Irrigation Utilisation in the Context of Protective and Productive Irrigation in Maharashtra

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Foreword

Irrigation development has a long history in India and by now it has endowed the country with the largest irrigation system in the world. Yet the efficiency of surface irrigation systems in India leaves much to be desired. This is particularly so in the state of Maharashtra, a large part of which is affected by recurrent drought and scarcity of water.

According to the Maharashtra State Irrigation Commission which assessed the ultimate irrigation potential of the State, full exploitation of all the available surface water resources would bring under irrigation only 26 per cent of the cultivated acreage of the State. In view of this, water resources have become the most limiting factor in the development of agriculture in such regions and therefore proper and efficient utilisation of the available irrigation potential assume crucial importance in securing maximum return from present and future investment in surface irrigation.

A number of studies have been carried out at the Institute in recent years into the economics of irrigation water use in Maharashtra and issues related to this. The present study is in continuation of the previous studies and is especially concerned with the crucial issues of full utilisation of the irrigational potential created.

This book is the outcome of a study undertaken at the instance of the Government of Maharashtra to examine the utilisation of irrigation potential with special reference to kharif season utilisation, covering all the five major agro-climatic zones in the state of Maharashtra. Problem of estimation of extent of utilisation by the traditional 'area approach' has been highlighted in this book and it goes on to suggest that in addition to 'area approach' water use approach needs to be followed to get a clear understanding of the issues involved in utilisation of irrigation potential.

The various factors accounting for the different levels of utilisation in different agro-climatic zones are identified and the relative importance of them assessed. These factors, which mainly reflect the operation of demand and/or supply constraints, of course, differ from one agro-climatic zone to another.

The book reveals the nature of conflict that arises in different zones between the objectives of supplying water for protective irrigation when rainfall is inadequate and for intensive or productive irrigation during fair weather seasons.

In the very high rainfall zone, on the other hand, the problem seems to be that of generating more demand for irrigation water with increased efficiency of water use to be brought about by suitable modification in design of the distribution system and in crop-mix, specially in kharif season.

It is hoped that the book will prove useful in answering some of the questions relating to efficient water management and for improving the irrigation system in the state of Maharashtra. Researchers in this area may also find in this book a perspective of the issue of utilisation of irrigation potential and a framework to analyse the same.

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V.S. Chitre
Director

Preface

In recent years there has been considerable investment in irrigation development in India with a view to raise agricultural production and productivity, specially of foodgrains. Such investment and consequent development have added significance in states like Maharashtra characterised largely by uncertain rainfall, scarcity of water and affected by recurrent drought. Under such situation the questions that naturally arise are, what should be the objective of providing irrigation water and how should the distribution be designed and planned in order to fulfill the stated objective? It is in this context that the objective of protective and/or productive irrigation comes into question which is likely to have deeper implications for agricultural development in Maharashtra.

One of the most serious problems of efficient use of available water is the problem of underutilisation of irrigation potential mainly from surface irrigation sources. While there is no denying the fact that the underutilisation exists in considerable measure, it has to be seen, examined and understood in the context of the nature of irrigation, i.e., whether it is protective and/or productive and the objectives sought to be achieved through such irrigation, specially in water scarce and drought prone regions like Maharashtra. It is only after examining and analysing the problem of underutilisation in this manner that it is possible to identify the factors underlying such development and the ways and means to change the course in tune with the priorities set.

These are some of the issues which have been raised and analysed in this book. To begin with an attempt has been made to bring in clear perspective the issue of irrigation potential and its utilisation and evolve a framework for appropriate analysis of the issues involved. This forms the subject matter of Chapter 2. Factors responsible for particularly low utilisation of irrigation potential in kharif season in respect of surface irrigation in different agro-climatic zones in Maharashtra are identified, analysed and their relative importance assessed. The analysis is based on the subjective (farmers' opinion) and objective (data base) evaluations of such factors mainly arising out of supply and demand constraints in different agro-climatic zones, presented in Chapters 3 and 4.

Maharashtra is a large state with substantial regional variations in soil-climatic conditions. At one extreme is *Konkan* with very high rainfall

In the very high rainfall zone, on the other hand, the problem seems to be that of generating more demand for irrigation water with increased efficiency of water use to be brought about by suitable modification in design of the distribution system and in crop-mix, specially in kharif season.

It is hoped that the book will prove useful in answering some of the questions relating to efficient water management and for improving the irrigation system in the state of Maharashtra. Researchers in this area may also find in this book a perspective of the issue of utilisation of irrigation potential and a framework to analyse the same.

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Chapter 1

Introduction

The Problem

Agricultural production in Maharashtra virtually remained stagnant during the decade early sixties to early seventies. It was only after that the overall production of foodgrains and most non-foodgrains showed an increasing trend specially from around mid-seventies to early eighties. However, the evidence of stagnancy in the production of most crops is being noticed again in the state in the period early eighty onwards. Considering that agriculture is the major pursuit of economic activity of the state it is inevitable that under the circumstances the state is reported to be a deficit state for long. The main reason being the lack of natural endowment necessary for a prosperous agriculture. In recent years, however, there has been considerable investment in agriculture particularly in the form of creation of irrigation resources, increasing availability of fertilizer and development of high yielding varieties etc., with a view to raise agricultural production and productivity, specially of foodgrains. It is in this context that the objective of protective and/or productive irrigation comes into question which is likely to have deeper implications for agricultural development in Maharashtra.

While protective irrigation is supposed to bring about stability in agricultural production by providing water over a wide area during a prolonged dry spell, productive irrigation seeks to increase the yield significantly over rainfed crops by concentrating the use of water and also by a shift in cropping pattern to high water intensive crops. In other words, protective irrigation leads to extensive use of water whereas productive irrigation leads to intensive use of water. Clearly there is conflict of interest in the objectives of these two types of irrigation. The conflict becomes more pronounced in the case of water scarce and drought prone regions.

Maharashtra is a major state of the Deccan plateau which is characterised by low and uncertain rainfall and suffers from periodic droughts. Even the minor irrigation sources, mainly from underground, which is expected to account for 40 to 45 per cent of the ultimate irrigation potential of the state, are known to be more uncertain and with poor discharge capacity. The longterm perspective of agricultural development in the region like this therefore, acquires a different and more serious dimension. It is obvious that the use of water in such regions has to be most efficient if agriculture is to develop and sustain the vast multitudes dependent on it.

One of the most serious problems of efficient use of available water is the problem of underutilisation of irrigation potential mainly from surface irrigation sources. While there is no denying the fact that the underutilisation exists in considerable measure, it has to be seen, examined and understood in the context of the nature of irrigation, i.e., whether it is protective and/or productive and the objectives sought to be achieved through such irrigation specially in water scarce and drought prone regions like Maharashtra. It is only after examining and analysing the problem of underutilisation in this manner that it would be possible to identify the factors underlying such a development and the ways and means to change the course in tune with the priorities set. It is this aspect of irrigation which has been highlighted in this study.

Scope of the Study

Underutilisation of irrigation potential of most of the major, medium and minor irrigation projects seems to be a perpetual and intricate problem in irrigation water management and distribution of India, and Maharashtra is no exception; if at all, the situation in this regard in Maharashtra is reported to be more serious than in many other states. While overall utilisation percentage in Maharashtra is reported to be low, there seems to be wide variation in the extent of utilisation of the irrigation potential between various seasons. Performance of a number of functioning surface irrigation projects in Maharashtra showed that actual water utilisation achieved on these projects was not impressive, particularly in kharif season, when water utilisation by farmers fell short of design assumption. It is further stated that major shortfall in utilisation is due to low utilisation in kharif season.

While overall underutilisation of irrigation potential may be attributed to a set of factors some of which would be common to all seasons, there ought to be some specific factors responsible for comparative poor performance in kharif season in particular. The present enquiry relates to a study of utilisation of kharif potential in respect of surface irrigation systems in different agro-climatic and rainfall zones in Maharashtra with a view to examine to what extent irrigation has been able to perform its protective role and the reasons thereof. The purpose of enlisting irrigation schemes from different agro-climatic zones is to ensure the inclusion of different rainfall pattern of the state which is likely to have an impact on utilisation of kharif irrigation potential in particular.

Many Commissions and Committees appointed from time to time by the Government of Maharashtra and also a number of other studies have gone into the question of overall underutilisation of irrigation potential, but, no indepth investigation into the cuases of underutilisation in kharif season in particular is available.[1]

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1. See for example

(a) *Government of Maharashtra, Report of the Irrigation Commission*, Bombay, 1962.

(b) Robert Wade, 'Performance of Irrigation Projects', *Economic and Political Weekly*, Vol. XI, No.3, January 17, 1976.

(c) *Government of Maharashtra, Report of the High Power Committee*, Irrigation Department, 1981.

Methodology for Assessing Underutilisation

Underutilisation of irrigation water in a particular project can be measured in two ways. In the first place, if the actual area irrigated under different crops during a season turns out to be less than the area visualised, proposed and designed by the project planners to be irrigated during the season, it may be termed underutilisation. Alternatively, if the volume of irrigation water used by farmers during the season turns out to be less than the quantity of water designed to be supplied during that season, then it may be termed underutilisation. It is quite possible that there may be underutilisation in a particular year in the first sense but not in the second, and vice versa. The first task therefore has been to ascertain the extent of such underutilisation in the aforementioned sense and also to ascertain the extent of such underutilisation in different agro-climatic zones.

Having ascertained the manner in which irrigation utilisation percentage is estimated and also the rationale behind the project authorities' stipulation of the percentage of area to be irrigated in kharif season under different crops we have enquired into the factors responsible for low utilisation of kharif potential.

Reasons for low utilisation of kharif potential may presumably be classified into reasons arising out of demand factors as well as of supply factors. In this study we attempt to look into these factors and examine them both from the point of view of objective evaluation as well as of subjective evaluation. The objective evaluation of the reasons for low utilisation of kharif potential arising out of both demand and supply factors involves looking into and examining and analysing the time series data made available from the official records, whereas the subjective evaluation of the same involves the opinion survey of the irrigators in the command area of different projects. The idea behind undertaking both objective and subjective evaluations is to find out the extent to which the findings of these evaluations correspond and/or match with each other.

The first aspect of the objective evaluation involves looking into and examining the area under crops irrigated during kharif season in different years. In this connection it would be necessary to find out the interval of each watering, total number of watering in the season and the dates of each watering. These data are expected to throw light on the periodicity of each watering during the entire kharif season.

The second aspect of the objective assessment is the amount of rainfall in the catchment and command areas and its distribution. Analysis of the time series data regarding this will enable us to explain both the demand and supply factors relating to utilisation of kharif potential. If the rainfall is adequate and well distributed in the catchment area and in the command area for the crops to be grown, the demand for water may be low. The two aspects mentioned above will have to be compared in order to see if the date of irrigation for each watering

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(d) Dhawan B.D., 'Questionable Conceptions and Simplistic Views about Irrigated Agriculture of India', *Indian Journal of Agricultural Economics*, January-March, 1985.

(e) Ashok K. Mitra, 'Underutilisation Revisited', *Economic and Political Weekly*, Vol. XXI, No.17, April 26, 1986.

corroborates with the distribution of rainy days; juxtaposing one against the other would reveal the reasons for the irrigators' demand for water in particular period. An analysis of the rainfall data for the last 10-15 years (depending upon the availability) would reveal the statistical probability of the periodicity of long and short breaks in monsoon. Further, the long break in monsoon and its periodicity would also affect the availability of water in the reservoir and even if there is demand for water, the supply would not be able to cope with the demand. All these would affect the utilisation percentage in kharif.

The third aspect of objective assessment is the cropping pattern in the command area under different crops grown under rainfed condition and under canal irrigated condition. A comparison of the area irrigated under different crops in kharif with the project cropping pattern would indicate the change in demand for water from what was contemplated in the project report due to the adoption of more water intensive crops by the irrigators in some regions, i.e., a shift from protective irrigation to productive irrigation.

The fourth aspect of the objective evaluation is to examine the need for and so also the existing practice of earmarking the quantity of water that is required to be stored every year for rabi and hot-weather seasons, because this would significantly affect the supply of water during the kharif season, again a pointer towards a shift in priorities.

As mentioned earlier the subjective evaluation of the reasons for particularly low utilisation in kharif involves the opinion survey of the irrigators. Accordingly, as proposed, relevant information are collected from the sample beneficiaries from different zones, through field investigation. It would be necessary to look into the cropping pattern and the nature of the crops grown during kharif season, the reason for choosing particular crop combination, the pattern and extent of demand for irrigation water and reasons thereof. The conventional crops might need comparatively less financial resources in the form of costly seeds, fertilizers and pesticides. Resources at the command of the farmers may put a restriction on use of such costly inputs for kharif cultivation, particularly so, if the limited financial resources are to be allocated for other crops grown in subsequent seasons. This aspect needs to be examined.

The question of yield differences between growing these crops under rainfed conditions in normal year and growing these crops under irrigated condition would also arise. If the yield differences are marginal the farmers may not demand water even during the period of small break in monsoon. But it is difficult to estimate such yield differences. One would like to compare the yield of those farmers in the command area who did not demand any water with that of those who did during normal years of monsoon, but such data would be difficult to get. Some approximation of such yield differences, if any, has to be arrived at by comparing the average yield of crops grown under irrigated and rainfed conditions in the catchment/command area of the project.

The other aspect of the subjective evaluation is the extent of well irrigation by the irrigators in the canal command. Availability of water in the well and the land under well command would adversely affect the demand for irrigation water from the state sources.

To examine all the aspects raised above in relation to the subjective evaluation of the reasons for particularly low utilisation of kharif potential, relevant information need to be collected from the irrigators through structured questionnaire.

The subjective evaluation through opinion survey of the farmers would throw light on farmers' perception of the question of kharif underutilisation. Carrying out an objective evaluation also along with the subjective evaluation should help us to bring about a correspondence between the reasons arising out of each evaluation and also to identify the reasons arising out of objective evaluation, considered to be most important from irrigators' point of view. We may also be able to find out how strong is the relation between water use and agro-climatic conditions, and if it is consistent with farmers' views. Finally, based on farmers' opinion survey (subjective evaluation) it may be possible to attach some kind of weights to the factors for low kharif utilisation arrived at by subjective evaluation. Obviously the agro-climatic conditions are different under different project areas and to that extent the importance of the factors for low utilisation will vary from zone to zone, however, the data to be examined would be common for all the projects.

Data Used for the Study

For the purpose of ascertaining the nature and extent of underutilisation the following data from the project authorities are used.

(i) The area under different crops, proposed to be irrigated in different seasons, as per the project scheme.

(ii) The total volume of irrigation water expected to be made available and utilised in different seasons as per the project scheme.

(iii) The areas under different crops actually irrigated in different seasons every year for the past 5 to 10 years.

(iv) The total quantity of irrigation water actually used (released) during different seasons every year for the last 5 to 10 years.

(v) The number of irrigation (rotation) expected for individual irrigated crops in different seasons in the project scheme.

For the above purposes copies of the project proposal in respect of each scheme, on the basis of which the projects were constructed and are supposed to be operated, are used along with the existing information on irrigation.

To examine all the issues raised in relation to the objective evaluation of the reasons for low utilisation of kharif potential the following data are used.

(i) Weekly rainfall data in the catchment area and command area of each of the five projects for the last 10 years or so (depending upon the availability of data), with number of rainy days and amount of precipitation for each observation.

(ii) Cropping pattern in the command area of the projects for the last 5 years.

(iii) Water content in the reservoir each day (at least each week) yearly for the last 5 to 10 years in respect of each project.

(iv) Live storage available at the beginning i.e., on 1st June every year for the last 5 to 10 years in respect of each project.

(v) Canal flow in each rotation in kharif and distributory flow in each rotation in kharif for last 5 years (depending upon the availability of data) for all the five projects.

(vi) Area irrigated in each rotation in kharif under each project for the last 5 years or so (depending upon the availability of data).

(vii) Villagewise water application (demand) in kharif for last 5 years (depending upon the availability of data) in respect of each of the five schemes.

(viii) Information regarding wells in the command area under each scheme and the development of well irrigation over the years.

The aforementioned information and data are obtained from the irrigation department and the relevant project authorities.

Sampling Framework

As mentioned earlier, to carry out the subjective evaluation through opinion survey of the farmers a sample of beneficiaries under each scheme is drawn for detailed investigation. In consultation with the Department of Irrigation, Government of Maharashtra, the study is taken up in respect of four existing medium irrigation schemes and one minor irrigation scheme in different agro-climatic zone as follows:

Agro-climatic zone	Name of the project (scheme) and site	No. of villages under command	No. of beneficiaries under command
1. Very high rainfall zone	Minor Irrigation Scheme, *Kalote Mokashi* (Raigad)	4	116
2. High rainfall zone	Medium Irrigation Scheme, *Asola-Mendha* (Chandrapur)	65	7609
3. Assured rainfall zone	Medium Irrigation Scheme, *Nirguna* (Akola)	22	1972
4. Transition zone (Less assured rainfall zone)	Medium Irrigation Scheme, *Manyad* (Jalgaon)	15	3486
5. Scarcity zone	Medium Irrigation Scheme, *Nazare* (Pune)	5	2155

In order to select the beneficiaries of a scheme a multi-stage stratified random sampling procedure is followed with the village as the primary unit and the beneficiaries in a village as the ultimate unit of sampling. Out of the 4 medium irrigation schemes selected for study a sample of 20 per cent of villages are selected from each of the three schemes, viz., *Asola Mendha, Nirguna* and *Manyad;* whereas for *Nazare* scheme in Pune district 3 villages are selected as the total number of villages benefiting by the scheme is only five. From the minor irrigation scheme in Raigad district two villages are selected out of four benefiting from the scheme. So, in all around 26 villages are covered out of a total number of 111 villages benefiting from the five schemes selected for study. In order to get representation from the head reach, middle reach and tail reach of the distribution system, villages under each scheme are classified according to their location along the distribution system. As far as possible an equal number of villages are then selected from each of the three reaches of the distribution system so as to make a sample of around 20 per cent of the total number of villages under each of the three medium irrigation schemes mentioned earlier. In the case of the fourth medium irrigation scheme (*Nazare,* Pune) one village each from head reach, middle reach and tail reach are selected and in the case of the minor irrigation scheme out of the two villages selected, one is from the head reach and the other is from the tail reach.

In the second stage of sampling the beneficiaries of the schemes are selected. The beneficiaries in each of the selected villages are listed in descending order of magnitude as per the land holding and then a total of twenty beneficiaries are selected randomly from the list from each village selected under the four medium irrigation schemes and, further, a total of another twenty beneficiaries are selected randomly from the list of the beneficiaries of the two selected villages under the minor irrigation scheme. The total number of beneficiaries as selected are around 530 from the five schemes selected for study.

In addition to specific information collected from the records of the irrigation department and from the project authorities of each scheme and also from the irrigators through structured questionnaire some relevant and useful information are also gathered from the discussion with the officials of the Agricultural Department and of the Agricultural Universities.

Chapterwise Scheme

The second chapter deals with the concept and the measurement of underutilisation with a view to highlight the manner in which underutilisation in irrigation system needs be considered and also to ascertain the extent of underutilisation yearwise under different schemes.

The third chapter presents the subjective evaluation of the factors responsible for low kharif utilisation. It is attempted through the opinion survey of the irrigators in the command area of the projects under study with a view to know how the farmers — the ultimate users and beneficiaries of the irrigation systems view the question of kharif underutilisation.

The fourth chapter discusses the objective evaluation of the factors responsible for low utilisation of kharif potential. The objective evaluation purports to

identify the major factors responsible for low utilisation on the basis of the analysis of the time series data on a number of important variables affecting the demand for and supply of irrigation water.

The fifth and the last chapter is the concluding part of the study. In this chapter we attempt to bring about a correspondence between the reasons arising out of each evaluation. The purpose is to ascertain which of the factors responsible for low utilisation in kharif arising out of objective evaluation is considered most important by the irrigators and also to examine if, based on the irrigators' opinion survey, it may be possible to attach some kind of weights to the factors for low kharif utilisation arrived at by objective evaluation.

Chapter 2

Underutilisation — The Concept and Measurement

Introduction

In this study we are concerned mainly with the utilisation of kharif irrigation potential so as to ascertain whether the extent of utilisation in kharif season is particularly low and then to find out the reasons thereof. Naturally the extent of utilisation and the reasons thereof would be different in different agro-climatic zones. However, to ascertain whether the extent of utilisation in kharif season is particularly low one would have to examine the extent of utilisation of irrigation potential in rabi and hot-weather seasons also. In this chapter, therefore, we begin with the conceptualisation of the oft repeated terms like 'irrigation potential', 'underutilisation' etc., and then examine the extent of underutilisation in different crop seasons during the year based on the measures devised for estimating underutilisation.

Conceptualisation of Irrigation Potential and Utilisation

Let us begin with the definition of irrigation potential as defined by the Planning Commission and accepted widely including the irrigation systems under study. According to the Planning Commission, "Irrigation Potential is the gross area that can be irrigated from a project in a design year (July 1 to June 30 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 further been 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 upto and including the irrigation outlet to serve an area upto 40 hectares is completed.[1]

From this definition it is clear that there are three important requirements in the creation of irrigation potential and these are (i) availability of water for the area proposed to be irrigated in each season during the irrigation year, (ii) availability of conveyance system to carry water upto the outlet head and

1. Government of Maharashtra, 1981, op. cit. pp. 5.

(iii) adherence to the projected cropping pattern.[2] It would be instructive to examine the conditions mentioned above, under which the 'potential created' is declared for any irrigation system.

The first condition is the availability of water for the area proposed to be irrigated in each season during the year. It is reasonable to assume that the availability of water for area proposed to be irrigated in each season during the year would vary from year to year, particularly in the region where the sources of water are not necessarily perennial in nature and, further, lower is the 'dependability ratio' higher would be such variation. It follows from this that the definition of 'potential created' looses much of its meaning viewed thus, because then the potential area for each season during the year might vary from year to year depending upon the available water and there cannot be a given area of potential created which is fixed for different seasons during the year for all times to come.

