a 10 per cent sample selected for study.

5.4 The following statement gives the names of the villages and the section of the distribution system under the command of which these villages fall. In addition 2 more villages (Sondala and Lohgaon) in the unirrigated area are also selected.

5.5 Irrigators from each village are selected by stratified random sampling. The farmers in each village are put in descending order as per size of holding and then stratified into 3 groups, viz., up to 2 hectares, above 2 hectares to 4 hectares and above 4 hectares. Five holdings (farmers) are selected from each group on a random basis, making a total of 15 farmers from each village. Thus in all 180 farmers are surveyed from the command area of MRBC and Branch I and Branch II. In addition 10 farmers in each of the two unirrigated villages are selected for comparison.

5.6 As mentioned earlier, around 30 well irrigators are also selected purposively for study in order to get supplementary and additional information on the factors influencing the choice of irrigated crops and the level of use of inputs under different crops grown under irrigated condition.

STATEMENT GIVING NAMES OF THE SELECTED VILLAGES AND THEIR LOCATIONS

Serial Number	Reach	Village	Location within reach
I	Head	1. Vanjarwadi (Head-Head) H H	Head reach of Sonal distributory and Minor 5
		2. Karanjagaon (Head-Middle) H M	Minor 2 of Sonal distributory - Middle part
		3. Khedle-Parmananda (Head-Middle) H M	Middle part of distributory 3
		4. Khupti (Head-Tail) H T	Tail part of minor 4 of distributory 3
II	Middle	5. Mahalas Palmpalgaon (Middle-Head) M H	Branch 1, distributory 1, Upper part
		6. Malichinchore (Middle-Middle) M M	Branch 1, distributory 1, Middle part
		7. Murme (Middle-Tail) M T	Branch 1, distributory 4, Minor 5 - Tail part
		8. Malewadi (Middle-Tail) M T	Branch 1, distributory 4, Minor 4 - Tail part
III.	Tail	9. Kukana (Tail-Head) T H	Branch II, distributory 1, Minor 2 - Upper part
		10. Chilekhanwadi (Tail-Middle) T M	Branch II, distributory 1, Middle part
		11. Deotaki (Tail-Tail) T T	Branch II, distributory 4, Tail part
		12. Bhalgaon (Tail-Tail) T T	Branch II, distributory 4, Minor 6, Tail part

5.7 A small sample of 14 irrigators out of 100 from a scheme on RWS, introduced on a pilot basis on an outlet, is also selected purposively to examine the extent of changes brought about in the crop-mix and in the level of input use because of the introduction of RWS.

6. CHAPTERWISE SCHEME

6.1 The study is divided into two parts. The first part of the study consists of three chapters. The second chapter deals with the development of the Mula Irrigation System from its inception with details of modification it underwent from time to time in terms of its location, storage capacity, command area, cropping pattern and consequent cost escalation.

6.2 The third chapter of this part deals with the utilisation of irrigation potential created, wherein we examine in detail the meaning of the term potential created and also the manner in which utilisation percentage is ascertained. Implications of these on the actual use of water and the crop pattern that develops are also examined in this chapter.

6.3 The second part of the study comprising five chapters relates to the manner in which water is supplied and used both under canal and well irrigation and what determines this and the way things can be changed. It also relates to working out costs and returns considering the long gestation period and also considering the cropping pattern that has actually developed over the years (with sugarcane restricted to 4 per cent of the crop area) as against the project cropping pattern. This may be possible if the factor governing the water distribution and use can be suitably changed arising out of discussion in the earlier chapters.

6.4 The discussions in the first four chapters (IV to VII) in the second part are mainly based on the data collected from the sample farms of the command area of the project. The fourth chapter presented in the second part deals with the water supply and its use in respect of the sample farmers selected from the cluster of villages falling in the head reaches, middle reaches and tail reaches of the distribution system. The discussion in this chapter is expected to throw light on the way water is supplied and distributed in different reaches of the canal and the consequent crop pattern that develops in these reaches so as to ascertain the reasons for the divergence between the potential created (sic) and actual utilisation.

6.5 In order to ascertain if the timely availability of irrigation water in adequate quantity and at frequent intervals induce the farmer to bring about a change in cropping pattern and in the nature and extent of use of inputs (e.g. fertilizer, hyv seeds etc.), compared to the

canal irrigated area where the water supply is reported to be uncertain and inadequate, we have discussed in the fifth chapter of this second part the cases of well irrigators (with plenty of water in the well and land in the command of the well), specially selected for this purpose.

6.6 In the sixth chapter presented in this part we have discussed the change and improvement that is sought to be brought about in the water distribution system through the introduction of RWS system, which is supposed to ensure required and timely distribution of water. We have evaluated the working of a pilot scheme of RWS introduced on a particular outlet in order to examine the change brought about in the frequency of water distribution and irrigation delta and the consequences of these changes on the cropping pattern and input use by the irrigators under this scheme. The discussion on the manner water supply and distribution can be improved is based on the evaluation of the RWS system introduced on a pilot basis.

6.7 The seventh chapter in the second part relates to the working out of costs and returns considering the long gestation period and the actual cropping pattern that has developed over the years. As mentioned earlier, the purpose of carrying out such an exercise is to highlight the adverse consequences of long gestation period in terms of cost escalation as well as in terms of cropping pattern that develops because of the way in which water is supplied and distributed leading to reduced irrigable command area than what was proposed. An exercise with alternative crop pattern, with sugarcane restricted to 4 per cent of crop area is also carried out to emphasise that if distribution system can be improved and consequently if the area under irrigation can be increased (extended over greater portion of ICA), the benefit-cost ratio is likely to improve.

CHAPTER II

MULA CANAL SYSTEM
DEVELOPMENT AND PROJECT OUTLAY

1. PROJECT FORMULATION AND DEVELOPMENT

1.1 Mula project was administratively approved for Rs. 933 lakhs vide Government of Bombay, PWD resolution Number M.I.P. 3857-J, dated 1.11.1957. The original project envisaged construction of 200 feet (61 metres) high masonry dam at Vanjarwadi impounding 22,252 Mcft (630 million cubic metre) of water and of a direct canal, 44 miles (70 kilometre long, taking off on right bank and irrigating 131,250 acres (53110 hectares). The break-up of the original cost of the project was as follows:

I Head works	Rs. 604 lakhs
II Main canal and its branches	Rs. 198 lakhs
III Distributories, Minors etc.	Rs. 110 lakhs
IV Establishment and Other Charges	Rs. 21 lakhs

The salient features of the original project were as follows:

1 Catchment area	927 Square miles
2 (a) Average yield (25 years)	35,000 Mcft
(b) Maximum yield	63,688 Mcft
(c) Minimum yield	13,748 Mcft
(d) 75 per cent dependable yield	28,500 Mcft
3 (a) Gross Storage	22,250 Mcft
(b) Live Storage	20,900 Mcft
4 (a) Gross utilisation	28,430 Mcft
(b) Net utilisation	20,900 Mcft
5 (a) Gross command area	275,000 acres
(b) Culturable command area	220,000 acres
(c) Irrigable command area	131,250 acres

6	(a) Length of right bank canal	44 miles
	(b) Capacity	1,350 Cusecs
7	Crop pattern - as percentage of Irrigable Command Area of 131,250 acres	
	(a) Perennials	
	i) Basic cane	14.00
	ii) Overlap	4.05
	(b) Cotton (two seasonals)	10.40
	(c) Kharif seasonals	28.45
	(d) Rabi seasonals	43.00
	(e) Hot weather seasonals	4.10

		104.00

2. STATEMENT ABOUT GCA, CCA AND ICA

2.1 Before we proceed with the modification, changes and revision that the original project underwent it would be useful to clarify the meaning of the command area of the project and the consequent irrigable area in the project command. There are three terms which are used in connection with the command area of any irrigation system; these are (i) Gross Command Area (GCA), (ii) Culturable Command Area (CCA) and Irrigable Command Area (ICA). The GCA denotes, the area between the river on which the dam is built and the main canal/s and includes, the entire culturable and unculturable land. The CCA denotes, only the culturable part of the gross command area and is arrived at, by subtracting the hilly areas and other areas not available for cultivation from the GCA. The ICA denotes the area to which irrigation water from the system can be provided. So, the entire CCA may not be irrigable. In the present case this ICA is around 60 per cent of the CCA. The ICA therefore indicates the net area irrigable with the distribution channels to be laid out.

2.2 As depicted earlier the net irrigable area according to the original project proposal was 131,250 acres. The cropping pattern presented earlier suggests the proportion of irrigable area proposed to be brought under irrigation under different crops during the entire irrigation year from July 1st to June 30th of the succeeding year. To arrive at the cropping intensity based on the proposed cropping pattern areas under perennials and two seasonals are counted only once. In point of fact if the areas under perennials and two seasonals are counted more than once, as they should be, the cropping intensity would turn out

to be more than 100 and hence the gross irrigated area would be greater than the ICA. We now discuss the revisions that the original project underwent over the years.

3. MODIFICATIONS AND REVISIONS IN THE ORIGINAL PROJECT

3.1 The dam originally proposed at *Vanjarwadi* involved deep foundations with heavy dewatering and difficult river diversion which was unexpected. So the alternative dam sites were considered up to 1960 and finally after detailed investigations of the alternative dam sites and study of cost economics, it was decided to shift the dam site and build an earthen dam at *Boregaon Nandur* with storage capacity of 26,000 Mcft (740 Mm³). The shift in the dam site was a major change in the scope of the project and implied a higher storage (26,000 Mcft) at the new site compared to a contemplated storage of 22,250 Mcft at the original site.

3.2 Meanwhile across the river Godavari, near *Paithan* in Aurangabad district, *Jaykwadi* project head works were decided to be built to harness Godavari water for irrigation downstream in Marathwada region of Maharashtra. The storage at *Jaykwadi* involved submergence of 36,000 acres (14,570 hectares) of gross command of *Mula* project in *Shevgaon* taluka of *Ahmednagar* district. This submergence necessitated investigation of additional command elsewhere for utilisation of *Mula* water. This also called for review and recasting of hydrology and water planning of the project, taking into account the additional data available by then.

3.3 Accordingly the project was reviewed in 1966 and the revised project in 1966 envisaged the construction of 153 feet (47 m) high dam at *Boregaon Nandur* with a gross storage of 26,000 Mcft and canals on both banks to irrigate 159,000 acres (64345 hectares) with revised crop pattern. Out of the ICA of 159,000 acres envisaged in the revised project, 134,000 acres (54230 hectares) were proposed on MRBC and 25,000 acres (10115 hectares) on MLBC.

3.4 The salient features of the revised project were as follows:

1.	Catchment area		878 square miles
2.	Yield (70 per cent reliability)		27,100 Mcft
3.	Storage	(a) gross	26,000 Mcft
		(b) net	21,500 Mcft
4.	Utilisation	(a) gross	28,100 Mcft
		(b) net	25,600 Mcft
5.	ICA		159,000 acres (64345 hectares)

6. Crop pattern - as percentage of ICA of 159,000 acres (64345 hectares)

i) Sugarcane	8.00
ii) Other perennials	4.00
iii) Cotton (two seasonals)	18.00
iv) Other two seasonals	8.00
v) Kharif seasonals	30.00
vi) Rabi seasonals	40.00
vii) Hot weather seasonals	4.00

	112.00

3.5 It is seen that the revised project envisaged construction of the dam of a greater height and a larger storage. As a result of this the irrigable command area of the revised project increased from 131,250 acres to 159,000 acres, to be irrigated by the MRBC and MLBC. The revised cropping pattern also suggests a higher cropping intensity. In this case a cropping intensity of 112 per cent presumably means that the actual area to be irrigated (gross irrigated area) during the irrigation year is 12 per cent more than the ICA. In point of fact if the area under perennials and two seasonals are counted more than once the cropping intensity as well as gross irrigated area would appear still higher.

3.6 The revised project was estimated to cost Rs. 1611 lakhs in 1966. The estimated revised project cost was as follows:

I	Head works	Rs. 1001 lakhs
II	Main canals	356 lakhs
III	Distribution system	98 lakhs
IV	Establishment and other charges	156 lakhs

These project estimates were based on the expenditure incurred till then and the anticipated expenditure of the residual work. It appears that the project cost increased by around 70 per cent due to revision. The main reasons for such a rise in cost is reported to be change in rates, change in dam site, addition of MLBC and distributories in the distribution net work and increased survey and investigation work etc. Out of these items due to which the estimated cost of the revised project increased, change in rate is due to cost escalation because of delay in construction and the change in dam site which were not anticipated.

3.7 Subsequent to the finalisation of the 1966 project there was persistent demand for extending the irrigation

benefits to a larger area. *Pathardi* taluka of Ahmednagar district is a chronic scarcity area and it was thought desirable to extend irrigation from MRBC to cover some area in that taluka by providing seasonal irrigation. With this consideration crop pattern was modified in 1973 and the areas proposed to be brought under irrigation (ICA) were modified as under:

i) MRBC	59,290 hectares
ii) MLBC	4,330 hectares
iii) <i>Pathardi</i> Branch	11,400 hectares
Total ICA	75,020 hectares

The modified crop pattern as percentage of ICA under MRBC + MLBC and as percentage of ICA under *Pathardi* branch was as follows:

Crop	For MRBC + MLBC ICA = 63,620 hectares	For <i>Pathardi</i> branch ICA = 11,400 hectares
1. Sugarcane	4.00	Nil
2. Other perennials	2.00	Nil
3. Two Seasonals	26.00	10.00
4. Kharif Seasonals	28.00	50.00
5. Rabi Seasonals	43.00	63.00
6. Hot Weather Seasonals	3.00	Nil
	-----	-----
	106.00	123.00

3.8 Modification of the cropping pattern in 1973 and consequent extension of irrigation through *Pathardi* branch canal lead to increase in the ICA of the project thereby increasing the possibility of using the available irrigation water more extensively.

3.9 In the year 1974 further changes were made in the project. Lift irrigation scheme on upstream of canal for an area of 4900 hectares and demand for increased irrigation on the Pravara RBC using water from MLBC up to 10120 hectares were accepted. In 1974, again the cost estimates of the project were revised and the revised total cost of the project according to 1974 estimates were as follows:

i) Head Works	Rs. 1,668 lakhs
ii) Main Canal and Branches	Rs. 569 lakhs
iii) Distribution System	Rs. 187 lakhs
iv) Establishment and Others	Rs. 77 lakhs

	Rs. 2,501 lakhs

It is seen that the cost estimates had increased by Rs. 1,568 lakhs (168 per cent) over the original 1957 estimates. The factors accounting for the excess cost estimates over 1957 are reported to be change in rates, land acquisition, change in dam site and additional work on the distribution system. We could not get the break-up of the estimated excess cost on the items mentioned above, but, it is reported that cost escalation due to delay in executing the work and the change in dam site are mainly responsible for such a rise in total cost of the project as estimated in 1974.

3.10 Finally in the year 1977, some more modifications were made in the cropping pattern and the irrigable areas under different canals in the project were as under:

i) MRBC	59,290 hectares
ii) MLBC	10,120 hectares
iii) Pathardi Branch Canal	11,400 hectares
iv) Lifts	4,900 hectares

	85,710 hectares

The revised water planning in 1977 also provided for water requirement of Mahatma Phule Krishi Vidyapeeth, Tank Water Supply for Ahmednagar and other places, sugar factories etc. According to the 1977 water planning the command under the Mula project was divided into the zones, namely, (i) perennial zone and (ii) non-perennial zone. In the perennial zone sugarcane and other perennials were permitted and in non-perennial zones only kharif, rabi and two seasonal crops were permitted. The MRBC with Branch I and II and MLBC come under perennial zone and only Pathardi branch of MRBC falls under non-perennial zone. The salient features and the cropping pattern of the two zones are as under:

1. Catchment area	2274 Km ²
2. (a) Maximum yield	1773 Mm ³
(b) Minimum yield	358 Mm ³
(c) Average yield	942 Mm ³
(d) 70 per cent dependable yield	767 Mm ³
3. (a) Gross storage	736 Mm ³
(b) Live storage	609 Mm ³
4. (a) Gross utilisation	825 Mm ³
(b) Net utilisation	749 Mm ³

5. (a) GCA 127187 hectares
 (b) CCA 118202 hectares
 (c) ICA 80810 hectares
6. (a) Length of MRBC 58 KM
 (b) Length of MLBC 18 KM
7. Villages Benefitted

	Taluka	Number of Villages	Area under Irrigation Command
a)	Rahuri	24	17287 hectares
b)	Newasa	89	44636 hectares
c)	Shevgaon	24	14434 hectares
d)	Pathardi	12	4453 hectares

8. Crop pattern as percentage of ICA under MRBC + MLBC (perennial zone) and as percentage of ICA under Pathardi Branch Canal (non-perennial zone).

Perennial Zone ICA = 69410 hectares		Non-perennial Zone ICA = 11400 hectares	
Crops	Percentage	Crops	Percentage
1. Perennial			
a) Sugarcane	4.00		Nil
b) Other perennials	1.00		-
	<u>5.00</u>		
2. Two seasonals			
a) Cotton (L.S.)	11.50	Turmeric	5.00
b) Chillies	8.00	Chillies	5.00
	<u>19.50</u>		<u>10.00</u>
3. Kharif seasonals			
a) Hybrid Bajra	8.00	Hybrid Bajra	15.00
b) Paddy	3.00	Maize Hybrid	5.00
c) Groundnut	8.00	Groundnut	20.00
d) Vegetables (Onion)	11.50	Vegetables	7.00
	<u>30.50</u>	Green Manure	3.00
			<u>50.00</u>
4. Rabi seasonals			
a) Wheat	13.00	Wheat	15.00
b) Jowar	20.00	Jowar	35.00
c) Hybrid Maize	7.00	Fodder	8.00
d) Gram	3.00	Vegetables	5.00
	<u>43.00</u>		<u>63.00</u>
5. Hot weather seasonals	3.00		-
6. Others (pulses etc.)	4.00		-
	<u>105.00</u>		<u>123.00</u>

3.11 The revised cropping pattern of 1977 which is supposed to be in operation in Mula irrigation system is considerably different and diluted from the one originally formulated in 1957 and subsequently revised in 1966. The areas under cane and other perennials are reduced to 4 per cent and 1 per cent from 18 per cent under cane in 1957 and from 8 per cent under cane and 4 per cent under other perennials respectively in 1966, in order to eliminate or at least alleviate water lagging problems. The reduction in perennials is made good by providing equally well paying cash crops like long staple cotton and chillies. The soil is stated to be eminently suited for growing long staple cotton. As the existing cropping practices indicated preference by farmers for rabi crops, the area under rabi crops was increased from 35 to 40 per cent to 43 per cent in the perennial zone and to an additional 63 per cent in non-perennial zone. Further, the extension of MRBC to the Pathardi Branch Canal would make it possible to provide irrigation to seasonal crops in the chronic scarcity affected areas. The above changes were contemplated to bring about an increase in the ICA of the system from 131,250 acres (53110 hectares) to 80810 hectares. Transit losses in the original project were assumed to be 10 per cent uniformly for the seasons which seemed to be inadequate, so, as per revised project the transit losses in canal were to be assumed at 10 per cent, 20 per cent and 25 per cent during kharif, rabi and hot weather seasons respectively.

3.12 The project was expected to be completed in all respects by March 1980. As such the revised estimates of Rs. 2,501 lakhs in 1974 took into cognizance the actual cost incurred up to 1974 and the expenditure that was likely to be involved thereafter to complete the project in toto. However, according to further revised estimates (1979) the latest cost of the Mula project was to be approximately Rs. 2,767 lakhs (Rs. 2,501 lakhs as per 1974 project report + Rs. 230 lakhs excess in Pathardi branch canal + Rs. 36 lakhs for remodelling of MRBC).

3.13 In the preceding section we have given a brief account of the original project proposal as also of the revision and modification that the original project proposal underwent from time to time. In what follows we attempt to give a brief account of the actual execution of the construction work in different stages and the present state of affair as regards the completion of the work.

4. PROGRESS OF CONSTRUCTION OF THE DAM AND THE DISTRIBUTION SYSTEM

4.1 The proposal to construct the earthen dam at *Boregaon Mandur* were finalised in the year 1960 and thereafter the construction work of the dam was started. In the year 1966, it was expected that full storage could be had against the gate by June 1971, but, that could actually be done only by June 1974. The construction was prolonged because of serious problems in the foundation and the gorge filling of

the dam could be completed only in the year 1969 and a partial storage was created in June 1969. The remaining works of dam were completed by 1974 and, as mentioned earlier, full storage against gates was created in June 1974.

4.2 Out of the net work of distribution system, the construction of MRBC was taken up simultaneously with the dam and after completing part length of the canal irrigation was started in the year 1972-73. The remaining part of the MRBC was completed in 1973-74 and the construction of MLBC was completed in 1974-75. However, part irrigation on these started only from the year 1975-76. The tail distributory was completed in the year 1976-77 and commissioned for irrigation in the year 1977-78. The work of Pathardi Branch Canal (non-perennial zone) started in the year 1975 and originally it was proposed to be completed in the year 1980. However, only part irrigation could be started on it in 1981-82. It was further proposed to be completed by the year 1983, however, the works on this branch was still in progress at the beginning of 1983.

5. EXPENDITURE ON THE PROJECT

5.1 The yearwise expenditure incurred on the project, made available by the Ahmednagar Irrigation Circle is given below. The details of the yearwise expenditure would give an idea of the time period of the expenditure incurred on different works, e.g. on dam and storage, on main canal and its branches and on distribution system.

STATEMENT SHOWING YEARWISE EXPENDITURE ON THE SCHEME

(in Rs. lakhs)

Year	Actual expenditure on works	Expenditure on establishment	Total expenditure	Mile stone
1956-57	12.68	-	12.68	Administrative approval
1957-58	15.72	1.02	16.74	
1958-59	34.44	3.72	38.16	Dam site change, work started
1959-60	47.74	4.14	51.88	
1960-61	93.94	3.88	97.82	
1961-62	57.59	4.22	61.81	
1962-63	42.74	4.03	46.77	
1963-64	78.27	6.25	84.52	
1964-65	79.30	8.03	87.33	
1965-66	203.61	11.28	214.89	
1966-67	78.05	13.80	91.85	
1967-68	125.27	13.80	139.07	

STATEMENT SHOWING YEARWISE EXPENDITURE ON THE SCHEME (Contd...)

Year	Actual expenditure on works	Expenditure on establishment	Total expenditure	Mile stone
1968-69	205.85	18.15	224.00	
1969-70	210.42	21.43	231.85	Partial storage created
1970-71	228.59	17.47	246.06	
1971-72	204.68	22.72	227.40	MRBC (Part) commissioned
1972-73	135.10	25.45	160.55	Branch I of MRBC commissioned
1973-74	119.93	22.43	142.36	Full storage created and Branch II of MRBC commissioned
1974-75	47.08	22.28	69.36	MLBC completed
1975-76	47.77	24.00	71.77	MLBC (Part) commissioned
1976-77	90.35	23.40	113.75	Tail distributory completed
1977-78	113.81	13.67	127.48	Tail distributory (Part) commissioned
1978-79	82.31	12.42	94.73	
1979-80	59.04	14.10	73.14	
1980-81	48.01	34.88	82.89	Pathardi Branch (Part) commissioned
1981-82	-	-	87.09	
1982-83	-	-	117.50	
1983-84	-	-	46.55	

			3060.00	

5.2 It appears that in the initial years, i.e. during 1956-57, 1957-58, 1958-59 and 1959-60 an expenditure of around Rs. 111 lakhs was incurred on survey and other preliminary work, e.g. roads, buildings, etc., and, as mentioned earlier, during this period the decision to change the dam site from Vanjarwadi to Boregaon Nandur was also taken. Real work on the dam could be started only in 1960-61 and a partial storage could be created only in 1969-70. The gates were ready and full storage was created by June 1974. The total expenditure incurred on the project up to 1973-74 was Rs. 1980 lakhs, of which the expenditure on dam was of the order of Rs. 1,560 lakhs.

5.3 Expenditure on canal and distribution net work, construction of which was taken up simultaneously, was only Rs. 420 lakhs from 1960-61 to 1973-74. This was estimated to form only 50 per cent of the estimated cost of canal and distribution net work. As a result of this only a small

part of the MRBC and MLBC could be commissioned for irrigation when the full storage was created. The work of the dam was delayed because of the problems of foundation, but, it is not known why this period was not utilised for completion of the canal and branches so that irrigation could have been started on a larger area immediately after completion of the dam and filling of the reservoir. In point of fact the entire distribution net work which was scheduled to be completed by 1980, according to the 1974 revised project report, was under progress even during 1983-84.