The second condition is the availability of conveyance system to carry water upto the outlet head. From the experience of the functioning of various irrigation systems it is known that creation (construction) of distribution net work is done in phases over a number of years. In fact the construction of considerable part of distribution system lags much behind the construction of the reservoir and the upper reaches of the main canal. Consequently, the potential is also created in phases and it is only after the full development of the irrigation system including distribution system upto the outlet to serve an area upto 40 hectares that the full potential can be said to have been created. Since the full development in the sense defined above generally takes a very long time (in some cases more than 10 years after the project is commissioned for use), the full potential is assumed to have been created within a period of 4 years from the date of commissioning irrespective of whether it has actually been created or not. In point of fact, in some cases in the absence of the information about the actual potential created, the project authorities consider either the ICA or the entire cropped area irrigable (which is ICAX intensity of cropping) as the potential created. It is obvious that the potential created declared in this manner looses much of its meaning because the conveyance system to carry water may not be existing for a considerable part of the potential created so declared.

There is another aspect in this regard which merits attention. The aspect is that of the term "full development" of the irrigation system for declaring irrigation potential created. Now, as per the Planning Commission's definition full development presumably means (i) development of the full storage capacity and (ii) development of the water distribution network such that water can be transmitted upto the outlet serving an area upto 40 hectares. Does this really mean full development of the conveyance system? What about the land development and field channels below the outlet? If the distribution network below the outlet is not fully developed, potential created in the aforementioned sense again looses much of its meaning because the entire irrigation potential so declared cannot be brought under irrigation because of the inadequate conveyance network below the outlet.

2. Ashok K. Mitra, 1986, op. cit. pp. 752.

The third condition is adherence to the project cropping pattern. It is the general experience that in respect of many projects (particularly those in sugarcane belt of Western Maharashtra) actual cropping pattern that emerges in the benefited areas is significantly different from what was projected. Under such a situation potential created needs to be modified in terms of the newly developed cropping pattern.

In so far as utilisation is concerned it is based on the data on the area actually irrigated in each season during the year. Here again no allowance is made for the nature of crops grown. It may so happen that in the cropping pattern that develops in the benefited area in the post project period, the proportion of heavy water using crop turns out to be larger than what was proposed. In such a case the area actually irrigated is bound to be less than what was projected.

Conceptualisation of Underutilisation and its Measures

Traditionally underutilisation is measured in terms of the proportion of potential area (created) not irrigated. In other words, if the area actually irrigated in a season or during the irrigation year is smaller than the area contemplated to be irrigated (potential created) then there is underutilisation. However, this way of expressing underutilisation (in terms of area) will be meaningful only if (i) water is available for the area proposed to be irrigated in each season during the irrigation year, (ii) conveyance system is fully developed to carry the water upto the outlet head at least and (iii) the projected cropping pattern is followed. In other words, potential created itself should be properly assessed for a meaningful assessment of the extent of underutilisation in terms of area.

Given these considerations it logically follows that whenever underutilisation is reported during an irrigation year, it means that a part of the water in storage for irrigation has remained unused. As mentioned earlier, traditionally irrigation utilisation is expressed as percentage of actual area irrigated to the potential created. It presumably means that given the same cropping pattern, whatever is the percentage of area actually irrigated is also the percentage of water actually used 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. However, in reality these ideal conditions are hardly fulfilled, yet the magnitude of underutilisation is estimated as mentioned above which consequently gives a distorted picture of the extent of utilisation. To get a clearer and truer picture of the extent of underutilisation, it would be necessary to take into account the amount of water used in various seasons from the quantity of water available in storage for irrigation in each season during the year, in addition to the area actually irrigated.

It is against this background that in this study we measure underutilisation in two ways. In the first place, if the actual area irrigated under different crops during different seasons of the irrigation year turns out to be less than the areas proposed to be irrigated in respective seasons, it may be termed underutilisation. Alternatively, if the volume of irrigation water used by farmers during each season turns out to be less than the quantity of water designed to be supplied in each season during the year, then it may be termed underutilisation. It is quite

possible that there may be underutilisation in a particular year in the first sense but not in the second and vice versa, or, it is also possible that the extent of underutilisation varies if measured in two different ways.

In what follows we attempt to ascertain the extent of such underutilisation in the aforementioned sense for the irrigation schemes from different agro-climatic zones under study for the last 5 to 10 years depending upon the availability of data. In order to determine if the utilisation is particularly low in kharif we estimate the extent of utilisation in rabi and hot-weather seasons also in addition to attempting such estimates for the kharif season.

Measurement of Underutilisation

An attempt is being made in this section to measure the extent of underutilisation in both the senses mentioned earlier. As the study pertains to five different agro-climatic zones in the state, what we proposed to do is to consider first the agro-climatic zones characterised by very high rainfall and high rainfall and then proceed one by one with the other zones characterised by less and less assured rainfall, finally ending with the zone characterised by scarcity conditions.

Very High Rainfall Zone

We first consider the 'area approach' of underutilisation in which, as defined earlier, if the area actually irrigated is smaller than the area proposed to be irrigated (potential created) then there is underutilisation. There is no separate information available about the potential created in respect of the scheme in this zone. But, since this happens to be a minor irrigation scheme and since the scheme was commissioned for use in 1976 and we are considering the last five years data it is reasonable to assume that the cropped area proposed to be irrigated in each season is synonymous with the potential created.

Area proposed to be irrigated has in its fold perennial crops also in addition to kharif, rabi and hot-weather crops as follows. The total cropped area excludes 10 per cent of unirrigated pulse in rabi. As against the area proposed to be irrigated in each season presented in Table 2.1 the actual area irrigated for the last six years is presented in Table 2.2.

Table 2.1: Area Proposed to be Irrigated as per Project Cropping Pattern

	Kharif	Rabi	Hot-weather	Two seasonals	Perennials	Total
1 Area (hectares)	112.50	72.50	21.25	-	12.50	218.75
2 Per cent ICA	(90.00)	(58.00)	(17.00)	-	(10.00)	(175.00)

Table 2.2: Yearwise and Seasonwise Area Actually Irrigated (Hectares)

Year	Kharif Area % of Proposed Area	Rabi Area % of Proposed Area	Hot-weather Area % of Proposed Area		Total	
1979-80	Nil	Nil	75.99	81.06	75.99	37.06
1980-81	Nil	Nil	79.15	84.43	79.15	38.60
1981-82	Nil	Nil	86.29	92.04	86.29	42.98
1982-83	Nil	Nil	78.11	83.32	78.11	38.09
1983-84	Nil	Nil	86.40	92.16	86.40	42.13
1984-85	Nil	Nil	81.51	86.94	81.51	39.74
Average	Nil	Nil	81.24	86.66	81.24	39.76

From Tables 2.1 and 2.2 it is clear that the utilisation percentage of irrigation potential in kharif is nil, whereas for rabi and hot-weather seasons together the same is very high, ranging from 81 to 92 per cent during different years. Because the kharif utilisation is nil the overall utilisation turns out to be around 40 per cent even though the combined utilisation of rabi and hot-weather is around 87 per cent on an average. Before making any comments on the performance of utilisation of irrigation potential particularly in kharif season let us estimate the extent of utilisation by the other measure.

Table 2.3: Water Proposed to be Released for Irrigation as per Project Water Planning (Mm^3)

Kharif	Rabi and Hot-Weather	Total
0.33 (8.42%)	1.95 (91.58%)	1.64 3.92 (100.00%)

Although Table 2.3 shows that around 8 per cent of water is proposed to be released in kharif season Table 2.4 shows that no water was actually released from the storage for irrigation in kharif season and this is in keeping with the fact presented in Table 2.2 that the area irrigated in kharif season is nil. In terms of water actually released as against proposed released (Table 2.4) the extent of utilisation in rabi and hot-weather seasons together is found to be as high as 86 per cent on an average and the same varies between 71 and 98 per cent in different years. The overall utilisation percentage is found to be around 79 on an average.

A comparison of the extent of utilisation by two measures in Tables 2.2 and 2.4 shows that the estimated utilisation percentage is higher when measured in terms of water released than when measured in terms of area irrigated. A small part of this difference is presumably due to differences in actual crop mix and the proposed one and low water allowances assumed in water planning compared to

Table 2.4: Yearwise Water Actually Released for Irrigation (Mm^3)

Year	Kharif		Rabi and Hot-weather		Total	
	Q	%	Q	%	Q	%
1976-77	Nil	Nil	2.24	62.40	2.24	57.14
1977-78	Nil	Nil	2.56	71.31	2.56	65.31
1978-79	Nil	Nil	2.89	80.50	2.89	73.72
1979-80	Nil	Nil	3.53	98.33	3.53	90.05
1980-81	Nil	Nil	3.23	89.97	3.23	82.40
1981-82	Nil	Nil	3.14	87.47	3.14	80.10
1982-83	Nil	Nil	3.10	86.35	3.10	79.08
1983-84	Nil	Nil	3.39	94.44	3.39	86.48
1984-85	Nil	Nil	3.70	103.06	3.70	94.39
Average	Nil	Nil	3.09	86.07	3.09	78.83

Q = Quantity of water in million cubic meter (Mm^3)
% = Per cent of water planned to be released

the actuals. However, the main reason for such a difference in this case is due to the fact that while water proposed to be utilised in kharif season is only around 8.46 per cent of the total water proposed to be released during the year, the proposed area to be irrigated in kharif season is as high as 90 per cent of the total area proposed to be irrigated during the year. In this connection it would be interesting to note that although water proposed to be released in kharif season is reported to be 0.33 Mm^3, the storage requirement planned for kharif season is reported to be nil. Presumably the kharif crops do not need any irrigation because of adequate rainfall during the monsoon in this region. From the aforementioned observations it is clear that in the execution of the scheme no provision was made for kharif irrigation and the system of distribution is also designed accordingly, hence raising the question of particularly low utilisation of kharif potential is not very meaningful in this context.

It may be recalled that unlike in other agro-climatic zones in Maharashtra where there are generally three irrigation seasons viz., kharif, rabi and hot-weather, in very high rainfall areas of Konkan there is only one irrigation season and that is known in local language as '*Konkan Hangam*', which is the non-monsoon season extending from beginning of December to end of April. In other words, the so called *Konkan Hangam* combines in itself the rabi season and the larger part of hot-weather season and the main crop grown in this season is paddy which is entirely irrigated. In the monsoon season also the main crop is paddy which is entirely grown on rain water, and traditionally irrigation for the monsoon crop is neither in demand nor is it supplied. The same practice is being followed under this scheme also ever since the system was commissioned for use. It again follows from this that the question of particularly low utilisation of kharif irrigation potential in this context does not make much sense.

There are, however, a number of important issues which need to be looked into. First of all it has to be ascertained from the time series data on daily rainfall

from the relevant rain guage station if the rainfall is reliable, adequate and fairly well distributed during the monsoon. This would indicate if there is need for protective irrigation in kharif for improving the productive potential of monsoon crop. Provision for kharif irrigation can then be made accordingly. Similarly the possibilities of introducing a change in cropping pattern may also be considered with a view to initiate kharif irrigation; this however would call for a change in the design of the distribution system. We shall examine all these issues in the subsequent sections.

High Rainfall Zone

We now examine the extent of utilisation in the high rainfall zone. We begin with the area approach, i.e., area actually irrigated as against area proposed to be irrigated. As this is a very old scheme potential created during the early years of the project is not relevant for our purpose. It is however found that the potential created data reported from as early as 1950-51 is the same as the ICA of the project mentioned in the project report. Hence we consider ICA of the project as the total potential created during the year and its distribution in different seasons as the potential created during different seasons.

The area proposed to be irrigated includes in its fold perennial crops in addition to kharif seasonal but rabi seasonal and hot-weather seasonal are not included in the proposed cropping pattern. The gross cropped area proposed to be irrigated comprises 90 per cent of ICA under kharif seasonal (mainly paddy) and 10 per cent of ICA under perennials (Table 2.5). As against the proposed area to be irrigated in each season the actual area irrigated for the last 10 years, for which we have data, is presented in Table 2.6.

Table 2.5: Area Proposed to be Irrigated as per Project Cropping Pattern

	Kharif	Rabi	Hot-weather	Two Seasonal	Perennial	Total
1. Area (hectares)	9721	-	-	-	198	9919
2. Per cent	(90.00)	-	-	-	(10.00)	(100.00)

Table 2.6 clearly indicates that the extent of utilisation of kharif potential is very high ranging from around 85 per cent to 98 per cent; on an average it turns out to be around 93 per cent. In so far as rabi and hot-weather seasons are concerned, although there is no provision for rabi and hot-weather crops in the project cropping pattern, in practice some area is actually reported to be irrigated in most of the years during these seasons. The reason is that a part of the area reported to be irrigated in rabi and hot-weather seasons is under perennial crops for which there is provision in the project cropping pattern and the other part of the area is presumably under second crop of paddy which occupies the rabi and part of the hot-weather seasons and to which irrigation water is given if the storage permits.

Table 2.6: Yearwise and Seasonwise Area Actually Irrigated (Hectares)

Year	Kharif		Rabi and Hot-weather				Total	
	Area	% of pro-posed area	Area	% of pro-posed area	Area	% of pro-posed area	Area	% of pro-posed area
1975-76	8282	85.20	2	-	1449	-	9733	98.12
1976-77	8956	92.13	96	-	-	-	9052	91.26
1977-78	8994	92.52	16	-	600	-	9610	96.89
1978-79	9484	97.56	154	-	-	-	9638	97.17
1979-80	9005	92.63	-	-	-	-	9005	90.79
1980-81	9012	92.71	528	-	528	-	10068	101.50
1981-82	8929	91.85	92	-	91	-	9112	91.86
1982-83	9193	94.57	-	-	-	-	9193	92.68
1983-84	9227	94.92	527	-	527	-	10281	103.65
1984-85	9219	94.84	-	-	18	-	9237	93.12
Average	9030	92.89	202	-	535	-	9493	95.70

The overall extent of utilisation during different years (last column, Table 2.6 varies between 91 and 102 per cent with 96 per cent utilisation on an average, a very high utilisation figure by any standard. Let us now see if the extent of utilisation turns out to be so by the other measure too.

It is to be noted here that information regarding the project water planning is not available in respect of this scheme because the scheme is very old and hence the extent of utilisation of potential created cannot be estimated in terms of water actually released as a percentage of water planned to be released. We may however take note of the water actually received during each of the last 7 years for which the data were made available to us.

Table 2.7: Yearwise and Seasonwise Water Actually Released for Irrigation (Mm^3)

Year	Kharif	Rabi	Hot-weather	Total
1978-79	49.95	2.04	5.12	57.11
1979.80	56.50	-	-	56.50
1980-81	28.80	-	11.50	40.03
1981-82	48.10	4.39	8.75	61.24
1982-83	33.58	-	-	33.58
1983-84	10.70	2.32	9.09	22.11
1984-85	40.28	-	-	40.28
Average	38.27	2.92	8.62	44.41

Water actually released for irrigation in kharif season varies between 11 and 57 Mm^3 during different years with an average release of around 38 Mm^3 which

turns out to be around 67 per cent of the live storage capacity of the reservoir. Similarly, water released for irrigation during the entire irrigation year varies between 22 Mm^3 and 61 Mm^3 during different years with an average release of around 44 Mm^3 which turns out to be around 79 per cent of the live storage capacity of the reservoir. However, these utilisation percentages do not give a correct picture of the extent of utilisation; at best these may be considered as the lower limits of the extent of utilisation because the full live storage may not be available every year. We shall examine this aspect in the subsequent chapters.

Notwithstanding the fact that the project water planning information is not available and therefore utilisation of potential in terms of water released as proportion of water planned to be released cannot be estimated, the utilisation percentage appears to be very high in the kharif season as well as for the entire irrigation year based on the area approach. In view of this the question of low utilisation of kharif potential in the case of this scheme does not arise.

It may be recalled that the main objective of starting the scheme was to provide protective irrigation to kharif paddy. The whole development of the scheme has also been towards meeting this end. The cropping pattern also shows that monsoon paddy is the most dominant crop to which the irrigation water is provided under long term agreement from September to November and the area irrigated every year during this period very well matches with the area proposed to be irrigated. There does not seem to be any underutilisation in this sense.

There are, however, a number of related issues which need to be examined. First of all the reliability, adequacy and distribution of rainfall have to be examined in the recent past based on the rainfall data. Secondly, the live storage available every year during different periods of kharif, rabi and hot-weather seasons has also to be examined to ascertain if water remains unused and may therefore be planned to be utilised better in kharif and in other two seasons by developing a suitable cropping pattern etc. This may, however, call for a change in the distribution system. Some of these important issues are discussed in the subsequent chapters.

Assured Rainfall Zone

In order to estimate the extent of utilisation of irrigation potential we begin with the area approach. Table 2.8 gives the potential created in respect of this scheme. The irrigation started from the year 1975-76 and by 1981-82, i.e., within a period of 7 years the full potential of 138 per cent (5836 hectares) of ICA (4229 hectares) has been created. As against the potential created the actual area irrigated in different seasons in the last 10 years is given in Table 2.9.

Estimates of the extent of utilisation based on area approach clearly show that the utilisation percentage is particularly low in the kharif season. It varies between nil and 9 per cent during different years with 5 per cent as the average utilisation over a period of 10 years. Even the overall extent of utilisation for the whole irrigation year is also not high, varying between 5 per cent and 35 per cent during different years with 20 per cent as the average utilisation over a period of 10 years. In point of fact rabi season shows a better utilisation percentage

Table 2.8: Yearwise and Seasonwise Potential Created (Hectares)

Year	Kharif	Rabi	Hot-weather	Total
1975-76	302	154	36	492
1976-77	984	473	110	1567
1977-78	1554	796	185	2535
1978-79	1671	855	199	2725
1979-80	2381	1219	283	3883
1980-81	2616	1340	312	4268
1981-82	3553	1818	465	5836
1982-83	3553	1818	465	5836
1983-84	3553	1818	465	5836
1984-85	3553	1818	465	5836
	(60.57%)	(31.15%)	(7.97%)	(100.00%)

Table 2.9: Yearwise and Seasonwise Area Irrigated (Hectares)

Year	Kharif		Rabi		Hot-weather		Total	
	Area	% of potential created	Area	% of potential created	Area	% of potential created	Area	% of potential created
1975-76	Nil	Nil	135	87.66	-	Nil	135	27.44
1976-77	Nil	Nil	442	93.45	25	22.73	467	29.80
1977-78	Nil	Nil	651	81.78	55	29.73	706	27.85
1978-79	146	8.74	673	78.71	135	67.84	954	35.01
1979-80	14	0.59	813	66.69	148	52.30	975	25.11
1980-81	150	5.73	945	70.52	120	38.46	1215	28.47
1981-82	44	1.24	532	29.26	134	28.82	709	12.15
1982-83	195	5.49	783	43.07	58	12.47	1035	17.73
1983-84	-	Nil	1041	57.26	309	66.45	1350	23.13
1984-85	172	4.84	241	13.26	29	6.24	270	4.63
Average	120	5.06	626	51.69	113	37.80	782	20.15

followed by the hot-weather season; on an average 52 per cent and 39 per cent respectively, but, since the extent of utilisation happens to be very low in kharif, with comparatively larger potential created, the overall utilisation percentage (overall seasons) turns out to be only 20 per cent on an average. During the first three years no utilisation of the potential created is reported in the kharif season and again in 1979-80 and in 1983-84, no utilisation is reported. Before we make further comments on the performance of kharif utilisation based on area approach let us examine the extent of utilisation by the other measure.

Even by the second measure, based on water reported to have been released for irrigation as against planned release, kharif utilisation is found to be

particularly low compared to the rabi and hot-weather seasons. The kharif utilisation percentage is seen to vary between 2 per cent and 31 per cent in different years with average utilisation around 20 per cent as against average utilisation of around 122 per cent and 42 per cent in rabi and hot-weather seasons respectively. Although the water planning proposed almost equal proportion of total water to be released in three seasons, water actually reported to have been released during different years show that much less water was actually released for kharif irrigation which naturally adversely affects the overall utilisation and we notice that even though rabi and hot-weather utilisation percentages on an average are around 122 and 42, the overall utilisation on an average is only 60 per cent (Tables 2.10 and 2.11).

Table 2.10: Water Proposed to be Released for Irrigation as per Project Water Planning (Mm^3)

Kharif	Rabi	Hot-weather	Total
11.53	10.57	12.41	34.51
(33.41%)	(30.63%)	(35.96%)	(100.00%)

A comparison of the extent of utilisation estimated by the two measures shows that the extent of utilisation particularly in kharif season appears to be higher by the second measure. Apart from the possible change in the crop mix from the one proposed and the low water allowances assumed in water planning, the other important season for such a situation is the fact that while the water proposed to be released in kharif season is around 33 per cent of the total water proposed to be released during the year, the area proposed to be irrigated in kharif season is around 61 per cent of the total area proposed to be irrigated during the year. In this connection it would be instructive to note that although water proposed to be released in kharif season is reported to be around 11.53 Mm^3, the storage requirement planned for kharif season is reported to be around 2.31 Mm^3 (20 per cent of the requirement). Presumably the remaining 80 per cent of the kharif requirement is to be met by the rainfall during this period.

From all these accounts it appears that the extent of utilisation is particularly low in kharif season. To understand the reason behind such a state of affair it would be necessary to look into a number of important issues which have bearing on the extent of utilisation. First of all it has to be ascertained if the rainfall is adequate and well distributed to take care of the 80 per cent of kharif water requirement as well as of the live storage requirement in the reservoir for the remaining two seasons. Secondly, the availability of live storage every year during different periods of kharif, rabi and hot-weather seasons has to be examined so as to ascertain if the water remains unused and may therefore be planned to be used by devising suitable cropping pattern etc. As mentioned earlier, we shall discuss some of these important issues in the subsequent chapters.

Table 2.11: Yearwise and Seasonwise Water Released (Mm^3)

Year	Kharif		Rabi		Hot-weather		Total	
	Q	%	Q	%	Q	%	Q	%
1978-79	3.61	31.33	-	-	-	-	-	-
1979-80	0.22	1.88	-	-	-	-	-	-
1980-81	2.82	24.46	18.65	176.47	2.59	20.86	24.06	69.71
1981-82	0.88	7.61	9.71	91.91	6.09	49.08	16.68	48.34
1982-83	2.58	22.38	13.51	127.86	3.75	30.20	19.84	57.49
1983-84	3.15	27.38	17.41	164.71	11.61	93.54	32.16	93.20
1984-85	2.83	24.54	5.09	48.17	2.29	18.45	10.21	29.59
Average	2.29	19.93	12.87	121.83	5.27	42.43	20.59	59.67

Q = Quantity of water in Mm^3
% = Per cent of water planned to be released

Less Assured Rainfall Zone

First of all we shall estimate the extent of utilisation by the area approach. The following table gives the potential created in respect of the scheme. The irrigation from the scheme started in the year 1975-76 and the full potential developed from the year 1980-81, i.e., within a period of six years full potential of 120 per cent (5837 hectares) of ICA (4864 hectares) is reported to have been created. As against the potential created the actual area reported to have been irrigated in different seasons during the last 10 years is given in Table 2.13.

Table 2.12: Yearwise and Seasonwise Potential Created (Hectares)

Year	Kharif	Rabi	Hot-weather	Total
1975-76	1993	1674	698	4365
1976-77	1993	1674	698	4365
1977-78	1993	1674	698	4365
1978-79	1993	1674	698	4365
1979-80	1993	1674	698	4365
1980-81	2658	2481	698	5837
1981-82	2658	2481	698	5837
1982-83	2658	2481	698	5837
1983-84	2658	2481	698	5837
1984-85	2658	2481	698	5837
Average	2362 (45.58%)	2122 (40.95%)	698 (13.47%)	5182 (100.00%)

Table 2.13: Yearwise and Seasonwise Area Irrigated (Hectares)

Year	Kharif		Rabi		Hot-weather		Total	
	Area	% of Potential Created	Area	% of Potential Created	Area	% of Potential Created	Area	% of Potential Created
1975-76	512	25.69	1717	102.57	349	50.00	2577	59.04
1976-77	696	34.92	1764	105.38	94	13.47	2555	58.54
1977-78	290	14.55	866	51.73	217	31.09	1372	31.43
1978-79	497	24.94	310	18.52	52	7.45	858	19.66
1979-80	45	2.26	1140	68.10	760	108.88	1944	44.54
1980-81	359	13.51	1411	56.87	772	110.60	2542	43.55
1981-82	255	9.59	811	32.69	284	40.69	1351	23.14
1982-83	520	19.56	253	10.20	18	2.58	791	13.55
1983-84	19	0.34	1130	45.55	900	128.94	2049	35.10
1984-85	20	0.75	941	37.93	415	59.45	1376	23.57
Average	321	13.59	1034	48.73	386	55.30	1741	33.60

The estimates of the extent of utilisation presented in Table 2.13 show that it is particularly low in kharif season, varying between less than 1 per cent in 1983-84 and 35 per cent in 1976-77 with an average estimate of around 14 per cent. Whereas the extent of utilisation is around 49 per cent on an average in rabi season and around 55 per cent on an average in hot-weather season. In fact the extent of utilisation is found to be more than 100 per cent during rabi and hot-weather seasons in some years. The overall extent of utilisation turns out to be around 34 per cent on an average. Since kharif area has comparatively a greater weight in the total potential created, even though the rabi season and hot-weather season utilisation percentages are higher, the overall utilisation percentage is lower because of lower percentage of utilisation in kharif. This is borne out by the observation that the extent of utilisation in kharif is as low as 0.33 per cent and 0.75 per cent in 1983-84 and 1984-85. Having examined the extent of utilisation based on the area approach we would now examine if the extent of utilisation estimated by other measure also shows similar result.

Table 2.14: Water Proposed to be Released for Irrigation as per Project Water Planning (Mm^3)

Kharif	Rabi	Hot-weather	Total
16.70 (36.87%)	15.57 (34.38%)	13.02 (28.75%)	45.29 (100.00%)

The water released as a percentage of the water planned to be released, the second measure of estimating the extent of underutilisation also shows that the

extent of utilisation is particularly low in kharif. Table 2.15 shows that the extent of utilisation varies between 5 per cent and 66 per cent over the years in kharif season with average utilisation percentage of around 24 per cent, whereas the extent of utilisation is estimated to be around 80 per cent and 77 per cent on an average in the rabi and hot-weather seasons. Even though the extent of utilisation is high in the rabi and hot-weather seasons, the overall extent of utilisation on an average turns out to be only 54 per cent because of the very low utilisation in the kharif season which according to the water planning accounts for around 37 per cent of the total water planned to be released (Table 2.14).

Table 2.15 : Yearwise and Seasonwise Water Released for Irrigation (Mm^3)

Year	Kharif		Rabi		Hot-weather		Total	
	Q	%	Q	%	Q	%	Q	%
1975-76	-	-	19.41	124.73	2.49	19.13	21.90	48.35
1976-77	10.98	65.76	22.86	146.91	6.37	48.91	29.23	64.54
1977-78	6.17	36.95	7.64	49.09	7.05	54.13	20.86	46.06
1978-79	3.39	20.34	5.91	38.00	3.40	26.09	12.71	28.06
1979-80	0.88	5.25	12.25	78.73	17.83	136.96	30.08	66.42
1980-81	2.83	16.95	14.55	93.45	22.07	169.57	39.45	87.11
1981-82	2.91	17.45	14.60	93.82	7.84	60.22	25.36	55.99
1982-83	3.71	22.20	6.74	43.27	5.66	43.48	16.10	35.55
1983-84	0.82	4.92	8.43	54.18	16.98	130.43	25.41	56.11
Average	3.96	23.73	12.49	80.24	9.96	76.55	24.57	54.25

Q = Quantity released in Mm^3
% = Per cent of water proposed to be released

A comparison of the extent of utilisation by the two measures suggests that the extent of utilisation turns out to be much higher when estimated by the second measure based on water released approach than by the first measure based on area approach. The main reason for such an occurrence is the fact that while potential created in kharif season accounts for almost half of the total potential created the water proposed to be released in kharif season accounts for about one-third of the total water planned to be released during the year. In this connection it would be instructive to note that although water proposed to be released in kharif season is reported to be around 16.70 Mm^3, the actual storage requirement planned for kharif season is only 3.31 Mm^3 (20 per cent of the requirement). Presumably for the remaining 80 per cent of the kharif requirement no storage is required as rainfall during this period would take care of this requirement.

From all these accounts it is clearly borne out that the kharif utilisation is particularly low in this region. Although the water planning provides for release of significant quantity of water for kharif irrigation, water actually released is much less; similarly although the area proposed to be irrigated in kharif is reported to be considerably high, the actual area irrigated is much less. It would be necessary to understand the reasons behind such a state of affair in order to

bring about any change if necessary. First of all the adequacy and distribution of rainfall has to be examined to find out if 80 per cent of the kharif requirement and the adequate live storage requirement to meet the 100 per cent of rabi and hot-weather requirement can be met. Secondly the availability of live storage every year during different periods of kharif, rabi and hot-weather seasons has to be examined to find out if the water remains unused and may therefore be planned to be used by devising suitable cropping pattern etc. Some of these important issues will be discussed in the subsequent chapters.

Scarcity Zone

Like in respect of other schemes for this scheme also first we attempt to estimate the extent of the seasonal and overall utilisation of irrigation potential by both the measures. In terms of area approach, area proposed to be irrigated as per project report is as presented in Table 2.16. It may be mentioned that full potential which in this case is the ICA of the project is reported to have been created by 1976-77, i.e., within a period of 3 years from the time of commissioning the project. Since there is no separate account of the yearwise and seasonwise potential created, we assume that the area proposed to be irrigated in different seasons as per project cropping pattern is also the respective potential created.

Table 2.16: Area Proposed to be Irrigated as per Project Cropping Pattern

	Kharif	Rabi	Hot-weather	Two seasonals	Total
1. Area (hectares)	1278	1426	-	492	3197
2. Per cent of ICA	(52)	(58)	-	(20)	(130)

Table 2.17 clearly shows that kharif utilisation is relatively very low. In fact if the area under two seasonals, separately reported in the area proposed to be irrigated, is added in kharif area proposed to be irrigated, the resulting estimates of kharif utilisation would be still lower. The estimates vary from as low as nil to somewhere around 21 per cent with an average utilisation of around 12 per cent in kharif over the last 10 years. Even if last 5 years average is taken the situation would not change favourably at all. The extent of utilisation is around 44 per cent on an average in rabi season and the utilisation percentage would look up further if last five years' average is taken instead of last ten years. Utilisation is reported in hot-weather every year for the last 10 years even though the project planning did not provide for any area to be irrigated in the hot-weather. Presumably area actually reported to have been irrigated in hot-weather is the area under two seasonals (mainly L.S.Cotton) which, as we have seen, is provided for in the cropping pattern. The overall extent of utilisation is only around 29 per cent on an average because of particularly low utilisation in kharif season. Let us now examine if the extent of utilisation in kharif turns out to be so low even by the second measure of underutilisation.

Table 2.17: Yearwise and Seasonwise area irrigated (Hectares)

Year	Kharif		Rabi		Hot-weather		Total	
	Area	% of proposed area	Area	% of proposed area	Area	% of proposed area	Area	% of proposed area
1975-76	67	5.24	165	11.57	44	-	276	8.64
1976-77	264	20.66	752	52.73	118	-	1134	35.48
1977-78	190	14.87	646	45.30	156	-	992	31.04
1978-79	206	16.12	368	25.81	193	-	767	24.01
1979-80	152	11.90	261	18.30	132	-	545	17.06
1980-81	106	8.29	364	25.53	192	-	662	20.70
1981-82	150	11.74	439	30.79	186	-	775	24.27
1982-83	Nil	Nil	967	67.81	130	-	1097	34.30
1983-84	44	3.44	1139	79.87	122	-	1305	40.84
1984-85	225	17.61	1235	86.61	171	-	1631	51.03
Average	157	12.28	634	44.46	144	-	918	28.74

Table 2.18: Water Proposed to be Released for Irrigation as per Project Water Planning (Mm^3)

Kharif	Rabi	Hot-weather	Total
7.30 (48.66%)	7.70 (51.34%)	- -	15.00 (100.00%)

As against water proposed to be released presented in Table 2.18, the water released yearwise is given in Table 2.19.

The extent of utilisation estimated by the second measure also shows that the utilisation percentage is particularly low in kharif, barely 16 per cent on an average over the last 10 years. It varies from zero utilisation in 1983-84 to around 33 per cent in 1977-78. In comparison in rabi and hot-weather seasons the extent of utilisation is relatively higher. In rabi season the extent of utilisation on an average turns out to be around 42 per cent and in hot-weather season considerable amount of water is released even though in the water planning no such provision was made. Presumably water actually released every year in the hot-weather is meant for the two seasonals for which there is provision in the proposed cropping pattern. On the whole the utilisation percentage is low around 39 per cent, because of very poor utilisation in kharif which as per Table 2.18 accounts for around 49 per cent of the water planned to be released during the year.

Table 2.19: Yearwise and Seasonwise Water Released for Irrigation (Mm^3)

Year	Kharif		Rabi		Hot-weather		Total	
	Q	%	Q	%	Q	%	Q	%
1975-76	0.71	9.69	0.82	10.65	1.13	-	2.66	17.72
1976-77	2.14	29.36	2.88	37.30	2.14	-	6.12	47.69
1977-78	2.40	32.89	5.60	72.69	1.02	-	9.01	60.11
1978-79	1.85	25.26	3.30	42.76	2.87	-	8.02	53.39
1979-80	0.14	1.94	1.81	23.49	1.42	-	3.37	22.50
1980-81	0.71	9.69	2.15	27.09	2.76	-	5.62	37.42
1981-82	0.99	13.56	2.07	26.80	2.41	-	5.47	36.38
1982-83	0.28	3.79	3.66	47.52	1.17	-	5.11	34.06
1983-84	-	-	5.18	67.25	0.73	-	5.91	39.39
1984-85	1.19	16.34	5.24	67.91	-	-	6.43	42.83
Average	1.16	15.84	3.27	42.43	1.74	-	5.88	39.15

If we compare the estimates of the extent of utilisation by the two measures presented in Tables 2.17 and 2.19 we find that the kharif utilisation percentages estimated by two measures on an average match fairly well with each other. It is only in the years 1977-78, 1978-79 and 1979-80 that the estimates of utilisation are seen to be higher by the second measure. Apart from the fact that there may have only been a marginal change in the existing cropping pattern and the proposed cropping pattern, the main reason for such an occurrence is more or less equal weight of the kharif area in the total area to be irrigated and kharif water in the total water to be released during the year as per the project planning.

On the whole the extent of utilisation in kharif is found to be particularly low. This is a matter for concern in a scarcity area in which the scheme is located. The project storage planning suggests only 20 per cent storage for kharif season, the remaining 80 per cent of the kharif requirement is to be met by rainfall during the season. This raises a number of questions which have to be answered. It has to be examined if the rainfall every year is adequate and well distributed to meet not only the 80 per cent of kharif requirement but also the 20 per cent storage requirement in kharif in addition to 100 per cent storage requirement for rabi as well as for two seasonals in hot-weather. It has also to be examined if any part of live storage remained unutilised in any given year. Some of these important issues would be discussed in the subsequent chapters.

On the basis of the above observations we may deduce that there is no utilisation at all of kharif potential in the very high rainfall zone. Effort in this zone is towards satisfying the irrigation requirements in rabi and hot-weather seasons whereas in high rainfall zone, characterised also by paddy growing, the effort is towards meeting kharif irrigation requirement (protective irrigation) and that is why the kharif utilisation is very high in that zone. In assured rainfall zone, less assured rainfall zone and scarcity zone, however, the kharif utilisation is particularly low and this is a matter of concern because kharif crops suffer most in these areas on account of vagaries of monsoon.

Chapter 3

Subjective Evaluation of Reasons for Low Kharif Utilisation

Introduction

This chapter deals with the subjective evaluation of the factors responsible for particularly low utilisation of kharif irrigation potential. It is attempted through the opinion survey of the irrigators in the command area of the projects under study with a view to know how the farmers - the ultimate users and beneficiaries of the irrigation systems, view the question of kharif underutilisation. Accordingly, as proposed, relevant informations are collected from the sample beneficiaries under the five schemes from different agro-climatic zones through field investigation with the help of the structured questionnaires as well as through the informal discussion with the beneficiaries of the schemes. The sampling procedure and the coverage for the field investigation are already represented in the first chapter; in what follows we discuss the results of the subjective evaluation so attempted.

Characteristic Features of the Sample Holdings

Before we take up the discussion of the factors responsible for the particularly low utilisation in kharif based on the subjective evaluation we present the characteristic features of the beneficiary households (holdings) whose opinion survey we have undertaken in this study.

Except in the case of the scheme in very high rainfall zone, in respect of the command area of all other schemes from other zones large holdings dominate. In so far as source of irrigation is concerned only in the case of the command area of the scheme in less assured rainfall zone and the scheme in scarcity zone that a considerable proportion of the net holding is irrigated by well. Further, the proportion of area irrigated by wells is seen to be increasing with the increase in farm size indicating thereby that the small land holders depend mainly on the public source of irrigation, that is canal. It is also observed that the main crop

grown in kharif in very high and high rainfall areas is paddy, in the scarcity zone it is hybrid bajra and short duration vegetable and in the assured and less assured rainfall zones the main crops in kharif are hybrid jowar, hybrid bajra, cotton and groundnut.

Holding Using/Not Using Canal Water for Kharif Irrigation

In order to make a subjective evaluation of the factors responsible for particularly low utilisation of irrigation facilities in kharif it is necessary to examine first the proportion of holdings not using canal water for kharif irrigation in the command area of different schemes in different zones.

Table 3.1 shows the distribution of beneficiaries on the basis of whether canal water is taken for kharif irrigation. We find two extreme cases, on the one hand no beneficiary is reported to be taking canal water for kharif irrigation in respect of scheme in very high rainfall zone and on the other all the beneficiaries covered in our sample are reported to be using canal water for kharif crops in respect of the scheme in high rainfall zone. It would be instructive to recall at this stage that the main crop grown in the command area of these two schemes is paddy. Thus we find that, as opposed to the beneficiaries of scheme in very high rainfall zone beneficiaries of the scheme in the high rainfall zone invariably use canal water in kharif for growing paddy. In respect of the scheme situated in less assured rainfall zone number of cases reporting kharif irrigation by canal is almost negligible at around 3 per cent. Use of canal water for kharif irrigation is reported to be comparatively higher in respect of schemes in scarcity zone and assured rainfall zone being around 22 per cent and 15 per cent respectively.

Another way of finding out if there is demand for canal water in kharif is to find out the number of irrigators submitting application every year to the canal authorities for the supply of water for kharif crops. Table 3.2 gives this information. We find that the irrigators do not demand water (no application made) in kharif season under scheme in very high rainfall zone. Since in the case of scheme in high rainfall zone the irrigators enter into long term agreement for kharif irrigation, water applications are made only once in three years and not every year. In respect of scheme in less assured rainfall zone and scheme in assured rainfall zone 37 per cent and 44 per cent of the irrigators respectively apply for kharif water supply, but, as seen in earlier table only 3 per cent and 15 per cent respectively actually receive canal water for kharif crops. This means there may be considerable rejection of the application by the scheme authorities for kharif irrigation. However, for scheme in scarcity zone number of applications made for kharif irrigation is smaller than the number of irrigators taking canal water for kharif irrigation. There seem to be some discrepancy in the data for this scheme.

Factors Responsible for Particularly Low Utilisation of Kharif Irrigation Potential

As mentioned earlier, in what follows we attempt a subjective evaluation of the factors accounting for particularly low utilisation of kharif irrigation potential. This evaluation is based on the opinion survey of the sample irrigators under

Table 3.1 : Distribution of Beneficiaries on the basis of whether Canal Water is taken for Kharif Irrigation

Agro-climatic zone	Number of beneficiaries		
	Using canal water for kharif crops	Not using canal water for kharif crops	Total
1. Very high rainfall zone	-	40 (100.00)	40
2. High rainfall zone	259 (99.62)	1 (0.38)	260
3. Assured rainfall zone	13 (15.48)	71 (84.52)	84
4. Less assured rainfall zone	3 (3.45)	84 (96.55)	87
5. Scarcity zone	14 (23.33)	46 (76.67)	60

(Figures in bracket indicate percentages)

Table 3.2 : Response to whether Application is made Every Year for Kharif Irrigation from Canal

Agro-climatic zone	Number of beneficiaries		
	Application made every year	Application not made every year	Total
1. Very high rainfall zone	-	40 (100.00)	40
2. High rainfall zone	-	260 (100.00)	260
3. Assured rainfall zone	37 (44.05)	47 (55.95)	84
4. Less assured rainfall zone	32 (36.78)	55 (63.22)	87
5. Scarcity zone	8 (13.33)	52 (86.67)	60

(Figures in bracket indicate percentages)

each of the five schemes. Because of the differences in agro-climatic complex between the regions chosen for study the importance of the reasons for low utilisation in kharif would in general be difference in different regions, which we have tried to identify. Table 3.3 lists the main reasons given by the irrigators for not using canal water for kharif irrigation for each of the five zones. Large number of reasons expressed by the irrigators in various forms have been classified into

six broad classes. Table 3.4 lists the most important reason out of the number of reasons mentioned for not resorting to irrigation for kharif cultivation.

In so far as scheme in high rainfall zone is concerned since all the irrigators demand and use canal water in kharif season the above question does not arise for them. We shall first, therefore, examine why is it so. As per the experience of the farmers the monsoon generally sets in this region during the 2nd or 3rd week of June. The farmers thereafter prepare their land for raising seedlings. Seedlings are raised (grown) entirely on rain water and after transplantation the crop solely depends on rain for its growth. Generally the rain starts receding from the middle of August and thereafter the irrigation is demanded by the farmers and the water is supplied to the standing crop of paddy. The irrigators enter into long term agreement with the irrigation department, renewable every three years, and the canal authorities are committed to provide water to the farmers until the crop is harvested by the middle of November.

Over the last 60 years the irrigation development has materialised in such a way that only paddy is suitable in this region; soil is reported to be not suitable for growing any other crop. Even if it is possible to grow any other crop in rabi and hot-weather seasons, there is no assurance of availability of water from the reservoir. In fact, there is a provision to carry over 15 to 20 per cent of water for irrigation in early kharif in case the monsoon is delayed and happens to be uneven in the initial period because the objective of the scheme is to provide protective irrigation to kharif crops.

Though the irrigation schedule should begin (as per irrigation year) on 1st of July every year, in actual practice the first watering for kharif season begins in 1st week of September and irrigation continues upto the middle of November. During this period 4 to 5 waterings are provided to the paddy crop. The rotation period of each watering is normally 15 days; this practice is followed considering the distribution of rainfall.

The irrigators under scheme in very high rainfall zone give only one reason for not using canal water for kharif crops and that is, 'no need of irrigation because of adequate rain during kharif season'. This reason is naturally the most important reason for not taking canal water for kharif cultivation (Table 3.4). This response clearly indicates that given the cropping pattern that is practised by the irrigators, in which paddy is the only crop grown during kharif season, irrigation in kharif season is not required because of adequate rainfall. It may be recalled that the scheme is located in the very high rainfall region and the main crop (indeed the only crop) grown during the monsoon (kharif) season is paddy. In fact the main crop grown during the post-monsoon season (known as '*Konkan Hangam*') is also paddy. Irrigation is required for the rabi, hot-weather season paddy, but, not for kharif paddy.