5.4 The above observation is typical of most of the major and medium irrigation projects. The construction of canal and distribution net work always lag behind very much, as a result when the full storage is created the canal and distribution net work are not ready for using the stored water fully. This not only adversely affects the benefits from the project, but, also leads to the development of cropping pattern in the head reaches of the canal which is against the interest of irrigation development, particularly in the drought prone areas. We shall re-open this issue in later chapters when we discuss the issue of irrigation potential created and utilised and that of cost-benefit analysis of the project.

5.5 In this context it would be relevant to quote here what Robert Wade wrote about irrigation projects. "Long gestation period is a characteristic of all irrigation projects. The obvious consequence of the long gestation period is that in the interval between initiation and completion the cost of construction and operations are likely to increase well beyond what was planned. Two other important consequences are, firstly, since the difficulties become apparent only gradually, irrigation project once started are rarely abandoned, there is a risk therefore that good money will be thrown after bad, and secondly that, in the interval, the original objectives may be lost sight of".¹

¹ "Performance of Irrigation Projects" - Robert Wade, *Economic and Political Weekly*, January, 17, 1976, p. 64.

CHAPTER III

IRRIGATION POTENTIAL AND ITS UTILISATION

1. INTRODUCTION

1.1 Due to the increasing emphasis that is being given in recent times on faster development of irrigation facilities in the country, it is necessary to ensure that scientific methods of assessment of irrigation potential created and its actual utilisation are adopted so that the correct picture regarding these is projected. It would be necessary therefore to recollect the concept and meaning of irrigation potential created in respect of an irrigation system. So much has been written on this aspect and so often it has been discussed and yet when one wants to look into the question of utilisation of irrigation potential created in respect of a particular irrigation project one is confronted with a number of unanswered questions in relation to the potential created and its utilisation.

2. CONCEPTUALISATION OF IRRIGATION POTENTIAL AND UTILISATION

2.1 Let us proceed with the definition of irrigation potential as defined by the Planning Commission and accepted widely including the irrigation system under study. According to the Planning Commission, "Irrigation potential is the gross area that can be irrigated from a project in a design year (1st July to 30th June of the succeeding year) for the projected cropping pattern and assumed water allowance on its full development. The gross irrigated area will be the aggregate of the areas irrigated in different cropping seasons, the areas under two seasonal and perennial crops being counted only once in a year". It has been further explained that before an area is included and reported under 'potential created', it has to be ensured that the water for the area to be reported upon is available and the conveyance system up to and including irrigation outlet to serve an area up to 40 hectares in the area is completed.¹

2.2 From the definition it is clear that theoretically there are three important considerations to declare an area irrigable (potential created) from an irrigation system, and these are: (i) availability of water for the area proposed to be irrigated in each season during the irrigation year, (ii) the availability of conveyance system to carry the water up to the outlet head, (iii) and the adherence to the projected cropping pattern. Given these considerations if the area actually irrigated during the

¹

Report of the High Power Committee, Irrigation Department, Government of Maharashtra, November 1981.

irrigation year is smaller than the area contemplated to be irrigated (potential created) then there is a case of underutilisation. It logically follows from this that whenever underutilisation is reported during an Irrigation year it means that part of the water in storage for irrigation has remained unused. As mentioned earlier, irrigation utilisation is expressed as a percentage of actual irrigated area to the potential created. It presumably means given the same cropping pattern, whatever is the percentage of area actually irrigated is also the percentage of water actually used up from the storage for irrigation during the year. In other words, for instance, if only 50 per cent of the potential area is actually irrigated, it follows that only 50 per cent of the water has been utilised. Under this condition the underutilisation, if any, can be explained by the lack of on farm development, e.g. land levelling, preparation of field channels, etc., and also by the slow acceptability of irrigated agriculture by the beneficiaries because of which even though the water is available, conveyance system up to outlet is ready, the proposed area is not actually irrigated.

2.3 However, in actual practice these conditions, to declare an area irrigable (potential created), are hardly fulfilled and yet the utilisation percentages are estimated as above in most of the studies and reports which result into distorted pictures of the extent of utilisation. Firstly, potential is often declared to have been created without the construction of proper distribution network, as a result of which even if adequate water is available in the system the projected area cannot be brought under irrigation because of inadequate conveyance network. In other words, potential created figures are themselves inflated, which when used to estimate the utilisation percentage, give higher estimates of underutilisation. Secondly, water available in the storage in a given year may be much less than what is estimated on the basis of dependability percentage which will lead to smaller area being irrigated and hence to lower utilisation percentage. Thirdly, and most likely, the cropping pattern in the ensuing years might have changed considerably such that the entire potential created cannot be irrigated, hence utilisation percentage would be lower if estimated considering the potential created based on the projected cropping pattern.

2.4 All these arguments go to suggest that the conventional way of viewing the extent of utilisation as area actually irrigated as percentage of potential created based on projected cropping pattern may at times be misleading in as much as it underestimates the utilisation percentage. For getting a clearer and truer picture of underutilisation, it would be necessary to take account of the amount of water actually released during the year from the quantity in the storage meant for irrigation, in addition to the area actually irrigated.

2.5 Considering the water actually released for irrigation one can estimate the area that can be irrigated considering the cropping pattern that has actually developed and based on the duty assumed and transmission and distribution losses assumed in the project. If the area actually irrigated is less than the estimated area then there is underutilisation. Similarly entire water meant for irrigation may not be used up. The surplus water in the storage is also an indication of underutilisation. The area that could have been irrigated with this surplus water, considering the actually developed cropping pattern, assumed duty and assumed transmission and distribution losses, can also be estimated. The actual irrigated area as percentage of the total of the two estimated irrigable area would give the utilisation percentage. The reasons for underutilisation can then be sought in inadequate on farm development to receive irrigation water, lack of demand for irrigation water, high duty and low transmission and distribution losses assumed and finally in unauthorised use of irrigation water.

2.6 Keeping these factors in view in what follows we have discussed the questions of irrigation potential and its utilisation in respect of the present system under study.

3. UNDERUTILISATION AND ITS MEASURES

3.1 According to 1966 project report, irrigation in Mula project was expected to begin in the year 1969-70 and was to be fully developed by 1975-76. Irrigation could, however, be started only in the year 1971-72 when part potential was created on MRBC. Table 3.1 gives the annual potential planned (as per 1966 project report), annual creation of potential and its utilisation as reported by the project authorities. A comparison of potential planned and potential created shows that no potential was created during 1969-70 and 1970-71 even though it was planned. However, during the period between 1971-72 and 1974-75 yearly creation of potential more or less matched with the yearly potential planned.

3.2 This happened mainly because of the slow progress of work of the construction of distributories and outlets. Though the work on the net work of distribution system began along with the head works, soon it started lagging behind and by the time full storage was created the distributories, minors and outlets were ready for use only at the upper reaches of the system. Similarly, the actual utilisation fell far short of planned utilisation, particularly after 1972-73 again because of the reason of considerable lag in the creation of distribution net work.

3.3 We now compare the yearly potential reported to have been created and yearly actual utilisation. From the table it is clear that the extent of utilisation calculated as per cent of yearly potential created is low and that it varies considerably from year to year. It can be said that, estimated in this manner, utilisation percentage generally

varied between 40 and 55 per cent during different years.

3.4 Following from our discussion earlier, the question arises whether the annual utilisation percentage arrived at and presented in Table 3.1 gives a correct picture of the same. In our attempt to find an answer to this question we shall proceed step by step as follows. We shall first look into the annual estimates of storage in the reservoir, gross utilisation for irrigation, storage at the end of each irrigation year and the total inflow.

3.5 Storage as on 1st July of every year means carry over water from the last irrigation year. Dead storage for the Mula project is 4500 Mcft, and carryover is put at 1000 Mcft., so 5500 Mcft of water need be left in the storage at the end of each irrigation year. We find from Table 3.2 that except for the first two years, i.e., in 1972-73 and 1973-74, when full storage had yet not been created, more water is left in the storage at the end of the each irrigation year than is required. On the basis of this observation the possibility of inadequate storage as one reason for underutilisation of irrigation potential may be ruled out.

3.6 The project is planned to store a maximum of 26,000 Mcft of water and again we find from the table that except in the first two years, when the full storage had yet not been created, the maximum storage in all other years matches fairly with the planned storage. Similarly, the total annual inflow, which comprises water used for irrigation, used for other purposes, overflow, lake losses and the difference between the lake content at the beginning and at the end, also shows that in 7 out of 10 years 70 per cent dependable yield (27,000 Mcft) was available.

3.7 Again, according to 1977 project report water planning, around 24,000 Mcft. of water was to be released for irrigation each year and from the table we find that actual water released for irrigation each year from 1977 onwards fairly matches with the planned released. All these observations go to suggest that availability of water in the system was not a constraint for maximisation of utilisation.

3.8 However, these broad indicators do not tell us anything about the extent of utilisation; for that we have to examine the water planned to be released for irrigation during different seasons, corresponding area planned to be irrigated as per the projected cropping pattern and water actually released in different years during different seasons and corresponding area actually irrigated as per the developed (actual) cropping pattern. We, therefore, proceed to look into the available data to examine these aspects.

3.9 Table 3.3 presents the project water planning in terms of volume of water to be released and areas to be irrigated during different seasons as per 1977 project report.

Tables 3.4 and 3.5 present the actual water released and actual area irrigated during different seasons during the past five years beginning from 1976-77.

3.10 A comparison of Table 3.2 and Table 3.3 and Table 3.4 shows that although the total quantity of water actually released every year for irrigation fairly matches with the planned release, actual area irrigated during each of the five years is much smaller than the area planned to be irrigated. Seasonwise water released during each year shows that while water released during kharif and rabi seasons matches fairly well with what was planned to be released during these two seasons in all the years except in 1979-80, water released in the case of hot weather season is much higher (almost double) than the planned release. However, the area irrigated in each of the seasons in all the years is much smaller than the area planned to be irrigated as per 1977 project plan. The extent of utilisation estimated as percentage of area actually irrigated in each season (Table 3.5) to the corresponding area planned to be irrigated (Table 3.3) is presented in Table 3.6.

3.11 The extent of utilisation estimated in this manner shows that the overall utilisation percentage is a little under 50 per cent. Among the three seasons utilisation percentage is considerably higher in the hot weather season which also shows continuous improvement over the years; utilisation percentage is lowest in kharif season and in the rabi season the utilisation percentage is generally of the same order as it is for all seasons. The foregoing account shows that while annual water released for irrigation matches fairly well with the planned release, corresponding area irrigated is considerably smaller than what was planned. In other words, while water available for irrigation is more or less entirely used up, the area expected to be irrigated with the released water is not fully irrigated. What could be the reason for that?

4. FACTORS RESPONSIBLE

4.1 We can think of three conceivable reasons for this state of affair. *Firstly*, the cropping pattern that has actually developed is markedly different from the one proposed, such that the areas under heavy water using crops are considerably higher than what were proposed, leading to less area that could be irrigated with the same amount of water than was proposed. *Secondly*, there may be unauthorised irrigation to a considerable extent which does not get reported in the area irrigated. *Thirdly*, the irrigation duties assumed are much larger and the transmission and distribution losses assumed are smaller in estimating the areas to be irrigated than actuals, resulting into less area actually irrigated than what was planned.

4.2 It appears all these factors together are responsible for smaller area being reported as irrigated than what was planned. As we have no information or data about what actually ought to be the irrigation duties at canal and distributory heads and also what actually are the transmission and distribution losses considering the soil and other agro-climatic conditions, we shall attempt to look into the two other factors, namely, changed cropping pattern and unauthorised irrigation, responsible for smaller area reported to be getting irrigated than what was planned.

4.3 Let us begin by examining the proposed cropping pattern and the actual cropping pattern that has developed over the past five years, presented in Table 3.7.

4.4 We find that sugarcane which was proposed to occupy only 4 per cent of the ICA actually occupies around 12 per cent of the area actually irrigated. Similarly, hot weather groundnut, which has only 3 per cent of ICA in the proposed cropping pattern, occupies around 12 per cent of the actual irrigated area. On the other hand, the proportion of areas under kharif seasonals and cotton to area actually irrigated are much smaller than those proposed in the project cropping pattern. In terms of absolute area also it is noted that the areas actually irrigated under sugarcane and groundnut are much higher than what were proposed in the project cropping pattern. It would not be unreasonable to assume that because of the increase in irrigated area under these heavy water using crops, mainly sugarcane, that the actual irrigated areas under kharif and rabi seasonal crops are smaller than what were proposed in the project cropping pattern thereby reducing the magnitude of total area that could be irrigated compared to what was planned.

4.5 It is estimated that the water required to irrigate a hectare of sugarcane can irrigate approximately 10 times the area (around 10 hectares) under seasonal grain crops. Similarly, it is estimated that water required to irrigate a hectare of hot weather crop can irrigate approximately three times (around 3 hectares) of kharif and rabi seasonal crops.®

4.6 We have seen that an additional area of 1065 hectares of cane and an additional area of 1760 hectares of hot weather groundnut have been brought under irrigation than what were proposed in project cropping pattern. In order to demonstrate how much of additional area under seasonal grain crops could have been brought under irrigation in lieu of growing additional sugarcane and groundnut, we

® Depth of water at canal head for the Mula System as per 1977 water planning for Sugarcane in 4.3 meter (annual) and for kharif, rabi and hot weather seasonals are 0.35 meter, 0.45 meters and 1.00 meter respectively.

subtract these additional areas (1065 ha + 1760 ha.) from the total area irrigated and instead add 10 times the sugarcane area, i.e. 10651 ha. and 3 times the groundnut area, i.e., 5280 ha. of seasonal grain crops to the total irrigated area. On account of this change the total irrigated area, average of past 5 years, increases from 42834 hectares (Table 3.5) to 55939 hectares, thereby increasing the utilisation percentage from 49.29 (projected 86900 hectares, utilisation 42834 hectares) to 64.37 (projected 86900 hectares and utilisation 55939 hectares). This exercise indicates that the utilisation percentage appears approximately 15 per cent lower than what it actually is because of the changed cropping pattern and hence because of estimating the utilisation percentage by considering the project cropping pattern rather than the observed cropping pattern. It is a moot point if the apparent lower utilisation due to change in cropping pattern should be called underutilisation at all or simply misutilisation.

4.7 Our next stage of enquiry takes us to the earlier observation that there may be unauthorised irrigation to a considerable extent which do not get reported thereby affecting the utilisation percentage adversely. We do not have any direct evidence to drive this point home but indirect evidences suggest that there are serious possibilities of unauthorised use of water for irrigation. Let us examine these indirect evidences.

4.8 Sugarcane in Mula command can be classified as under, (a) sugarcane exclusively on canal, (b) sugarcane exclusively on well, and (c) sugarcane on both canal and wells. Sugarcane grown exclusively on canal is given annual sanction which is restricted to the percentage permitted in the sanctioned cropping pattern (4 per cent of ICA). Sugarcane on both canal and well is primarily cane grown on well with supplemental irrigation from canal by seasonal sanctions. When the full storage was created in 1973-74 and irrigation started, the full canal system and distributory network were not ready. As a result large quantity of water remained unused in the reservoir from year to year (refer Table 3.2, years 1974-75, 1975-76 and 1976-77). Farmers growing sugarcane on well started demanding increasingly the supply of canal water to supplement the water from wells. Realising that there exists an unending possibility of getting the supply of canal water to supplement the water available from well for growing cane, over the years the farmers have been increasing the area of cane on well getting supplementary supply of canal water.

4.9 Number of wells increased from 6800 in 1972 to 8200 in 1981 and the area under sugarcane on well has increased from 2400 hectares to 6400 hectares during the same period. Out of this increase in area under sugarcane on well, area under cane on well supplemented by canal increased from 740 hectares to around 4400 hectares, whereas cane grown exclusively on well water increased from 1710 hectares to 2020 hectares.

4.10 It is on account of sugarcane grown on well with supplementary irrigation from canal and sugarcane grown exclusively on well that there exists a serious possibility of unauthorised use of canal water. Although sanction given for this purpose is seasonal and the irrigation from canal is supposed to be of supplementary in nature, a considerable proportion of the area under cane on so called well-cum-canal may be getting fully irrigated by canal water only, or at least largely. There is no way of checking this unauthorised use because of common field channels for well and canal irrigation. So, even though the sugarcane area irrigated in this manner is not understated the actual water used for irrigation is much greater than what it ought to be for providing supplementary irrigation thereby adversely affecting the availability of water for the grain crops.

4.11 Further, a part of the area under cane reported to be fully under well irrigation may also be getting the unauthorised supply of canal water. We cannot ascertain the magnitude of such unauthorised use, but, it would not be unreasonable to assume that part of the underutilisation even after adjusting for the cropping pattern changes can be explained by the unauthorised irrigation not getting reported. Our discussion with the canal officials and with the irrigators during the course of field investigation brings out the unauthorised use as a distinct possibility.

5. RESULTING IMPACT

5.1 Increase in the area under sugarcane (a very heavy water using crop) not only affects the utilisation percentage, both directly and indirectly, but also has a serious repercussion on extensive use of irrigation water, specially in a drought prone area like Western Maharashtra, where the main objective of the irrigation system is to provide protective irrigation to as extensive an area as possible. Development of irrigation in different reaches of the command (head reach, middle reach and tail reach) should give some idea about the concentration or otherwise of the irrigation. In order to examine this aspect we present below the information about the crops irrigated on some selected MRBC distributories from the three reaches (head, middle, tail), made available by the Ahmednagar Irrigation Circle and the WALMI.

5.2 The empirical evidence indicates that the utilisation percentage is higher in the head reaches than in the tail reaches of the canal and that the area under sugarcane decreases progressively from head to tail. Concentration of heavy water using crop like sugarcane in the head reaches of the canal is obvious from the markedly high proportion of area under sugarcane in the head reaches compared to the middle and tail reaches. This kind of development would certainly have an adverse impact on the availability of water to the tail enders particularly. Even though it is seen from the table that around 44 per cent of the ICA in

the tail end get irrigated, in practice however water is seldom made available to the tail enders in each rotation, particularly in rabi and hot weather seasons. Often the irrigators at the tail end would have to make do with less watering because of water being not supplied to them in each of the 4 to 6 rotation of watering specified for a season.

5.3 Our interview with the irrigators, specially with the tail enders, in the Mula command confirms the inferences drawn regarding inadequate availability of canal water, specially to the tail ender even though the official policy is to begin the irrigation from the tail end. In this connection it may be worthwhile mentioning Robert Wade's observation on underutilisation which is a common feature of canal irrigation schemes almost everywhere in the world. Commonly farmers in the head reaches are allowed to take water while the canals further down are under construction. They, therefore, have ample water in this initial period, and adopt water intensive cropping pattern; when the lower reaches are ready they mount intense resistance to the consequent reduction in their water supply. This has been a particular problem of canal schemes in drought prone areas, where the irrigation policy aims to spread water over as large an area as possible and in that sense is protective

..... Through their politicians, the farmers in the head reaches exert strong pressures to ensure that they are subsequently not prevented from growing heavy water using crops. Hence, farmers in the tail areas get much less water than was intended.²

5.4 Another adverse impact of this type of irrigation development is the water logging and soil salinity mainly in the upper reaches of the canal. The official statistics of the Ahmednagar Irrigation Circle shows that around 13 per cent and 8 per cent of ICA in the head reaches and tail reaches respectively of MRBC are not available for irrigation because of water logging, salinity and alkalinity.

5.5 Like a part of the underutilisation, even after adjusting for the cropping pattern that has actually developed, can be explained by unauthorised irrigation, the other part of it can presumably be explained by high irrigation duty adopted and low transmission and distribution losses assumed in the project and water planning. As mentioned earlier, we do not have adequate technical data to verify the extent of underutilisation because of these factors, the irrigation official circle, however, is quite conscious of this fact.

² 'Performance of Irrigation Projects' - Robert Wade, *Economic and Political Weekly*, January 17, 1976, p. 64.

6. CONCLUDING OBSERVATIONS

6.1 We may now summarise the whole discussion as follows. The extent of utilisation of irrigation potential estimated, as a rule, as percentage of area irrigated to the potential created does not give a correct picture of the utilisation percentage as seen in the present exercise. *Firstly*, because the potential created, as defined, assumes that the land development (levelling, construction of field channels, etc.) below the outlet head, which is supposed to be the responsibility of the farmers, is complete and that the 'chak' is ready to receive the irrigation water, whereas in actual practice it may not be so and, *secondly*, because the cropping pattern that actually develops may be considerably different from what is assumed while ascertaining potential created.

6.2 In view of these two factors utilisation percentage estimated in the usual manner may turn out to be lower than what actually it is. It would therefore be more meaningful to estimate the extent of utilisation by taking into account the water actually released compared to the planned release and area actually irrigated. If the water actually released is more or less equal to the planned release during the year and the area actually irrigated is smaller than the area that could have been irrigated on the basis of observed cropping pattern and assumed duty and transmission and distribution losses, then there is under-utilisation and that can be estimated by expressing area actually irrigated as percentage of area that could have been irrigated with the given quantity of water released.

6.3 Underutilisation under such circumstances would then be due either to unauthorised use of water or to high duty and low transmission and distribution losses assumed or may be due to both. An attempt should then be made to find out the area getting unauthorised irrigation. Having taken that into account in area actually irrigated, any under-utilisation then can only be due to high duty and low transmission and distribution losses assumed. Only way of improving the utilisation percentage then is through deliberate effort to reduce the transmission and distribution losses and through assuming lower duty based on actual observation.

6.4 However, if the actual water released is considerably smaller than the planned release then the utilisation percentage is to be calculated in two stages. *Firstly*, the area actually irrigated as a percentage of area that could have been irrigated with the given quantity of water released and assuming the cropping pattern that has actually developed would give an utilisation percentage. *Secondly*, assuming the developed cropping pattern, the area that could have been irrigated with the unutilised water in the storage is to be estimated and added to the area that could have been irrigated with the water actually released. The

utilisation percentage can then be calculated as per cent of area actually irrigated to the total estimated area that could have been irrigated. The difference between these two utilisation percentages would indicate mainly the extent of underutilisation due to lack of potential created and resulting unused water in the storage. A careful analysis of all these factors is likely to throw a clearer and more meaningful picture about underutilisation of irrigation potential.

6.5 *One very significant issue*, which should not be lost sight of, is the disproportionate importance given to the engineering aspects of the irrigation project compared to the agricultural and marketing aspects, which is part of the explanation for low utilisation. Irrigation engineering tend to view the output of the canal system as 'water' and not the additional crop which the water should allow. Therefore, they tend to see poor utilisation of water by farmer as a demand problem not a supply problem. They tend to explain unsatisfactory performance of a scheme in terms of the backwardness of the farmers.³ This is a matter of serious concern and this concern has promoted a major rethinking in irrigation policy. One of the outcome is the 'Command Area Development Programme' which is supposed to be the main plank for proper development and utilisation of irrigation potential.

³ Robert Wade, *op. cit.*, p. 66.