The farmers wait for the rain and the entire kharif cultivation is reported to be dependent on rain. Even when there is break in monsoon in mid-September or so for a period of 10 to 12 days, irrigators do not demand canal water. The farmers are of the opinion that kharif rice production is not affected adversely because of occasional and periodic interruption in rain. The farmers prepare the land and sow paddy seed for raising seedlings generally by the end of May or first

Table 3.3: Reasons for Non-using Canal Water for Kharif Irrigation

Reasons for not using canal water	Number of respondents				
	Very high rainfall zone	High rainfall zone	assured rainfall zone	Less assured rainfall zone	Scarcity zone
1. Kharif water rate is high	-	-	19 (26.76)	16 (18.39)	-
2. Adequate well water available	-	-	2 (2.81)	11 (13.10)	3 (6.52)
3. Water is not made available/not made available in time when required	-	1 (100.00)	59 (83.10)	73 (86.90)	46 (100.00)
4. No need for irrigation because of adequate rain	40 (100.00)	-	28 (39.44)	9 (10.77)	-
5. No need for applying for canal water because water is automatically available through leakage and through overflow	-	-	3 (4.23)	-	-
6. In this region rabi crop is most important. Farmers do not bother much about kharif cultivation	-	-	-	-	27 (58.69)
* Total number of beneficiaries not using canal water in kharif season	40	1	71	84	46

* Total number of respondents may be more than the total of beneficiaries because a beneficiary may give more than one reason.

(Figures in brackets indicate percentage to total number of beneficiaries)

Table 3.4: Most Important Reason for Not Using Canal Water for Kharif Irrigation

Agro-climatic zone	Number of respondents		
	Water is made available/not made available in time when required	No need for irrigation because of adequate rain	Total number of beneficiaries not using canal water
1.Very high rainfall zone	-	40 (100.00)	40
2. High rainfall zone	- Not applicable -		
3.Assured rainfall zone	40 (56.34)	-	71
4.Less assured rainfall zone	58 (69.005)	-	84
5.Scarcity zone	35 (76.09)	-	46

(Figures in brackets indicate percentages)

week of June depending upon the moisture in the field. The monsoon generally sets in by the first or second week of June in this region. Even if the break of monsoon is delayed farmers wait for the rain because the seed once sown is expected to remain so and finally when the rain comes germination takes place, though very late. This naturally leads to late harvesting and therefore late beginning of the next season. The farmers report that even if rain is delayed for a longer period the paddy seeds already sown are not affected and germinate after the first shower, hence even if the irrigation department makes provision for pre-monsoon irrigation for raising seedlings the farmers may not avail of the facility. Thus it is the demand factor which is most crucial in this region.

In respect of scheme in scarcity zone, the reasons given by the irrigators for not using canal water in kharif season are nonavailability of water when required, importance of rabi crop, hence kharif crop neglected and availability of adequate well water. Naturally many irrigators have given more than one reason for not using canal water for kharif cultivation. We note from Table 3.3 that all the irrigators not resorting to irrigation in kharif season give nonavailability of water from the canal system as one of the reasons for not asking for canal water, 59 per cent of the irrigators also report about the importance of rabi crop and hence kharif cultivation neglected (left to the vagaries of monsoon) and only 7 per cent mention availability of alternate source of irrigation as the reason for not demanding canal water. The most important reason as listed in Table 3.4 is nonavailability of water when required; around 76 per cent of the irrigators not resorting to canal irrigation assign this as the most important reason. As a matter of fact when extreme uncertainty of availability of water for kharif irrigation is the prevalent situation, the irrigators naturally would mention that they would rather concentrate on rabi crops which happens to be the main crop in this zone considering the rainfall and soil condition. It is against this background that irrigators often opine that kharif irrigation would be preferred only after full provision for rabi season requirement is assured. They do not want kharif irrigation at the cost of rabi irrigation.

As noted earlier the crops grown in kharif in this scarcity zone are hybrid bajra, hybrid jowar and groundnut, mainly of course hybrid bajra. The irrigators opine that because canal water is released for kharif irrigation (if at all) only by the middle of July, there is no demand for water from the irrigators. The irrigators would like to get canal water during last week of May and/or first week of June so that after the kharif harvest land is available for rabi cultivation. But the canal authorities do not supply water at that time. They further opine that in case water is made available when they demand (beginning from the end of May) they would take canal water in kharif for 50 per cent of grain crops, 25 per cent of groundnut and 25 per cent of vegetable. The crop rotation then may be hybrid bajra to be followed by jowar and groundnut to be followed by wheat and gram.

It appears from the above account that it is mainly the supply factor which seems to be responsible for every low demand for kharif irrigation. If the irrigators are not assured of the availability (supply) of water when they need, alongwith an assurance of providing full supply in rabi season even after meeting the kharif requirement, naturally there would not be any demand from the irrigators for the same in kharif season.

In respect of schemes in assured rainfall zone and less assured rainfall zone the reasons assigned by the irrigators for not resorting to kharif irrigation are largely the same, namely, (i) nonavailability of water for kharif irrigation, (ii) high water rates for kharif crops, (iii) availability of adequate well water and (iv) adequate rain. Of these reasons around 83 per cent and 87 per cent of the irrigators not using canal water for kharif irrigation give nonavailability of canal water for kharif crops as one of the reasons, around 40 per cent and 18 per cent assign adequate rainfall as the reason and around 27 per cent and 18 per cent assign high water rate as the reason for not using canal water in kharif season in assured and less assured rainfall zones respectively. If we look into the most important reason listed in Table 3.4 we find that around 60 per cent or more of the irrigators not using canal water for kharif irrigation assign nonavailability of canal water when required as the most important reason for not demanding water for kharif cultivation in these two zones. As a matter of fact all other reasons are only supplementary reasons because there is absolutely no certainty of getting irrigation water in kharif season.

It may be recalled that the important crops grown in kharif season in less assured rainfall region are jowar, groundnut and pulses and to some extent cotton. The irrigators report that the water for kharif irrigation is released (if at all) as a rule around middle of July, which according to them is very late for sowing kharif crops considering the follow-up crops to be grown in rabi and hot-weather seasons. The irrigators would like to get water for kharif sowing much earlier, i.e., by the end of May or at best by the 1st week of June and the impression that is created is that in case water is made available in time when it is required there would be significant increase in the demand for canal water for kharif irrigation.

The first thing that the irrigators mention is that there is no guarantee of assured water supply during kharif season hence they do not demand water even though they would very much like to get water which helps to increase the yield of the crop. It is opined that by the time first water is released (around July, 15) monsoon has already set in and the farmers do not need water at that time because of availability of adequate rain water. In point of fact the fields are prepared in such a way that these can receive rain water (no field channels) and afterwards when the crop is already grown it becomes difficult to make field channels to receive canal water, hence they do not demand canal water even afterwards.

What the farmers want is the assured supply of water during the first and second weeks of June for land preparation and sowing of hybrid jowar, groundnut and cotton; by 10th June these crops should have been sown (ideal period). Groundnut is a crop of around 96 to 100 days and is harvested by the middle of September making land available for rabi cultivation. Hybrid jowar remains in the field upto October end and cotton upto November. Hot-weather groundnut is taken up on the area occupied by hybrid jowar and/or cotton in kharif. Farmers are prepared to fill in the water application form by the end of May for kharif irrigation so that water can be given to them during the first week of June. According to them if the above practice is followed demand for kharif irrigation would increase very considerably.

It is clear from the above discussion that the issue of particularly low response for kharif irrigation is very much related to the supply factor. Early sowing (pre-monsoon) of kharif crops, as desired by the irrigators, requires assured supply of canal water during this period, at least of one watering without fail. Thereafter the crop does not require water for another 2 to 3 weeks and thereafter the monsoon sets in and the farmers may require 2 to 3 waterings during July, August and September depending upon the amount and distribution of rainfall. Meeting these requirements from supply side would certainly induce the farmers to respond very favourably to kharif irrigation. In this connection a very important factor should not be lost sight of, that is increasing demand for the supply of canal water for hot-weather groundnut by the irrigators. Over the years hot weather groundnut has become very popular crop with the farmers in this area, and if irrigation is provided to this crop there may not be enough water available in the storage for pre-monsoon kharif irrigation. Thus there arises a conflict of interests between protective irrigation versus productive irrigation. Alongwith this aspect it needs to be examined if the kharif water rates are high considering the fact that the irrigators may take only 2 to 3 waterings during the entire season.

It may be recalled that the important crops grown in kharif season in assured rainfall region are hybrid jowar and cotton and to an extent pulses (mostly unirrigated). Of these crops, as per farmers' opinion, hybrid jowar does not require much irrigation and it can withstand fairly long period of dry spell and the yield is reported not to be very much affected. The monsoon generally sets in by the 2nd or 3rd week of June. Land is kept ready for kharif sowing and as soon as there is first monsoon rain, sowing operation is completed. The crop rotation followed is generally of three types, (i) cotton in kharif is followed by groundnut in rabi-hot-weather. Cotton is sown in mid-June depending on rain and harvested in mid-November or so and then groundnut is sown on the same land in mid-January and harvested by the end of April or beginning of May, (ii) unirrigated pulses in kharif followed by wheat or gram in rabi and (iii) hybrid jowar in kharif followed by wheat/gram in rabi or summer groundnut in mid-January. The combination which the farmers choose depends upon time of onset of monsoon because the farmers depend upon rain for kharif sowing. Since the farmers depend upon rain for kharif sowing, if the onset of monsoon is delayed, the kharif cultivation is delayed and hence the following rabi and summer seasons are delayed which affect the production of crops adversely.

At present, as we have noted, there is negligible demand for kharif watering. In case there is dry spell in the month of September/October, some farmers may demand canal water mainly for cotton. As mentioned earlier, main reason for the lack of demand for water in kharif season is that water is not released for early sowing and also that there is no assurance of the availability (supply) of canal water even during the dry spell in kharif season. The reason next in importance is the high water rates for kharif. The farmers opine that the water charges are made for the entire kharif season even though a farmer may have taken only one or two waterings during the entire kharif season. In fact, there is great resentment by the irrigators of the fact that the water charges are made for two seasons for the same crop if the irrigation happens to get spread over two seasons.

From our discussion with the cultivators, it is clear that they are ready to take canal water for early sowing, without waiting for rains and subsequently during dry spells in kharif season if there is a complete assurance about the availability of water and also if the charges are made per watering rather than for the season. This will not only ensure kharif utilisation but will also ensure timely rabi sowing.

It may be deduced from the above account that the issue of particularly low utilisation in kharif arises mainly out of supply factor. For early sowing assured supply of water is required (may be for 2 waterings), thereafter assured water supply during dry spell is also required to induce the irrigators to demand water for kharif irrigation. It is, however, necessary that the demand for kharif irrigation comes in bulk and in contiguous block. In this connection the popularity of summer groundnut with the irrigators has to be kept in view. It has to be evaluated objectively if the water for early sowing (pre-monsoon) in kharif will be available in case water is released for hot-weather groundnut. Further, in the assured rainfall zone, from the demand side feasibility of adjusting the water rates for kharif crops in order to make the irrigators more responsive to kharif irrigation has also to be taken note of.

Factors responsible for particularly low utilisation of kharif irrigation potential can also be conveniently discerned by analysing the responses of those who use canal water in kharif season and the difficulties they face in doing so. As mentioned earlier, most of the irrigators under the schemes in scarcity zone, assured rainfall zone and less assured rainfall zone do not use canal water and again under the scheme in very high rainfall zone no irrigators use canal water for kharif cultivation, thus only a few use canal water for raising kharif crops. In what follows we examine the responses of these small number of users to ascertain the nature of difficulties they face which may be deterrent for other farmers to go for kharif irrigation.

Table 3.5 shows the number of irrigators (from amongst those who use canal water for kharif cultivation) taking water in each rotation. It is seen that quite a large proportion of irrigators do not take water in each rotation the reasons for which is presented in Table 3.6. We once again find that because water is not made available when required the irrigators do not take water in each rotation. The other reason, that of adequate rain, is confind to the scheme in assured rainfall zone only. Presumably those who do not take irrigation water in kharif season are influenced by the observation that water is not made available when required hence better not to resort to kharif irrigation.

Similarly, when we examine the area that is sanctioned by the irrigation department as against the area for which demand applications are made by the irrigators resorting to kharif irrigation (Table 3.7), it is observed that for a considerably large number of irrigators in respect of each of the three schemes in scarcity zone, assured rainfall zone and less assured rainfall zone sanctioned area is reported to be less than the area demanded to be irrigated by the irrigators. This again discourages the irrigators from asking (demanding) for kharif irrigation.

Table 3.5: Response to Whether Water was Taken in Each Rotation (only for those who take canal water in kharif)

Agro climatic zone	Number of beneficiaries		
	Water taken in each rotation	Water not taken in each rotation	Total
1.Very High rainfall zone	N.A.	N.A.	N.A.
2.High rainfall zone	192 (74.13)	67 (25.87)	259
3.Assured rainfall zone	8 (61.54)	5 (38.46)	13
4.Less Assured rainfall zone	-	3 (100.00)	3
5. Scarcity zone	7 (50.00)	7 (50.00)	14

N.A. = Not applicable

(Figures in brackets indicate percentages)

Table 3.6: Main Reasons for Not Taking Water in Each Rotation for Kharif Crops (only for those who take canal water in kharif)

Reasons	Number of respondents zonewise				
	Very high rainfall zone	High rainfall zone	Assured rainfall zone	Less assured rainfall zone	Scarcity zone
1.Water is not made available at all/not made available when required	N.A.	60 (89.55)	2 (40.00)	3 (100.00)	7 (100.00)
2.No need of irrigation water because of adequate rain	N.A.	7 (10.45)	3 (60.00)	-	-
Total	-	67	5	3	7

N.A. = Not applicable

(Figures in brackets indicate percentages)

Table 3.7: Distribution of the Beneficiaries (Taking Water in Kharif from Canal) on the Basis of Area Sanctioned for Kharif Irrigation as Against Area Demanded to be Irrigated

Agro-climatic zone	Number of beneficiaries			
	With sanctioned area *equal to* demand area (ha.)	With sanctioned area *less than* demand area (ha.)	With sanctioned area *more than* demand area (ha.)	Total
1. Very high rainfall zone	N.A.	N.A.	N.A.	N.A.
2. High rainfall zone	235 (90.74)	20 (7.72)	4 (1.54)	259
3. Assured rainfall zone	8 (61.54)	5 (35.46)	-	13
4. Less assured rainfall zone	-	3 (100.00)	-	3
5. Scarcity zone	6 (42.86)	8 (57.14)	-	14

N.A. = Not applicable

(Figures in brakcets indicate percentages)

Table 3.8: Response to Whether the Demand Applicable Depends Upon the Rain (only for those who take canal water for kharif Irrigation)

Agro-climatic zone	Number of beneficiaries		
	Application depends on rain	Application does not depend on rain	Total
1. Very high rainfall zone	N.A.	N.A.	N.A.
2. High rainfall zone	-	259 (100.00)	259
3. Assured rainfall zone	12 (92.31)	1 (7.69)	13
4. Less assured rainfall zone	-	3 (100.00)	3
5. Scarcity zone	-	14 (100.00)	14

N.A. = Not applicable

(Figures in brackets indicate percentages)

Table 3.8 shows if the demand applications of the irrigators taking canal water for kharif irrigation depends upon rain. It is noted that it is only in the case of the scheme in assured rainfall zone that the irrigators apply for the supply of canal water depending upon rain, and may wait for rain varying from upto June 30 to August 15 before applying for the supply of canal water. Most likely consequence of late application is the inadequate supply of water from the distribution system, and that is what is being observed from the responses tabulated in Table 3.9. Most of the irrigators under the scheme in scarcity zone and the scheme in less assured rainfall zone and sizable proportion of irrigators under the scheme in assured rainfall zone do not get adequate water because of submitting the applications late for water supply. The natural tendency of the farmers, at-least in the assured rainfall areas, is to largely depend on rain for kharif cultivation. However, they would like to sow the crop with the help of canal water if the monsoon is delayed and also to save the crop during long dry spell. But, if there is no certainty of the availability of adequate water from the schemes when demanded (even if late) the irrigators naturally are discouraged from depending on canal water for kharif cultivation.

So far as yield of the crops grown in kharif season is concerned, all the irrigators taking canal water in kharif season in respect of the schemes in less assured rainfall zone, assured rainfall zone and high rainfall zone respectively, opine that the yield gets adversely affected because of inadequate and delayed application of water. In respect of the scheme in scarcity zone around 43 per cent of the irrigators taking water for kharif cultivation opine that there is no significant adverse effect on kharif production of delayed and inadequate supply of water (Table 3.10). This opinion is mainly because of less importance given by the irrigators to kharif cultivation and also because of the nature of crop grown in kharif (withstanding adverse condition) in this scarcity zone. Irrigators who think that the yield gets adversely affected because of delayed and inadequate water supply would not entirely depend upon rain but would like to supplement it with canal water as and when required. This is what should be the objective of the protective irrigation in kharif season but, since in practice this does not happen, as noted earlier, majority of the irrigators do not demand canal water for kharif irrigation. In so far as irrigators under the scheme in very high rainfall zone is concerned since there is no practice of using canal water for kharif crop (paddy), the irrigators do not have any opinion in this regard. It may also be mentioned that as per the irrigators' opinion the range of adverse effect due to delayed application of water varies from 20 per cent to around 50 per cent of normal (good) yield depending upon the length of the dry spell and the stage of the growth of the crops.

In some cases, as noted earlier (Table 3.3), the farmers may prefer to keep the land, that can be irrigated in kharif, fallow for rabi crops. Table 3.11 shows that except in the case of irrigators from the scheme in scarcity zone no such case is reported in the case of the irrigators from other zones. As noted earlier in the scarcity zone of Western Maharashtra the farmers in general give preference to rabi crops, mainly jowar, which is sown in late September. The kharif crop (which is dependent on rain water and is hardly possible to be supplemented by canal water) may keep the land occupied and come in the way of timely sowing

Table 3.9: Response to Whether the Adequate Supply of Water Available, if Applied Late for Canal Water (only for those who take canal water in kharif irrigation)

Agro-climatic zone	Number of beneficiaries			
	Adequate water available	Adequate water not available	Not applicable	Total
1. Very high rainfall zone	N.A.	N.A.	N.A.	N.A.
2. High rainfall zone	-	-	259 (100.00)	259
3. Assured rainfall zone	9 (69.23)	4 (30.77)	-	13
4. Less assured rainfall zone	-	3 (100.00)	-	3
5. Scarcity zone	4 (28.57)	10 (71.43)	-	14

N.A. = Not applicable

(Figures in brackets indicate percentages)

Table 3.10: Response to Whether Yield Gets Adversely Affected Because of Delayed Applicable on Canal Water (only for those who take canal water on kharif)

Agro-climatic zone	Yes	No	Total
1. Very high rainfall zone	N.A.	N.A.	-
2. High rainfall zone	259 (100.00)	-	259
3. Assured rainfall zone	13 (100.00)	-	13
4. Less assured rainfall zone	3 (100.00)	-	3
5. Scarcity zone	8 (57.14)	6 (42.86)	14

N.A. = Not applicable.

(Figures in brackets indicate percentages)

of rabi crops. This is the reason why around 50 per cent of the irrigators prefer to keep the irrigable land fallow in kharif. However, if timely and adequate irrigation water is made available in kharif and because of that availability (supply) of water is not adversely affected in rabi season the farmers may not keep the land fallow in kharif necessarily.

It may be recollected that one of the reasons cited for not using canal water in kharif season is the availability of alternate source of irrigation, viz., well (Table 3.3). We now examine this aspect in detail to ascertain the extent of applicability of such a statement.

Table 3.11: Response to Whether the Land that can be Irrigated in Kharif is Kept Fallow for Rabi Irrigation

Agro-Climatic Zone	Number of beneficiaries		
	Yes	No	Total
1. Very high rainfall zone	-	40 (100.00)	40
2. High rainfall zone	-	260 (100.00)	260
3. Assured rainfall zone	-	84 (100.00)	84
4. Less assured rainfall zone	-	87 (100.00)	87
5. Scarcity zone	29	31 (48.33)	60 (51.67)

(Figures in brackets indicate percentages)

Table 3.12 presents the distribution of beneficiaries on the basis of having wells or not having wells for irrigation on the farms. We find that 50 per cent of the irrigators under the scheme in scarcity zone and the scheme in less assured rainfall zone have wells on the farm for irrigation. While irrigators under the scheme in very high rainfall zone do not have wells for irrigation, only around 5 per cent of irrigators under the scheme in assured rainfall zone and the scheme in high rainfall zone have wells for irrigation on farms. Some irrigators under the scheme in high rainfall zone irrigate a small area by sources other than well, but that is mostly small pond water accumulated from rain.

Table 3.13 gives the information on irrigation by well in the command area of the schemes in scarcity, transition, assured rainfall and high rainfall zones respectively. In terms of area irrigated perennial crops seem to be the important crop under well irrigation in respect of all the zones except in high rainfall zone where mainly rabi and hot-weather crops are irrigated by well water.

A number of irrigators using wells for irrigation have land which can be irrigated both by well and canal. Table 3.14 gives the distribution of well users by the land that can and cannot be irrigated by both the sources. It is observed

Table 3.12: Distribution of Beneficiaries by Having and Not Having Wells on Farm

Agro-climatic zone	Number of beneficiaries size groupwise							
	Less than 1 ha.	1 to 2 ha.	Above 2 ha.	Total	Less than 1 ha.	1 to 2 ha.	Above 2 ha.	Total
	Having Wells				Not having Wells			
1. Very high rainfall zone	-	-	-	-	13 (32.5)	17 (42.5)	10 (25.0)	40 (100.0)
2. High rainfall zone	-	2	12	14 (5.38)	56	71	119	246 (94.62)
3. Assured rainfall zone	-	-	4	4 (4.76)	16	30	34	80 (95.24)
4. Less assured rainfall zone	2	15	34	51 (50.62)	11	11	14	36 (49.38)
5. Scarcity zone	5	13	17	35 (50.33)	7	4	14	25 (49.67)

(Figures in brackets indicate percentages)

Table 3.13: Irrigation by Wells, Seasonwise in Different Zones

Agro-climatic zone	Perennial		Kharif		Rabi		Hot-weather	
	Number of cases	Area (ha)	Number of cases	Area (ha)	Number of cases	Area (ha)	Number of cases	Area (ha)
1. Very high rainfall zone	-	-	-	-	-	-	-	-
2. High rainfall zone	1	0.04	-	-	6	1.87	7	0.87
3. Assured rainfall zone	3	4.30 (1.43)	1	1.21 (0.40)	-	-	-	-
4. Less assured rainfall zone	40	40.87 (1.02)	15	12.57 (0.84)	16	14.57 (0.91)	7	5.26 (0.75)
5. Scarcity zone	8	5.10 (0.64)	23	11.09 (0.48)	20	9.83 (0.49)	2	0.51 (0.26)

Table 3.14: Distribution of Well Users by Land which can be Irrigated Both by Canal and Well

Agro-climatic zone	Number of well users			If by both the sources	
	Area irrigable both by canal and well	Area not irrigable both by canal and well	Total	Area (ha.)	Average area (ha.)
1. Very high rainfall zone	-	-	-	-	-
2. High rainfall zone	11 (78.57)	3 (21.43)	14	27.70	2.52
3. Assured rainfall zone	2 (50.00)	2 (50.00)	4	5.50	2.75
4. Less assured rainfall zone	37 (72.55)	14 (27.45)	51	70.27	1.90
5. Scarcity zone	24 (68.57)	11 (31.43)	35	34.71	1.45

(Figures in brackets indicate percentages)

that most of the well users have land that can be irrigated both by canal and well. Table 3.15 depicts what is actually being practised by these irrigators and we find that almost 100 per cent of the irrigators with well and with land irrigable both by well and canal also actually irrigate those area both by canal and well in all the zones except in less assured rainfall zone where the proportion of the same is around 90 per cent. This indicates that the irrigators having wells in the command area of the schemes in different zones use well water in kharif season mainly as a supplementary source of irrigation and not necessarily a main source of irrigation. This is also borne out by the reasons given by these irrigators for doing so. They express that since adequate water is not available either from the well or from the canal there is canal and well mix-up in providing irrigation water to the crops. On the basis of this observation we may presume that one of the reasons for not using canal water for kharif irrigation, that of availability of adequate well water for irrigation, assigned by the irrigators, does not seem to be very strong and tenable.

Table 3.15: Distribution of Irrigators (with Land Irrigable Both by Canal and Well) by Actual Source of Irrigation

Agro-Climatic Zone	Number of cases by source of irrigation			
	By well only	By canal only	By both canal & well	Total
1. Very high rainfall zone	-	-	-	-
2. High rainfall zone	-	-	11 (100.00)	11
3. Assured rainfall zone	-	-	2 (100.00)	2
4. Less assured rainfall zone	4 (10.81)	-	33 (89.19)	37
5. Scarcity zone	-	-	24 (100.00)	24

(Figures in brackets indicate percentages)

It is generally expected that with the onset of irrigation the beneficiary farmers in the command area of an irrigation project would begin to incorporate high yielding and fertilizer responsive varieties of crops in the cropping pattern in order to take advantage of the controlled water distribution. It is with this view that the irrigators covered under our field investigation were asked to indicate their awareness about the prevailing high yielding varieties of different crops that can be grown in kharif alongwith the time of sowing and application of recommended doses of fertilizer.

Table 3.16 shows that around 70 per cent or more of the irrigators under every scheme is aware of the prevailing improved varieties, improved cultivation

practices and application of fertilizer for kharif crops. However, even though the irrigators are by and large aware of the recent development, on being asked if they receive any help or guidance from the agricultural department in that regard, more than 50 per cent of the irrigators replied in negative (Table 3.17). From this observation it would not be very unreasonable to surmise that since most of the irrigators are already aware of the development of new variety, improved cultivation practices and application of fertilizer, it would not be difficult to convince the irrigators to adopt a suitable crop sequence under assured supply of water in order to improve the utilisation of kharif irrigation, if at all.

It may be recalled that around 18 per cent and 27 per cent of the irrigators not using canal water for kharif cultivation in respect of the scheme in less assured rainfall zone and the scheme in assured rainfall zone respectively attribute high water rate to be the reason for not resorting to kharif irrigation (Table 3.3). Subsequently, all irrigators surveyed were specifically asked if they thought kharif season rates for different crops were high. The response of the irrigators is tabulated in Table 3.18. It is seen that more than 80 per cent of the irrigators under the command of the scheme in less assured rainfall zone and the scheme in assured rainfall zone opine that the kharif water rate is on the higher side. Their argument is that since these schemes are located in generally assured rainfall zone normally only 2 or at the most 3 irrigation (waterings) are required for raising kharif crops, but once sanction is given the charges for different crops per unit of land is for the entire season irrespective of the number of watering the irrigators avail of. They are therefore, of the opinion that the water charges in kharif season at least should be on the basis of number of waterings rather than on the basis of the season. It is further opined that this changed practice would not only make them take water as and when required but will also reduce the total water charges payable for kharif irrigation. However, as mentioned earlier this is a supplementary reason and would not have arisen had irrigation water been made available in time and in adequate quantity in kharif season.

In respect of the scheme in very high rainfall zone the irrigators are generally indifferent to the question of water rates in kharif because there is no irrigation in kharif season. In respect of the scheme in scarcity zone, since the irrigators are convinced that there is hardly any possibility of getting canal water for kharif cultivation even if they demand, they opine that water charges for kharif season are not high if adequate water is made available by the canal authorities for kharif cultivation and that it does not matter even if the charges are made on seasonal basis than on the basis of number of waterings. The situation is different in respect of irrigators in the scheme in high rainfall zone. We have seen earlier that the irrigators under this scheme entirely depend upon canal water for growing paddy in kharif and that they enter into a long term agreement for this purpose with the irrigation department. Their reason for mentioning that the kharif water rates are high is presumably different and they naturally want the kharif water rates to be on seasonal basis (although lower than the existing) because they generally need all the waterings supplied from canal during the kharif season.

Table 3.16: Response to the Awareness About the High Yielding Varieties, Application of Fertilizer and Improved Practices for Kharif Cultivation

Agro-climatic zone	Number of beneficiaries		
	Aware	Not aware	Total
1. Very high rainfall zone	28	12	40
	(70)	(30)	
2. High rainfall zone	179	81	260
	(68.85)	(31.15)	
3. Assured rainfall zone	75	9	84
	(89.29)	(10.71)	
4. Less assured rainfall zone	84	3	87
	(96.55)	(3.45)	
5. Scarcity zone	49	11	60
	(81.67)	(18.33)	

(Figures in brackets indicate percentages)

Table 3.17: Response About the Availability of Help and Guidance from the Agricultural Department

Agro-climatic zone	Number of beneficiaries		
	Yes	No	Total
1. Very high rainfall zone	25	16	40
	(62.5)	(37.5)	
2. High rainfall zone	90	170	260
	(34.62)	(65.38)	
3. Assured rainfall zone	30	54	84
	(35.71)	(64.29)	
4. Less assured rainfall zone	30	57	87
	(34.48)	(65.52)	
5. Scarcity zone	36	24	60
	(60)	(40)	

(Figures in brackets indicate percentages)

Summing up

The subjective evaluation of the factors responsible for particularly low utilisation of kharif irrigation water based on the farmers opinion survey indicates that the main reason for not using canal water for kharif cultivation in the generally assured rainfall zone and in the scarcity zone is the nonavailability of water, particularly when required, from the distribution systems of these schemes. This opinion of the farmers has to be checked with factors responsible for low kharif utilisation based on the objective evaluation in order to ascertain if required and projected quantities of water is released and/or is possible to be

Table 3.18: Response to whether Water rates are Exorbitant for Kharif Crops

Agro-climatic zone	Number of beneficiaries			
	Yes	No	N.A.	Total
1. Very high rainfall zone	8	26	6	40
	(20)	(65)	(15)	
2. High rainfall zone	191	67	2	260
	(73.46)	(25.77)	(77)	
3. Assured rainfall zone	72	3	9	84
	(85.71)	(3.57)	(10.72)	
4. Less assured rainfall zone	70	11	6	87
	(80.46)	(12.64)	(6.90)	
5. Scarcity zone	7	12	41	60
	(11.67)	(20)	(68.33)	

N.A. = Not Applicable

(Figures in brackets indicate percentages)

released every year for kharif irrigation and the reasons thereof. Other reasons assigned for low kharif utilisation by the irrigators also need to be corroborated with the factors arising out of objective evaluation. Similarly, in respect of the scheme in very high rainfall zone the reason attributed by the irrigators for not at all using canal water for kharif cultivation (mainly paddy) because of heavy and fairly well distributed rainfall has also to be checked with the objective evaluation of time series data on rainfall and the live storage available at the end of what is locally known as *Konkan Hangam*.

Chapter 4

Objective Evaluation of the Reasons for Low Kharif Utilisation

Introduction

The objective evaluation of the reasons for particularly low utilisation of kharif irrigation is undertaken with a view to identify the major factors responsible for such a situation on the basis of the analysis of the time series data on a number of important variables affecting the demand for and supply of irrigation water. As mentioned earlier, the idea behind undertaking both objective and subjective evaluations is to find out the extent to which the findings of these evaluations correspond and/or match with each other.

Change in Crop-mix and Underutilisation

One of the reasons for low utilisation percentage estimated by the conventional area approach may be the change in cropping pattern from the one proposed originally. This may affect the utilisation percentage, thus estimated, adversely in as much as the existing cropping pattern incorporates heavy water using perennial or seasonal crops anew or allocates larger area under such crops compared to what was projected and/or incorporates crops in the hot-weather season which were not proposed in the project cropping pattern. Naturally such changes would result in less area irrigated overall and also in kharif season with the given quantity of water than was proposed, giving rise to higher underutilisation percentage.

In very high rainfall and high rainfall zones no perennial and/or two seasonal crops are grown. In fact the only crop grown in these two zones is paddy. In very high rainfall zone kharif paddy is grown entirely rainfed and the second crop of paddy is fully irrigated. Whereas in high rainfall zone kharif paddy is fully irrigated and irrigation water is provided to the summer paddy if there is any surplus left after kharif irrigation.

In the case of other zones also perennial crops are not grown and to that extent there is no diversion from the original crop-mix suggested but, hot-weather groundnut is grown in the less assured rainfall zone and scarcity zone which was not incorporated in the proposed cropping pattern. To the extent hot-weather groundnut is incorporated in the crop-mix, availability of water for kharif (particularly for pre-monsoon watering) irrigation is bound to be adversely affected thereby bringing down the kharif utilisation percentage.

Supply and Demand Constraints and Underutilisation

While the extent of utilisation is estimated by comparing every year the water actually released for irrigation seasonwise with the water planned to be released as per project planning, it may so happen that in some years there may not be enough water in the reservoir to be released for irrigation. Under such circumstances underutilisation can be explained in terms of supply constraints. Similarly, in some other years it may so happen that because of more than normal rainfall, necessity of releasing water for irrigation, particularly in kharif season, may not arise. Again under such circumstances underutilisation can be explained in terms of demand constraints. In what follows we examine constraints, if any, arising out of supply and demand factors. For this purpose we present in Tables 4.1 to 4.5 some relevant data on gross storage attained, water released for irrigation in each season every year for a period of five years or so in respect of the schemes from different zones.

As mentioned earlier paddy is the only crop grown in the very high rainfall and high rainfall zones. For the scheme in very high rainfall zone although there is provision for kharif irrigation of 0.33 Mm^3 as per project water planning (Table 2.3) no water is released for kharif irrigation; the first water released every year is in the month of December for the second crop of paddy (*Konkan Hangam*) which is fully irrigated. On the other hand for the scheme in high rainfall zone the kharif paddy is grown under irrigated condition and the first water is released every year sometime in the month of August (Table 4.2). In the case of scheme in very high rainfall zone full storage capacity is attained every year by the end of July and the balance of water available at the end of *Konkan Hangam* irrigation, after accounting for the dead storage, could have been utilised for pre-monsoon kharif irrigation in 6 out of 9 years (Table 4.1). It appears it would be possible to provide around 2 waterings during the first fortnight of June to raise paddy seedlings early for kharif paddy. However, it must be mentioned that for irrigation water to be supplied during the first 2 weeks of June for raising seedlings irrigators should agree to raise the same in contiguous blocks within the mid-reach of the distribution system otherwise transmission and distribution losses would be very heavy and it would perhaps not be possible to meet the demand from the entire command area.

In the case of the scheme in high rainfall zone full storage capacity is attained in almost all the years before irrigation begins in mid-August. Balance of live storage available every year after kharif irrigation varies between 8 Mm^3 to 40 Mm^3, a part of which is used, in years with sufficient balance, for irrigating second crop of paddy in rabi/hot-weather seasons (Table 4.2), although there is

Table 4.1: Availability and Utilisation of Irrigation Water in Respect of Scheme in Very High Rainfall Zone

Year	Rainfall (mm)	Maximum gross storage attained (mm), date	Date of water released for irrigation	Gross storage available on date of releasing water (Mm^3)	Water used for irrigation (Mm^3)	Water balance (April end) (Mm^3)
1976-77	3022	NA	15.12.76	3.56	2.24	1.32
1977-78	3212	NA	20.12.77	3.64	2.56	1.08
1978-79	2550	NA	25.12.78	3.50	2.89	0.61
1979-80	3060	4.37(31/7)	24.12.79	3.69	3.53	0.16
1980-81	3102	4.37(15/7)	16.12.80	3.52	3.23	0.29
1981-82	2618	4.28(31/7)	26.12.81	3.69	3.14	0.55
1982-83	3578	4.37(31/7)	13.12.82	3.98	3.10	0.88
1983-84	3364	4.37(15/7)	10.12.83	3.86	3.39	0.47
1984-85	3364	4.37(31/7)	10.12.84	3.72	3.70	0.02
Average	3097			3.68	3.09	0.59

Gross capacity of the reservoir = 4.34 Mm^3

Dead storage = 0.15 Mm^3

Table 4.2: Availability and Utilisation of Irrigation Water in Respect of Scheme in High Rainfall Zone

Year	Rainfall (mm)	Date of water released for kharif irriga-tion	Gross storage availa-ble on the date of rele-asing water (Mm^3)	Water used for kharif irriga-tion (Mm^3)	Gross storage availa-ble at the end of kharif season (Mm^3)	Water used for rabi season (Mm^3)	Gross storage availa-ble at the end of rabi season (Mm^3)	Water used for hot-weather season	Balance storage (end of May) (Mm^3)	Maximum storage attained (Mm^3), date
1978-79	1478	2.8.78	53.54	49.95	30.24	2.04	26.36	5.12	17.49	N.A.
1979-80	941	15.8.79	68.49	56.50	20.22	Nil	17.88	-	11.94	68.49(15/8)
1980-81	1193	20.9.80	66.07	28.20	41.30	Nil	32.35	11.50	20.21	59.19(31/8)
1981-82	1169	20.8.81	69.47	48.10	39.86	4.39	32.05	8.75	23.26	70.47(15/8)
1982-83	952	3.9.82	25.47	33.58	24.34	Nil	22.06	-	16.30	25.30(31/7)
1983-84	1355	28.8.83	58.86	10.70	50.94	2.32	43.12	9.09	28.53	68.75(31/8)
1984-85	792	8.8.84	66.40	40.28	18.96	-	17.29	-	12.62	64.65(15/8)
Average	1126		58.33	38.19	32.27	2.92	27.30	8.62	18.62	

Gross capacity of the reservoir = 67 Mm^3

Dead storage = 11 Mm^3

Table 4.3: Availability and Utilisation of Irrigation Water in Respect of Scheme in Assured Rainfall Zone

Year	Rainfall (mm)	Date of water released for Kharif irrigation	Gross storage available on the date of releasing water (Mm^3)	Water used for kharif irrigation (Mm^3)	Date of release of water for rabi season	Gross storage available on the date of releasing water (Mm^3)	Water used for rabi season (Mm^3)	Date of release of water for hot-weather season	Gross storage available on the date of releasing water (Mm^3)	Water used for hot-weather season (Mm^3)	Balance storage (end of June) (Mm^3)	Maxi-mum storage attained (Mm^3), date
1978-79	761	13.9.78	32.32	3.61	29.10.78	29.75	N.A.	2.3.79	9.38	N.A.	3.56	N.A.
1979-80	756	26.8.79	29.20	0.22	16.10.79	32.78	N.A.	2.3.80	11.81	N.A.	5.27	32.40(31/8)
1980-81	891	20.7.80	5.35	2.82	19.10.80	29.85	18.65	8.3.81	9.00	2.59	3.45	21.78(31/10)
1981-82	982	26.7.81	4.30	0.88	29.10.81	21.54	9.71	2.4.82	9.15	6.09	4.18	23.48(31/10)
1982-83	706	5.9.82	21.90	2.58	1.11.82	23.48	13.51	1.4.83	7.78	3.75	5.13	32.63(15/8)
1983-84	1406	12.8.83	32.70	3.15	1.12.83	32.29	17.41	1.4.84	11.37	11.61	5.24	11.30(31/10)
1984-85	690	16.9.84	9.95	2.83	2.12.84	11.24	5.09	3.4.85	5.23	2.29	32.40	33.09(31/7)
Average	885		19.39	2.29		25.85	12.87		9.10	5.27	8.46 (4.47)*	

*Average excluding the year 1984-85

Gross capacity of the reservoir = 32.29 Mm^3

Dead storage = 3/45 Mm^3

Table 4.4: Availability and Utilisation of Irrigation Water in Respect of Scheme in Less Assured Rainfall Zone

Year	Rainfall	Maximum gross storage attained (Mm^3), date	Date of release of water for irrigation	Gross storage available on the date of releasing water (Mm^3)	Water used for kharif irrigation (Mm^3)	Date of release of water for rabi season	Gross storage available on the date of releasing water (Mm^3)	Water used for rabi season (Mm^3)	Date of release of water for hot-weather season	Gross storage available on the date of releasing water (Mm^3)	Water used for hot-weather season (Mm^3)	Balance storage (end of June) (Mm^3)
1975-76	-	N.A.	-	-	-	N.A.	N.A.	19.41	1.3.76	34.33	2.49	31.85
1976-77	448	N.A.	3.7.76	32.55	10.98	1.11.76	48.13	22.86	2.3.77	25.62	6.37	19.24
1977-78	265	22.65(28/2)	1.8.77	22.07	6.17	5.11.77	20.97	7.64	21.3.78	22.11	7.05	26.60
1978-79	338	22.03(15/7)	21.7.78	26.72	3.39	10.11.78	23.35	5.91	15.3.79	16.41	3.40	13.73
1979-80	680	54.59(15/9)	9.9.79	52.36	0.88	15.11.79	53.91	12.25	9.3.80	39.62	17.83	22.64
1980-81	431	54.33(31/8)	19.7.80	22.07	2.83	2.11.80	53.49	14.55	6.3.81	38.63	22.07	17.26
1981-82	300	39.51(31/10)	10.9.81	20.38	2.91	16.11.81	39.90	14.60	8.3.82	25.53	7.84	27.34
1982-83	250	32.83(31/10)	7.8.82	28.38	3.71	7.12.82	33.00	6.74	20.3.83	25.19	5.66	19.81
1983-84	807	53.91(15/8)	7.7.83	19.81	0.82	25.11.83	53.83	8.43	12.3.84	43.86	16.98	27.45
1984-85	440	53.91(15/9)	-	-	-	1.11.84	53.91	N.A.	5.3.85	34.67	N.A.	18.37
Average	440	-	-	28.04	3.96 (2.96) *	-	42.28	12.49	-	30.60	9.97	22.43

*Average (deleting 1976-77)

Gross capacity of the reservoir = 54 Mm^3

Dead storage = 13.68 Mm^3

no provision in this scheme for growing irrigated crops in rabi/hot-weather seasons. Remaining balance is reserved for irrigation in early kharif next year in case the monsoon is delayed and/or is uneven in the initial period as per the provision to carry over 15 to 20 per cent of live storage, i.e., around 10 Mm^3. Thus, we see that the supply position of irrigation water is very favourable in the case of schemes in the very high rainfall zone and high rainfall zone and would not come as constraint for kharif irrigation.

In so far as the schemes in assured rainfall zone, less assured rainfall zone and scarcity zone are concerned the supply position of irrigation water is likely to be different and may appear as constraint to extending kharif irrigation. We shall examine that presently. Cotton and hybrid jowar are the main crops grown in the kharif in assured rainfall zone and less assured rainfall zone respectively. Wheat and gram are the rabi crops in the zones and hot-weather groundnut has also become an important crop in these two zones. Under the schemes from both the zones the first water released for kharif irrigation varies considerably from year to year ranging from July to September. Even the gross storage available on the date of releasing water for kharif irrigation varies considerably and shows full storage only in 2 to 3 years out of 7 to 9 years. In fact full capacity storage before rabi irrigation is attained only in 50 per cent of the years (Tables 4.3 and 4.4). Considerably small quantity of water is released for kharif irrigation as compared to project water planning and there is considerable variation too in it from year to year.