Table 3.1 : ANNUAL POTENTIAL PLANNED, POTENTIAL CREATED AND ITS UTILISATION (in Hectares)

Year	Planned potential	Created potential	Planned utilisation	Actual utilisation	Per cent utilisation (4 as % of 2)
	1	2	3	4	5
1969-70	1700	-	-	-	-
1970-71	15587	-	569	-	-
1971-72	19838	20400	5768	7690	37.7
1972-73	34008	29310	12372	15850	54.1
1973-74	42510	47770	23129	13091	27.4
1974-75	51012	49393	32119	14942	30.2
1975-76	72097	54372	42609	28569	52.5
1976-77	72097	59757	55298	33962	56.8
1977-78	72097	60730	65032	35710	58.8
1978-79	72097	65560	72097	33430	51.0
1979-80	72097	66360	72097	28733	43.3
1980-81	72097	73320	72097	30816	42.0
1981-82	72097	73320	72097	32104	43.8

Table 3.2 : ANNUAL STORAGE, WATER RELEASED FOR IRRIGATION AND TOTAL INFLOW IN RESPECT OF MULA PROJECT

Year	Storage as on 1-7 (Mcft)	Maximum storage (Mcft)	Date of attaining maximum storage	Irrigation release (Mcft)	Total inflow (Mcft)
1972-73	4712	13199	22.80	10172	25814
1973-74	4933	20744	27.90	10641	30698
1974-75	9775	25242	10.11	15854	23450
1975-76	14034	26000	1.11	18860	35318
1976-77	16041	25560	11.90	26480	40221
1977-78	8361	24984	11.90	25003	28906
1978-79	8725	22119	4.10	26435	23855
1979-80	5535	25415	24.10	17150	45395
1980-81	16775	24869	14.10	26460	33777
1981-82	5772	25912	30.90	23696	30246

Mcft = Million cubic feet

Table 3.3 : PROJECTED WATER PLANNING AND AREA TO BE IRRIGATED

Seasons	Area in hectares	Volume in Mcft
Kharif	32310	6,998
Rabi	41340	11,771
Hot weather	13250	4,621
	<u>86900</u>	<u>23,390</u>

Table 3.4 : YEARLY WATER RELEASED DURING DIFFERENT SEASONS

Year	Volume of Water Released (Mcft)			
	Kharif	Rabi	Hot Weather	Total
1976-77	8,668	9,607	8,205	26,480
1977-78	6,724	9,252	9,027	25,003
1978-79	6,064	13,720	6,651	26,435
1979-80	2,893	6,313	7,944	17,150
1980-81	6,476	10,630	9,354	26,460
Average of past 5 years	6,165	9,904	8,236	24,306

Table 3.5 : YEARLY AREA IRRIGATED DURING DIFFERENT SEASONS

Year	Area Irrigated in (Hectares)			
	Kharif	Rabi	Hot Weather	Total [@]
1976-77	12,202	22,985	7,180	42,367
1977-78	13,546	20,134	8,126	41,806
1978-79	13,459	20,460	8,909	42,828
1979-80	14,038	13,615	11,266	38,919
1980-81	15,321	20,289	12,632	48,242
Average of past 5 years	13,713	19,497	9,623	42,833

[@] The yearwise extent of utilisation in terms of area, presented in column 4 of Table 3.1 and in the last column of Table 3.7, is seen to be smaller than the yearwise total area irrigated, presented in the last column of Table 3.5. The reason for this difference presumably lies in the manner seasonwise area irrigated figures are reported which may be including area under perennials and two seasonals in more than one season.

Table 3.6 : SEASONWISE ANNUAL UTILISATION PERCENTAGE

Year	Seasonwise Utilisation Percentage			
	Kharif	Rabi	Hot Weather	All Seasons
1976-77	37.76	55.60	54.19	48.75
1977-78	41.93	48.70	61.33	48.11
1978-79	41.66	49.49	67.24	49.28
1979-80 ^e	43.45	32.93	85.03	44.79
1980-81	47.43	49.08	95.33	55.51
Average	42.45	47.16	72.63	49.29

^e In 1979-80 the total inflow was 45,395 Mcft (ref. Table 3.2). The rainfall was very high and well distributed as a result of which release of water during kharif and rabi seasons was considerably lower than planned and there was a large carryover in 1980-81

Table 3.7 : DETAILS OF THE CROPPING PATTERN PROPOSED AND THE OBSERVED CROPPING PATTERN

	Cropping Pattern Proposed				Observed Cropping Pattern	
	@Perennial Zone ICA=69410 Ha.		Non-Perennial Zone (ICA=11400 Ha.)		(Average of past five years) Total Irrig. area = 32,530 Ha.	
	Per cent of ICA	Area (Ha.)	Per cent of ICA	Area (Ha.)	Per cent of irrig. area	Area (Ha.)
1 Sugarcane	4.0	2,775	-	-	11.8	3,840
2 Other Perennials	1.0	695	-	-	-	-
3 L.S. Cotton	19.5	13,535	10.0	1,140	4.3	1,400
4 Kharif Seasonals	30.5	21,170	50.0	5,700	19.8	6,440
5 Rabi Seasonals	43.0	29,850	63.0	7,180	46.6	15,155
6 Groundnut (Hot weather)	3.0	2,080	-	-	11.8	3,840
7 Others	4.0	2,775	-	-	5.7	1,855
Total	105.0	72,880	123.0	14,020	100.0	32,530

^e MRBC has two zones, (i) perennial zone, where perennials and hot weather seasonals are permitted, and (ii) non-perennial zone where only kharif, rabi and two seasonal crops are permitted.

Table 3.8 : AREA UNDER DIFFERENT CROPS IRRIGATED AS PER CENT OF ICA IN DIFFERENT REACHES OF THE CANAL (1980-81)

	<i>Head reach</i>	<i>Middle reach</i>	<i>Tail reach</i>	<i>Total</i>
ICA (hectares)	18191	15279	24640	58110
Crops (% of ICA)				
1 Sugarcane	18.6	7.9	6.7	10.8
2 Two seasonals (L.S. Cotton)	0.2	0.3	0.1	0.2
3 Kharif seasonals	9.3	6.3	6.7	7.4
4 Rabi seasonals	14.6	18.5	21.8	18.7
5 H.W. Seasonals	9.3	13.7	9.0	10.3
Grand Total	52.0	46.7	44.3	47.4

CHAPTER IV

PATTERN OF WATER DISTRIBUTION AND ITS USE
UNDER CANAL IRRIGATION

1. INTRODUCTION

1.1 This chapter deals with the aspects of water supply and its use in respect of the sample farmers selected from the cluster of villages falling in the head reaches, middle reaches and tail reaches of the distribution system. The discussion in this chapter is expected to throw light on the nature and extent of water received by the irrigators and its use and the manner in which water is distributed through the distribution system in different reaches of the canal. This enquiry in turn would help us in dealing with the question of great divergence between the potential created and actual utilisation of water in the canal system.

1.2 Accordingly, as proposed, relevant data and other information were collected from the sample villages and selected beneficiaries through field investigation with the help of the structured questionnaires as well as through informal discussions with the beneficiaries of the scheme. The sampling procedure and the coverage for the field investigation are already presented in the first chapter; in what follows we discuss the findings of the analysis so attempted.

2. CHARACTERISTIC FEATURES OF THE SAMPLE VILLAGES

2.1 As mentioned earlier villages under the sample were selected from different reaches of the distribution system so as to get a comparative picture of the availability of irrigation water and of the crop pattern followed in the villages in the command area of different reaches of the distribution system.

2.2 Table 4.1 gives the relevant information in respect of the selected villages with a view to highlight the aspects of availability of canal and well water and its use in these villages. As presented earlier in a statement in Chapter 1, Table 4.1 also depicts that out of 4 villages selected from the head reach of the main distribution system, 1 is from the head part of the distributory in the head reaches (HH), 2 are from middle part of the distributory in the head reaches (HM) and 1 is from tail part of the distributory in the head reaches (HT). Similarly, out of 4 villages selected from the middle reach of the main distribution system, 1 is from head part of the distributory in the middle reaches (MH), 1 is from middle part of the distributory in the middle reaches (MM), and 2 are from tail part of the distributory in the middle reaches (MT). Likewise out of 4 villages selected from the tail reach of the distribution system, 1 is from head part of the distributory in the tail reaches (TH), 1 is from middle part of the distributory in the tail

reaches (TM) and 2 are from tail part of the distributory in the tail reaches (TT). Further, 2 villages are selected from the uncommand area for comparison.

2.3 We find that 4 villages in the upper reaches of the main distribution system considered together are in a better position than the 4 villages considered together in the middle reaches of the distribution system in respect of CCA, percentage of farmers getting canal water, availability of canal water, number of wells, area under sugarcane per well and availability of well water. Similarly 4 villages in the middle reaches of the main distribution system considered together are found to be in better position than the 4 villages considered together in the tail reaches of the main distribution system in respect of the aforementioned variables. However, in respect of the aspects of water logging and availability of labour, villages in the tail reach and middle reach of the main distribution system seem to be either not adversely affected or are less adversely affected.

2.4 It is also noted that within each reach (head, middle, tail) of the main distribution system, the tail part is relatively worse off than the head part. In other words, although villages in the head reaches of the main distribution system are better placed on the whole, there seems to be considerable divergence in the availability of water, etc., between the villages in the tail end and head end within the head reach itself and so also in other reaches of the main distribution system.

2.5 Differential provisions of water in different sample villages in the command area could have been better explained if we had the villagewise data on i) the net cultivated area, ii) the ICA, and iii) the area that received water during the year of survey. The cropwise break-up of the total irrigated area in the sample villages could also have thrown more light on the above aspect. In the absence of such information we can make only a reasonable assumption on the basis of the indirect evidences presented in Table 4.1 that the villages at the upper reaches of the main distribution system are relatively better placed in terms of availability of canal water.

2.6 Similarly regarding the question of well irrigation it would have been more useful if we had the villagewise data on the extent of cultivated area of a village outside the ICA and, further, the extent of well irrigation in the non-command and command (ICA) area separately. In the absence of these information, from the given data in Table 4.1 we may reasonably surmise that the wells in the upper reaches of the main distribution system are relatively better placed in terms of availability of water. Area under sugarcane per well in different reaches of the main distribution system highlights this point.

3. ANALYSIS OF THE SAMPLE HOUSEHOLDS

3.1 As mentioned earlier, data for the sample households were collected from the sample villages from three reaches of the main distribution system with a view to get a comparative picture of the availability of irrigation water at different reaches of the canal and also of the crop pattern followed under each reach. We have therefore attempted a clusterwise analysis of the sample households in respect of area irrigated, sources of irrigation and the cropping pattern. We shall consider the villages and households selected for study from the head reach, middle reach and tail reach of the canal as cluster I, cluster II and cluster III respectively.

3.2 Table 4.2 shows the distribution of total cultivated area of the sample households into irrigated and unirrigated by cluster. Two households from the head reaches and six households from the tail reaches could not be included because of incomplete information in respect of those households and hence the sample size got reduced to 172 instead of 180 as depicted earlier.

3.3 The extent of irrigated area is found to be as high as 80 per cent in the tail end (cluster III) compared to 77 per cent and 58 per cent in cluster I and II respectively. Similarly irrigated cropped area out of the gross cropped area, presented in Table 4.3, is also found to be higher in cluster III than in clusters I and II.

3.4 Distribution of irrigated land by the sources of irrigation, presented in Tables 4.4 and 4.5, however, shows that the percentages of irrigated area by canal and so also the percentage of gross cropped area irrigated under canal are marginally higher in clusters I and II compared to cluster III.

3.5 One would have expected a much smaller proportion of irrigated area at the tail end, particularly under canal, in view of the difficulties experienced in getting canal water, but, the reason for finding more or less similar proportion of area reported to be irrigated under canal is that the reported figures of canal irrigated area are not the ones actually irrigated but the ones that are irrigable, and as mentioned earlier, it is more likely that actual irrigated area during any year is considerably smaller than the reported irrigable area, particularly at the tail end of the distribution system. Further, the gross area irrigated in cluster III, which appears to compare favourably with those in clusters I and II also does not give the correct picture of the intensity of irrigation because of lack of availability of water at the tail end of the distribution system. Importance of this point could have been better appreciated if we had the villagewise data on the extent of area outside the CCA and/or ICA of the Mula canal system in which these sample households are located. In the absence of such an information a clearer picture may emerge

if we look into the crop pattern in respect of these clusters, separately for canal and well irrigated areas.

3.6 Table 4.6 shows the crop-mix in the canal irrigated area for the sample households selected from sample villages in different reaches of the main distribution system (clusters).

3.7 Sugarcane is found to account for around 23 per cent of the gross area irrigated in cluster I and only around 14 per cent and 11 per cent in clusters II and III respectively. Wheat is found to occupy around 26 per cent of the gross area irrigated in cluster I but only 14 per cent and 17 per cent in clusters II and III respectively. Further, area under hot-weather groundnut is found to be 17 per cent, 19 per cent and 11 per cent of the gross area irrigated in cluster I, cluster II and cluster III respectively.

3.8 Concentration of sugarcane in the upper reaches of the canal is thus evident from the above observation and it is also evident that two other crops which require timely and adequate quantity of water for their proper growth, viz., wheat and hot-weather groundnut are also found to be largely confined to the upper reaches of the canal. On the other hand, jowar, bajra and gram the three least water requiring crops are seen to have higher percentage of gross area irrigated in the tail end of the canal as compared to the upper reaches.

3.9 In point of fact, in the tail end of the canal (cluster III) jowar and bajra which are reported to be grown on canal water, more often than not do not get any canal water or get in very inadequate quantity (may be only 1 or at the most 2 waterings in the whole season). As such even though more than 40 per cent of the total cropped area in the tail end of the canal is reported to be under irrigated jowar and bajra, in actual practice most of the reported area may be getting very little water. Therefore, if we consider the entire reported area, particularly under jowar and bajra as irrigated area, the proportion of gross cropped area irrigated in the tail end gets inflated and appears to be comparing favourably with the head reaches of the canal.

3.10 Although we do not have any direct evidence to substantiate the above observation, the indirect evidences presented in the 'Remarks' column of Table 4.1 suggest the serious possibilities of such a state of affair. We do not have any information about the number of watering received by the irrigators under each cluster; this information could have been useful in explaining the inadequate availability of irrigation water at the tail end.

3.11 A different picture emerges when we examine the crop pattern under well irrigation of the same irrigators selected from the sample villages forming three clusters. We present this data in Table 4.7.

3.12 Sugarcane seems to be the dominant crop grown under well irrigation in all the three clusters, though the percentage area is relatively smaller in cluster III than in clusters I and II. The percentage of area under wheat grown with well water is higher in cluster I compared to clusters II and III. The same under groundnut is also higher in clusters I and II compared to cluster III. Less water consuming crops like jowar, bajra, gram, etc., are seen to be concentrated in cluster III.

3.13 It would not be unreasonable to surmise from this observation that although sugarcane occupies around 50 per cent or more of the gross area irrigated under well in each cluster, heavy water using crops like sugarcane are mainly concentrated in cluster I and II. This observation is also borne out by the data on area under sugarcane per well presented in column 7 of table 4.1.

3.14 Presumably the wells in cluster I particularly, and also in cluster II, are endowed with better availability of water throughout the year, being located in the command area of the upper reaches of the main distribution system. Since the farmers even in cluster III grow sugarcane in almost 50 per cent of the gross area irrigated under well most of the available well water seem to be used up in growing sugarcane. Being located in the tail end of the command area of the distribution network with consequent limited availability of water in the wells, a large part of which is used up mainly for growing sugarcane, cultivation of other timely water requiring crops like wheat and hot weather groundnut under canal irrigation gets severely restricted.

3.15 In this context it would be instructive to examine the availability of water in wells in different seasons in respect of the sample households in different clusters. Table 4.8 shows the number of wells in respect of the sample household selected from clusters I, II and III along with area under well irrigation in each cluster.

4. SEASONWISE AND CLUSTERWISE AVAILABILITY OF WATER IN WELLS

4.1 Tables 4.9, 4.10 and 4.11 present the distribution of wells by height of water column in kharif, rabi and summer seasons.

4.2 We find that in head zone out of 46 wells 20 show water column between 11 and 20 feet, 19 show water column above 20 feet and 7 show water column up to 10 feet in kharif season. In rabi season in head zone 12 wells show water column up to 10 feet and 20 and 14 show water column between 11 and 20 feet and above 20 feet respectively. In summer season in this cluster the wells showing up to 10 feet of water column number 16, between 11 and 20 feet of water column number 20 and above 20 feet of water column number 10.

4.3 In the case of cluster II, out of 41 wells, 6 show water column up to 10 feet, 13 show water column between

11 and 20 feet and 22 show water column above 20 feet in kharif season. In rabi season 8 wells show water column up to 10 feet, 17 show water column between 11 and 20 feet and 16 show water column above 20 feet. In hot weather (summer) season 18 wells show water column up to 10 feet, 14 show water column between 11 and 20 feet and 9 show water column above 20 feet.

4.4 In the case of cluster III, out of 49 wells, wells showing water column up to 10 feet, between 11 and 20 feet and above 20 feet in kharif season number 8, 23 and 17 respectively. In rabi season 18 wells show water column up to 10 feet, 19 wells between 11 and 20 feet and 9 wells above 20 feet of water column. In hot weather (summer season) number of wells showing up to 10 feet of water column, between 11 and 20 feet of water column and above 20 feet of water column are 30, 12 and 4 respectively.

4.5 The above observations clearly indicate that the wells located in the upper reaches of the command area of the canal system are endowed with more water than the wells located in the tail command of the canal system. This is presumably because of the seepage effect of the greater water supply in the upper reaches of the canal as noted earlier. In fact, adequate availability of water in summer is mainly confined to the wells located in the upper reaches of the canal command. This is the reason we find (as discussed earlier) concentration of sugarcane (a perennial crop), grown even under well irrigation, in the upper reaches of the canal command.

4.6 We have earlier noted in table 4.8 that the area irrigated per well is smaller in cluster III to those in clusters I and II and further, that the area under sugarcane per well is also smaller in cluster III as compared to clusters I and II. This corroborates with our earlier observations of availability of less water in well, particularly in fair weather, in cluster III compared to clusters I and II.

5. AVAILABILITY OF CANAL WATER

5.1 We now deal with the issue of availability of canal water to the selected beneficiaries in the canal command not only in terms of the quantity of water available but also availability of water at proper time and interval. An examination of this field level information may lead us to some explanation for the greater divergence that we notice between potential created and actual utilisation of irrigation water of Mula system.

5.2 Table 4.12 shows the availability of canal water among the respondent holdings in each cluster. The availability of canal water in required quantity is found to be reported by a comparatively larger proportion of households (57 per cent) in the head reacher (cluster I) of the canal system. On the other hand more than 40 per cent of the households

in clusters II and cluster III report availability of water not in required quantity and in addition 28 per cent and 11 per cent of the households in cluster II and cluster III report non-availability of canal water. These observations give the indication that it is largely the tail enders who suffer on account of either not getting required quantity of canal water or not getting canal water at all inspite of being within the ICA of the canal command and making a timely demand for it.

5.3 Out of the number of holdings getting canal water, clusterwise, whether in required quantity or not, some may be getting water in time and some may not be getting in time. Table 4.13 gives this information. In this case also we find that the holdings located in the lower reaches of the distribution system suffer more, in as much as around 60 per cent of the holdings in these reaches do not get water in time.

5.4 Table 4.14 gives the further details of the availability of canal water in time. We find that of the holdings getting required quantity of canal water, clusterwise, also generally get the required quantity of water in time although the proportion of the same is comparatively smaller amongst the households in cluster III than in clusters I and II. However, in the case of those holdings which do not get required quantity of water also do not get the same in time, irrespective of whether the households are from the upper reaches or lower reaches of the distribution system.

5.5 We now look into the reasons for not getting canal water at all and also for not getting canal water in required quantity and in time. First of all we look into the reasons for not getting required quantity of canal water which is presented in table 4.15. The most important reason is found to be 'location land at the tail end'. Even the households located at the head zone give this as the most important reason for not getting required quantity of water. Presumably these households (farms) are located at the tail ends of the head distribution which indicates that even beneficiaries located at the head zone of the main distribution net work may not get adequate water if these are further located at the tail end of the distributions, i.e. (HT) as per table 4.1. It may however be mentioned that the non-availability of water in required quantity in the lower reaches of the distribution system (cluster III), i.e. in TH, TM and TT, as per table 4.1 is of a much larger magnitude than that in upper reaches, although we do not have any data to substantiate the point.

5.6 Reasons for not getting canal water in time, presented in table 4.16 again shows more or less the same picture as found in table 4.15. 'Land at the tail end' is the most important reason assigned irrespective of the cluster in which the households are located. However, in respect of cluster II and III the other reasons are 'field channel

not in condition' and 'land levelling not done'. One more common reason observed in tables 4.15 and 4.16 mainly in the case of clusters II and III is that the influential irrigators manage to take up the water into their fields and are callous and negligent in allowing water to flow to the fields lower down.

5.7 Reasons for not getting canal water at all, presented in table 4.17, shows that the tail enders do not get water not only because of land being at the tail end but also because land development work at the tail end, like preparing field channels and maintaining them and land levelling has not been carried out. Reasons for not getting canal water mainly in the lower reaches of canal are more often than not interrelated.

5.8 It is evident from the foregoing analysis that the entire ICA can not be brought under irrigation and that the ICA which does not receive canal water is mainly from the lower reaches of the distribution system thereby leading to a great divergence between the potential created and actual utilisation. Inadequate land development activities and lack of 'on farm development' work, mainly in the lower reaches of the distribution system, result into water use remaining concentrated in the upper reaches. This situation inevitably leads to concentration of heavy water using crops in the upper reaches of the distribution system with all its ill effects. There is bound to be great divergence between the potential created and actual utilisation in terms of area irrigated under such a state of affair.

5.9 In this context the Supplementary Report of the Controller and Auditor General of India for 1975-76, presented in December, 1977, on utilisation of irrigation potential created by 12 major projects should have a sobering effect on all this euphoria about ambitious new irrigation schemes and their impact on agricultural production and productivity. According to the report in many projects water courses and field channels remained to be constructed and the water distribution system was generally ineffective. In almost all the projects there was little progress in land levelling; loss of water during transmission and distribution was far heavier than had been envisaged in the project reports. Drainage schemes had not been provided for in the original project reports of any of the schemes, resulting in water logging after the introduction of irrigation. Further, according to the report, there were large scale violations of prescribed cropping pattern and unauthorised cultivation of water-intensive crops. Unequal distribution of irrigation was also reflected in the fact that the quantity of water supplied to the area actually irrigated was invariably larger than envisaged. That rural land relations have not a little to do with the low utilisation of irrigation potential is also implied in some of the other findings of the report. Therefore, it should surprise no one if it turns out that it is generally the farmers with larger holdings

and greater political influence who have succeeded in cornering available supplies in these and other ways.¹

¹ 'For Whom the Water Flows', *Economic and Political Weekly, Review of Agriculture*, March, 1978.

Table 4.1 : SALIENT FEATURES OF THE SELECTED VILLAGES

Village	Location	C.C.A. (hectares)	Farmers getting canal water (percentage)	Canal water availability	No. of wells
(1)	(2)	(3)	(4)	(5)	(6)
1. Vanjarwadi	HH	600	93	Abundant	200
2. Karanjgaon	HM	1263	96	Adequate	98
3. Khedle Parmanand	HM	874	57	Adequate	78
4. Khupti	HT	1004	69	Poor	77
5. Mahalas Pimpalgaon	MH	696	62	Good	84
6. Malichinchore	MM	1652	89	Good	104
7. Murme	MT	372	36	Poor	10
8. Malewadi	MT	777	72	Poor	24
9. Kukana	TH	599	70	Good	80
10. Chilekhanwadi	TM	615	57	Adequate	94
11. Deotakli	TT	1101	60	Poor	79
12. Bhalgaon	TT	680	59	Poor	84
13. Saundale	Uncommand	Nil	Nil	Nil	60
14. Lohgaon	Uncommand	Nil	Nil	Nil	125

(Contd..)

Table 4.1 (Contd..)

Village	Area under sugarcane per well (hectares)	Availability of well water	Water logging	Availability of labour	Remarks
	(7)	(8)	(9)	(10)	(11)
1. Vanjarwadi	2.25	Adequate	Yes	Shortage	Field channels are in poor conditions at tail end of the Sonai distributory/Minor
2. Karanjgaon	5.20	Good	Expected	"	Portions of minors and field channels are in bad condition
3. Khedle Parmanand	4.30	Good	"	"	Complaints of inadequate supply of water due to poor condition of the minor
4. Khuptl	1.40	Inadequate	"	"	There are hardly any field channels in existence, hence unassured water supply
5. Mahalas Pimpalgaon	2.00	Adequate	Yes	Adequate	Field channels at the tail end of the distributory in bad condition
6. Malichinchore	2.60	Adequate	No	Shortage	Field channels at the tail end of the distributory in bad condition
7. Murme	1.30	Inadequate	No	Abundant	Being at the tail end of distributory & water supply is very poor and unassured
8. Malewadi	1.20	Inadequate	No	Abundant	

(Contd..)

Table 4.1 (Contd..)

Village	Area under sugarcane per well (hectares)	Availability of well water	Water logging	Availability of labour	Remarks
	(7)	(8)	(9)	(10)	(11)
9. Kukana	0.50	Poor	No	Adequate X	Conditions of field channels bad
10. Chilekhanwadi	0.50	Poor	No	Adequate X	
11. Deotakli	0.80	Poor	No	Abundant X	Irrigators do not get adequate and timely water supply and hence large area is rainfed
12. Bhalgaon	1.00	Poor	No	Abundant X	
13. Saundale	0.24	Poor	No	Abundant	-
14. Lohgaon	0.44	Poor	No	Abundant	-

(Concluded)

Table 4.2 : DISTRIBUTION OF TOTAL CULTIVATED AREA INTO IRRIGATED AND UNIRRIGATED BY CLUSTER

Cluster / Village	Number of sample households	Total cultivated Area (hectares)	Irrigated Area (hectares)	Non-irrigated Area (hectares)
I. (Head reaches)	58	200.31	154.95 (77.36)	45.36 (22.64)
II. (Middle reaches)	60	243.58	139.71 (57.36)	103.87 (42.64)
III. (Tail reaches)	54	180.68	145.44 (80.50)	35.24 (19.50)
Total	172	624.57	440.10 (70.46)	184.47 (29.54)

Figures in parenthesis indicate percentage to total.

Table 4.3 : DISTRIBUTION OF GROSS CROPPED AREA INTO IRRIGATED AND NON-IRRIGATED BY CLUSTER

Cluster	Gross Cropped Area (hectares)	Irrigated Cropped Area (hectares)	Non-irrigated Cropped Area (hectares)
I. (Head reaches)	222.21	181.06 (81.48)	41.15 (18.52)
II. (Middle reaches)	254.53	159.81 (62.79)	94.72 (37.21)
III. (Tail reaches)	208.63	175.82 (84.27)	32.81 (15.73)
Total	685.37	516.69 (75.39)	168.68 (24.61)

Figures in parenthesis indicate percentage to total.

Table 4.4 : CLUSTERWISE DISTRIBUTION OF IRRIGATED LAND UNDER DIFFERENT SOURCES OF IRRIGATION

(in hectares)			
<i>Cluster</i>	<i>Irrigated Area</i>	<i>Irrigated by canal</i>	<i>Irrigated by well</i>
I. (Head reaches)	154.95 (100.00)	82.62 (53.32)	72.33 (46.68)
II. (Middle reaches)	139.71 (100.00)	74.75 (53.50)	64.96 (46.50)
III. (Tail reaches)	145.44 (100.00)	73.11 (50.27)	72.33 (49.73)
Total	440.10 (100.00)	230.48 (52.37)	209.62 (47.63)

Figures in parenthesis indicate percentage.

Table 4.5 : CLUSTERWISE DISTRIBUTION OF IRRIGATED CROPPED AREA ACCORDING TO SOURCES OF IRRIGATION

(In hectares)			
<i>Cluster</i>	<i>Irrigated Cropped Area</i>	<i>Irrigated Cropped Area under canal</i>	<i>Irrigated Cropped Area under well</i>
I. (Head reaches)	181.06	103.91 (57.39)	77.15 (42.61)
II. (Middle reaches)	159.81	92.06 (57.61)	67.75 (42.39)
III. (Tail reaches)	175.82	94.69 (53.85)	81.13 (46.15)
Total	516.69	290.66 (56.25)	226.03 (43.75)

Figures in parenthesis indicate percentage to irrigated cropped area.

Table 4.6 : CLUSTERWISE CROPPING PATTERN IN RESPECT OF AREA IRRIGATED BY CANAL

Crop	Cluster I		Cluster II		Cluster III		Total	
	Area (ha.)	%	Area (ha.)	%	Area (ha.)	%	Area (ha.)	%
A. Perennials								
1. Sugarcane	23.39	22.51	13.15	14.28	10.83	11.46	47.37	16.31
2. Other perennials	0.40	0.38	1.62	1.76	0.20	0.21	2.22	0.76
B. Two seasonals								
1. L.S.Cotton	0.20	0.19	0.20	0.22	1.62	1.71	2.02	0.70
C. Kharif seasonals								
1. Jowar (Hybrid)	5.61	5.40	1.82	1.98	1.92	2.03	9.35	3.22
2. Bajra (Hybrid)	-	-	5.18	5.63	12.71	13.45	17.89	6.16
3. Bajra (Local)	-	-	1.02	1.11	2.63	2.78	3.65	1.26
4. Pulses	1.60	1.54	1.06	1.15	2.15	2.28	4.81	1.66
D. Rabi seasonals								
1. Jowar (Local)	24.83	23.90	32.27	35.05	32.24	33.92	89.15	30.69
2. Wheat	26.97	25.96	13.33	14.48	15.78	16.70	56.08	19.31
3. Gram	3.00	2.89	4.00	4.34	4.02	4.25	11.02	3.79
4. Vegetables	0.10	0.09	0.61	0.66	-	-	0.71	0.24
E. Hot-weather seasonals								
1. Groundnut	17.81	17.14	17.80	19.34	10.59	11.21	46.20	15.91
Total	103.91	100.00	92.06	100.00	94.69	100.00	290.66	100.00

Table 4.7 : CLUSTERWISE CROPPING PATTERN IN RESPECT OF AREA IRRIGATED BY WELL

Crop	Cluster I		Cluster II		Cluster III		Total	
	Area (ha.)	%	Area (ha.)	%	Area (ha.)	%	Area (ha.)	%
A. Perennials								
1. Sugarcane	45.91	59.51	53.23	78.56	37.45	46.18	136.59	60.43
2. Other perennials	2.67	3.46	3.44	5.08	4.22	5.20	10.33	4.57
B. Two seasonals								
1. L.S. Cotton	0.71	0.92	0.51	0.75	2.12	2.61	3.34	1.48
C. Kharif seasonals								
1. Jowar (Hybrid)	2.83	3.67	0.41	0.61	3.64	4.49	6.88	3.04
2. Bajra (Hybrid)	-	-	-	-	4.25	5.24	4.25	1.88
3. Bajra (Local)	-	-	-	-	1.82	2.24	1.82	0.81
4. Pulses	1.10	1.43	0.62	0.92	0.92	1.13	2.64	1.17
D. Rabi seasonals								
1. Jowar (Local)	7.13	9.24	3.24	4.78	15.28	18.83	25.65	11.35
2. Wheat	14.29	18.52	3.63	5.36	9.21	11.35	27.13	12.00
3. Gram	0.92	1.19	0.50	0.74	1.00	1.23	2.42	1.07
4. Vegetables	-	-	0.15	0.22	-	-	0.15	0.06
E. Summer seasonals								
1. Groundnut	1.59	2.06	2.02	2.98	1.22	1.50	4.83	2.14
Total	77.15	100.00	67.75	100.00	81.13	100.00	226.03	100.00

Table 4.8 : CLUSTERWISE DISTRIBUTION OF WELLS AND OF AREA UNDER WELL IRRIGATION

Cluster	Number of holdings	Number of wells	Irrigated area per well (hectares)	Sugarcane area per well (hectares)
I. Head Zone	58	46	1.57	1.00
II. Middle Zone	60	41	1.58	1.30
III. Tail Zone	54	49	1.47	0.76
Total	172	136	1.54	1.00

Table 4.9 : CLUSTERWISE DISTRIBUTION OF WELLS BY HEIGHT OF WATER COLUMN IN KHARIF SEASON

Cluster	Height of Water Column in Kharif Season						Total number of wells
	Up to 10 feet	11-20 feet	21-25 feet	26-30 feet	Above 30 feet	Not given	
I. Head Zone	7	20	10	2	7	-	46
II. Middle Zone	6	13	13	5	4	-	41
III. Tail Zone	8	23	8	6	3	1	49
Total	21	56	31	13	14	1	136

Table 4.10 : CLUSTERWISE DISTRIBUTION OF WELLS BY HEIGHT OF WATER COLUMN IN RABI SEASON

Cluster	Height of Water Column in Rabi Season						Total number of wells
	Up to 10 feet	11-20 feet	21-25 feet	26-30 feet	Above 30 feet	Not given	
I. Head Zone	12	20	6	1	7	-	46
II. Middle Zone	8	17	10	3	3	-	41
III. Tail Zone	18	19	4	4	1	3	49
Total	38	56	20	8	11	3	136

Table 4.11 : CLUSTERWISE DISTRIBUTION OF WELLS BY HEIGHT OF WATER COLUMN IN SUMMER SEASON

Cluster	Height of Water Column in Summer Season						Total number of wells
	Up to 10 feet	11-20 feet	21-25 feet	26-30 feet	Above 30 feet	Not given	
I. Head Zone	16	20	4	1	5	-	46
II. Middle Zone	18	14	7	2	-	-	41
III. Tail Zone	30	12	3	1	-	3	49
Total	64	46	14	4	5	3	136

Table 4.12 : AVAILABILITY OF CANAL WATER AMONG THE RESPONDENT HOLDINGS IN EACH CLUSTER

Cluster	Number of holdings	Number of holdings reporting		
		Availability of required amount of canal water	Availability not in required quantity	Non-availability of canal water
I. Head Zone	58 (100.00)	33 (56.90)	20 (34.48)	5 (8.62)
II. Middle Zone	60 (100.00)	19 (31.67)	24 (40.00)	17 (28.33)
III. Tail Zone	54 (100.00)	23 (42.59)	25 (46.30)	6 (11.11)
Total	172 (100.00)	75 (43.60)	69 (40.12)	28 (16.28)

Figures in parenthesis indicate percentage.

Table 4.13 : AVAILABILITY OF CANAL WATER IN TIME IN EACH CLUSTER

Cluster	Number of holdings getting canal water	Number of holdings getting canal water	
		in time	not in time
I. Head Zone	53 (100.00)	32 (60.38)	21 (39.62)
II. Middle Zone	43 (100.00)	18 (41.86)	25 (58.14)
III. Tail Zone	48 (100.00)	21 (43.75)	27 (56.25)
Total	144 (100.00)	71 (49.31)	73 (50.69)

Figures in parenthesis indicate percentage.

Table 4.14 : DISTRIBUTION OF SAMPLE HOLDINGS ACCORDING TO AVAILABILITY OF CANAL WATER AND WHETHER GETTING IT IN TIME IN EACH CLUSTER

Cluster	Total households having availability of required amount of canal water	Availability of required amount of canal water and		Availability not in required quantity but		Total households having availability of canal water but not in required quantity
		Getting it in time	Not getting it in time	Getting it in time	Not getting it in time	
I. Head Zone	33 (100.00)	32 (96.97)	1 (3.03)	-	20 (100.00)	20 (100.00)
II. Middle Zone	19 (100.00)	17 (89.47)	2 (10.53)	1 (4.17)	23 (95.83)	24 (100.00)
III. Tail Zone	23 (100.00)	20 (86.96)	3 (13.04)	1 (4.00)	24 (96.00)	25 (100.00)
Total	75 (100.00)	69 (92.00)	6 (8.00)	2 (2.90)	67 (97.10)	69 (100.00)

Table 4.15 : DISTRIBUTION OF SAMPLE HOUSEHOLDS ACCORDING TO REASONS FOR NOT GETTING REQUIRED QUANTITY OF WATER IN EACH CLUSTER

Cluster	Reasons for not getting required water					Total
	Land at the tail end	Farmers at the upper side and the canal inspector do not let water flow down	'Chari' not in condition	Land not in level	Others	
I. Head Zone	13 (65.00)	2 (10.00)	2 (10.00)	-	3 (15.00)	20 (100.00)
II. Middle Zone	11 (45.83)	4 (16.67)	7 (29.16)	1 (4.17)	1 (4.17)	24 (100.00)
III. Tail Zone	12 (48.00)	5 (20.00)	3 (12.00)	3 (12.00)	2 (8.00)	25 (100.00)
Total	36 (52.17)	11 (15.94)	12 (17.39)	4 (5.80)	6 (8.70)	69 (100.00)

Table 4.16 : DISTRIBUTION OF SAMPLE HOUSEHOLDS ACCORDING TO REASONS FOR NOT GETTING CANAL WATER IN TIME - CLUSTERWISE

Cluster	Reasons for not getting canal water in time					Total
	Land at the tail end	Farmers at the upper side and canal inspector do not allow water flow down	Field channels not in condition	Land levelling not done	Others	
I. Head Zone	13 (61.90)	2 (9.52)	2 (9.52)	1 (4.76)	3 (14.29)	21 (100.00)
II. Middle Zone	11 (44.00)	3 (12.00)	8 (32.00)	2 (8.00)	1 (4.00)	25 (100.00)
III. Tail Zone	14 (51.85)	5 (18.52)	4 (14.81)	4 (14.81)	-	27 (100.00)
Total	38 (52.05)	10 (13.70)	14 (19.18)	7 (9.59)	4 (5.48)	73 (100.00)

Table 4.17 : DISTRIBUTION OF SAMPLE HOUSEHOLDS ACCORDING TO REASONS FOR NOT GETTING CANAL WATER -
CLUSTERWISE

Cluster	Reasons for not getting canal water at all				Total
	Land at the tail end	Field channel not in condition	Land levelling not done	Others	
I. Head Zone	2 (40.00)	1 (20.00)	1 (20.00)	1 (20.00)	5 (100.00)
II. Middle Zone	6 (35.29)	2 (11.77)	8 (47.06)	1 (5.88)	17 (100.00)
III. Tail Zone	2 (33.33)	2 (33.33)	2 (33.33)	-	6 (100.00)
Total	10 (35.71)	5 (17.86)	11 (39.29)	2 (7.14)	28 (100.00)

CHAPTER V

APPRAISAL OF WELL IRRIGATORS

1. INTRODUCTION

1.1 Its a general observation that most of the cultivators in any command area of any irrigation project in Western Maharashtra prefer to grow sugarcane to any other crops. There is of course a host of reasons for this but one of the reasons frequently given by almost all canal irrigators is the uncertainty of getting canal water at frequent and predetermined intervals. Usually the gap between two rotations will be more than 20 days or so. Sometimes, particularly in hot weather, it may even extend up to 30 days or even more. It is reported that sugarcane only can withstand such a high water stress without endangering the yield significantly. And, therefore, under such conditions of highly uncertain water supply from the irrigation system, sugarcane is the only alternative left. So goes the argument and at least superficially, a strong plea is made in favour of sugarcane.

1.2 Of course, there is no denying the fact that there is a considerable element of uncertainty in the supply of canal water. The gap between two rotations can be unduly long. But, is uncertainty of supply of canal water the main determining factor behind growing sugarcane in preference to other seasonal crops? Suppose, this element of uncertainty is eliminated and the cultivators start getting water frequently at shorter intervals, will they switch over to seasonal grain and other crops? Of course this purely a speculative question and nothing can be said unless a study of those cultivators is made who have got sufficient water at their disposal and use it frequently at shorter intervals as and when the crop requires. Obviously, such cultivators will be those who have got their own wells as the source of irrigation and have plenty of water in their wells with which, if they wish they can irrigate large area of land within the well command. The present appraisal of well irrigators has been undertaken with a view to examining this aspect of water use by the well irrigators.

1.3 Secondly, irrigation being the key input, usage of other inputs depends upon it. For example, chemical fertilizers can be used in significant quantities only in presence of assured and adequate irrigation. Since the canal irrigation is irregular and erratic, farmers may not risk applying fertilizer dose in significant quantities. Because, if they apply fertilizer dose and if the canal water is not supplied in time and inadequate quantity or is not supplied at all, they will have to bear considerable loss. Large scale adoption of high yielding varieties of hybrids also pre-supposes timely irrigation in adequate quantity. So it is usually argued that fertilizer consumption and adoption

of HYVs have not picked up much in command area because of highly erratic canal irrigation. If this is accepted then it means that 'it' must have picked up well where dependable source of irrigation such as well irrigation is available in abundance and can be given as per requirements of crops and inputs. The present appraisal of well irrigators looks into this aspect also.

1.4 There is a general impression that well irrigators use water more economically as compared to canal irrigators. This has also been checked in this appraisal.

1.5 In short, if timely irrigation in adequate quantities and at frequent intervals is available (as in the case of well irrigation), and the availability of land within the well command to be irrigated with the available water is not a restriction, then is there any positive change in cropping pattern, usage of inputs and increase in outputs? This is the question which has been dealt with in this appraisal of well irrigators.

2. SAMPLE SELECTED FOR ANALYSIS

2.1 As mentioned earlier, the criteria for the selection of well irrigators was that they should have their own wells with sufficient water and that land in the command area of the well that can be irrigated with the available water is not a constraint for extending the irrigation over a wider area. A total number of 30 such well irrigators was selected. The selection was based upon general enquiry in the villages regarding the availability of water and economic condition of the irrigators.

2.2 Having collected the data from 30 well irrigators it was found that out of those 30 selected, 4 irrigators irrigate their land by lifting water from *Jayakwadi* backwater. Since they cannot be called well irrigators they have not been considered for further analysis.

3. LIMITATIONS OF THE ANALYSIS

3.1 Before analysing the collected data, the unavoidable limitations of the present appraisal must be made clear.

i) The data collected is, primarily, based upon the personal interviews of the well irrigators and not necessarily on the field observations.

ii) Since it is a personal interview, factors such as tendency to exaggerate the difficulties and expenditures, and to underestimate income are likely to be relevant.

iii) A general indifference or casualness of big irrigators towards the questions asked is also observed. Therefore, authenticity of data can't be taken for granted. However, within these limitations attempt was made to get as reliable data as possible.

iv) Some of the well irrigators have more than one well. Their cropping pattern and corresponding information with respect to each well could not be obtained separately. But, their overall information has been taken to serve the purpose.

v) Water depths applied for various crops by well irrigators, again, should not be treated as exact because the calculations are based on information given by irrigators and not on scientific observations made for a considerable period of time. However, these figures are indicative and are generally found to be approximately tallying with the expected trend.

3.2 In short, the present analysis is essentially a case study with above limitations and perhaps, its results - especially those regarding inputs and outputs may not be generalised. However, it does not make any difference because the present appraisal is primarily and essentially concerned with the investigation of the relation between availability of water and cropping pattern. Or to be more specific, the main interest of the analysis is to find out whether or not well irrigators go for anything else than sugarcane when they have got ample water in relation to the land available for irrigation and can give it at shorter intervals.

4. ANALYSIS OF WATER AVAILABLE IN THE WELL AND ITS USE

4.1 In what follows we analyse the data collected from 26 well irrigators with a view to examine the cropping pattern practiced, availability of water in the well and the depth of water applied cropwise by the irrigators on the irrigable land by wells.

4.2 Table 5.1 presents the details of the land holding and its use for each of the 26 well irrigators selected for study in ascending order of their land holdings.

4.3 The irrigable area means area which can be irrigated by well water but may not necessarily be completely irrigated during the year for which information is collected. This is the reason we find that in the case of number of irrigators, area actually irrigated during the year (presented in the last column) is smaller than the corresponding irrigable area.

4.4 It is seen that except 2 irrigators all other irrigators grow sugarcane. The 2 irrigators who do not grow sugarcane are seen to be concentrating or growing other crops. We shall turn to this point latter in our analysis. Eleven out of the remaining twenty four irrigators grow sugarcane in 70 to 100 per cent of the gross cropped area irrigated, in the case of six irrigators sugarcane accounts for 50 to 70 per cent of the gross cropped area irrigated, in the case of three irrigators sugarcane accounts for 25 to 50 per cent of the gross cropped area irrigated and in

the case of four irrigators the area under sugarcane accounts for only less than 25 per cent of gross cropped area irrigated. So, it is observed that majority of the well irrigators have sugarcane as the major crop in the ICA of the well. In other words, it is quite clear from the table that majority of the irrigators give first preference to growing sugarcane.

4.5 In order to analyse the availability of well water for irrigation we have classified the selected well irrigators according to the depth of water column available in the well during kharif, rabi and hot weather seasons. In so classifying the irrigators we have considered different ranges within which depth of water column varies during different seasons. Table 5.2 gives this information.

4.6 We find that majority of the well irrigators, (around 65 per cent) fall in the class where availability of water in the well in hot weather is less than 10 feet deep, although water column in kharif and rabi seasons is generally more than 10 feet. Availability of water in the well, even during the hot weather does not seem to be constraint for well irrigation.

4.7 It can be argued that overall picture may sometimes be misleading. Therefore, it is necessary to carry out more in-depth analysis of well irrigators based upon availability of water in the well for irrigation. For attempting such analysis, it is necessary to find out the discharge of water in terms of cubic metre per hour at the disposal of every well irrigator and the depth of water (in mm) he has actually applied to various crops. When these figures of discharge, (Q) and depth (Δ) are available for every individual well irrigator, perhaps, a more clear picture may emerge.

4.8 As already mentioned, the discharge and depth calculations are entirely based upon the information given by the well irrigators themselves. This information consists of horse power of Motor/Engine, suction and delivery head details of the pump, pipe line details, etc. Using this data, discharge (Q) in cubic metre per hour is calculated. We also have per rotation, per hectare time (T in hrs.) for which water is given for some particular crop by the irrigators. So multiplying this 'T' by 'Q' we get per hectare, per rotation Volume (in m^3) applied for that crop. Then dividing this volume by unit crop area we get water depth applied, (Δ), in mm/hectare/rotation. Multiplying these ' Δ 's for one rotation by total number of rotations given for that crop, we get total depth of water applied to the crop during its base period (i.e. from sowing to harvesting).

4.9 The total water depths for different crops irrigated by the sample irrigators have been actually computed as explained above and are presented in Table 5.3. In this table, recommended water depths for the same crops are

also given for comparison. It is found that more than necessary water depths are applied for sugarcane, lucern, onion and vegetables. This is a generally expected trend. Table 5.3 in fact, suggests that some water can be easily diverted to grain crops and vegetables even if sugarcane is taken.

4.10 As mentioned earlier, cropwise estimates of water depths per hectare applied is based on the averages for all the 26 well irrigators. We have attempted a further in-depth analysis of water use by each of the 26 well irrigators based on the availability of water in well in hot weather.

4.11 As we know, hot weather is the season when water becomes all the more scarce. The water levels in the wells go down significantly. In fact, many of the wells become totally dry. Under such circumstances, the cultivators depending upon well irrigation only cannot grow perennial crops and/or hot weather crops. Therefore, it becomes a crucial question, in the context of the present study, whether the selected well irrigators have got water in their wells in hot weather or not. If they have got water, then, to what extent? How many of them are better placed as far as water availability in hot weather is concerned? Or, to put it in other words, if one gets the minimum necessary water depth in the well even in summer, then it is reasonable to assume that he gets sufficient water in other seasons also. In short, hot weather water depths are treated as 'base' depths in further analysis.

4.12 We have made use of three sets of data from all the 26 well irrigators selected for study, viz., (i) water depths in well in all the three seasons, (ii) available discharge and water depths estimated to have been applied for various crops, and (iii) cropping patterns. Bringing together all the three sets of data we can attempt an in-depth analysis of well water use based on the availability of water in hot weather.

4.13 The base depths in hot weather are classified in three categories, viz., water depths above 20 feet in hot weather, water depths between 10 feet-20 feet in hot weather and water depth below 10 feet in hot weather. Now, the well irrigators are identified in each category depending upon their available water depths in hot weather. After classifying well irrigators in these three depthwise groups, the other two sets of data viz. estimated water depths applied for various crops and cropping pattern are also brought in and placed in respective groups. So now, we know for certain the group in which a particular well irrigator falls and the depth of water column in feet, he has got at his disposal even in summer; and also the cropping pattern he follows and the water depths estimated to have been applied by him to various crops. The results of this analysis are tabulated in Tables 5.4 (a), (b) and (c).

4.14 In Group 1, the average well water depth available in hot weather is 32.5 feet (range 25' to 40'). The average irrigable area of two farmers in this group is 3.60 hectares (range 2.4 to 4.8 hectares). Out of this average irrigable area of 3.60 hectares sugarcane accounts for 2.4 hectares. But it must be noted that one farmer has grown exclusively sugarcane whereas the other farmer has opted for graincrops, vegetables and even fruits without going for any sugarcane.

4.15 The estimated water depth used for sugarcane turns out to be 504 mm per hectare per rotation which is definitely on a very higher side. But the other farmer has distributed water to all crops, and the estimates of water depth used seem to be reasonable. This farmer is from Jour village, famous for vegetables and hardly 10 kms away from Nagar city having assured market for foodgrains, fruits, etc. The farmer taking exclusively sugarcane is from Pravarasangam with cooperative sugar factory nearby and having no readily available market for vegetable etc. near the village.

4.16 In group 2, the average water depth available in hot weather is about 15 feet (range 10' to 20'). The average irrigable area of 7 farmers in this group is 3.47 hectares (range 2.00 to 7.60 hectares). Out of this average irrigable area, 1.50 hectares are under sugarcane (range 0.20 to 3.2 hectares). All of the seven farmers have grown sugarcane and no one has cultivated crops like onions and other vegetables. Only one farmer has taken chillies along with jowar, wheat, lucern and of course, sugarcane. Two farmers have taken sugarcane only, obviously, giving more than necessary water (311 mm and 348 mm respectively per hectare per rotation). Other two farmers have grown lucern also along with sugarcane. Again water depths applied (lucern - 123 mm, sugarcane - 153 mm) are more than required. Remaining two farmers have grown wheat along with sugarcane. Though, water depths applied for wheat (77 mm and 92 mm) are approximately equal to the requirement, depths applied for sugarcane (129 mm and 173 mm) are again on the higher side.