Rabi season irrigation begins late, and varies between mid-November to early December whereas it should begin by mid-October as per schedule. This happens because of the late sowing of the kharif crop. However, rabi season supply of irrigation water is much better in most of the years. Since the rabi season gets extended, hot-weather season also begins late but, since there is considerable overlap between rabi season crops and hot-weather season crops (wheat, groundnut) that it is preferable to consider the water released for these two seasons together. In a number of years the reservoir gross storage available at the time of release of water for rabi irrigation varies between 60 to 80 per cent. On an average around 80 per cent of planned release of water is actually released considering rabi and hot-weather seasons together.

Whereas in the case of scheme in assured rainfall area the balance of storage available at the end of irrigation year is hardly sufficient to meet the dead storage, in the case of scheme in less assured rainfall zone the balance of water available every year leaves some utilisable surplus after meeting the dead storage even though the full storage is hardly attained in any year. Obviously availability (supply) of water is a clear constraint in the assured irrigation zone and it would be possible to divert water for kharif irrigation, particularly pre-monsoon, only if hot weather irrigation is curtailed considerably and even then the supply will be uncertain as seen earlier. However, in case of the scheme in less assured rainfall zone supply constraint is not that pronounced. In fact it is possible to accommodate kharif irrigation to some extent, particularly pre-monsoon, even without substantially cutting down hot-weather irrigation. But, it should nevertheless be noted that the supply even then would be uncertain because of

Table 4.5: Availability and Utilisation of Irrigation Water in Respect of Scheme in Scarcity Zone

Year	Rainfall (mm)	Maximum gross storage attained (Mm^3), date	Date of release of water for kharif irrigation	Gross storage available on the date of releasing water (Mm^3)	Water used for kharif irrigation (Mm^3)	Date of release of water for rabi season	Gross storage available on the date of releasing water (Mm^3)	Water used for rabi season (Mm^3)	Date of release of water for hot-weather season	Gross storage available on the date of releasing water (Mm^3)	Water used for hot-weather season (Mm^3)	Balance of storage (end of June) (Mm^3)
1976-77	595	N.A.	7.7.76	16.31	2.14	13.10.76	16.16	2.88	3.4.77	10.47	2.14	14.00
1977-78	455	16.30(15/8)	14.7.77	16.23	2.40	18.10.77	16.13	5.60	6.4.78	9.34	1.02	9.96
1978-79	325	14.91(31/10)	1.7.78	9.91	1.85	20.10.78	14.85	3.30	5.3.79	11.89	2.87	6.34
1979-80	754	16.22(31/8)	-	6.79 (7.8.79)	-	29.10.79	16.16	1.81	10.3.80	14.15	1.42	10.56
1980-81	578	16.16(15/7)	13.7.80	16.16	0.71	20.10.80	16.16	2.15	10.3.81	13.59	2.76	7.66
1981-82	637	17.7.81	?	16.16	0.99	11.11.81	16.16	2.07	19.3.82	11.75	2.41	7.62
1982-83	415	16.16(31/10)	1.7.82	7.57	0.28	1.11.82	16.16	3.66	16.4.83	8.94	1.17	6.12
1983-84	522	16.10(31/10)	-	5.67 (7.8.83)	-	25.10.83	16.16	5.18	24.4.84	7.64	0.33	5.76
1984-85	489	16.16(31/8)	10.7.84	7.36	1.19	13.11.84	16.16	5.24	16.4.85	9.06	-	5.97
Average	530			12.81	1.16		16.01	3.27		10.76	1.74	8.22

Gross capacity of the reservoir = 16.17 Mm^3

Dead storage = 5.66 Mm^3

uncertain monsoon which is reflected in reservoir not getting filled in full in most of the years.

In respect of the scheme in scarcity zone the main crops grown in kharif season are bajra, cotton and groundnut. Traditionally farmers are interested more in cultivation mainly of jowar; of late however hot-weather groundnut is becoming a very sought after irrigated crop in this zone. In the years in which any water is released for kharif irrigation it is released by first or second week of August but there is wide year to year variation in the amount of water released for kharif irrigation. Indeed last few years' observations (Table 4.5) show that hardly any water was released for kharif irrigation. Full storage capacity is not attained in most of the years before kharif irrigation begins, if any. However, full storage capacity of water is seen to be available every year before the rabi irrigation begins in late October. Even then there is considerable year to year variation in the water released for irrigation. Great deal of overlap is reported in this case also in the release of water for crops grown in the rabi season and hot-weather season. Main crop grown in hot-weather is groundnut which is sown sometime by the end of January or beginning of February when irrigation for rabi crops still remains in progress.

Gross storage available at the time of releasing water for hot-weather season in different years (Table 4.5) is very much in excess considering no hot-weather irrigation proposed in project water planning. This happens mainly because less than 50 per cent of the water planned for rabi season is actually released even though full storage is available every year before rabi irrigation begins. Gross storage available at the end of the irrigation year also varies considerably; in a number of years it is no more than the dead storage required to be maintained (Table 4.5).

One may deduce from the above observation that there is supply constrain not only for overall irrigation but particularly for kharif irrigation, specially if the full irrigation requirement of rabi season and unplanned hot-weather season water requirement are to be met. If kharif irrigation is to be encouraged in this zone it would be necessary to reduce the hot-weather irrigation so that two or three pre-monsoon irrigation can be provided to kharif crops. So in terms of supply of water there seems to be conflict of interest between protective irrigation and productive irrigation in the scarcity zone.

We have so far considered only the supply side (availability) of the issue of irrigation utilisation. It is quite possible that even if water is available for irrigation in kharif season in particular, there may not be any/enough demand for it. This would be the case if rainfall during the kharif season is adequate and is also well distributed, if there is alternative source of water to take care of kharif irrigation in times of break in monsoon and if the yield of the crop is not significantly different under irrigated and unirrigated conditions and/or any combination of the above factors.

We shall begin by examining the distribution of rainfall in respect of the catchment and command area of the schemes in different zones. Tables 4.6 through 4.14 present detailed information on weekly precipitation, number of rainy days in a week and the variations in these two variables over the years

affecting the intensity of rainfall. The statistics computed are:

$\bar{X}$ i) Average precipitation every week ending over the number of years for which data are available.

ii) Average number of rainy days every week ending over the corresponding number of years.

S.D. i) Standard deviation of the week ending precipitation.

ii) Standard deviation of the week ending rainy days.

C.V. i) Coefficient of variation in the week ending precipitation.

ii) Coefficient of variation in the week ending number of rainy days.

M.D. i) Mean deviation in week ending precipitation.

ii) Mean deviation in week ending number of rainy days.

Before making any observation based on the analysis of the rainfall data it should be made clear that we have very few years' data from each zone and that too from a very few rainguage stations; not necessarily representing fully the catchment or command areas of the respective schemes. Hence, no trend can be analysed from such scanty data and all we can do is to make some observations on the intensity of rainfall, its distribution and the variations in those.

In the very high rainfall zone and high rainfall zone the monsoon in general begins by the end of first week of June and second week of June respectively and tapers off by the end of September and end of third week of September respectively (Tables 4.6 through 4.8). Thus it is seen that the duration of monsoon is more by about a fortnight in the very high rainfall zone compared to high rainfall zone. The other difference is that whereas high and uninterrupted rainfall continues till the end of September in very high rainfall zone, the same is not so high, and continues uninterrupted till only the first week of August. In both the zones considerable variations in the week ending amount of precipitation and number of rainy days are noticed and the variation in the latter is seen to be more than the variation in the farmer. As mentioned earlier paddy is the only crop grown in these two zones; under rainfed condition in kharif in very high rainfall zone and under protective irrigated condition in kharif in high rainfall zone. This seems to be in keeping with the rainfall conditions and its distribution in these two zones. There is therefore no demand for water in kharif season in very high rainfall zone and there is demand for protective irrigation in kharif in high rainfall zone, which is fully met. Experiments conducted at Agricultural University Research Station at Dapoli (Konkan) on protective irrigation during monsoon, found the production of paddy and fodder to be 10 per cent and 6 per cent higher than those under unirrigated condition. This is however not borne out by the farmers field experience and it cannot therefore be concluded that a significant and perceptive yield difference would arise between paddy grown entirely rainfed and grown with required protective irrigation during dry spell in very high rainfall zone. Hence in this zone demand for irrigation water in kharif season is a constraint on utilisation even though supply is abundant for kharif irrigation.

Table 4.6: Weekly Total Rainfall, Number of Rainy Days and Variations for Centre 1 (Kalote Mokasi, Raigad)

1st Line Rainfall (in mm) 2nd Line Number of Rainy Days

Week ending	79-80	80-81	81-82	82-83	83-84	84-85
Rainfall	**2541.15**	**3067.75**	**3067.27**	**2205.93**	**3902.21**	**3412.40**
Days	**80**	**99**	**97**	**95**	**105**	**105**
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0
5 4 Jun	0.00	25.75	0.00	0.00	0.00	0.00
	0	3	0	0	0	0
6 11 Jun	0.00	313.25	0.00	32.62	0.00	25.40
	0	5	0	1	0	3
7 18 Jun	0.00	34.00	41.25	177.07	41.22	289.74
	0	6	1	6	4	7
8 25 Jun	145.00	314.75	181.57	237.49	335.28	33.78
	7	4	4	6	7	6
9 2 Jul	307.05	467.25	526.24	15.78	110.48	400.05
	7	7	7	2	6	7
10 9 Jul	142.03	228.25	315.13	105.41	59.69	368.26
	7	7	7	5	6	7
11 16 Jul	12.36	44.00	119.53	16.87	199.85	287.10
	7	7	7	6	7	5
12 23 Jul	47.09	82.50	371.63	69.85	476.03	523.51
	7	6	7	7	7	7
13 30 Jul	413.50	226.25	127.15	166.12	248.56	389.29
	5	7	7	7	7	7
14 6 Aug	450.00	647.50	408.78	37.03	332.75	120.85
	6	7	7	7	7	7
15 13 Aug	347.89	111.0 0	156.21	298.68	580.83	201.99
	7	7	6	7	7	7
16 20 Aug	43.32	59.50	95.17	334.53	577.47	97.87
	3	5	7	7	7	7
17 27 Aug	0.00	189.75	81.20	192.54	72.80	83.06
	0	7	6	7	6	7
18 3 Sep	48.00	99.25	42.07	34.03	179.69	79.99
	3	7	4	4	7	7
19 10 Sep	25.50	46.00	62.69	121.93	90.75	70.06
	2	5	3	6	6	7
20 17 Sep	170.75	30.75	151.13	3.04	78.74	285.75
	4	2	7	1	4	6

Continued...

Week ending	79-80	80-81	81-82	82-83	83-84	84-85
Rainfall	2541.15	3067.75	3067.27	2205.93	3902.21	3412.40
Days	80	99	97	95	105	105
21 24 Sep	179.00	84.25	191.98	135.82	139.06	5.08
	7	3	6	4	7	1
22 1 Oct	127.75	51.25	43.18	95.06	207.59	120.14
	5	3	6	3	3	5
23 8 Oct	3.00	12.50	58.42	0.00	95.22	25.40
	1	1	1	0	4	1
24 15 Oct	5.25	0.00	60.92	0.00	76.20	0.00
	1	0	2	0	3	0
25 22 Oct	73.66	0.00	0.00	53.32	0.00	0.00
	1	0	0	2	0	0
26 29 Oct	0.00	0.00	0.00	3.81	0.00	5.08
	0	0	0	1	0	1
27 5 Nov	0.00	0.00	33.02	22.86	0.00	0.00
	0	0	2	2	0	0
28 12 Nov	0.00	0.00	0.00	52.07	0.00	0.00
	0	0	0	4	0	0

Week Ending	XBar	S.D.	C.V.	M.D.
1 7 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
5 4 Jun	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
6 11 Jun	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
7 18 Jun	97.21	102.60	105.54	90.79
	4.00	2.65	66.14	2.33
8 25 Jun	207.98	102.86	49.46	87.86
	5.67	1.25	22.01	1.11
9 2 Jul	304.48	185.20	60.83	160.90
	6.00	1.83	30.43	1.33
10 9 Jul	203.13	111.28	54.78	100.75
	6.50	0.75	11.75	0.67
11 16 Jul	113.29	101.67	89.76	88.88
	6.50	0.76	11.75	0.67
12 23 Jul	261.77	200.64	76.65	195.29
	6.83	0.37	5.45	0.28

Continued...

Week Ending	XBar	S.D.	C.V.	M.D.
13 30 Jul	261.81	106.45	40.66	93.06
	6.67	0.75	11.18	0.56
14 6 Aug	332.82	204.51	61.45	169.28
	6.83	0.37	5.45	0.28
15 13 Aug	282.77	155.66	55.05	126.37
	6.83	0.37	5.45	0.28
16 20 Aug	201.31	194.20	96.47	169.79
	6.00	1.53	25.46	1.33
17 27 Aug	103.23	68.24	66.10	58.61
	5.50	2.50	45.45	1.83
18 3 Sep	80.51	49.80	61.87	39.31
	5.33	1.70	31.87	1.67
19 10 Sep	69.49	30.92	44.49	24.76
	4.83	1.77	36.66	1.56
20 17 Sep	120.03	95.19	79.31	82.52
	4.00	2.08	52.04	1.67
21 24 Sep	122.53	62.88	51.32	51.91
	4.67	2.21	47.38	2.00
22 1 Oct	107.50	54.84	51.02	44.33
	4.17	1.21	29.12	1.17
23 8 Oct	32.42	34.11	105.21	29.60
	1.33	1.25	93.54	0.89
24 15 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
25 22 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00

Only for the Weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.7: Weekly Total Rainfall, Number of Rainy Days and Variation for Centre 9. Asola Mendha Tank-Chandrapur

1st Line Rainfall (in mm) and 2nd Line Number of Rainy Days

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1105.00**	**1073.60**	**1478.40**	**941.40**	**1192.60**	**1168.90**	**951.80**
Days	**57**	**66**	**70**	**50**	**73**	**61**	**55**
1 7 May	0.00	0.00	0.00	0.00	0.00	10.40	0.00
	0	0	0	0	0	2	0
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1105.00**	**1073.60**	**1478.40**	**941.40**	**1192.60**	**1168.90**	**951.80**
Days	**57**	**66**	**70**	**50**	**73**	**61**	**55**
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
5 4 Jun	0.00	0.00	0.00	1.00	8.00	0.00	0.00
	0	0	0	1	1	0	0
6 11 Jun	11.00	0.00	0.00	0.00	21.80	0.00	0.00
	1	0	0	0	2	0	0
7 18 Jun	18.00	4.40	93.20	3.00	62.20	16.00	20.60
	1	2	4	1	4	1	2
8 25 Jun	38.60	45.40	116.40	185.60	78.20	120.40	16.60
	3	4	5	5	5	5	2
9 2 Jul	23.90	94.00	62.00	113.00	77.00	112.60	39.60
	3	7	3	4	6	6	2
10 9 Jul	99.50	120.20	147.80	49.60	93.00	137.20	16.20
	6	5	6	1	6	7	1
11 16 Jul	187.30	57.20	178.20	44.60	99.60	90.40	30.40
	6	5	5	5	5	6	4
12 23 Jul	205.40	29.80	114.20	29.40	6.20	33.00	71.80
	7	2	5	2	1	2	6
13 30 Jul	44.00	47.60	116.60	76.00	106.80	190.20	90.00
	5	5	3	2	6	5	5
14 6 Aug	164.50	126.00	34.80	115.20	180.80	107.40	58.60
	4	7	5	4	7	5	4
15 13 Aug	7.20	71.40	19.00	119.00	61.40	131.60	74.00
	3	3	3	6	4	3	5
16 20 Aug	41.00	1.60	152.00	8.00	68.60	69.00	112.00
	3	1	6	3	4	5	5
17 27 Aug	38.40	191.80	156.00	0.00	126.00	43.20	9.80
	3	6	7	0	5	1	2
18 3 Sep	147.60	115.60	110.20	16.00	47.20	6.20	28.80
	5	5	2	1	2	1	3
19 10 Sep	40.20	22.00	2.00	2.00	62.20	0.00	148.00
	2	1	1	1	5	0	6
20 17 Sep	33.80	36.60	3.40	4.00	62.60	12.80	64.00
	4	2	2	1	4	2	2
21 24 Sep	4.60	0.00	30.80	2.00	6.80	34.00	6.80
	1	0	4	1	1	4	1
22 1 Oct	0.00	0.00	16.00	128.60	0.00	50.30	0.00
	0	0	1	4	0	5	0
23 8 Oct	0.00	17.60	0.00	0.00	0.00	0.00	0.00
	0	2	0	0	0	0	0
24 15 Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
25 22 Oct	0.00	0.00	0.00	0.00	0.00	0.00	123.20
	0	0	0	0	0	0	3

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1105.00**	**1073.60**	**1478.40**	**941.40**	**1192.60**	**1168.90**	**951.80**
Days	**57**	**66**	**70**	**50**	**73**	**61**	**55**
30 26 Nov	0.00	41.20	0.00	0.00	0.00	0.00	0.00
	0	3	0	0	0	0	0
31 3 Dec	0.00	17.00	0.00	16.40	0.00	0.00	0.00
	0	1	0	2	0	0	0
34 24 Dec	0.00	0.00	0.00	12.40	0.00	0.00	0.00
	0	0	0	1	0	0	0
36 7 Jan	0.00	0.00	0.00	8.00	0.00	0.00	0.00
	0	0	0	3	0	0	0
37 14 Jan	0.00	17.00	0.00	0.00	10.60	0.00	0.00
	0	2	0	0	2	0	0
38 21 Jan	0.00	0.00	1.40	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
39 28 Jan	0.00	0.00	29.80	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
40 4 Feb	0.00	0.00	0.60	0.00	0.00	4.20	0.00
	0	0	1	0	0	1	0
41 11 Feb	0.00	0.00	54.00	0.00	0.00	0.00	25.40
	0	0	1	0	0	0	1
42 18 Feb	0.00	0.00	21.60	4.60	0.00	0.00	0.00
	0	0	2	1	0	0	0
43 25 Feb	0.00	0.00	8.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
47 25 Mar	0.00	0.00	0.00	0.00	7.60	0.00	0.00
	0	0	0	0	2	0	0
49 8 Apr	0.00	1.20	0.00	0.00	0.00	0.00	0.00
	0	1	0	0	0	0	0
51 22 Apr	0.00	0.00	10.40	3.00	0.00	0.00	0.00
	0	0	1	1	0	0	0
52 29 Apr	0.00	16.00	0.00	0.00	6.00	0.00	0.00
	0	2	0	0	1	0	0
53 30 Apr	0.00	0.00	0.00	0.00	0.00	0.00	16.00
	0	0	0	0	0	0	1

Week ending	XBar	S.D.	C.V.	M.D.
1 7 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00

Continued...

Week ending	XBar	S.D.	C.V.	M.D.
4 28 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
5 4 Jun	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
6 11 Jun	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
7 18 Jun	31.06	31.25	100.62	26.65
	2.14	1.25	58.12	1.06
8 25 Jun	85.89	54.51	63.47	47.07
	4.14	1.12	27.15	0.98
9 2 Jul	74.79	32.19	43.16	28.07
	4.43	1.76	39.77	1.63
10 9 Jul	94.79	43.91	46.33	35.87
	4.57	2.32	50.78	2.04
11 16 Jul	98.24	58.01	59.04	48.68
	5.14	0.64	12.42	0.49
12 23 Jul	69.97	64.36	91.98	51.85
	3.57	2.19	61.45	2.08
13 30 Jul	95.89	46.13	48.11	35.98
	4.43	1.29	29.21	1.10
14 6 Aug	112.47	48.59	43.20	39.03
	5.14	1.25	24.22	1.06
15 13 Aug	69.09	42.81	61.96	34.19
	3.86	1.12	29.16	0.98
16 20 Aug	64.60	50.21	77.73	40.91
	3.86	1.55	40.23	1.31
17 27 Aug	80.74	70.51	87.32	66.16
	3.43	2.44	71.20	2.20
18 3 Sep	67.37	51.92	77.07	48.94
	2.71	1.58	58.13	1.39
19 10 Sep	39.49	49.23	124.68	37.70
	2.29	2.12	92.70	1.84
20 17 Sep	31.03	23.75	76.55	20.82
	2.43	1.05	43.23	0.90
21 24 Sep	12.14	13.04	107.38	11.58
	1.71	1.48	86.60	1.31
22 1 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
23 8 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
24 15 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
25 22 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00

Only for the weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.8: Weekly total Rainfall, Number of Rainy Days and Variation for Centre 11. Saoli-Chandrapur

1st Line Rainfall (in mm) and 2nd Line Number of Rainy Days

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1259.20**	**1352.86**	**1531.00**	**447.50**	**1724.50**	**722.29**	**695.75**
Days	**60**	**59**	**66**	**8**	**86**	**34**	**40**
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
5 4 Jun	0.00	0.00	14.20	0.00	7.40	0.00	0.00
	0	0	1	0	1	0	0
6 11 Jun	34.40	0.00	9.00	0.00	22.00	0.00	7.80
	3	0	1	0	2	0	2
7 18 Jun	10.40	42.20	82.30	0.00	68.80	0.00	2.30
	2	1	5	0	5	0	1
8 25 Jun	48.30	18.60	122.50	247.00	59.60	0.00	110.90
	2	3	6	5	4	0	3
9 2 Jul	74.40	80.20	75.00	192.50	95.00	0.00	13.70
	4	6	3	2	6	0	2
10 9 Jul	239.90	195.60	182.80	8.00	48.50	83.30	48.40
	7	6	7	1	2	4	4
11 16 Jul	304.90	47.60	241.20	0.00	103.00	76.40	115.70
	6	5	4	0	5	4	4
12 23 Jul	200.60	25.20	98.20	0.00	36.60	197.66	159.70
	7	2	5	0	2	5	5
13 30 Jul	9.60	152.40	138.80	0.00	123.80	204.74	87.16
	2	6	4	0	3	7	4
14 6 Aug	92.60	88.90	13.40	0.00	182.60	14.80	58.74
	5	6	2	0	6	1	6
15 13 Aug	14.60	48.40	30.20	0.00	141.00	3.50	8.80
	3	5	3	0	7	1	2
16 20 Aug	38.40	0.00	172.60	0.00	130.70	33.00	63.50
	3	0	6	0	7	3	5
17 27 Aug	20.00	488.30	236.00	0.00	49.60	0.00	15.00
	3	7	7	0	7	0	1
18 3 Sep	126.00	105.60	81.00	0.00	88.70	0.00	4.05
	7	5	4	0	7	0	1
19 10 Sep	18.30	10.40	2.40	0.00	139.20	0.00	0.00
	3	1	1	0	7	0	0

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1259.20**	**1352.86**	**1531.00**	**447.50**	**1724.50**	**722.29**	**695.75**
Days	**60**	**59**	**66**	**8**	**86**	**34**	**40**
20 17 Sep	26.80	34.40	0.00	0.00	205.80	19.59	0.00
	3	2	0	0	6	2	0
21 24 Sep	0.00	0.00	10.80	0.00	128.60	6.40	0.00
	0	0	3	0	4	1	0
22 1 Oct	0.00	5.00	7.40	0.00	73.00	12.90	0.00
	0	1	2	0	3	3	0
23 8 Oct	0.00	10.06	0.00	0.00	0.00	70.00	0.00
	0	3	0	0	0	3	0
24 15 Oct	0.00	0.00	4.20	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
25 22 Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
	*	**	***			
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
5 4 Jun	5.08	0.00	0.00	0.00	0.00	0.00
	2	0	0.00	0.00	0.00	0.00
6 11 Jun	9.08	11.40	10.41	10.78	103.60	8.13
	3	1	1.33	1.15	86.60	1.04
7 18 Jun	76.20	18.40	33.40	32.50	97.30	30.20
	2	1	1.89	1.79	94.85	1.43
8 25 Jun	21.60	0.00	69.83	75.37	107.92	60.20
	3	0	2.89	1.91	66.17	1.48
9 2 Jul	234.36	55.00	91.13	72.32	79.36	55.22
	8	3	3.78	2.35	62.11	1.98
10 9 Jul	39.80	55.40	100.19	78.34	78.19	70.61
	3	4	4.22	1.99	47.08	1.63
11 16 Jul	46.60	18.30	105.97	97.00	91.54	76.42
	4	2	3.78	1.69	44.61	1.23
12 23 Jul	97.48	93.20	100.96	69.03	68.37	56.68
	4	5	3.89	2.02	52.06	1.70

* Rainfall Days ** 1378.16 77 *** 776.36 46

Continued...