4.17 Above data indicate that this group of farmers also, prefer sugarcane as their main crop. Not only that, they give unnecessarily more water to sugarcane. They can easily save the water and use it to cultivate foodgrains and vegetables. In fact, at present most of the farmers growing sugarcane alone have not used all of their irrigable area. They can even cultivate this area using excess water which they are giving for sugarcane. So, for this group also availability of water is not a constraint. Even in hot weather on an average 15 feet water depth is available in their wells. And the irrigators can give this water to the crops any time during the season. Therefore, once again it is observed that choice of crops does not necessarily depend only upon assured irrigation.

4.18 Existence of sugar factory within a reasonable distance from the villages make the farmers grow sugarcane. Similarly

the absence of assured market for vegetables and other cash crops refrain the farmers from growing vegetable and other crops.

4.19 In group 3, the average well water depth available in hot weather is 4.6 feet (range 2' to 8'). The average irrigable area of 17 farmers in this group is 3.36 hectares (range 0.40 to 8.0 hectares). Out of this average irrigable area, 1.20 hectares are under sugarcane (range 0.30 to 2.80 hectares). Out of 17 farmers as many as 16 farmers have taken sugarcane. Out of these, 3 farmers have taken exclusively sugarcane. Two of them are from *Newasa Bk.* and one is from *Lohagaon*. Out of six farmers those who have grown chillies, 3 are from *Jeur*, 2 are from *Lohagaon*, 1 is from *Saundala*. Again out of 4 farmers those who have taken onions, 3 are from *Jeur* and 1 is from *Lohagaon*. Two farmers who have taken other vegetables are from *Jeur* again. *Ghodegaon* which is a market place is only 3 km away from these villages.

4.20 In this group one thing should be noted, that is, as many as 13 farmers out of 17 have taken one or more grain crops in addition to sugarcane and they are from different villages. But it is also observed that out of these 13 farmers as many as 10 farmers have got their maximum irrigable area under sugarcane although in most of the cases actual irrigated area is smaller than the irrigable area under the command of the well. This shows that more area could have been brought under irrigation than is presently done. If the water use pattern is observed, again it is noticed that more than necessary water depths (average 172 mm) have been applied for sugarcane. Same is the case with lucern (91 mm), onion (83 mm) and vegetables (77 mm). Thus water also does not seem to be a constraint in changing over to a different cropping pattern, if so desired.

4.21 From above analysis following observations in general can be made:

- i) those who grow vegetables, onions and chillies, have got market place close to their villages;
- ii) first preference in majority of the cases is sugarcane and more than necessary water is given to it;
- iii) the general impression that the well irrigators use water more economically and rationally than the canal irrigators is not borne out by the above observation. Now, having attempted the hot weather water depth analysis we can draw some conclusion.

4.22 Even though the selected well irrigators have got ample water at their disposal which can be extended over a wider area in the well command instead of concentrating its use on a smaller area and have relatively sound economic condition to afford to use that water at shorter intervals when-

ever they want, they still give first preference to sugarcane. Therefore, it can be argued that the choice of crop does not necessarily depend only upon the availability of assured irrigation and that erratic irregular and uncertain availability of water under canal irrigation cannot be said to be the only reason for the craze for sugarcane.

4.23 There are sufficient grounds to assume that even if canal irrigation efficiency is improved to remove element of uncertainty, the irrigators may still prefer to take sugarcane as their main crop in present set up.

5. ANALYSIS OF THE LEVELS OF INCOME WITH ALTERNATIVE CROPPING PATTERN

5.1 It would be useful and instructive at this stage to attempt an exercise for the well irrigators with more land to irrigate, showing what would have been the comparable income position with a different crop pattern under the well. In what follows we attempt such an exercise.

5.2 Our exercise is based on the overall average of the 26 well irrigators in respect of cropping pattern, depth of water applied per hectare for different crops, gross cropped area irrigated and irrigable area in the well command. These are presented in Table 5.5 for further analysis.

5.3 On the basis of the data presented in Table 5.5 we can compute that 1.23 hectare of sugarcane requires, $6335 \text{ mm} = 1.23 \times 5150$ of water depth. Now if we are to suggest an alternative cropping pattern in place of sugarcane (*adsali* - one and half year crop) we have to find out how many hectares of seasonal crops can be grown with the same amount of water as provided to 1.23 hectares of sugarcane. We find that around 15 hectares of hybrid jowar ($6335+400$), around 14 hectares of wheat ($6335+455$) and around 10 hectares of groundnut ($6335+650$) can be irrigated. But the ICA of the well is only 3.41 hectares hence individually these seasonal crops cannot be grown in lieu of sugarcane. However, considering that sugarcane occupies the land for one and half year, during this period a sequence of three seasonal crops may be grown with proper crop planning. It may be possible, for instance to grow hybrid jowar in kharif followed by wheat in rabi and groundnut in summer covering a period of one and half years.

5.4 Considering the sequence of hybrid jowar - wheat - groundnut and also considering the water used per hectare for each of these crops we estimate that around 4.25 hectares of each of these crops can be irrigated in kharif, rabi and hot weather seasons with the amount of water that is used for sugarcane presently. This estimated area is again seen to be larger than the ICA of the well and hence cannot be fully brought under irrigation.

5.5 It is clear that only 3.41 hectare of ICA (net) can be brought under irrigation. Hence instead growing sugarcane

on 1.23 hectares and other crops on 1.51 hectares (as is the existing practice) the entire irrigable command can be brought under the crop sequence of hybrid jowar (kharif)-Wheat (rabi)-groundnut (hot weather), each occupying around 3.41 hectare in each of the three seasons. The depth of water used then would be around a total of 5133 mm for all the three crops ($400 \text{ mm} \times 3.41 + 455 \text{ mm} \times 3.41 + 650 \text{ mm} \times 3.41$).

5.6 The estimated net value of produce per hectare of different irrigated crops are presented in Table 7.6 in Chapter VII. We make use of these estimates to assess the comparable income position with different crop patterns with well irrigation. Using those estimates of the net value of produce we find that the net income from 3.41 hectare of hybrid jowar, wheat and groundnut each turns out to be around Rs. 16,220 ($\text{Rs. } 1,225 \times 3.41 + \text{Rs. } 1,707 \times 3.41 + \text{Rs. } 1,825 \times 3.41$). As against this the existing cropping pattern gives around Rs. 14,240 from 2.74 hectares ($\text{Rs. } 9,550 \times 1.23 = \text{Rs. } 11,747$ for sugarcane, $\text{Rs. } 1,225 \times 0.05 = \text{Rs. } 61$ for hybrid jowar, $\text{Rs. } 868 \times 0.56 = \text{Rs. } 486$ for local jowar, $\text{Rs. } 1,707 \times 0.42 = \text{Rs. } 717$ for wheat, $\text{Rs. } 1,825 \times 0.18 = \text{Rs. } 329$ for groundnut and $\text{Rs. } 3,000 \times 0.30 = \text{Rs. } 900$ for vegetables, etc.). The increase in net income following the alternative cropping pattern is around Rs. 1,980 and in addition the farmers may sell the surplus water of the well and earn some additional income. Even if all the 3.41 hectares are considered under the existing cropping pattern instead of 2.74 hectares increase in net income following alternative cropping pattern will be around Rs. 1,000.

5.7 It may be mentioned that since the exercise is based on very rough (approximate) estimates of depth of water applied per hectare of different crops the results of the exercise may be considered as only indicative in nature. Further, the exercise is based on the averages of the 26 well irrigators on different variables, situations regarding availability of area under the command of the well, depth of water column in the well etc., may be considerably different in different cases, hence there is a limitation on generalising the outcome of the exercise.

5.8 Sugarcane is heavy water using crop (consuming almost 8 to 10 times more water than most of the seasonal crops) and income per unit of land from sugarcane is also very high compared to other seasonal crops. Hence a farmer with plentiful of water from his well in relation to his irrigable command area of well would prefer growing sugarcane if with the available water he cannot extend his net and/or gross irrigated cropped area so much as to neutralise the high income from sugarcane by income from the alternate crop combination.

5.9 Our indicative exercise shows the constraint faced on account of the ICA of the well. However, our exercise also

shows that even with the given irrigable area an alternative cropping pattern compared to sugarcane gives a higher net return, in addition the irrigator may sell excess water of the well to earn additional income, if he so desires. Under such circumstances the well irrigators should switch over to the alternative cropping pattern, but we find that such is not the case.

5.10 Improvement of irrigation efficiency, removal of element of uncertainty in the supply of water and irrigation at shorter intervals are, no doubt, part of necessary condition for switching over to a more diversified cropping pattern but that is not sufficient. Although we have no direct evidence but the indirect evidences and our discussion with the irrigators suggest that the sufficient condition may involve perhaps most of other infrastructural and technical development problems such as availability of assured markets and transport facilities, provision for modern storage facilities, availability of adequate and timely supervised credit, availability of suitable high yielding varieties, control of pest and diseases, awareness of the technology of irrigated seasonal crops, timely availability of labour during busy period and most important of all effective support prices for grain crops and vegetables. Without a solution to these problems possibility of switch over to a more diversified cropping pattern including seasonal grain crops and others instead of concentrating only on sugarcane seem to be remote.

6. LEVELS OF INPUT USED AND OUTPUT REALISED

6.1 As already discussed, in present study, we are also interested to see whether the timely well irrigation in adequate quantities at frequent intervals has promoted the use of HYVs, chemical fertilizers and insecticides/pesticides or not. Similarly, we are also interested in observing whether outputs of crops have been increased as a result of timely well irrigation at shorter intervals or not. If well irrigation has promoted the consumption of all inputs and has increased the outputs, then we can conclude that canal irrigation with improved efficiency at shorter intervals can also increase the input consumption and outputs.

6.2 Of course, use of HYVs and chemical fertilizers is so much dependent on key input, i.e., irrigation that one can always safely argue that with assured irrigation (such as well irrigation) adoption of HYVs and consumption of chemical fertilizers on larger scale become possible and should increase. We want to check up whether this has happened or not. If not, then again we will have to conclude that timely and assured irrigation is a necessary condition in this case also but it is not a sufficient condition.

6.3 Since we do not have adequate information about other inputs we confine our discussion to the use of organic and inorganic manures and fertilizers.

6.4 Table 5.6 presents the data on the use of organic manure and chemical fertilizer per hectare of irrigated land, cropwise, separately for well irrigated area and canal irrigated area. For well irrigated area the average estimates are based on the data obtained from 26 well irrigators and for the canal irrigated area the same is based on the data obtained from sample of canal irrigators and from other surveys carried out earlier.

6.5 The first thing to be noted is that the level of input use is considerably low under both canal and well irrigation in comparison to what it should be under assured irrigated condition. Well irrigated crops show a slightly higher levels of manure and fertilizer use compared to canal irrigated crops and to a certain extent this may presumably be due to relative certainty of supply of water from well.

6.6 Let us now look into the cropwise output per hectare in the well irrigated and canal irrigated areas. The sources of getting the output estimates for well and canal irrigators are the same as those used for estimating input per hectare. Table 5.7 presents these estimates.

6.7 In general the output per hectare is seen to be higher in the case of well irrigated crops although the differences do not seem to be very significant.

6.8 After analysing the available data for well irrigators, it cannot be said positively that the timely well irrigation in adequate quantities at frequent intervals has significantly promoted the use of organic manures and chemical fertilizers. Nor, the yields have been increased significantly as a direct effect of assured and adequate irrigation only. Again the same conclusion perhaps, will have to be drawn i.e., timely and assured irrigation is a necessary condition in this case also but it is not a sufficient condition. Hence, the erratic and irregular availability of water under canal irrigation cannot be said to be the only reason for lower consumption of fertilizers, etc.

Table 5.1 : LAND HOLDING, IRRIGABLE AREA AND ITS USE

Sr. No.	Net cultivated area (hectares)	Irrigable area (hectares)	Area under sugarcane (hectares)	Area under other crops (hectares)	Gross cropped area irrigated (hectares)	Remarks
1.	1.60	1.60	- (Nil)	2.40	2.40	
2.	2.05	2.05	1.80 (100.00)	-	1.80	
3.	2.40	2.40	1.80 (75.00)	0.60	2.40	
4.	2.40	2.40	2.40 (100.00)	-	2.40	
5.	2.55	2.55	1.60 (91.00)	0.15	1.75	
6.	3.20	3.20	1.80 (67.92)	0.85	2.65	
7.	3.80	3.80	0.30 (27.27)	0.80	1.10	2 wells
8.	4.00	2.00	0.40 (17.39)	1.90	2.30	
9.	4.30	1.90	0.20 (80.00)	0.05	0.25	
10.	4.80	4.80	- (Nil)	6.25	6.25	2 wells
11.	5.61	3.80	1.50 (40.98)	2.16	3.66	2 wells
12.	5.89	4.15	0.40 (10.58)	3.38	3.78	2 wells
13.	5.90	1.90	0.45 (60.00)	0.30	0.75	
14.	6.00	0.40	0.40 (100.00)	-	0.40	
15.	6.20	1.10	1.00 (100.00)	-	1.00	
16.	6.60	6.60	2.40 (37.21)	4.05	6.45	2 wells
17.	6.90	2.10	1.00 (45.45)	1.20	2.20	
18.	7.60	7.60	3.20 (53.33)	2.80	6.00	3 wells
19.	8.00	8.00	1.60 (50.00)	1.60	3.20	3 wells
20.	8.80	2.40	0.60 (21.82)	2.15	2.75	
21.	8.80	2.80	2.80 (100.00)	-	2.80	

(Contd..)

Table 5.1 (Contd..)

Sr. No.	Net cultivated area (hectares)	Irrigable area (hectares)	Area under sugarcane (hectares)	Area under other crops (hectares)	Gross cropped area irrigated (hectares)	Remarks
22.	10.95	3.75	0.20 (15.38)	1.10	1.30	2 wells
23.	11.68	4.36	1.20 (38.10)	1.95	3.15	2 wells
24.	12.55	7.20	2.00 (43.96)	2.55	4.55	2 wells
25.	14.62	3.82	2.00 (52.36)	1.82	3.82	
26.	15.80	2.00	1.00 (100.00)	-	1.00	

Figures in the parentheses indicate percentage of area under sugarcane to gross cropped area irrigated.

Table 5.2 : DISTRIBUTION OF WELL IRRIGATORS BY THE DEPTH OF WATER COLUMN (FEET)

Depth of water column			No. of irrigators
Hot weather	Kharif	Rabi	
25-40 (32.50)	50-55 (52.50)	50-55 (52.50)	2
10-20 (15.43)	15-35 (26.71)	15-30 (26.00)	7
2- 8 (4.60)	6-55 (24.30)	8-55 (22.10)	<u>17</u>
			26

Figures in the parentheses indicate average of the class.

Table 5.3 : ESTIMATES OF WATER DEPTHS PER HECTARE ACTUALLY APPLIED AND THE WATER DEPTHS RECOMMENDED

Crops	Water depth actually applied (mm)	Water depth recommended (mm)
1. Jowar (Hybrid)	162 (2)	450 - 650
2. Jowar (Local)	320 (4)	-
3. Wheat	455 (5)	450 - 650
4. Sugarcane	5150 (26)	2000 - 2500
5. Lucern	3267 (30)	800 - 1600
6. Chillies	1420 (26)	-
7. Onion	2000 (20)	375 - 500
8. Vegetables	1000 (18)	300 - 600

(1) Figures given under column 'water depth actually applied' are average figures for all the 30 well irrigators; (2) Recommended depths are taken from chart supplied by WALMI; (3) Figures in the parentheses indicate average number of watering given to each crop.

Table 5.4 : WELLWISE AND SEASONWISE WATER DEPTHS AVAILABLE, CROPPING PATTERN AND WATER DEPTHS APPLIED

A in hectares and Δ in mm/ha/rotation

Sr. No. of well irrigator	Depths in feet			Cropping pattern and depth of water (Δ) applied																	
	H.W.	Kharif	Rabi	Hy. Jowar		Local Jowar		Wheat		Sugarcane		Chillies		Lucern		Onion		Vegetables		Others	
				Area	Δ	Area	Δ	Area	Δ	Area	Δ	Area	Δ	Area	Δ	Area	Δ	Area	Δ	Area	Δ
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
(a) Water depthwise Group 1 (depth of water above 20 feet in Hot Weather)																					
6	40	50	50	-	-	-	-	-	-	2.40	504	-	-	-	-	0.20	168	0.85	34	1.20	168
13	25	55	55	0.40	101	2.60	101	0.40	134	-	-	-	-	0.60	134	0.20	168	0.85	34	1.20	168
Average	32	52	52	0.40	101	2.60	101	0.40	134	2.40	504	-	-	0.60	134	0.20	168	0.85	34	1.20	168
(b) Water depthwise Group 2 (depth of water between 10-20 feet in Hot Weather)																					
3	18	25	25	-	-	-	-	-	-	1.80	311	-	-	-	-	-	-	-	-	-	-
7	15	30	30	-	-	-	-	-	-	1.60	153	-	-	0.15	123	-	-	-	-	-	-
12	20	30	30	-	-	-	-	-	-	0.20	46	-	-	0.05	23	-	-	-	-	-	-
14	15	22	22	-	-	-	-	2.00	77	1.50	129	-	-	0.12	96	-	-	-	-	0.40	128
21	15	15	15	-	-	-	-	1.20	92	3.20	173	-	-	-	-	-	-	-	-	1.60	47
27	10	30	30	-	-	1.20	93	0.40	99	1.20	47	0.15	47	0.20	37	-	-	-	-	-	-
30	15	35	30	-	-	-	-	-	-	1.00	348	-	-	-	-	-	-	-	-	-	-
Average	15	27	26	-	-	1.20	93	1.20	89	1.50	172	0.15	47	0.13	70	-	-	-	-	1.00	88

(Contd..)

le 5.4 (Contd..)

Water depthwise Group 3 (depth of water below 10 feet in Hot Weather)

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
8	40	20	0.80	60	0.80	81	0.80	91	-	-	-	-	-	-	-	-	-	-	-	-	-	
5	18	18	-	-	-	-	0.40	62	1.80	104	0.20	62	-	-	-	-	-	-	-	-	-	
5	35	30	0.80	73	-	-	0.50	82	1.80	228	-	-	0.20	82	0.25	82	0.40	65	-	-	-	
5	15	15	-	-	-	-	0.20	101	0.30	189	-	-	-	-	-	-	-	-	-	0.60	126	
																					(Gram)	
7	35	30	-	-	1.20	71	0.30	53	0.40	26	0.40	53	-	-	-	-	-	-	-	-	-	
4	6	8	-	-	3.33	101	-	-	0.40	168	-	-	0.05	134	-	-	-	-	-	-	-	
4	12	12	-	-	-	-	-	-	0.45	154	0.10	77	0.20	58	-	-	-	-	-	-	-	
4	10	12	-	-	-	-	-	-	0.40	289	-	-	-	-	-	-	-	-	-	-	-	
4	20	20	-	-	-	-	-	-	1.00	144	-	-	-	-	-	-	-	-	-	-	-	
7	40	30	-	-	-	-	1.20	62	2.40	124	0.70	74	0.15	74	1.20	62	-	-	-	-	0.80	350
																						(Cotton)
5	35	35	-	-	0.60	89	0.20	133	1.00	267	0.20	89	-	-	-	-	0.20	89	-	-	-	
4	21	21	-	-	-	-	1.60	101	1.60	168	-	-	-	-	-	-	-	-	-	-	-	
4	16	16	-	-	1.60	67	0.20	101	0.60	269	-	-	0.05	134	0.30	67	-	-	-	-	-	
3	15	15	-	-	-	-	-	-	2.80	316	-	-	-	-	-	-	-	-	-	-	-	
3	30	30	-	-	0.40	91	0.20	121	0.20	151	0.10	90	0.20	45	0.20	121	-	-	-	-	-	
3	55	55	-	-	2.00	48	0.40	77	2.00	96	-	-	0.15	96	-	-	-	-	-	-	-	
2	10	10	-	-	0.80	81	0.80	81	2.00	101	-	-	0.22	101	-	-	-	-	-	-	-	
verage	5	24	22	0.80	67	1.34	79	0.57	89	1.20	175	0.28	74	0.15	91	0.49	83	0.30	77	-	-	
erall verage	10	27	26	0.05	78	0.56	82	0.42	92	1.23	198	0.07	70	0.09	87	0.08	100	0.06	63	0.18	164	

IRRIGATION IN DROUGHT PRONE AREAS

(Contd..)

Table 5.4 (Contd..)

Sr. No. of well irrigator	Gross cropped area irrigated (Ha.)	Irrigable area (Ha.)	Total area (Ha.)	Remarks
1	23	24	25	26
<i>(a) Water depthwise Group 1 (depth of water above 20 feet in Hot Weather)</i>				
6	2.40	2.40	2.40	Prawarasangam
13	6.25	4.80	4.80	Jeur
Average	4.32	3.60	3.60	
<i>(b) Water depthwise Group 2 (depth of water between 10-20 feet in Hot Weather)</i>				
3	1.80	2.05	2.05	Prawarasangam
7	1.75	2.55	2.55	Saundala
12	0.25	1.90	4.30	Lohagaon
14	4.02	3.80	5.61	Lohagaon
21	6.00	7.60	7.60	Newasa Bk.
27	3.15	4.36	11.68	Lohagaon
30	1.00	2.00	15.80	Newasa Bk.
Average	2.57	3.47	7.08	

(Contd..)

Table 5.4 (Contd..)

(c) Water depthwise Group 3 (depth of water below 10 feet in Hot Weather)

1	23	24	26	26
1	2.40	1.60	1.60	Jeur
5	2.40	2.40	2.40	Lohagaon
8	3.95	3.20	3.20	Jeur
10	1.10	3.80	3.80	Malewadi
11	2.30	2.00	4.00	Saundala
15	3.78	4.15	5.89	Lohagaon
16	0.75	1.90	5.90	Lohagaon
17	0.40	0.40	6.00	Newasa Bk.
18	1.00	1.10	6.20	Lohagaon
19	6.45	6.60	6.60	Jeur
20	2.20	2.10	6.90	Imampur
22	3.20	8.00	8.00	Malewadi
23	2.75	2.40	8.80	Lohagaon
24	2.80	2.80	8.80	Newasa Bk.
26	1.30	3.75	10.95	Jeur
28	4.55	7.20	12.55	Saundala
29	3.82	3.82	14.62	Lohagaon
Average	2.66	3.36	6.83	
Overall average	2.76	3.41	6.65	

(Concluded)

Table 5.5 : IRRIGATED AREA AND ESTIMATED DEPTH OF WATER PROVIDED UNDER DIFFERENT CROPS

<i>Crops</i>	<i>Area (hectares)</i>	<i>Water depth per hectare (mm)</i>
Jowar (Hybrid)	0.05	400
Jowar (Local)	0.56	320
Wheat	0.42	455
Sugarcane	1.23	5150
Vegetables	0.30	2400
Others (Groundnut)	0.18	650

Gross cropped area irrigated	2.74	
Irrigable area	3.41	

Table 5.6 : ESTIMATED AVERAGE CONSUMPTION OF ORGANIC MANURE AND CHEMICAL FERTILIZER PER HECTARE OF IRRIGATED CROP

<i>Crop</i>	<i>Organic Manure (carts per hectare)</i>		<i>Chemical Fertilizer (quintal per hectare)</i>	
	<i>Well irrigated</i>	<i>Canal irrigated</i>	<i>Well irrigated</i>	<i>Canal irrigated</i>
	Jowar (Hybrid)	10	8	1.33
Jowar (Local)	18	10	1.50	1.10
Wheat	15	8	2.00	1.10
Sugarcane	45	30	6.00	7.50
Vegetables	28	N.A.	2.00	N.A.
Groundnut	N.A.	5	N.A.	1.05

Table 5.7 : ESTIMATED AVERAGE OUTPUT PER HECTARE OF IRRIGATED CROPS

<i>Crops</i>	<i>Output per hectare</i>	
	<i>Well irrigated</i>	<i>Canal irrigated</i>
Jowar (Hybrid)	25 quintals	17 quintals
Jowar (Local)	10 quintals	9 quintals
Wheat	20 quintals	15 quintals
Sugarcane	90 tons	85 tons
Groundnut	15 quintals	12 quintals
Cotton	10 quintals	10 quintals

CHAPTER VI

MANAGEMENT OF WATER DISTRIBUTION

1. INTRODUCTION

1.1 As mentioned earlier one of the prerequisites for fuller and efficient utilisation of irrigation potential is the proper operation, maintenance and management of the water distribution system. Even when distribution system is in proper condition, i.e. specified discharge and flow of water in the main canal, distributories, minors, outlets etc., can be maintained, if the distribution of water is not properly managed the extent of utilisation would leave much to be desired.