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
*	**	***				
13 30 Jul	93.80	42.46	94.75	64.31	67.88	53.50
	6	2	3.78	2.15	56.88	1.80
14 6 Aug	65.60	204.00	80.07	68.22	85.20	55.07
	4	4	3.78	2.15	56.88	1.85
15 13 Aug	123.20	25.60	43.92	49.34	112.33	40.19
	5	5	3.44	2.11	61.38	1.83
16 20 Aug	180.16	124.40	82.53	66.75	80.88	61.72
	7	4	3.89	2.51	64.65	2.12
17 27 Aug	54.80	5.40	96.57	155.04	160.55	118.04
	2	1	3.11	2.88	92.72	2.59
18 3 Sep	74.60	0.00	53.33	48.81	91.53	46.50
	4	0	3.11	2.77	88.93	2.54
19 10 Sep	51.60	6.60	25.39	43.12	169.82	31.12
	6	2	2.22	2.48	111.80	2.07
20 17 Sep	82.40	22.20	43.47	62.29	143.30	44.73
	4	3	2.22	1.93	86.89	1.58
21 24 Sep	67.80	3.60	24.13	42.25	175.06	32.92
	3	1	1.33	1.49	111.80	1.33
22 1 Oct	41.60	20.40	17.81	23.25	130.56	18.13
	6	1	1.78	1.87	105.33	1.53
23 8 Oct	0.00	3.20	0.00	0.00	0.00	0.00
	0	1	0.00	0.00	0.00	0.00
24 15 Oct	0.00	47.80	0.00	0.00	0.00	0.00
	0	4	0.00	0.00	0.00	0.00
25 22 Oct	0.00	2.00	0.00	0.00	0.00	0.00
	0	1	0.00	0.00	0.00	0.00

Only for the weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.9: Weekly Total Rainfall, Number of Rainy Days and Variation for Centre 6. Chondhi-Akola

1st Line Rainfall (in mm) 2nd Line Number of Rainy Days

Week ending	77-78	78-79	79-80	80-81	81-82	82-83	83-84
Rainfall	442.50	761.00	756.00	891.00	982.00	706.40	1406.00
Days	19	54	47	57	69	38	62
1 7 May	0.00	0.00	4.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
2 14 May	0.00	0.00	0.00	0.00	22.00	0.00	0.00
	0	0	0	0	2	0	0

* Rainfall Days ** 1378.16 77 *** 776.36 46

Continued...

Week ending	77-78	78-79	79-80	80-81	81-82	82-83	83-84
Rainfall	**442.50**	**761.00**	**756.00**	**891.00**	**982.00**	**706.40**	**1406.00**
Days	**19**	**54**	**47**	**57**	**69**	**38**	**62**
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
4 28 May	0.00	0.00	0.00	0.00	0.00	4.00	0.00
	0	0	0	0	0	1	0
5 4 Jun	0.00	10.00	0.00	21.00	14.00	0.00	53.00
	0	1	0	2	1	0	1
6 11 Jun	0.00	0.00	0.00	57.00	0.00	0.00	0.00
	0	0	0	4	0	0	0
7 18 Jun	0.00	77.00	6.00	80.00	27.00	5.00	0.00
	0	4	1	2	2	1	0
8 25 Jun	0.00	85.00	77.00	14.00	46.00	72.00	19.00
	0	4	5	2	3	2	1
9 2 Jul	0.00	7.00	72.00	40.00	31.00	24.00	91.00
	0	3	3	2	3	1	5
10 9 Jul	0.00	96.00	25.00	120.00	89.00	5.40	12.00
	0	5	2	3	7	2	1
11 16 Jul	0.00	53.00	69.00	11.00	31.00	59.00	128.00
	0	6	4	2	4	5	5
12 23 Jul	0.00	40.00	0.00	0.00	9.00	205.00	24.00
	0	3	0	0	3	4	2
13 30 Jul	0.00	83.00	54.00	41.00	28.00	50.00	45.00
	0	7	4	6	3	4	4
14 6 Aug	0.00	17.00	133.00	114.00	94.00	10.00	121.00
	0	2	7	7	2	1	5
15 13 Aug	0.00	7.00	72.00	35.00	54.00	5.00	316.00
	0	2	3	4	3	1	6
16 20 Aug	0.00	58.00	23.00	163.00	41.00	104.00	44.00
	0	3	2	5	6	5	4
17 27 Aug	0.00	60.00	0.00	59.00	8.00	44.00	30.00
	0	4	0	5	1	2	1
18 3 Sep	89.00	12.00	0.00	24.00	7.00	0.00	177.00
	6	2	0	3	1	0	3
19 10 Sep	0.00	0.00	0.00	7.00	9.00	13.00	20.00
	0	0	0	1	2	1	3
20 17 Sep	20.00	0.00	115.00	12.00	87.00	78.00	39.00
	1	0	4	2	3	3	5
21 24 Sep	0.00	0.00	19.00	4.00	61.00	10.00	63.00
	0	0	2	1	6	2	4
22 1 Oct	0.00	0.00	60.00	0.00	45.00	7.00	106.00
	0	0	1	0	4	1	4
23 8 Oct	89.00	50.00	0.00	0.00	21.00	0.00	65.00
	2	1	0	0	2	0	4
24 15 Oct	0.00	0.00	0.00	0.00	0.00	0.00	3.00
	0	0	0	0	0	0	1

Continued...

Week ending	77-78	78-79	79-80	80-81	81-82	82-83	83-84
Rainfall	**442.50**	**761.00**	**756.00**	**891.00**	**982.00**	**706.40**	**1406.00**
Days	**19**	**54**	**47**	**57**	**69**	**38**	**62**
25 22 Oct	0.00	13.00	3.00	0.00	0.00	0.00	0.00
	0	1	1	0	0	0	0
26 29 Oct	0.00	0.00	0.00	0.00	3.00	6.00	0.00
	0	0	0	0	1	1	0
28 12 Nov	0.00	16.00	0.00	0.00	0.00	5.00	0.00
	0	1	0	0	0	1	0
29 19 Nov	0.00	0.00	1.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
30 26 Nov	76.50	0.00	5.00	0.00	0.00	0.00	0.00
	2	0	1	0	0	0	0
31 3 Dec	27.00	29.00	5.00	0.00	0.00	0.00	0.00
	1	2	1	0	0	0	0
32 10 Dec	0.00	29.00	0.00	0.00	0.00	0.00	0.00
	0	1	0	0	0	0	0
33 17 Dec	0.00	0.00	5.00	0.00	24.00	0.00	0.00
	0	0	1	0	2	0	0
34 24 Dec	0.00	0.00	4.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
35 31 Dec	0.00	0.00	0.00	32.00	0.00	0.00	0.00
	0	0	0	2	0	0	0
36 7 Jan	5.00	0.00	2.00	0.00	0.00	0.00	25.00
	1	0	1	0	0	0	1
37 14 Jan	0.00	0.00	0.00	11.00	65.00	0.00	10.00
	0	0	0	1	2	0	1
38 21 Jan	0.00	10.00	0.00	26.00	0.00	0.00	0.00
	0	1	0	1	0	0	0
39 28 Jan	49.00	9.00	0.00	0.00	0.00	0.00	0.00
	2	1	0	0	0	0	0
40 4 Feb	0.00	0.00	0.00	0.00	55.00	0.00	0.00
	0	0	0	0	2	0	0
41 11 Feb	49.00	0.00	0.00	0.00	0.00	0.00	15.00
	1	0	0	0	0	0	1
43 25 Feb	0.00	0.00	0.00	16.00	0.00	0.00	0.00
	0	0	0	1	0	0	0
45 11 Mar	10.00	0.00	2.00	0.00	0.00	0.00	0.00
	1	0	1	0	0	0	0
47 25 Mar	0.00	0.00	0.00	4.00	91.00	0.00	0.00
	0	0	0	1	3	0	0
50 15 Apr	0.00	0.00	0.00	0.00	20.00	0.00	0.00
	0	0	0	0	1	0	0
52 29 Apr	28.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0	0	0	0	0	0

Week ending	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**690.00**				
Days	**35**				
1 7 May	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
5 4 Jun	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00
6 11 Jun	16.00	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00
7 18 Jun	62.00	32.13	32.99	102.69	30.66
	2	1.50	1.22	81.65	1.00
8 25 Jun	0.00	39.13	33.10	84.60	30.88
	0	2.13	1.69	79.58	1.41
9 2 Jul	52.00	39.63	29.14	73.54	24.13
	2	2.38	1.41	59.31	1.13
10 9 Jul	20.00	45.93	44.53	96.96	41.81
	4	3.00	2.12	70.71	1.75
11 16 Jul	58.00	51.13	37.03	72.43	27.84
	1	3.38	2.00	59.14	1.78
12 23 Jul	120.00	49.75	69.72	140.13	56.38
	3	1.88	1.54	81.92	1.41
13 30 Jul	0.00	37.63	26.15	69.50	21.22
	0	3.50	2.35	67.01	1.88
14 6 Aug	65.00	69.25	50.51	72.94	46.25
	3	3.38	2.50	73.98	2.22
15 13 Aug	7.00	62.00	99.09	159.82	66.00
	2	2.63	1.73	65.81	1.38
16 20 Aug	25.00	57.25	49.12	85.79	38.31
	4	3.63	1.80	49.61	1.47
17 27 Aug	5.00	25.75	24.24	94.14	22.50
	1	1.75	1.71	97.94	1.44
18 3 Sep	0.00	38.63	59.25	153.40	47.19
	0	1.88	1.96	104.77	1.63
19 10 Sep	5.00	6.75	6.70	99.31	5.50
	1	1.00	1.00	100.00	0.75
20 17 Sep	29.00	47.50	38.30	80.63	34.38
	3	2.63	1.49	56.94	1.22
21 24 Sep	36.00	24.13	24.51	101.61	21.91
	1	2.00	1.94	96.82	1.50
22 1 Oct	22.00	30.00	35.70	118.99	30.25
	2	1.50	1.58	105.41	1.38

Continued...

Week ending	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**690.00**				
Days	**35**				
23 8 Oct	38.00	32.88	31.39	95.50	27.63
	1	1.25	1.30	103.92	1.06
24 15 Oct	130.00	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00
25 22 Oct	0.00	0.00	0.00	0.00	0.00
	0	0.00	0.00	0.00	0.00

Only for the weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.10: Weekly Total Rainfall, Number of Rainy Days and Variation for Centre 8. Malegaon-Akola

1st Line Rainfall (in mm) and 2nd Line Number of Rainy Days

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1147.80**	**1232.80**	**937.20**	**803.00**	**788.98**	**840.82**	**718.40**
Days	**58**	**81**	**66**	**48**	**57**	**73**	**56**
1 7 May	0.00	0.00	0.00	0.00	0.00	6.00	0.00
	0	0	0	0	0	1	0
2 14 May	0.00	6.40	0.00	13.80	0.00	5.40	0.00
	0	1	0	1	0	1	0
3 21 May	0.00	0.00	0.00	2.00	0.00	0.00	0.60
	0	0	0	1	0	0	1
4 28 May	0.00	11.60	0.00	0.00	0.00	0.00	0.00
	0	3	0	0	0	0	0
5 4 Jun	0.00	0.00	0.00	0.00	21.00	2.00	0.00
	0	0	0	0	2	1	0
6 11 Jun	14.40	0.00	13.80	0.00	35.00	4.20	0.20
	4	0	2	0	3	1	1
7 18 Jun	0.40	62.40	98.00	12.80	38.20	10.40	13.40
	1	1	4	1	2	1	2
8 25 Jun	146.00	90.40	58.60	107.20	18.40	32.00	82.00
	4	7	4	6	2	2	6
9 2 Jul	16.60	107.60	10.00	52.00	48.20	79.42	0.00
	3	6	3	1	5	7	0
10 9 Jul	116.80	51.60	180.80	46.80	41.40	71.80	36.00
	5	6	5	1	4	6	3
11 16 Jul	90.40	19.20	89.40	57.80	12.00	27.20	105.40
	6	2	7	4	3	4	4

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1147.80**	**1232.80**	**937.20**	**803.00**	**788.98**	**840.82**	**718.40**
Days	**58**	**81**	**66**	**48**	**57**	**73**	**56**
12 23 Jul	133.60	38.20	58.40	0.00	0.00	3.20	170.20
	4	4	3	0	0	2	5
13 30 Jul	7.40	84.80	65.20	117.60	71.60	31.80	27.40
	2	5	4	5	7	3	7
14 6 Aug	37.80	14.00	55.40	127.00	133.00	87.20	16.60
	4	4	4	6	5	2	2
15 13 Aug	7.20	153.60	27.80	52.20	19.20	56.60	17.40
	1	5	5	4	3	3	4
16 20 Aug	88.60	0.00	52.80	46.60	122.58	30.20	80.40
	4	0	2	3	4	4	6
17 27 Aug	71.80	117.80	46.80	0.00	109.20	6.80	45.00
	2	5	4	0	5	2	4
18 3 Sep	251.00	93.20	14.40	0.60	20.00	0.00	0.00
	7	7	3	1	3	0	0
19 10 Sep	47.20	2.60	0.00	0.00	4.20	62.60	3.60
	5	1	0	0	1	4	1
20 17 Sep	0.40	47.00	0.00	49.60	12.80	37.40	63.00
	1	2	0	3	2	4	3
21 24 Sep	4.20	0.00	0.00	46.80	47.40	112.80	20.00
	1	0	0	4	2	6	3
22 1 Oct	0.00	12.40	0.00	48.60	1.60	47.60	10.40
	0	2	0	2	1	3	2
23 8 Oct	0.00	114.20	41.80	0.00	0.00	8.00	0.00
	0	2	3	0	0	2	0
24 15 Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
25 22 Oct	0.00	0.00	21.40	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
26 29 Oct	0.00	0.00	0.00	0.00	0.00	6.60	0.00
	0	0	0	0	0	2	0
27 5 Nov	0.00	0.00	0.00	0.00	0.00	11.80	0.00
	0	0	0	0	0	1	0
28 12 Nov	16.40	0.00	3.00	0.00	0.00	0.40	14.80
	1	0	1	0	0	1	1
29 19 Nov	0.00	0.00	1.60	0.40	0.00	0.00	0.00
	0	0	1	1	0	0	0
30 26 Nov	93.40	77.80	0.00	0.00	0.00	0.00	0.00
	1	2	0	0	0	0	0
31 3 Dec	0.00	12.80	58.20	17.00	0.00	0.00	0.00
	0	2	2	2	0	0	0
32 10 Dec	0.00	0.00	4.80	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
34 24 Dec	0.00	0.00	0.00	0.00	0.00	21.80	0.00
	0	0	0	0	0	3	0

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**1147.80**	**1232.80**	**937.20**	**803.00**	**788.98**	**840.82**	**718.40**
Days	**58**	**81**	**66**	**48**	**57**	**73**	**56**
35 31 Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
36 7 Jan	0.00	0.00	0.00	0.80	0.00	0.00	0.00
	0	0	0	1	0	0	0
37 14 Jan	0.00	10.60	0.00	0.00	1.00	21.40	0.00
	0	1	0	0	1	3	0
38 21 Jan	0.00	0.00	8.00	0.00	22.00	0.00	0.00
	0	0	2	0	1	0	0
39 28 Jan	0.00	6.00	5.40	0.00	0.00	0.00	12.00
	0	1	2	0	0	0	1
40 4 Feb	0.00	10.00	0.00	0.00	0.00	56.00	0.00
	0	1	0	0	0	3	0
41 11 Feb	0.00	5.20	4.60	0.00	0.00	0.00	0.00
	0	2	1	0	0	0	0
42 18 Feb	0.00	0.00	11.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
43 25 Feb	0.00	6.80	0.00	0.00	0.00	0.00	0.00
	0	2	0	0	0	0	0
44 4 Mar	4.20	0.00	6.00	0.00	0.00	0.00	0.00
	2	0	1	0	0	0	0
45 11 Mar	0.00	10.20	0.00	0.00	0.00	0.00	0.00
	0	2	0	0	0	0	0
46 18 Mar	0.00	12.80	90.00	0.00	10.20	0.00	0.00
	0	1	0	0	1	0	0
47 25 Mar	0.00	0.00	0.00	0.00	0.00	0.20	0.00
	0	0	0	0	0	1	0
49 8 Apr	0.00	3.20	0.00	0.00	0.00	0.00	0.00
	0	1	0	0	0	0	0
50 15 Apr	0.00	2.20	0.00	3.40	0.00	0.00	0.00
	0	1	0	1	0	0	0
52 29 Apr	0.00	48.20	0.00	0.00	0.00	0.00	0.00
	0	2	0	0	0	0	0

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**1506.20**	**519.40**				
Days	**78**	**56**				
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00

Continued...

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**1506.20**	**519.40**				
Days	**78**	**56**				
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
5 4 Jun	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
6 11 Jun	0.00	11.20	8.76	10.93	124.88	8.75
	0	3	1.56	1.42	91.47	1.28
7 18 Jun	2.00	102.80	37.82	38.16	100.89	33.36
	1	6	2.11	1.66	78.77	1.28
8 25 Jun	32.20	0.40	63.02	44.46	70.55	38.56
	1	1	3.67	2.16	58.92	1.93
9 2 Jul	66.00	12.80	43.62	34.45	78.97	30.02
	6	2	3.67	2.31	62.98	2.07
10 9 Jul	15.20	22.40	64.76	49.82	76.94	38.92
	1	2	3.67	1.89	51.43	1.70
11 16 Jul	120.60	30.00	61.33	38.67	63.04	35.66
	5	2	4.11	1.59	38.79	1.26
12 23 Jul	30.00	10.80	49.38	58.47	118.42	47.57
	4	2	2.67	1.70	63.74	1.48
13 30 Jul	95.20	5.20	56.24	37.76	67.14	34.04
	6	1	4.44	2.01	45.14	1.73
14 6 Aug	98.00	84.20	72.58	41.74	57.51	37.00
	6	3	4.00	1.41	35.36	1.11
15 13 Aug	393.80	0.60	80.93	118.86	146.86	85.67
	7	2	3.78	1.69	44.61	1.36
16 20 Aug	83.00	16.60	57.86	36.88	63.74	31.80
	5	3	3.44	1.64	47.63	1.28
17 27 Aug	7.80	6.40	45.73	42.81	93.61	36.15
	2	2	2.89	1.59	55.20	1.43
18 3 Sep	87.40	3.20	52.20	78.47	150.33	61.11
	5	4	3.33	2.54	76.16	2.15
19 10 Sep	18.80	2.60	15.73	21.90	139.19	18.09
	4	1	1.89	1.79	94.85	1.63
20 17 Sep	95.20	10.80	35.13	30.32	86.29	25.90
	5	2	2.44	1.42	58.21	1.16
21 24 Sep	97.40	17.40	38.44	39.53	102.83	33.47
	5	1	2.44	2.06	84.31	1.83
22 1 Oct	115.00	27.80	29.27	35.25	120.43	27.42
	5	3	2.00	1.49	74.54	1.11
23 8 Oct	58.40	7.40	25.53	37.19	145.67	30.62
	5	2	1.56	1.64	105.46	1.38

Continued...