1.2 In Chapter III, dealing with the irrigation potential and its utilisation we have noted that the extent of utilisation is low and that one of the reasons for such low utilisation is the present system of distribution of water which encourages wasteful use of water from the distribution system. Further, it is also observed that under the present system of distribution of water in many areas under the canal command the long term productivity of irrigated land is threatened by increased salinity and water logging.

1.3 Discussion in Chapter IV suggests that the existing system of distribution of water leads to inadequate and uncertain availability of canal water over a wider area in the canal command, particularly in the tail reaches of the distribution system. A large numbers of farmers under the canal command, particularly at the tail reaches of the distribution system complain about the very uncertain and inadequate nature of water supply from the distribution net work.

1.4 The existing system of distribution of water not only leads indirectly to restricting the supply of water to a smaller ICA than what was contemplated in the project planning, and that too at the upper reaches of the distribution system, the water use efficiency is also very low which go against the objective of providing protective irrigation to as large an area as possible in water scarce region like this.

1.5 There is therefore an urgent need for improving the management of water distribution in water scarce regions like this in order to meet the stated objective of providing protective irrigation over as wide as area as possible. It is against this need that we propose to examine in this section the improvement in water distribution and use which is sought to be brought about through the introduction of what is known as Rotational Water Supply, henceforth referred to as the RWS. But before we discuss the RWS proper we briefly touch upon the steps taken in recent years

towards bringing improvement in the command area to enhance the extent of utilisation.

2. COMMAND AREA DEVELOPMENT PROGRAMME

2.1 The imperative for scientific water management was recognised in 1973 when the Government decided to establish the Command Area Development (CAD) programme. CAD is a major institutional innovation. The assumption in CAD is that the potential for improvement is maximum below the outlet and that the underperformance of irrigation systems is directly linked to the absence of any governmental involvement and influences over on farm activities that determine how efficiently water is used. Thus CAD authority is to promote (i) construction of field channels and drains and lining of field channels and water courses and (ii) land shaping and land levelling. The CAD authority is also supposed to make arrangements for the timely and adequate supply of various other inputs like credit, seeds, fertilizer and plant protection measures to strengthen the existing extension agencies.

2.2 Although CAD activities started in 1973 and gathered momentum over the years since then, its performance has not been very satisfactory on all the accounts. The bench mark survey (1981) for Mula command area carried out by the Administrative Staff College of India substantiates above statement by furnishing relevant data.

2.3 We present these data in Table 6.1. It can be seen that performance on all counts leaves much to be desired. Similarly a study conducted by the Planning Commission in 1980 and quoted in a recent article revealed that the CAD had not been taken up on a very serious footing.¹

2.4 All these should not detract us from the usefulness of CAD and a need for reinvestigating its activities. The point to be made is that even when CAD is a great success on all the counts mentioned earlier, the increase in water use efficiency may not necessarily follow. In other words, inspite of CAD's success in bringing about improvement in the distribution net work below the outlet and in on farm development, the extent of utilisation may not increase significantly unless improvement is also brought about in the manner of distribution of water.

2.5 This takes us to the question of manner of water supply and distribution under the existing set-up. The present system of distribution of water is known as *Sejpal* system in local parlance. Under this system water is supplied (reportedly) from tail to head of the distribution system

1 Jai Ram Ramesh, 'Managing Canal Irrigation', Times of India, April 27, 1982.

and there is no control on the supply of water to an irrigator either in terms of volume or in terms of time. This system of water distribution naturally leads to a considerable wastage and consequent underutilisation in terms of potential area irrigated. It is with this end in view that RWS is now being propagated with the expectation that along with CAD activities this system of water distribution would bring about considerable improvement in the extent of utilisation of irrigation potential.

3. THE CONCEPT OF RWS

3.1 The concept of RWS is not new, it can be traced to the *Warawandi* system of water distribution followed in northern India. In fact RWS is nothing other than *Warawandi* system, perhaps more systematically adopted. In this system water is supplied on a volumetric basis for a specified period of time to individual irrigators in the command.

3.2 *Warawandi* has been in practice in Punjab, Haryana and Western Uttar Pradesh for almost a century. It specifies the day and time when a farmer will receive water and determines the water supply on the basis of the crops and size of holding. The irrigation schedule is worked out in advance and is well publicized among the water users.

3.3 RWS also follows the same procedure of water distribution and requires a steady water supply through the outlet. RWS requires a fairly level topography, an uniform soil, technically sound distribution net work and a high level of self-discipline among the farmers. Water supply through the canal outlet not only needs to be steady but also predictable; the amount of water being delivered and received needs to be monitored and accounted for accurately. RWS has been said to be appropriate for enlarging the area under irrigation compared to the traditional *shejpal* method by reducing water wastage and by supplying water efficiently to all potential users.

4. OBJECTIVE OF THE ENQUIRY

4.1 All these need to be examined carefully to find out how successfully the RWS is implemented for efficient water utilisation and distribution. Therefore it is considered worthwhile to carry out the evaluation of the 'Pilot Project' in Mula Command Area where RWS is in practice for the last two years. After such an evaluation is it possible to draw some conclusions regarding the functioning of the RWS and regarding the difficulties encountered in implementing the system.

4.2 To be precise the evaluation is undertaken with two main objectives, viz., (i) to study how the new water distribution technique, i.e. RWS is being implemented in practice and what has been its impact, (ii) to study the experience of the beneficiaries of the scheme and to examine the change

in cropping pattern effected by them after the system is introduced.

4.3 In order to carry out the enquiry on the implementation and functioning of the RWS, as mentioned in Chapter I, 14 irrigators, out of a total of 100 irrigators from various outlets in the command area of the pilot project were interviewed. A schedule was specifically prepared for this, as spelt out earlier. In addition, two field inspections, one after commencement of canal and one during the period of closure of canal were carried out to understand the distribution net work as also to make some indicative flow measurements. The issues involved were also discussed with concerned irrigation officials, and of course, whenever required data were also collected from official records.

4.4 In what follows we present the analysis based on the above mentioned data. First we present some salient features of the pilot project, describe the technical improvements carried out so far and its impact on the irrigators. We then present an account of responses given by the irrigators themselves.

5. SALIENT FEATURES AND GENERAL OBSERVATIONS

5.1 As mentioned earlier, the pilot project was started on direct 'Outlet No. 18'. This outlet takes off from MRBC at chainage 25/4500 (miles/feet) near Ghodegaon. Previously, (before the pilot project started) outlet number 18 was providing irrigation water to 177 hectares of ICA. The field channels were in very bad conditions and there were no field drains. Land levelling had also not been done. There was no way to measure the volume of water supplied and the manner of water distribution left much to be desired. Hence the irrigation efficiency was very low and the tail enders were not getting water.

5.2 Direct outlet number 18 was selected for introducing RWS on pilot basis and before the RWS was introduced on this outlet required technical improvements were brought about in the outlet itself and in the field channels so that the required discharge could be maintained for RWS. After effecting those improvements, which the irrigation department called 'modernisation', the RWS was introduced which has been in operation since then.

5.3 The first technical changes required to be brought about for introducing RWS were reduction in *chak* sizes and provision of number of outlets. Instead of only one outlet irrigating 177 hectares, now 12 outlets, 6 on the left side of the minor and 6 on the right side have been provided. Now each outlet serves about 15 hectares of land on an average of 3 to 4 irrigators. Considering the outlet capacity as 1 cusec this is quite a satisfactory and easily manageable arrangement.

5.4 The second improvement was in connection with the rehabilitation of the minor to improve its discharge carrying capacity. The rehabilitated minor can carry 6 cusec discharge and at least 5 outlets can run simultaneously. The minor is unlined but drops have been provided with necessary rubble lining.

6. FIELD OBSERVATION ON THE STATE OF DISTRIBUTION SYSTEM

6.1 Though the minor has been rehabilitated and its present condition is far better as compared to the past, it must be noted that the minor is not up to the required standard and it needs further improvement. The levels of some of the outlets are considerably below the minor bed level or above it. Artificial heading up of water is required to be done at certain drops in order to get required discharge. Uniform cross sections and longitudinal sections have been properly maintained. Considerable scouring has taken place just below the drops. Leakage of water through improper construction of outlet is also found to be a common feature. In fact, the tail outlet OL6 is completely out of order and not even a single irrigator has demanded water on this outlet because the outlet is nearly one feet above the bed level and water cannot be taken through it.

6.2 In short the most important precondition of RWS, i.e. a technically sound distribution network, has not been completely fulfilled in the pilot project. As a result many of the outlets do not enable discharge of 1 cusec through this is assumed while preparing the RWS programme.

6.3 The concerned officials recognise these difficulties but they point out that the defects are such that all these cannot be removed through minor alterations.

6.4 The land levelling is reported to have been completed all over the command area of the pilot project. The field channels are also reported to have been constructed to carry water from outlet head to farm head. Most of the field channels are unlined and need frequent maintenance. As everywhere, here in the pilot project also, the irrigators are rather reluctant to take the responsibility of maintaining their own field channels. With the exception of few lined field channels, other field channels are not up to mark, perhaps because of lack of maintenance. Of course maintenance of unlined field channels always poses a problem and as officials point out, perhaps it cannot be solved satisfactorily unless the irrigators themselves take the initiative. In addition the alignment between the outlet and field channels are also faulty at many a places in the project area.

6.5 The pilot project was visited after starting of rotation and some indicative readings on the Parsall Flumes (PF), a measuring device, were taken. The findings of the spot observation are presented in Table 6.2. It may be mentioned

that PFs have been installed on all the 12 outlets in order to measure the discharge of water. The six PFs on right side of minor are of cement concrete and their throat width is 6 inches and the 6 PFs on the left side are of sheet metal having throat width of 3 inches.

6.6 We found that some of the outlets were open and some were closed according to the RWS programme. The discharge through open outlets was not found to be 1 cusec; usually it was less, sometimes much less (varying from 0.25 cusecs to more than 1 cusec). The leakage through the closed outlet gates was also measured. The leaked water was either flowing to some sugarcane plot or it was going into the drain.

6.7 Unauthorised use of water by field channels taken out from outlets at a point before the point of installed SWF on the outlet was also observed. It is obvious that water flowing through these field channels cannot be accounted for and hence discharge through the outlet at the point of location of PF would be less than 1 cusec. This idea of stealing water has made the corresponding PFs useless.

6.8 In order to drain out excess water and avoid water logging and salinity drains have been provided for in almost all fields. But unfortunately many of the drains are in poor conditions; these are choked up by vegetation and silting in some of the reaches.

In addition the section of the main drain also seems to be inadequate. The adjacent fields get affected by these choked drains resulting into water logging which render these fields more or less useless for growing crops.

7. OPERATION OF RWS

7.1 The RWS was introduced as a pilot project from the kharif season of 1980-81. The main constituents of the system are described below:

- (a) Before the commencement of every rotation crop water requirements of various crops are worked out based on daily pan evaporation observations.
- (b) Considering pan evaporation, irrigation interval, present crop growth, crop factor and 1 cusec discharge, time of irrigation of 1 hectare of particular crop is decided.
- (c) Based on these calculated irrigation periods for various crops, specific time is allotted for every irrigator for his cropped area.
- (d) A detailed time table for water distribution programme is prepared arranging irrigators in 'tail to head

manner' and giving them particular date and time at which they can take water for specified period (Transit losses up to outlets only and travel times are also considered).

7.2 This is, in general, the skeleton or frame of RWS. But the important points are, (i) correct crop water requirements, (ii) maintaining a specified discharge throughout the rotation, (iii) technically sound distribution network and (iv) observation of RWS schedule by all the irrigators.

7.3 Out of these important points, observation of RWS schedule by all participants is said to be successfully put into practice by the canal authorities as well as by the irrigators. Since the irrigators get assured and timely water supply, turn by turn they seem to have accepted the system, but then complaints are still there about the inadequate supply of water during the specified time.

7.4 Regarding working out crop water requirement, the present method is better than the earlier rule of thumb, but one wonders if it is possible to bring about further improvement in this considering that too much variation in soil types does pose a serious problem and that some assumption regarding soil type becomes unavoidable. Since there is considerable variation between the results obtained on crop water requirement under controlled condition and actual practice many irrigators complain that the time allotted for crops is not sufficient; specially in hot weather.

7.5 This particular pilot project for introducing RWS on a minor specified a discharge of 1 cusec. Maintaining a discharge of 1 cusec throughout the rotation is really a problem when poor distribution network is considered. Tremendous fluctuations in discharge (as noticed) obviously jeopardises the whole RWS Schedule based on a constant 1 cusec flow in each outlet. Time of irrigation is allotted to irrigators assuming that 1 cusec water would be flowing during that period, but in practice the discharge is always less and the time allotted never changed accordingly. So, naturally the irrigators do not receive their required quota of water.

7.6 It may however be mentioned here that less than 1 cusec discharge by itself cannot upset RWS. It is possible to work out a time schedule for irrigation for a given rate of discharge to make such a calculation. The fact of a smaller discharge due to design and construction defects at the outlet, which might require complete reconstruction of the outlet, may require more time. Till then the needed water supply can be ensured by fixing the time schedule on the basis of the observed flow in the outlet.

7.7 Before the commencement of the RWS through the pilot project, sugarcane was the dominant crop in that command area of canal irrigation. Needless to mention that cane

was also grown on wells. Now, after initial years of the introduction of RWS sugarcane still remains a dominant crop as 'cane on well'. Government has severely restricted the supply of canal water to sugarcane. The main water supply schedule and volume are designed for seasonal crops.

8. OPINION SURVEY AND RESPONSES OF THE IRRIGATORS

8.1 So far we have discussed about the technical improvement that have been carried out as a part of the pilot project and as requirements for introducing the RWS. In the light of these discussions we now propose to analyse the responses of the irrigators under the RWS.

8.2 As mentioned earlier, out of a total of 100 irrigators in the pilot project, 14 irrigators were interviewed. These 14 irrigators are selected from 7 different outlets out of a total of 12 outlets under the project.

8.3 On the basis of the total land holding, of the total of the irrigators selected for study, 3 irrigators may be considered as small farmers (less than 2 hectares), 9 may be considered medium farmers (2 to 4 hectares) and 2 may be considered large farmers (above 4 hectares). Table 6.3 gives the size groupwise distribution of land holding and its break-up in canal irrigated as well as well irrigated areas. It also gives the area under sugarcane size groupwise.

8.4 It is noted that on an average a small group operates around 0.69 hectares of which 0.65 hectares are under well irrigation. Average land holding of the medium farmer is around 2.63 hectares of which 0.81 hectares are under well irrigation and 1.82 hectares are under canal irrigation. Sugarcane occupies around 0.88 hectares of irrigated area. In the large farms group, average holding size is 4.82 hectares. On an average 2.63 hectares and 2.00 hectares are under well and canal respectively.

8.5 The details of cropwise area under well and canal irrigation for each of the 14 selected irrigators are presented in Table 6.4. Only 1 out of 5 small holders has a well, of the 7 medium land holders, 5 have wells and in the large category 1 farmer has 1 well and the other one has 2 wells. All the small land holders are seen to be concentrated at the tail end of the minor (OL6) and since OL6 is not in operational condition, 3 farmers located on this do not get any canal water. One small farmer prefers to grow sugarcane only and hence does not take any canal water but uses only well water. Three irrigators, one from each group, have land which can be irrigated both by canal and well. Remaining 7 farmers have irrigated land which are either under well command or under canal command.

8.6 It is further noted from Table 6.4 that sugarcane is the only crop grown under well irrigation by all the sample

irrigators with only 2 large farmers using well water for growing wheat and vegetable also on some land in addition to sugarcane. This shows a marked preference for growing sugarcane by the irrigators. Canal water use is however restricted to seasonal grain crops and others because sugarcane is not allowed to be grown under RWS. The main crops grown under canal irrigation are wheat and summer groundnut; the interval at which the canal flows (15-20 days) suits growing these crops, but for growing very short duration vegetables the interval should be of 10 days at the most. Since this is not practiced presently, the irrigators do not grow vegetables.

8.7 The irrigators in general appreciate getting canal water regularly for a specified period under the RWS and they seem inclined to believe that this system of distribution of water is better than the *Shejpali* system practiced all over the canal command, but they raise two points in respect of the RWS. Firstly they point out that the time allotted for the flow of water to an irrigator is inadequate to irrigate the crops fully, and secondly, that there ought to be no restriction on growing sugarcane under the RWS.

8.8 So far as the first point is concerned the irrigators seem to have a genuine complain as has been borne out by the evaluation of the technical requirement for the successful implementation of the RWS. It may be recalled that although the whole schedule of allotment of time to irrigators for the supply of water is based on the assumption of 1 cusec flow in each outlet, in reality this requirement is rarely fulfilled owing to technical defects in the outlets and field channels. As regards the second point, the marked preference for growing sugarcane is obvious, from the observation that the irrigators grow sugarcane only under well irrigation. All the selected irrigators opine that there should not be any restriction on growing sugarcane under the RWS. They state that they would prefer RWS along with freedom of choice of crops. Some of the irrigators suggest that a sugarcane block of at least 0.20 hectares should be allowed to be brought under irrigation to all those who participate in the RWS.

8.9 The RWS as is operated on minor 18 as an instrument to implement the planned cropping pattern and to achieve efficient distribution of water along with increased water use efficiency does not seem yet to have been a full success. The immediate reason for this is that the pre-conditions of RWS, viz., technically sound distribution network, steady and predictable discharge etc., have remained unfulfilled. The other reason seems to be restriction on the choice of the crops, sugarcane in particular, to be grown by the irrigators under RWS. These two reasons are not necessarily independent of each other but seem to be very much interrelated.

8.10 As a result of the technical defects in the distribution system in effect what happens is that often irrigation schedule

is disrupted and the irrigators are compelled to take water for a longer period (hrs.) than stipulated in the irrigation schedule. This happens, as mentioned earlier, mainly because of the fact that the irrigation schedule for each irrigation is worked out by taking into consideration crop water requirement and the quantity of water released in the distribution system. However, the quantity of water flowing in outlets and received by the field channels is always less than what is stipulated resulting into irrigators' crops not getting fully irrigated within the time (hours) allotted. This naturally leads to irrigators demanding more time than is allocated. Once that is allowed the whole concept of RWS gets initiated and the whole schedule of RWS is disrupted and that sets into motion a chain of action by the irrigators. Then there is no account of the time allotted to each irrigator and under such a condition, in addition to irrigating specified crops as per irrigation schedule, cane supposed to be grown exclusively under well water is also given canal water, which is not permitted under RWS. Under such circumstances illegal diversion of canal water for irrigating sugarcane cannot be prevented as it is difficult to prove that water given to sugarcane is from canal and not from well because of common field channels for the given plot of land.

8.11 From these observations it is clear that the disruption of the RWS schedule (based on specific discharge) because of technical defects in the distribution not only does not irrigate the specified crops of the irrigators fully but may also lead to diversion of canal water to irrigate sugarcane. Secondly, it is also borne out by the observation that the irrigators would like to get canal water for irrigating sugarcane under RWS also.

8.12 As mentioned earlier, by and large the irrigators have accepted the operation of RWS because it ensures supply of water to every irrigator in the command, however its functioning leaves much to be desired.

8.13 In order to improve its functioning and make it an efficient system of water distribution commensurate with the objectives of introducing this system, firstly the technical improvement in the distribution system has to be brought about so that the specific discharge (1 cusec), based on which the RWS schedule is designed, can be uniformly maintained. But the fact of a smaller discharge due to design and construction defects at the outlet, which might require complete reconstruction of the outlet, may require more time. Till then the needed water supply can be ensured by fixing the time schedule on the basis of the observed flow in the channel and thus RWS can be conveniently operated.

8.14 Secondly, the irrigators should be given a free choice to grow any crop with canal irrigation even under RWS and there need be no restriction on growing heavy water using perennial crops like sugarcane under RWS. Since the volume

of water to be supplied is calculated on the basis of the seasonal crops under RWS and the time schedule for each irrigator is fixed considering a specified discharge, the irrigator should be free to use this volume of water on any crop he desires, it need not prevent growing sugarcane.

8.15 The possibility of running the minor in such a way so as to supply water once every 10 days but in smaller quantity per rotation may be explored. If possible that would meet the requirement for growing vegetables, without upsetting anything for other crops, for which smaller quantity of water can be taken twice in 20 days.

8.16 Introduction of RWS in the existing manner seems to bring about increasing involvement of the irrigation department in water distribution below the outlet and in maintaining the schedule of distribution. Success in bringing about improvement in surface irrigation would ultimately depend upon effective involvement of the irrigators in water distribution, particularly below the outlet. Discipline among the irrigators and social pressure against erring individuals would ensure proper and efficient distribution. It is therefore necessary to handover the water distribution within the outlet to begin with, and later within the minor command, to the irrigators themselves. The irrigators under each outlet may form groups with group leader and a committee who will be responsible for the distribution schedule below the outlet. In the initial stage, the committee may be helped by the irrigation department in allocating time (hours) to each irrigator based on the fixed discharge in the outlet, and area to be irrigated. Gradually the farmers should be encouraged to take over the distribution work with minimum supervision from departmental staff. The departmental officer should be consulted only if the irrigators cannot come to agreement on some matters. The responsibilities of maintaining the outlet and also maintaining the specified discharge in each rotation is of course those of the department.

**Table 6.1 : PROGRESS OF ON-FARM DEVELOPMENT (OFD) WORKS
(MULA COMMAND AREA DEVELOPMENT AUTHORITY)**

No.	Item	Total target in hectare	Work completed up to July 1981 (in hectares)	Achievement (Percentage)
1.	Soil survey	1,18,202	-	-
2.	Topographical survey	1,18,202	60,331	51.0
3.	Planning and designing of 'On-Farm Develop- ment' works	1,18,202	57,985	49.0
4.	Constructions of field channels	1,18,202	90,698	76.7
5.	Lining of field channels	1,18,202	-	-
6.	Construction of drains	1,18,202	64,766	54.7
7.	Construction of hydraulic structures	1,18,202	62,207	52.6
8.	Land levelling and shaping	1,18,202	70,587	59.7
9.	Outlets	2,877 (Nos.)	1,337 (Nos.)	46.4
10.	Length of field channels	8,728 (Km)	4,728 (Km)	54.2

Source : Bench Mark Survey (1981) of Mula Command Area, Administrative Staff College of India, Hyderabad.

Table 6.2 : OBSERVATION IN RESPECT OF PILOT PROJECT-I (DIRECT OUTLET NO. 18 OF MRBC) INTRODUCING RWS SWF reading 1.5 feet. (6 cusec discharge according to Canal Inspector (CI) at 10.00 a.m.)

Outlet Nos.	Regular Flow			Leakage Flow			Leakage flow to	Remarks
	3" PF	6" PF	Discharge (cusec)	3" PF	6" PF	Discharge (cusec)		
1	2	3	4	5	6	7	8	9
OL ₁	-----Outlet closed-----			3"	-	0.12	Sugarcane	Rotation just started. Head outlet closed.
OR ₁	-----Outlet closed-----			-	5"	0.50	1) Sugarcane 2) Groundnut	Outlet 1 foot below CBL according to CI.
CL ₂	-----Outlet closed-----			3"	-	0.12	Sugarcane	Reverse slope to FC. One more FC before PF.
OL ₃	11"	-	0.90	-	-	-	-	Siphon pipe-left in FC itself. Unauthorised FC before PF Gate 1 below CBL. PF on higher level
OR ₂	-----Outlet closed-----			3"	3"	0.25	Sugarcane	Well in the field but no separate FC for well water.
OR ₃	-----Outlet closed-----			-	2"	0.12	Drain	-
OL ₄	9"	-	0.64	-	-	-	-	Two salt affected farms. FC breached, well water salty.
OR ₄	-----Outlet closed-----			-	3"	0.25	Sugarcane at 2 places	Siphon pipe left in main lined FC itself.

(Contd..)

Table 6.2 (Contd..)

1	2	3	4	5	6	7	8	9
OR ₅	-	6"	0.70	-	-	-	-	1.5 stone wall above fall to head up the water
	-	4"	0.30	-	-	-	-	Stone wall removed. Water taken out of turn for groundnut plot at outlet head only. Siphon and FC combined.
OL ₅	PF over flowing	-	Much more than 1.0 cusec	-	-	-	-	FC from well merged in main FC at outlet head only.
OR ₆	-	3"	0.25	-	-	-	-	Outlet open but gate closed.
	-	8"	1.07	-	-	-	-	Outlet open, gate also completely open. Portion of field near main drain water-logged. Sugarcane being irrigated.
OL ₆	-----Outlet closed-----			-	-	-	-	Rotation just started. But this tail outlet is closed. No demand. Outlet gate 1 foot above CBL, cannot get 1.0 cusec water. (hardly 0.50 cusec) according to CI and cultivators both. Everybody has got well. Sugarcane is grown on well water.

Pilot Project - Part I is up to OL₆. OL₆ onwards - Part 2 starts. No RWS yet in this part. According to CI, requirement of Part I is first fulfilled and then only water is let out for Part II. But it is observed that Part II started getting water as soon as rotation started.

Note : These observations have been taken in presence of Mr. Shinde, CI of Pilot Project on 17th July from 10.00 a.m. to 12.30 p.m.

(Concluded)

Table 6.3 : SIZE GROUPWISE LAND HOLDINGS AND IRRIGATED AREA

<i>Size Group</i>	<i>No. of farmers</i>	<i>Total land holding (hectares)</i>	<i>Canal irrigated holding (hectares)</i>	<i>Well irrigated holding (hectares)</i>	<i>Area under sugarcane (hectares)</i>
Below 2 Hectares	5	3.43 (0.69)	-	3.24 (0.65)	2.56 (0.51)
2-4 Hectares	7	18.43 (2.63)	12.74 (1.82)	5.65 (0.81)	6.13 (0.88)
Above 4 Hectares	2	9.65 (4.82)	4.00 (2.01)	5.25 (2.63)	4.45 (2.22)

Note : Figures In parentheses denote averages.

Table 6.4: CROPPING PATTERN OF THE IRRIGATION UNDER THE RWS SYSTEM

Sr. No.	Outlet No.	No. of wells	Total area (hectares)	Canal irrigated area (hectares)	Well irrigated area (hectares)	Crops taken on canal (hectares)				Crops taken on well (hectares)			
						Sugar-cane	Wheat	Ground-nut	Other	Sugar-cane	Wheat	Other	
1.	OL ₆	-	0.49	-	0.30	-	-	-	-	0.30	-	-	
2.	OL ₆	-	0.51	-	0.51	-	-	-	-	0.51	-	-	
3.	OL ₆	1	0.55	-	0.55	-	-	-	-	0.55	-	-	
4.	OR ₅	-	0.85	-	0.81	-	0.50	0.50	-	0.31	-	-	
5.	OL ₅	-	1.03	-	1.03	-	-	-	-	0.90	-	0.13	Brinjal
6.	OR ₅	1	2.20	-	2.20	-	-	-	-	2.20	-	-	
7.	OR ₂	1	2.23	1.40	0.83	-	-	1.40	-	0.83	-	-	
8.	OR ₅	-	2.40	1.20	1.20	-	0.80	0.40	-	1.20	-	-	
9.	OL ₅	-	2.40	2.00	0.40	-	0.80	0.80	0.40 (Jowar)	0.40	-	-	
10.	OL ₅	1	2.40	2.00	0.40	-	0.80	0.80	0.40 (Jowar)	0.40	-	-	
11.	OL ₄	1	2.80		2.80	-	0.60	1.40	-	0.80	-	-	
12.	OL ₄	1	1.26	0.60	0.66	-	-	-	-	0.30	-	-	
	OR ₁	-	2.74	2.74	-	-	-	2.74	-	-	-	-	
13.	OL ₂	1	1.55	0.50	1.05	-	-	0.50	-	1.05	-	-	
	OL ₅	-	1.45		1.45	-	-	-	-	1.10	-	0.35	
	OR ₅	-	1.25		1.25	-	-	-	-	0.30	0.40	0.40	Brinjal
14.	OR ₃	1	1.20	-	1.20	-	-	-	-	1.20	-	-	
	OR ₅	1	2.20	-	1.80	-	-	-	-	0.80	0.80	0.40	Brinjal
	OL ₅	-	2.00	0.80	1.20	-	-	0.80	-	-	-	-	
Total		9	31.51	16.74	14.14	-	3.50	9.34	0.80	13.14	1.20	1.28	

Note : Figures between canal irrigated area and well irrigated area show the area that can be irrigated both by canal and well and have been included in canal irrigated area.

CHAPTER VII

BENEFITS AND COSTS OF THE PROJECT

1. INTRODUCTION

1.1 In this chapter we wish to discuss one of the crucial aspects of water resource development planning, namely the costs and benefits of the irrigation project. We do not intend to dwell into the methodological issues involved in the benefit-cost analysis of a project in this study. What we propose to do is to estimate the approximate costs and benefits with the help of data that we have been able to lay our hands on, which will give us a reasonable idea about the performance of the Mula Irrigation Project.

1.2 The cost to the project involves the capital expenditure incurred and the regular maintenance and administrative expenses, and the benefits to the project incorporates the net value of additional agricultural output possible to be produced because of the irrigation development. The capital cost of the project and the administrative and maintenance expenses are available from the records of the irrigation department; the net benefits, however, depends upon the cropping pattern adopted by the beneficiaries.

1.3 We have found, as mentioned in the earlier chapter, that there is a great divergence between the cropping pattern finally envisaged in 1973 project report and modified in 1977 project report and the cropping pattern actually practised by the beneficiary farmers. Again, as discussed earlier, we find that sugarcane, which is stipulated to occupy only 4 per cent of the ICA as per the said project report, actually occupies much more than that when we consider the area of cane on well receiving canal water and also the unauthorised use of irrigation water for growing cane. Further, hot weather groundnut which according to the suggested cropping pattern in the project report should have occupied only 3 per cent of the ICA actually occupies around 12 per cent, and on the other hand, long staple cotton which was projected to occupy 19.5 per cent of the ICA actually accounts for around 5 per cent of ICA. All these lead to a great divergence between created irrigation potential projected to be utilised and the actual utilisation of the irrigation potential. And this is one of the reasons why we find only around 45 to 50 per cent utilisation of the irrigation potential created, measured in conventional term.

1.4 As mentioned in our earlier discussion, on the basis of our field investigation of the sample households, we have tried to ascertain the reasons for farmers choosing crop pattern which is considerably different from the one suggested in the project report. One thing which very clearly emerges from our enquiry and discussion with the farmers is their marked preference for growing sugarcane. Whether the

farmer has his own source of irrigation or is dependent on the supply of irrigation water from canal, he shows a clear preference for growing sugarcane subject to his resource constraints. This is found to be the practice irrespective of the size of farms.

2. REASONS FOR DEVELOPMENT OF EXISTING CROP-MIX

2.1 Sugarcane happens to be the most profitable crop in terms of net value of produce per unit of land. It gives very good return commensurate with the inputs. Even with the fluctuating prices over the years (which has been the characteristic with the sugarcane price for the last few years), farmers get a reasonably good financial return. A good cultivator who personally attends to all operations in his field, is careful about frequency of water supply carries out planting, other cultivation practices and fertilizer application, etc., at proper time, can get an yield of more than 100 tons per hectare. Even those farmers who do not bother to get all the operations done under their personal supervision and also those who can not afford to apply very heavy doses of fertilizer are also assured of getting, on an average, an yield of 80 tons per hectare.

2.2 Sugarcane is a robust plant. It can stand a high water stress. It can also stand excess water supply to a considerable extent. Even if the period between two waterings is prolonged, the yield is not greatly affected. Such prolonged rotation periods are not uncommon in canal irrigation.

2.3 Sugarcane is also not affected by pests and diseases and weeds. The cultivators are not required to be vigilant about water supply, pest control, etc. They can employ labourers to attend to routine operations like watering etc., and can remain away from the field for long durations. This suits both the small as well as big farmers. Small farmers, so that they can look for and take up wage employment; and the big farmers so that they can make themselves available for other activities like money lending, trading, arranging for the timely supply of credit and other inputs and, last but not the least, indulging in active politics to strengthen more and more their social and political influence on the masses..

2.4 An increasing demand from the well irrigators for supply of canal water for sugarcane to supplement the water available from wells, and the consequent seasonal sanction given by the irrigation authorities for such irrigation has led to a considerable increase in the area under sugarcane, getting both authorised and unauthorised canal water.

2.5 Finally, the development of co-operative sugar factories, which give adequate support to the member cultivators from sowing to harvesting, in the form of advances for inputs, assured market, harvesting and transport by the factories, etc., has also contributed to the emergence of sugarcane as the most preferred crop in the irrigated tracts.

2.6 As against this the reasons for less than projected development of irrigated area under other seasonal crops are mainly low yield, fear of crop failure due to pests and diseases, uncertainty of availability of labour during the peak periods, uncertainty regarding the availability of canal water in adequate quantity and at proper intervals, and considerable instability in the prices of the seasonal crops.

2.7 Hybrid jowar, which was expected to develop into an important irrigated kharif seasonal crop, has not developed to its full potential inspite of sustained Governments campaigns because of its poor quality in terms of tastes and also because of poor fodder quality. Further, whenever the rainfall is good and uniformly distributed, the irrigated area under this crop goes down. Similarly hybrid bajra, another kharif seasonal shows very insignificant area under canal irrigation because of its susceptibility to the disease 'argot'.

2.8 Amongst the rabi seasonals, jowar and wheat seem to be the major crops and they compete with each other. Area under rabi seasonals, mainly jowar and wheat more or less corresponds with the area under the same as per the 1977 project report. However, it should be noted that not an inconsiderable part of the canal water shown in the official records to have been given to jowar actually is diverted to sugarcane. The sufferer in such cases are the farmers at the tail end of the canal as is evident from our discussion in chapter IV.

2.9 Groundnut is a seasonal crop which seems to have gained the farmers' favour, mainly the one which is grown in the hot weather. It is interesting to note that in the projected cropping pattern this crop was not provided for. However, kharif groundnut was provided for in the project cropping pattern, but, except in the initial few years, kharif groundnut has been completely replaced by hot weather groundnut. It has become popular with the farmers because its yield is higher, damage due to pests and diseases is comparatively less in summer season, it fits into the cropping sequence with sugarcane being harvested in February, March, and, finally, because of the consistently relative high prices for the crop which together with high yield gives a better return to the farmer.

2.10 Just opposite is the case with the long staple cotton (L.S. Cotton). The project cropping pattern stipulated about 20 per cent of the ICA under this crop however, after a few initial years of success, with the introduction of new varieties like Vara Laxmi, Savitri etc., the area under the crop has almost vanished from the command area of MRBC. This is mainly because of the very uncertain nature of yield of this crop. It is reported to be very susceptible to even minor changes in atmospheric conditions. Even if the L.S. cotton is a high yielding crop under normal conditions,

fluctuation in yield from year to year is so violent that the farmers in general do not want to take the risk. Similarly even the high relative price for this crop fails to induce the farmers to resort to growing L.S. Cotton.

In an earlier study on irrigation we had suggested alternatives to growing sugarcane which will give higher net returns for the given amount of water. The crop combination included seasonal crops over the duration of 18 months as an alternative to 'Adsali Cane'. Similarly a seasonal crop combination over the duration of 12 months as an alternative to 'Suru Cane' was also suggested in that study¹.

3. WATER REQUIREMENT AND NET VALUES OF PRODUCE PER UNIT OF WATER USED

3.1 Water requirements of different crops at the distributory head have been ascertained and based on these water requirement, area that can be irrigated per Mcft of water for each crop are estimated and after that the net value of produce per Mcft of water for each crop is arrived at by multiplying the area under different crops that can be irrigated per Mcft of water with the corresponding estimates of net profit per acre. We reproduce here the result of that exercise in table 7.1.

3.2 As is seen in the exercise, the estimates of net value of produce per unit of water shows that sugarcane is one of the least paying crops at the given level of prices (1978-79) of different crops. All the seasonal foodgrain crops show a higher net income per unit of water than sugarcane, hybrid jowar, in particular, shows comparatively a very high income. Among the cash crops onion, cotton and groundnut show very high income. As mentioned earlier this happens to be so because the area that can be irrigated per Mcft of water in respect of crops other than sugarcane is much larger and this more than makes up for the comparatively smaller return per acre for these crops. Therefore, it follows that with a million cubic feet of water that is available and can be used any time during the period over which sugarcane is grown, growing any seasonal foodgrain crop or one of the cash crops or any suitable crop combination on a larger area will add more to the total social income than growing sugarcane.

3.3 It may be mentioned here that in our said study the net value of production for each crop is based on the average yield of past 5 years. Now it is quite likely that the average yield is often not realised by large number of farmers and in any given year, particularly in the case of

1 Economics of Irrigation In Water-Scarce Regions: A Study of Maharashtra - Nilakantha Rath and A.K. Mitra, Gokhale Institute Study (mimeograph), March, 1987.

seasonal grain and other crops. The co-efficient of variation is found to be considerably higher in the case of these crops. In view of this the net value of produce for the alternative crops to sugarcane is computed by taking the lower yield levels of these crops instead of average yield level, but in spite of this the alternative crop combination gives higher net value of produce per Mcft than sugarcane. This is in the nature of sensitivity analysis. Similarly even another sensitivity analysis by considering high relative price of sugarcane to seasonal crops (than that was prevalent during 1978-79) also shows a higher net value of produce per Mcft of water in respect of other crops than sugarcane. We reproduce here the results of the exercise in the aforementioned study in Table 7.2.

3.4 The results of all these exercises go to suggest that water use efficiency appear to be more favourable in the case of alternative crops than in the case of sugarcane. So, instead of growing sugarcane and concentrating irrigation more in the upper reaches of canal over a smaller area if the irrigation water is distributed to other crop mix it may not only generate larger total social income, it may also bring about a more widespread distribution of the canal water available for irrigation over a larger area.

4. CONDITIONS NECESSARY TO INDUCE CHANGES IN CROP-MIX

4.1 However, in judging the economics of alternative crop pattern there are certain other important aspects which needs to be borne in mind. Farmers' acceptance of a particular crop combination depends on host of factors other than the relative prices of these crops. Our discussion with the farmers brings out this aspect very clearly. To our suggestion regarding switch over from sugarcane to a crop combination showing higher net value per Mcft. of water the farmers raised a number of questions which have bearing on the acceptance of the proposed cropping pattern.

4.2 First of all, even if a higher net value of produce for a given quantity of water in the case of alternative crops is accepted without any reservation a farmer having limited land and plentiful of water supply from the state irrigation system will not find it economical to change over from sugarcane to other crops.

4.3 Secondly, assuming that in the larger interest of the social economy, this change over is essential, then other technical and related problems associated with adopting the alternative crop combination, as mentioned earlier, will crop up. Farmers in general, are known to be rational in their behaviour. They would definitely accept the crop combination which turns out to be most profitable, subject to all constraints. They are yet not fully convinced about the profitability of other crop mix as alternative to sugarcane. It would need much more to convince them about this fact than simply working out for them the economics of the alternative crop mix.

4.4 *First and foremost* is an assured supply of water at shorter intervals, specially during the hot weather season, than is the practice today. This may induce the farmers more to go for the seasonal crops or even short duration vegetables etc. In this context introduction of RWS system would go a longway in mitigating the problem of uncertain supply of water to the irrigators and at uncertain interval.

4.5 *Secondly*, an active involvement and participation of agricultural extension worker in crop husbandary in irrigated agriculture in terms of proper farm management, and timely control of the occurrence of pests and diseases are necessary pre-conditions for any desired change over. The Command Area Development Authority (CADA) is expected to play a fruitful role in this direction.

4.6 *Thirdly*, an assured market for their produce is also a very essential aspect of a desired change in crop mix. It would be of no use demonstrating the high and assured yield of seasonal crops with proper crop husbandary unless the farmers are assured of a ready market for their produce and of a reasonable price. This involves determination of proper support prices for agricultural produce and also strengthening the operation of Food Corporation of India and other public sector agencies.

4.7 Finally, in order to make the desired change in crop pattern possible in the command area of the project and also to extend the coverage of irrigation and spread it over a wider area, it is absolutely essential to reduce the area under cane drastically so that the resulting available water can be redistributed over a wider area of the canal command. However, this presupposes the completion of the necessary outlets and field channels and the maintenance of these outlets and field channels in proper working conditions. As we have seen earlier, the main reason for poor utilisation of the available water supply is the absence of the necessary outlets and field channels, particularly at the tail end of the canal. Again the CADA is expected to play a very fruitful role in this respect.

4.8 Once all these difficulties in the way of extending the irrigation potential over a wider area of the canal command have been removed it would be possible to convince the beneficiary farmers about the economic feasibility of growing alternative crop mix instead of concentrating on heavy water using crops like sugarcane.

5. EXISTING CROPPING PATTERN AND THE ENVISAGED CROPPING PATTERN

5.1 The 1977 project cropping pattern for the Mula Irrigation Project which was developed on the basis of the availability of water, soil type in the canal command and suitability of growing different crops during different seasons, apportioned only 4 per cent of the ICA to sugarcane in order to extend, irrigation over a wider area in the canal

command for the seasonal crops, with a cropping intensity of around 105 per cent in the perennial zone of the canal. In the non-perennial zone of the canal (Pathardi branch) no perennial crops were introduced, only the seasonal grain and other seasonal crops and two seasonals were proposed to be irrigated in this zone with a cropping intensity of 123 per cent.

5.2 As mentioned earlier, though the project cropping pattern envisaged putting a restriction on the area under cane on canal in actual practice this was not followed and a significant area of cane on canal directly or indirectly developed over the years at the cost of extending the irrigation water over a wider area in the canal command. To get an idea of the crop pattern that has come up in the perennial zone of the Mula Command we present in Table 7.3 the cropping pattern based on the averages of past five years as compared to that envisaged in 1977, as reported in study on Evaluation studies of Mula Irrigation project by WALMI, Aurangabad.

5.3 The area under cane which was envisaged to be only 4 per cent actually accounts for around 12 per cent, three times what was stipulated. Again it should be noted that these figures are based on the water demand records and not on what actually gets irrigated every year. In fact, our field investigation suggests that the actual irrigation every year is much different from what is reported in the official statistics because of the practice of unauthorised irrigation on a large scale mainly in respect of sugarcane. This has ultimately led to a considerable underutilisation of the irrigation potential.

6. SUGGESTED CROP PATTERN

6.1 In view of this for the future development and full utilisation of irrigation potential we assume that cane on canal will be strictly restricted to 4 per cent of the ICA in the perennial zone and further that no permission for supplementary canal irrigation to cane on well will be granted in future. On the basis of these two assumptions we project cropping pattern for the future in order to estimate the benefits that will accrue to the project. Once the restriction on area on cane on canal is strictly adhered to and no canal water is made available to the cane on well as supplementary irrigation, which in its turn will minimise the unauthorised irrigation, it will be possible to extend seasonal irrigation to the entire irrigation potential likely to be created as per 1977 project report.

6.2 Suggested cropping pattern under irrigated condition includes sugarcane as well as other seasonal crops which respond to irrigation very favourably, like cotton, groundnut and wheat. However, as mentioned earlier, the area under cane is restricted only to 4 per cent of the ICA. The crop pattern envisaged is by and large based on what was suggested in 1977 project crop pattern and also taken

into consideration the preferences shown by the farmers for different seasonal crops as observed in the cropping pattern followed in the past five years. We give the crop pattern envisaged for the perennial and non-perennial (Pathardi Branch) zone of the Mula Canal System in Table 7.4.

6.3 Full potential irrigable area (gross) in the perennial zone is 71630 hectares on the basis of 105 per cent cropping intensity. Full potential of irrigable area (gross) for Pathardi branch (non-perennial zone) is 14020 hectares on the basis of 123 per cent cropping intensity. Thus the total potential irrigable area (gross) under Mula Canal System is 85650 hectares according to cropping pattern of 1977 project report. In computing the net annual benefit from irrigation we have assumed that the full potential irrigable area of 85650 hectares as per the modified cropping pattern, suggested in Table 7.4 would be irrigated by 1985-86.

6.4 The crop pattern without irrigation is presented in Table 7.5. This crop pattern is arrived at on the basis of the cropping pattern practised by the farmers in the dry tract i.e. in the non-command area of the Mula Canal System. As is expected we find that such crop pattern comprises mainly of jowar (88 per cent), that too, rabi jowar. Bajra in kharif season and wheat and gram in rabi season occupy very insignificant area. We assume that in the absence of irrigation the farmers would have grown different crops as presented in Table 7.5.

7. ESTIMATION OF ANNUAL BENEFITS

7.1 Estimation of benefits from an irrigation project requires data on cropping pattern, irrigation intensity, crop yields, output of by-products with and without irrigation and prices of inputs and outputs and by-products.

7.2 An extremely useful rule of thumb approach identify the overall return arising from an irrigation project is to ask what will be the impact "with" and "without" the project. The difference is in general, the net benefit arising from the project.² In simple terms the direct benefit of an irrigation project consists of increase in the value of agricultural produce as a result of irrigation. In other words, the benefit of the project is given by the value of the produce of the land irrigated by the project minus the produce of the same land prior to irrigation. The value of the produce of the irrigated land is naturally much greater than that of the unirrigated land. But the expenses of cultivation of irrigated land are also much greater than the expenses of cultivation of unirrigated land. Hence, in

² *Economic Analysis of Agricultural Projects*, J. Price Gittinger, The Economic Development Institute, I.B.R.D., 1976, pp. 15.

comparing the two, we should consider the net value of produce, that is, value of produce net of expenses of cultivation.

7.3 On the basis of the field investigation of the sample farmers, mentioned earlier and supplemented by data on farm input-output from other sources we have first estimated the average yield of various crops grown under irrigated conditions and also under unirrigated conditions. Gross value of produce for each crop is then estimated by using the prices of the respective commodities prevalent in 1982, the year of field investigation.

7.4 Average cost of cultivation in the form of seeds, farm yard manure, fertilizer, insecticide etc., and the other cultivation expenses for different crops grown under irrigated and unirrigated conditions are again estimated on the basis of the data generated from the field investigation of the sample farmers and supplemented by data available from other studies and/or sources. The same is presented in Table 7.6.

7.5 The net value of produce for different crops is then arrived at by subtracting the estimated cost of the inputs from the respective value of gross produce, separately for the irrigated and unirrigated crops. The per hectare net value of produce thus estimated is then used in estimating total net value of produce, first 'with' and then 'without' irrigation on the basis of share of each crop in gross irrigated cropped area in the case of irrigated crop (with irrigation) and share of each crop in total cropped area in the case of unirrigated crops (without irrigation). This is presented in Tables 7.4 and 7.5. The estimated net value of produce with irrigation (A) is Rs. 1611 lakhs and the same without irrigation (B) works out to Rs. 276 lakhs.

7.6 The net annual benefit is obtained by subtracting the net value of produce without irrigation (B) from the net value of produce with irrigation (A). The net annual benefit thus estimated shows the net benefit achieved because of irrigation brought about by the said irrigation system. It works out to be Rs. 1335 lakhs.

8. ESTIMATION OF ANNUAL COST

8.1 The annual cost comprises (i) interest on capital, (ii) depreciation and (iii) administrative expenses which may be considered as operation and maintenance expenses. Conventionally the interest is charged at the rate of 10 per cent per annum. Again, according to normal practice, the depreciation is calculated at the rate of 2 per cent assuming the life of the project to be 50 years. We have, however, not calculated the interest and depreciation in this manner as a part of the annual project cost. Instead we have made use of the 'Capital Recovery Factor' for arriving at the annual project cost. Capital recovery factor is the annual payment that will repay Re 1 loan in 'X' years

with compound interest on the unpaid balance.

8.2 As mentioned earlier, capital expenditure on the project for the construction of the head works and the canal system began in 1956-57 and thereafter every year construction cost and expenditure on establishment have been incurred till 1983-84. However, although the capital expenditure on the project began in 1956-57, the dam with the gates were completed and substantial irrigation from the Mula system was started only from the year 1975-76. The year 1975-76 is therefore considered as the starting year of the project life of 50 years. In effect therefore it took almost 20 years for the investment to yield some return and hence the interest on yearwise expenditure should be capitalised for this period between 1956-57 and 1974-75. It is only after that the annual cost of the project is to be computed considering the remaining life of the project. By not capitalising the interest on capital invested for the period of construction we shall underestimate the cost.

8.3 In view of this we have capitalised the interest on yearwise expenditure incurred from 1956-57 to 1974-75 i.e up to the end of 19th year from the beginning of construction period. Considering the first year, 1956-57 (t_1) as an example, it may be seen that interest will continue to be added to the original capital from the end of the 1st year through the end of 19th year and compounded. Thus, the amount at the end of 19th year will be the original expenditure along with interest compounded for 19 years. A similar process is followed for the 2nd year, 1957-58 (t_2), the interest on capital expenditure in the 2nd year will continue to be compounded for 18 years, similarly for 3rd (t_3) year and so on up to the 19th year (t_{19}). The computation is presented in Table 7.7. The total expenditure on the project is sum of the total capitalised value of expenditure up to 1974-75 and the total of annual expenditure incurred from 1975-76 to 1984-85 which is to be realised annually over the remaining life of the project with compound interest on unpaid balance.

8.4 As mentioned earlier 1975-76 is considered as the starting year of the 50 year project life. Full irrigation potential is expected to develop, as per the modified cropping pattern suggested earlier, in 1985-86 by which time a period of 10 years would have been completed out of the 50 years life span of the project. Therefore the recovery of the project cost is assumed out of annual payment over 40 years with compound interest of 10 per cent on unpaid balance. Total expenditure on the project up to 1984-85 thus turns out to be Rs. 5,868.20 lakhs (Table 7.7). The 10 per cent capital recovery factor may now be applied to this amount considering 40 years as the remaining life of the project as follows.

1. Total capital expenditure = Rs. 5868.20 lakhs
2. Capital recovery factor
at 10 per cent over 40 years = Rs. 0.102259
3. The annual cost of capital = 5868.20×0.102259
= 600 lakhs (a)

Administrative charges are conventionally put at Rs. 25 per hectare of irrigated area in different studies.³ We have also used the same in our estimation of the annual cost of the project.

4. Administrative charges = Rs. 25 per hectare of
irrigated area
5. Irrigated area = 85650 hectares
6. Annual administrative cost = 25×85650
= Rs. 21.41 lakhs (b)
7. Total annual cost of
the project = (a+b) = Rs. 600 lakhs +
Rs. 21.41 lakhs
= Rs. 621.41 lakhs

9. BENEFIT-COST RATIO

9.1 The annual benefits should be related to the annual costs of the project in order to find out the benefit cost ratio of the project. Hence the benefit cost ratio of the present project works out to:

$$\frac{\text{Net annual benefit}}{\text{Annual cost of the project}} = \frac{1335.00}{621.41} = 2.15$$

9.2 The benefit cost ratio computed in this manner turns out to be more than the stipulated 1.5 recommended by the Second Irrigation Commission (1972) as acceptable from economic consideration. Though estimation of benefit cost ratio in this manner may not be very accurate, it nevertheless is good enough for a valid comparison with what was computed in the original and revised project proposals. It may be mentioned here that the estimated benefit-cost ratio of 2.15 is possible to be achieved only if the cropping pattern suggested in 1977 project report (with some modification as per the field observation, presented in Table 7.4) is followed. This cropping pattern, by restricting the area under cane to 4 per cent of ICA makes it possible to extend the irrigation over a larger area to cover the entire potential created.

9.3 In order to highlight this observation we have also computed the benefit-cost ratio of the Mula irrigation

³ *Economic Appraisal of Irrigation Project in India*, Baswan Sinha and Ramesh Bhatia, Agricola Publishing Academy, New Delhi, 1982, pp. 80-81.

project on the basis of the cropping pattern that has actually developed (average of the past five years) in the Mula system. An area of 85650 hectares was planned to be irrigated under MRBC + MLBC + Pathardi Branch in 1977 project report. However the cropping pattern that has actually developed (average of the last five years) has a higher percentage of perennials. So the average total area irrigated under MRBC and MLBC is only 32530 hectares instead of 71630 hectares as per 1977 project report. Irrigation in Pathardi branch is still to fully develop though 1977 project report had envisaged an area of 14020 hectares to be irrigated on the basis of 123 per cent cropping intensity with no sanction for perennial crops. It would be reasonable to assume that except sugarcane the cropping pattern observed on other areas (MRBC and MLBC) will also develop in Pathardi branch. Since the average of past 5 years under MRBC and MLBC shows around 50 per cent utilisation we assume a similar utilisation percentage under Pathardi branch also. A 50 per cent utilisation amounts to around 7000 hectares of irrigated area under Pathardi branch. So the total irrigated area under Mula system (MRBC + MLBC + Pathardi Branch) works out to 39530 hectares on the basis of the cropping pattern that has actually developed under MRBC and MLBC.

9.4 Area under different crops as per the cropping pattern that has actually developed and the net income from these crops are presented in Table 7.8. We assume no sugarcane on canal water will be grown in that zone. Area under different crops grown under unirrigated condition and the corresponding net income are presented in Table 7.9. The benefit cost ratio considering the actual cropping pattern that have developed in the Mula system works out as under:

1. Net income as per actual cropping pattern with irrigation	= Rs. 847.74 lakhs
2. Net income from the corresponding area without irrigation	= Rs. 136.80 lakhs (Table 7.8)
3. Net annual benefit	= 847.74 - 136.80 = Rs. 710.94 lakhs
4. Benefit cost ratio	= $\frac{710.94}{621.41} = 1.14$

9.5 Based on the actual cropping pattern (average of past 5 years) that has developed, the benefit-cost ratio turns out to be 1.14 which is less than the stipulated 1.5 recommended by the Second Irrigation Commission (1972) as acceptable from economic consideration.

9.6 It is thus clearly borne out that extending the irrigation over wider area in the canal command by growing seasonal crops instead of more than stipulated area under sugarcane, may not only increase the gross cropped area irrigated spread over wider area under canal command, but may also improve the benefit-cost ratio of the project.

Table 7.1 : IRRIGATION WATER REQUIREMENT OF CROPS AT DISTRIBUTORY HEAD AND THE NET VALUE OF PRODUCE PER UNIT OF WATER USED (1978-79)

<i>Name of the crop</i>	<i>Water requirement (acre inch)</i>	<i>Area that can be irrigated per Mcft (in acres)</i>	<i>Net profit per acre (in Rs.)</i>	<i>Net value of produce per Mcft (in Rs.)</i>
1	2	3	4	5
1. Sugarcane (Adsali)	175	1.55	1515	2348
2. Sugarcane (Suru)	136	2.00	1195	2390
3. Bajra (Hyv-Kharif)	20	13.80	441	6086
4. Bajra (Local)	20	13.80	251	3464
5. Groundnut (Hyv-Kharif)	24	11.50	525	6038
6. Groundnut (Local-Kharif)	24	11.50	340	3910
7. Cotton (Hyv-Kharif)	24	11.50	649	7463
8. Maize (Local-Kharif)	20	13.80	435	6003
9. Hybrid jowar (Kharif)	15	18.40	485	8924
10. Jowar (Local- Rabi)	22	12.50	317	3962
11. Wheat (Hyv)	30	9.20	492	4526
12. Wheat (Local)	30	9.20	243	2235
13. Onion (Rabi)	36	7.65	1060	8109
14. Gram (Local)	18	15.30	290	4437
15. Onion (Hot weather)	42	6.55	1060	6943
16. Maize (Hot weather)	36	7.65	435	3328
17. Cotton L.S. (Hot weather)	42	6.55	760	4978
18. Groundnut (Hot weather)	36	7.65	485	3710

Table 7.2 : NET VALUE OF PRODUCE PER ACRE AND PER MCFT OF WATER AT 1981-82 PRICES OF THE CROPS

<i>Name of the Crop</i>	<i>Net profit per acre (in Rs.)</i>	<i>Net value of produce per Mcft (in Rs.)</i>
1. Sugarcane (Adsali)	5865	8936
2. Sugarcane (Suru)	4735	9470
3. Bajra (Hyv)	736	10157
4. Bajra (Local)	451	6224
5. Groundnut (Hyv-Kharif)	927	10660
6. Groundnut (Local-Kharif)	610	7015
7. Cotton (Hyv-Kharif)	904	10396
8. Maize (Local-Kharif)	567	7825
9. Hybrid Jowar (Kharif)	732	13469
10. Jowar (Local-Rabi)	517	6463
11. Wheat (Hyv)	896	8243
12. Wheat (Local)	518	4766
13. Onion (Rabi)	1207	9234
14. Gram (Local)	344	5263
15. Onion (Hot weather)	1207	7906
16. Cotton L.S. (Hot weather)	1093	7159
17. Groundnut (Hot weather)	875	6694
18. Maize (Hot weather)	567	4338

Table 7.3 : CROPPING PATTERN ENVISAGED IN 1977 PROJECT REPORT AND THE ACTUAL CROPPING PATTERN

Crops	Cropping pattern based on the average of past five years (per cent)	Cropping pattern as envisaged in 1977 project report (per cent)	
		MLBC +MRBC	Pathardi Branch
1. Perennial			
a) Sugarcane	11.8	4.0	-
b) Other perennials	-	1.0	-
Total	11.8	5.0	-
2. Two Seasonals			
a) L.S. Cotton	4.3	11.5	-
b) Chillies	-	8.0	5.0
c) Turmeric	-	-	5.0
Total	4.3	19.5	10.0
3. Kharif			
a) Hy. Bajra	3.3	8.0	15.0
b) Hy. Jowar	13.9	-	-
c) Hy. Maize	-	-	5.0
d) Paddy	2.6	3.0	-
e) Groundnut	-	8.0	20.0
f) Vegetable	-	11.5	7.0
g) Green Manure	-	-	3.0
Total	19.8	30.5	50.0
4. Rabi			
a) Jowar	23.4	20.0	35.0
b) Wheat	20.6	13.0	15.0
c) Hy. Maize	-	7.0	-
d) Gram	2.6	3.0	-
e) Fodder	5.7	-	5.0
f) Vegetables	-	-	8.0
Total	52.3	43.0	63.0
5. Hot Weather Seasonals	11.8	3.0	-
Grand Total	100.0	101.0	123.0

Table 7.4 : CROPPING PATTERN BASED ON 1977 PROJECT REPORT AND TOTAL NET INCOME (MRBC+MLBC+PATHARDI BRANCH)
WITH IRRIGATION

Crop	ICA=68220 ha. MRBC+MLBC		ICA=11400 ha. Pathardi Branch		Total Area (ha.)	Net profit per hectare* (Rs.)	Total net income (Rs. lakhs)
	%	Area (ha)	%	Area (ha)			
1.	2	3	4	5	6	7	8
Perennials							
1. Sugarcane	4	2730	-	-	2730	9550	261
2. O.P. (Banana)	1	685	-	-	685	10000	69
Two Seasonals							
1. L.S. Cotton	5	3410	-	-	3410	1775	61
2. Chillies	2	1365	5	570	1935	1200	23
Kharif							
1. Hy. Jowar	17	11595	25	2850	14445	1225	177
2. Hy. Bajra	5	3410	10	1140	4550	1155	53
3. Paddy	3	2050	-	-	2050	1300	27
4. Groundnut	5	3410	10	1140	4550	1250	57
5. Vegetables	3	2050	5	570	2620	8000	210
Rabi							
1. Jowar	20	13645	30	3420	17060	868	148
2. Wheat	18	12280	25	2850	15130	1707	258
3. Gram	5	3410	5	570	3980	955	38
4. Vegetables	-	-	3	340	340	8000	27

(Contd..)

Table 7.4 (Contd..)

1	2	3	4	5	6	7	8
Hot weather							
1. Groundnut	12	8185	-	-	8185	1825	149
Fodder	5	3410	5	570	3980	1500	60
All Crops	105	71630	123	14020	85650		1618

* Net profit per hectare is taken from Table 7.6

(Concluded)

Table 7.5: CROPPING PATTERN AND TOTAL NET INCOME *WITHOUT* IRRIGATION

Crop	Percentage	Area (ha)	Net income per hectare (Rs.)	Total net income (Rs. in lakhs)
Rabi Jowar	88.1	70128	341	239.14
Bajra	3.4	2706	285	7.71
Wheat	3.8	3025	482	14.58
Gram	4.7	3741	375	14.03
All Crops	100.0	79600		275.46

Table 7.6 : PER HECTARE EXPENDITURE ON INPUT, PRODUCTION AND NET VALUE OF PRODUCE

Crops	Unirrigated yield per hectare	Price per quintal	Value of main product	Value of main by product	Gross value of produce	Expendi- ture on inputs	Net value of produce
<i>Crops</i>							
Jowar((L)	4.2 Quintal	180	756	85	841	500	341
Wheat	5.5 "	215	1182	50	1232	750	482
Bajra (L)	3.0 "	160	480	85	565	280	285
Gram	3.6 "	250	900	25	925	550	375
<i>Irrigated</i>							
Groundnut (kharif)	9.0 "	300	2700	100	2800	1550	1250
Hybrid Jowar	16.8 "	150	2520	200	2720	1495	1225
Jowar (Local)	9.6 "	180	1728	220	1948	1080	868
Bajra, Hybrid	14.2 "	150	2130	175	2305	1150	1155
Bajra (Local)	9.5 "	160	1520	170	1690	1000	690
Wheat (Hyv)	15.5 "	215	3332	150	3482	1775	1707
Groundnut (H.W.)	12.0 "	300	3600	125	3725	1900	1825
Cotton, L.S.	10.0 "	400	4000	-	4000	2225	1775
Gram	8.0 "	230	1840	75	1915	960	955
Paddy	15.0 "	160	2400	300	2700	1400	1300
O.P. (Banana)	-	-	-	-	-	-	10000
Sugarcane	85.0 Tons	230/ton	19550	-	19550	10000	9550
Fodder (other crop)	-	-	-	-	-	-	1500

Table 7.7 : TOTAL EXPENDITURE ON THE PROJECT INCLUDING THE CAPITALISED VALUE

<i>Project year</i>	<i>Expenditure (Rs.in lakhs)</i>	<i>Compound interest factor to the end of 19th year at 10%</i>	<i>Capitalised value at the end of 19th year (Rs.in lakhs)</i>
1956-57 (t ₁)	12.68	6.115909	77.55
1957-58 (t ₂)	16.74	5.559917	93.07
1958-59 (t ₃)	38.16	5.054470	192.88
1959-60 (t ₄)	51.88	4.594973	238.39
1960-61 (t ₅)	97.82	4.177208	408.62
1961-62 (t ₆)	61.81	3.797498	234.72
1962-63 (t ₇)	46.77	3.452271	161.46
1963-64 (t ₈)	84.52	3.138428	265.26
1964-65 (t ₉)	87.33	2.853117	249.16
1965-66 (t ₁₀)	214.89	2.593742	557.37
1966-67 (t ₁₁)	91.85	2.357948	216.58
1967-68 (t ₁₂)	139.07	2.143589	298.11
1968-69 (t ₁₃)	224.00	1.948717	436.51
1969-70 (t ₁₄)	231.85	1.771561	410.74
1970-71 (t ₁₅)	246.06	1.610510	396.28
1971-72 (t ₁₆)	227.40	1.464100	332.94
1972-73 (t ₁₇)	160.55	1.331000	213.69
1973-74 (t ₁₈)	142.36	1.210000	172.26
1974-75 (t ₁₉)	69.36	1.100000	76.30
1975-76	71.77	-	71.77
1976-77	113.75	-	113.75
1977-78	127.48	-	127.48
1978-79	94.93	-	94.73
1979-80	73.14	-	73.14
1980-81	82.89	-	82.89
1981-82	87.09	-	87.09
1982-83	117.50	-	117.50
1983-84	46.55	-	46.55
1984-85	21.41	-	21.41

			5868.20

**Table 7.8 : NET INCOME AS PER ACTUAL CROPPING PATTERN IRRIGATED
(AVERAGE OF PAST FIVE YEARS)**

<i>Crop</i>	<i>Area (ha)</i>	<i>Net income per hectare (in Rs.)</i>	<i>Total net income (Rs. in lakhs)</i>
Sugarcane	3838	9550	366.53
Kh.Hy. Jowar	5532	1225	67.77
Hy.Bajra	1178	1155	13.61
Paddy	928	1300	12.06
Rabi Jowar	10243	868	88.91
Wheat	9101	1707	155.35
Gram	928	955	8.86
H.W.Groundnut	4212	1825	76.87
L.S.Cotton	1535	1775	27.25
Other Crops (fodder)	2035	1500	30.53
All Crops	39530		847.74

Table 7.9 : NET INCOME AS PER UNIRRIGATED CONDITION

<i>Crop</i>	<i>Area (ha)</i>	<i>Net income per hectare (in Rs.)</i>	<i>Total net income (Rs. in lakhs)</i>
Rabi Jowar	34826	341	118.76
Bajra	1344	285	3.83
Wheat	1502	482	7.24
Gram	1858	375	6.97
All Crops	39530		136.80

CHAPTER VIII

SUMMARY AND CONCLUDING REMARKS

1. The present study envisages to look into and analyse the aspects of planning and implementation for the fuller and timely development of the irrigation project under study as well as the aspect of management of water distribution and its use for fuller and efficient utilization of the irrigation potential created under the system.
2. The said analysis is undertaken with a view to ascertain the factors responsible for long gestation period and of under - utilization of irrigation potential, if any, as well as to examine the manner in which water is supplied and used so as to examine the nature and consequences of long gestation period and of underutilization of irrigation potential.
3. The study is based on the analysis of the data collected from the official records of the irrigation system under study as well as of the primary data collected from the sample farms in the command area of the project benefiting from the said irrigation system. The data and relevant information from the official records analysed are in respect of development of the Mula Irrigation System from its inception with details of modification it underwent from time to time in terms of its location, storage capacity, command area, cropping pattern and consequent cost escalation. The analysis of the data collected through field investigation relates to the manner in which water is supplied and used, both under canal and well irrigation and what determines this and the way things can be changed. It also relates to working out costs and returns considering the long gestation period and also considering the cropping pattern that has actually developed over the years, but, with sugarcane restricted to 4 per cent of the crop area instead of more than 10 per cent, as exists. In what follows we summarize the main findings of the study.
4. The original project proposal is seen to have undergone considerable revision and modification from time to time and the work on the project which was started in early sixties and was to be completed in all respects by 1983 was still in progress even when this investigation was conducted in 1983. The work on the dam was delayed because of the problems of foundation and the completion of distribution network was further delayed because of frequent changes and modification the original project has undergone. As a result when the full storage was created the canal and distribution network were not ready for using the stored water fully. This led to the development of the type of cropping, particularly in the head reaches of the canal, which not only may adversely affect the benefits from the project but is also against the interest of irrigation development, particularly in the drought-prone areas.

5. Conventional procedure of estimating underutilization by expressing area actually irrigated as a percentage of potential irrigable area based on project cropping pattern may at times give misleading picture. This study shows that the extent of underutilization is overestimated by using this conventional procedure. For getting a clearer and truer picture of underutilization, it would be necessary to take account of the amount of water actually released during the year from the quantity in the storage meant for irrigation, in addition to the area actually irrigated. Our enquiry into this matter shows that while water available for irrigation is more or less entirely used up, the area actually irrigated is much smaller than what was expected to be irrigated based on project cropping pattern. It is a moot point whether this should be termed underutilization at all.
6. There are three important factors for such a state of affair. Firstly, the cropping pattern that has actually developed is markedly different from the one proposed, such that the area under heavy water using crops are considerably higher than what were proposed, leading to less area that could be irrigated with the same amount of water than was proposed. Secondly, there is indirect evidence to suggest unauthorised irrigation to a considerable extent which does not get reported in the area irrigated. Thirdly, the irrigation duties assumed are much larger and the transition and distribution losses assumed are smaller in estimating the areas to be irrigated than the actuals, resulting into less area actually irrigated than what was planned.
7. Pattern of water distribution and its use under canal irrigation based on the investigation of the sample farmers in the command area suggests that the entire ICA cannot be brought under irrigation and that the ICA which does not receive canal water is mainly from the lower reaches of the distribution system thereby leading to a greater divergence between potential created and actual utilization. Inadequate land development activities and lack of 'on farm development' work, mainly in the lower reaches of the distribution system, result into water use remaining concentrated in the upper reaches. This situation inevitably leads to concentration of heavy water using crops in the upper reaches of the distribution system with all its ill-effects. There is bound to be great divergence between the potential created and actual utilization in terms of area irrigated under such a situation.
8. Analysis of the data collected through the field investigation of the well irrigators indicates that even when the availability of timely and adequate quantity of water is assured from the wells the farmers generally grow sugarcane in preference to seasonal crops. Hence the contention that the uncertainty of availability of canal water at frequent and pre-determined intervals is the reason for farmers not resorting to seasonal cash crops under canal irrigation is

not borne out by this enquiry. There is sufficient ground to assume that even if canal irrigation efficiency is improved to remove element of uncertainty, the irrigators may still prefer to grow sugarcane as their main crop in present set up. Further, the general impression that the well irrigators use water more economically and rationally than the canal irrigators and that the levels of input use (particularly that of manure and fertilizer) and output realized are necessarily higher in the case of well irrigated crops is also not borne out by our analysis.

9. Improvement in water distribution and in its use is sought to be brought about through the introduction of what is known as the Rotational Water Supply. Our investigation of a pilot scheme with RWS in operation clearly indicates that for the RWS to be successful not only a technically sound distribution network with controlled and assured supply of water is necessary but effective organizations of the irrigators below each outlet are also necessary and essential prerequisite for operating RWS.

10. Estimations of the approximate costs and benefits with the help of the data that we have been able to lay our hands on, have been attempted with a view to assess the economic performance of the Mula Irrigation System. Long gestation period in developing full potential of the system has certainly led to cost escalation which could have been avoided. Our exercise into the cost benefit analysis shows that extending irrigation over wider area in the canal command by growing seasonal crops instead of growing sugarcane on more than stipulated area, may not only increase the gross cropped area irrigated, spread over wider area under canal command, but may also improve the benefit-cost ratio of the project.

11. Delay in the construction of distribution network even after full storage had been created not only led to cost escalation which adversely affected the return from the project but also led to a kind of irrigation development particularly in the upper reaches of the main canal which resulted into a lower benefit-cost ratio of the project and which is also against the objective of irrigation development in a drought prone area. In addition the present system of distribution of water encourages the farmers not only to increasingly resort to growing heavy water using perennial crops like sugarcane but also to wasteful use of scarce water largely meant to provide protective irrigation over as wide an area as possible.

12. The existing water distribution policy involves seasonal, annual or longer duration sanctions given to individual farmers based on their applications and within the constraints of availability of water. The sanction stipulates the crops and the area under each crop. The farmers apply for one crop but use the water for other more remunerative crops like sugarcane under the existing water distribution system.

Thus there is no effective control on crops to be grown under canal irrigation which results into considerable uneven development of irrigation in the entire canal command with a substantial part of ICA not getting any irrigation water. It seems under the existing system of water distribution at times there is conflict between the primary objective of the project and the individual farmer's interest.

13. It is therefore necessary to give a fresh look into the management of the irrigation system so as to devise a proper water distribution system by which the irrigation authorities control only the quantity of water to be supplied without any restriction on crops, but, at the same time ensure equitable distribution of water. The suggested water distribution system should be able to resolve the conflict of interest between the irrigation project on the one hand and the individual irrigators on the other.

X 14. Under the suggested water distribution system a given (fixed) quantity of water is to be allocated per hectare for kharif, rabi and hot weather seasons. The quantity of water to be supplied in each season is to be fixed on the basis of the water requirement of the predominant crop of the season such as hybrid jowar in kharif, wheat and jowar in rabi and groundnut in hot weather. Considering the ICA under an outlet (Chak), the crop water requirement and the transmission and distribution losses, water to be released in each rotation of each season can be fixed. Every month there is to be three rotations starting on 1st, 11th and 21st day of the month.

15. The quantity available in rabi and hot-weather can be changed from year to year depending upon the available storage. The quantity in kharif season would be reasonably low consistent with past experience of low utilization in this season. The quantity to be fixed for kharif season would be ensured by providing a reasonable carry over from the previous year.

16. Knowing the quantity of water to be supplied in each rotation per hectare in a season, the farmer shall be free, to use this water for any crop in his field. He will, of course, decide the area of the crop of his choice, to match with the water allocated to him. He may use all the water allocated for say one hectare only on 1/10th of a hectare to grow sugarcane if he so decides. This should be permissible.

✓ 17. The existing system of water application for sanction should be done away with. Water should be allocated on the basis of individual holdings in the entire command area and should be supplied on volumetric measure such as cusec hours. The discharge of the outlet be kept constant at one cusec and supply schedules can be worked out on this basis, as is being practised under RWS. The discharge available at the farm head would be calculated on the basis of estimated losses in the field channels.

18. Each hectare in the command area should get the same quantity of water irrespective of its location, soil type, crop grown, etc. The CADA personnel would advise the irrigators about the crop or the combination of crops that can be most profitably grown considering the water that would be available in different rotations of 10 days interval and also the market situation in respect of different crops.

19. But, as mentioned earlier, for the suggested water distribution system to be successful farmers' total involvement in the distribution of water below the outlet is a necessary condition. There is much less scope for manipulation of discharge and use of water unauthorisedly under the suggested system. Any such attempt will affect the right of other persons who would immediately complain. Under such circumstances it should be possible to build up and operate social pressure to enforce discipline in water distribution to be handled mainly by the irrigators themselves.

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