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**1506.20**	**519.40**				
Days	**78**	**56**				
24 15 Oct	0.00	99.00	0.00	0.00	0.00	0.00
	0	3	0.00	0.00	0.00	0.00
25 22 Oct	0.00	0.80	0.00	0.00	0.00	0.00
	0	1	0.00	0.00	0.00	0.00

Only for weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.11: Weekly Total Rainfall, Number of Rainy Days and Variation for Centre 4. Talode-Jalgaon

1st Line Rainfall (in mm) 2nd Line Number of Rainy Days

Week ending	78-79	79-80	80-81	81-82	82-83	83-84	84-85
Rainfall	**465.60**	**663.90**	**667.00**	**364.00**	**385.20**	**375.00**	**675.00**
Days	**43**	**44**	**43**	**40**	**35**	**23**	**34**
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
2 14 May	0.00	0.00	0.00	10.00	0.00	0.00	0.00
	0	0	0	2	0	0	0
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
5 4 Jun	7.00	0.00	16.00	0.00	0.00	0.00	0.00
	1	0	1	0	0	0	0
6 11 Jun	2.40	8.50	62.40	0.00	0.00	0.00	0.00
	1	1	5	0	0	0	0
7 18 Jun	51.80	3.00	19.40	0.00	28.00	14.00	7.00
	4	1	3	0	1	2	1
8 25 Jun	19.20	48.00	6.20	0.00	143.00	4.60	0.00
	2	3	1	0	5	2	0
9 2 Jul	4.00	34.00	2.00	23.00	0.00	6.40	23.60
	1	1	1	3	0	1	2
10 9 Jul	54.20	34.00	5.00	36.00	6.00	0.00	91.00
	5	4	1	4	1	0	5
11 16 Jul	29.00	42.00	0.00	7.60	32.20	220.00	57.00
	3	1	0	3	5	7	4
12 23 Jul	23.00	1.40	0.00	15.80	1.00	51.00	16.00
	1	1	0	3	1	3	1

Continued...

Week ending	78-79	79-80	80-81	81-82	82-83	83-84	84-85
Rainfall	**465.60**	**663.90**	**667.00**	**364.00**	**385.20**	**375.00**	**675.00**
Days	**43**	**44**	**43**	**40**	**35**	**23**	**34**
13 30 Jul	0.00	104.00	2.00	11.60	6.80	16.00	0.00
	0	5	1	2	2	2	0
14 6 Aug	2.40	58.00	38.00	39.00	0.00	12.20	51.00
	1	6	5	2	0	3	1
15 13 Aug	0.00	69.00	10.00	40.00	1.20	50.80	36.00
	0	2	4	3	2	3	4
16 20 Aug	13.00	0.00	278.00	39.00	9.60	0.00	26.40
	2	0	6	3	3	0	3
17 27 Aug	50.00	2.00	16.60	0.00	4.40	0.00	9.00
	2	1	3	0	2	0	1
18 3 Sep	66.00	45.00	44.00	4.00	54.00	0.00	0.00
	4	3	2	1	3	0	0
19 10 Sep	46.00	0.00	61.00	17.00	31.00	0.00	10.00
	3	0	2	2	2	0	1
20 17 Sep	0.00	67.00	20.60	58.00	12.00	0.00	127.00
	0	4	1	5	2	0	2
21 24 Sep	0.00	74.60	18.80	39.00	22.00	0.00	20.00
	0	6	2	3	2	0	1
22 1 Oct	4.80	21.40	0.00	15.00	5.00	0.00	23.00
	1	3	0	2	1	0	4
23 8 Oct	17.20	0.00	0.00	5.00	0.00	0.00	111.00
	1	0	0	1	0	0	2
24 15 Oct	0.00	10.00	0.00	0.00	0.00	0.00	67.00
	0	1	0	0	0	0	2
25 22 Oct	0.00	42.00	0.00	0.00	0.00	0.00	0.00
	0	1	0	0	0	0	0
27 5 Nov	0.00	0.00	0.00	4.00	3.00	0.00	0.00
	0	0	0	1	1	0	0
28 12 Nov	15.00	0.00	0.00	0.00	26.00	0.00	0.00
	2	0	0	0	2	0	0
30 26 Nov	1.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	0	0	0	0	0	0
31 3 Dec	19.00	0.00	0.00	0.00	0.00	0.00	0.00
	2	0	0	0	0	0	0
34 24 Dec	0.00	0.00	12.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
35 31 Dec	0.00	0.00	24.00	0.00	0.00	0.00	0.00
	0	0	2	0	0	0	0
36 7 Jan	2.60	0.00	0.00	0.00	0.00	0.00	0.00
	1	0	0	0	0	0	0
38 21 Jan	5.40	0.00	15.00	0.00	0.00	0.00	0.00
	1	0	1	0	0	0	0
39 28 Jan	24.20	0.00	0.00	0.00	0.00	0.00	0.00
	3	0	0	0	0	0	0

Continued...

Week ending	78-79	79-80	80-81	81-82	82-83	83-84	84-85
Rainfall	**465.60**	**663.90**	**667.00**	**364.00**	**385.20**	**375.00**	**675.00**
Days	**43**	**44**	**43**	**40**	**35**	**23**	**34**
44 4 Mar	8.40	0.00	0.00	0.00	0.00	0.00	0.00
	1	0	0	0	0	0	0
47 25 Mar	0.00	0.00	16.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0

Week ending	X Bar	S.D.	C.V.	M.D.
1 7 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
5 4 Jun	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
6 11 Jun	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
7 18 Jun	17.60	16.60	94.33	13.26
	1.71	1.28	74.54	1.10
8 25 Jun	31.57	48.11	152.39	36.53
	1.86	1.64	88.38	1.31
9 2 Jul	13.29	12.35	92.94	11.64
	1.29	0.88	68.49	0.69
10 9 Jul	32.31	30.29	93.73	24.56
	2.86	1.96	68.56	1.88
11 16 Jul	55.40	69.55	125.55	47.49
	3.29	2.19	66.51	1.76
12 23 Jul	15.46	16.76	108.42	12.56
	1.43	1.05	73.48	0.90
13 30 Jul	20.06	34.72	173.13	23.98
	1.71	1.58	92.04	1.18
14 6 Aug	28.66	21.83	76.18	20.39
	2.57	2.06	80.12	1.80
15 13 Aug	29.57	24.55	83.01	22.15
	2.57	1.29	50.31	1.06
16 20 Aug	52.29	93.06	177.99	64.49
	2.43	1.92	78.92	1.51
17 27 Aug	11.71	16.56	141.36	12.33
	1.29	1.03	80.12	0.90

Continued...

Week ending	X Bar	S.D.	C.V.	M.D.
18 3 Sep	30.43	26.10	85.77	24.94
	1.86	1.46	78.45	1.31
19 10 Sep	23.57	21.70	92.08	19.22
	1.43	1.05	73.48	0.94
20 17 Sep	40.66	43.06	105.91	37.15
	2.00	1.77	88.64	1.43
21 24 Sep	24.91	23.84	95.69	18.22
	2.00	1.93	96.36	1.43
22 1 Oct	9.89	9.07	91.75	8.50
	1.57	1.40	89.07	1.22
23 8 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
24 15 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00
25 22 Oct	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00

Only for the weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.12: Weekly Total Rainfall, Number of Rainy Days and Variation for Centre 5. Manyad Dam-Jalgaon

1st Line Rainfall (in mm) 2nd Line Number of Rainy Days

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**448.40**	**265.00**	**210.60**	**679.80**	**195.00**	**259.20**	**224.00**
Days	**33**	**21**	**13**	**40**	**8**	**28**	**21**
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
5 4 Jun	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
6 11 Jun	127.00	4.00	0.00	18.00	39.00	0.00	0.00
	3	1	0	3	1	0	0
7 18 Jun	0.00	29.00	0.00	0.00	26.00	0.00	0.00
	0	1	0	0	2	0	0
8 25 Jun	28.00	98.00	6.00	38.00	0.00	0.00	67.00
	1	6	1	2	0	0	2

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**448.40**	**265.00**	**210.60**	**679.80**	**195.00**	**259.20**	**224.00**
Days	**33**	**21**	**13**	**40**	**8**	**28**	**21**
9 2 Jul	24.50	19.00	0.00	0.00	0.00	0.00	0.00
	2	2	0	0	0	0	0
10 9 Jul	18.20	0.00	28.00	15.00	0.00	20.00	2.00
	3	0	2	2	0	3	1
11 16 Jul	6.40	0.00	17.00	37.00	0.00	0.00	23.00
	3	0	1	1	0	0	5
12 23 Jul	17.20	42.00	0.00	0.00	0.00	0.00	0.00
	2	4	0	0	0	0	0
13 30 Jul	8.00	40.00	23.60	55.00	0.00	3.00	6.00
	1	3	2	3	0	1	1
14 6 Aug	55.20	0.00	0.00	46.00	0.00	48.50	0.00
	6	0	0	5	0	3	0
15 13 Aug	0.00	14.00	9.00	66.00	0.00	28.00	0.00
	0	2	1	3	0	2	0
16 20 Aug	0.00	0.00	11.00	0.00	42.00	25.00	30.00
	0	0	1	0	1	2	1
17 27 Aug	34.00	0.00	0.00	0.00	58.00	6.00	0.00
	2	0	0	0	2	1	0
18 3 Sep	78.80	0.00	25.00	26.00	0.00	1.70	26.00
	5	0	1	3	0	2	1
19 10 Sep	0.00	0.00	26.00	0.00	0.00	14.00	33.00
	0	0	1	0	0	2	3
20 17 Sep	15.00	19.00	0.00	172.80	0.00	62.00	17.00
	2	2	0	5	0	4	1
21 24 Sep	36.10	0.00	0.00	49.00	30.00	15.00	6.00
	3	0	0	3	2	4	1
22 1 Oct	0.00	0.00	0.00	65.00	0.00	14.00	3.00
	0	0	0	2	0	1	1
23 8 Oct	0.00	0.00	30.00	0.00	0.00	5.00	0.00
	0	0	1	0	0	1	0
24 15 Oct	0.00	0.00	0.00	16.00	0.00	0.00	0.00
	0	0	0	1	0	0	0
25 22 Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
26 29 Oct	0.00	0.00	0.00	40.00	0.00	0.00	3.00
	0	0	0	1	0	0	1
27 5 Nov	0.00	0.00	0.00	0.00	0.00	17.00	3.00
	0	0	0	0	0	2	1
28 12 Nov	0.00	0.00	0.00	0.00	0.00	0.00	5.00
	0	0	0	0	0	0	2
29 19 Nov	0.00	0.00	0.00	6.00	0.00	0.00	0.00
	0	0	0	1	0	0	0
30 26 Nov	0.00	0.00	0.00	6.00	0.00	0.00	0.00
	0	0	0	2	0	0	0

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**448.40**	**265.00**	**210.60**	**679.80**	**195.00**	**259.20**	**224.00**
Days	**33**	**21**	**13**	**40**	**8**	**28**	**21**
31 3 Dec	0.00	0.00	0.00	24.00	0.00	0.00	0.00
	0	0	0	3	0	0	0
39 28 Jan	0.00	0.00	20.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0
47 25 Mar	0.00	0.00	15.00	0.00	0.00	0.00	0.00
	0	0	1	0	0	0	0

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**807.00**	**440.00**				
Days	**43**	**23**				
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
5 4 Jun	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
6 11 Jun	0.00	24.00	23.56	38.83	164.86	26.52
	0	2	1.11	1.20	107.70	1.04
7 18 Jun	14.00	0.00	0.00	0.00	0.00	0.00
	1	0	0.00	0.00	0.00	0.00
8 25 Jun	0.00	0.00	26.33	33.53	127.31	27.93
	0	0	1.33	1.83	136.93	1.33
9 2 Jul	0.00	85.70	0.00	0.00	0.00	0.00
	0	2	0.00	0.00	0.00	0.00
10 9 Jul	0.00	48.40	14.62	15.50	106.01	12.55
	0	3	1.56	1.26	80.81	1.16
11 16 Jul	252.00	32.40	40.87	75.83	185.55	46.92
	7	3	2.22	2.35	105.59	2.02
12 23 Jul	46.00	19.00	0.00	0.00	0.00	0.00
	4	2	0.00	0.00	0.00	0.00
13 30 Jul	0.00	0.00	15.07	19.00	126.09	16.31
	0	0	1.22	1.13	92.71	0.96

Continued...

Week ending	83-84	84-85	XBar	S.D.	C.V.	M.D.
Rainfall	**807.00**	**440.00**				
Days	**43**	**23**				
14 6 Aug	3.00	0.00	0.00	0.00	0.00	0.00
	1	0	0.00	0.00	0.00	0.00
15 13 Aug	36.00	13.50	18.50	20.59	111.29	16.56
	3	1	1.33	1.15	86.60	1.04
16 20 Aug	63.00	14.00	20.56	20.47	99.60	17.28
	4	1	1.11	1.20	107.70	0.84
17 27 Aug	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00
18 3 Sep	44.00	0.00	22.39	24.98	111.55	19.52
	3	0	1.67	1.63	97.98	1.41
19 10 Sep	21.00	16.00	12.22	12.08	98.84	10.86
	3	1	1.11	1.20	107.70	1.04
20 17 Sep	109.00	52.00	49.64	54.75	110.29	43.83
	5	1	2.22	1.87	84.26	1.63
21 24 Sep	77.00	14.00	25.23	24.17	95.80	20.26
	3	1	1.89	1.37	72.52	1.23
22 1 Oct	58.00	34.00	19.33	24.91	128.86	22.00
	4	2	1.11	1.29	115.76	1.04
23 8 Oct	32.00	74.00	0.00	0.00	0.00	0.00
	3	2	0.00	0.00	0.00	0.00
24 15 Oct	52.00	13.00	0.00	0.00	0.00	0.00
	2	2	0.00	0.00	0.00	0.00
25 22 Oct	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0.00	0.00	0.00	0.00

Only for weeks reporting rainfall; week ending dates adjusted for Leap Year.

Table 4.13: Weekly Total Rainfall, Number of Rainy Days and Variation for Centre 2. Nazare-Pune

1st Line Rainfall (in mm) 2nd Line No. of Rainy Days

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**594.50**	**455.00**	**325.00**	**754.00**	**578.00**	**637.00**	**415.00**
Days	**39**	**47**	**35**	**54**	**42**	**28**	**32**
1 7 May	0.00	0.00	0.00	0.00	38.00	0.00	7.00
	0	0	0	0	1	0	1
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**594.50**	**455.00**	**325.00**	**754.00**	**578.00**	**637.00**	**415.00**
Days	**39**	**47**	**35**	**54**	**42**	**28**	**32**
3 21 May	0.00	0.00	0.00	0.00	0.00	0.00	47.00
	0	0	0	0	0	0	2
4 28 May	0.00	5.00	61.00	0.00	0.00	0.00	7.00
	0	1	4	0	0	0	1
5 4 Jun	0.00	0.00	15.00	0.00	19.00	0.00	28.00
	0	0	1	0	1	0	1
6 11 Jun	193.00	8.00	0.00	15.00	117.00	24.00	6.00
	3	1	0	1	4	1	1
7 18 Jun	0.00	56.00	18.00	10.00	25.00	59.00	0.00
	0	3	4	1	3	2	0
8 25 Jun	14.00	48.00	21.00	0.00	14.00	26.00	4.00
	1	2	4	0	2	1	1
9 2 Jul	50.00	42.00	3.00	29.00	27.00	0.00	0.00
	2	6	1	2	2	0	0
10 9 Jul	0.00	25.00	5.00	0.00	45.00	65.00	4.00
	0	3	1	0	7	3	1
11 16 Jul	36.20	6.00	3.00	0.00	1.00	13.00	0.00
	4	2	2	0	1	1	0
12 23 Jul	24.30	20.00	2.00	0.00	4.00	0.00	20.00
	7	1	1	0	3	0	1
13 30 Jul	20.00	24.00	4.00	83.00	1.00	0.00	2.00
	2	4	2	5	1	0	1
14 6 Aug	99.00	10.00	7.00	26.00	52.00	23.00	3.00
	6	4	3	3	2	2	1
15 13 Aug	0.00	32.00	8.00	23.00	11.00	5.00	12.00
	0	1	2	7	3	1	4
16 20 Aug	0.00	0.00	0.00	2.00	15.00	0.00	13.00
	0	0	0	2	1	0	3
17 27 Aug	0.00	2.00	15.00	0.00	114.00	0.00	8.00
	0	1	2	0	2	0	1
18 3 Sep	15.00	22.00	0.00	68.00	7.00	0.00	0.00
	3	3	0	3	2	0	0
19 10 Sep	9.00	0.00	0.00	11.00	0.00	105.00	0.00
	2	0	0	2	0	5	0
20 17 Sep	0.00	0.00	0.00	118.00	0.00	80.00	0.00
	0	0	0	6	0	3	0
21 24 Sep	65.00	5.00	56.00	156.00	38.00	122.00	71.00
	3	1	2	6	3	4	4
22 1 Oct	6.00	23.00	25.00	54.00	31.00	0.00	111.00
	1	1	2	3	3	0	4
23 8 Oct	10.00	40.00	0.00	0.00	19.00	0.00	0.00
	1	5	0	0	1	0	0
24 15 Oct	0.00	15.00	0.00	0.00	0.00	0.00	0.00
	0	1	0	0	0	0	0

Continued...

Week ending	76-77	77-78	78-79	79-80	80-81	81-82	82-83
Rainfall	**594.50**	**455.00**	**325.00**	**754.00**	**578.00**	**637.00**	**415.00**
Days	**39**	**47**	**35**	**54**	**42**	**28**	**32**
25 22 Oct	0.00	0.00	17.00	15.00	0.00	0.00	45.00
	0	0	2	2	0	0	1
26 29 Oct	0.00	0.00	0.00	0.00	0.00	59.00	0.00
	0	0	0	0	0	2	0
27 5 Nov	0.00	8.00	0.00	0.00	0.00	28.00	0.00
	0	1	0	0	0	1	0
28 12 Nov	28.00	0.00	37.00	48.00	0.00	11.00	25.00
	2	0	1	1	0	1	3
29 19 Nov	0.00	6.00	0.00	60.00	0.00	0.00	0.00
	0	1	0	5	0	0	0
30 26 Nov	25.00	2.00	0.00	6.00	0.00	0.00	0.00
	2	1	0	1	0	0	0
31 3 Dec	0.00	56.00	28.00	7.00	0.00	0.00	0.00
	0	4	1	3	0	0	0
39 28 Jan	0.00	0.00	0.00	0.00	0.00	0.00	2.00
	0	0	0	0	0	0	.1
48 1 Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
49 8 Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
50 15 Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0	0	0	0
51 22 Apr	0.00	0.00	0.00	0.00	0.00	17.00	0.00
	0	0	0	0	0	1	0
53 30 Apr	0.00	0.00	0.00	23.00	0.00	0.00	0.00
	0	0	0	1	0	0	0

Week ending	83-84	84-85	85-86	XBar	S.D.	C.V.	M.D.
Rainfall	**522.00**	**489.00**	**277.00**				
Days	**43**	**40**	**28**				
1 7 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
2 14 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
3 21 May	0.00	0.00	4.00	0.00	0.00	0.00	0.00
	0	0	1	0.00	0.00	0.00	0.00
4 28 May	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00

Continued...

Week ending	83-84	84-85	85-86	XBar	S.D.	C.V.	M.D.
Rainfall	**522.00**	**489.00**	**277.00**				
Days	**43**	**40**	**28**				
5 4 Jun	8.00	13.00	0.00	8.30	9.56	115.19	8.36
	1	1	0	0.50	0.50	100.00	0.50
6 11 Jun	0.00	25.00	26.00	41.40	60.00	144.93	45.44
	0	3	2	1.60	1.28	80.04	1.12
7 18 Jun	39.00	57.00	12.00	27.60	22.28	80.71	20.12
	3	4	1	2.10	1.45	68.84	1.30
8 25 Jun	9.00	0.00	16.00	15.20	13.62	89.62	10.04
	5	0	2	1.80	1.54	85.35	1.20
9 2 Jul	3.00	17.00	6.00	17.70	17.45	98.57	15.44
	2	2	1	1.80	1.60	88.89	1.04
10 9 Jul	0.00	27.00	2.00	17.30	21.58	124.73	18.56
	0	2	1	1.80	2.04	113.31	1.56
11 16 Jul	18.00	30.00	17.00	12.42	12.23	98.48	10.42
	2	2	1	1.50	1.12	74.54	0.90
12 23 Jul	7.00	11.00	55.00	14.33	15.97	111.48	12.40
	2	2	4	2.10	2.02	96.30	1.54
13 30 Jul	4.00	3.00	0.00	14.10	24.34	172.60	16.94
	1	1	0	1.70	1.55	91.32	1.24
14 6 Aug	5.00	2.00	29.00	25.60	28.61	111.75	20.72
	2	1	4	2.80	1.47	52.49	1.20
15 13 Aug	44.00	9.00	8.00	15.20	12.95	85.21	10.68
	3	3	2	2.60	1.85	71.34	1.40
16 20 Aug	53.00	1.00	0.00	8.40	15.82	188.32	11.16
	4	1	0	1.10	1.37	124.98	1.14
17 27 Aug	3.00	1.00	0.00	14.30	33.55	234.60	20.08
	1	1	0	0.80	0.75	93.54	0.64
18 3 Sep	3.00	0.00	6.00	12.10	19.91	164.52	13.74
	1	0	1	1.30	1.27	97.60	1.16
19 10 Sep	0	0	0	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
20 17 Sep	73.00	33.00	0.00	0.00	0.00	0.00	0.00
	4	2	0	0.00	0.00	0.00	0.00
21 24 Sep	99.00	48.00	0.00	66.00	46.51	70.48	36.80
	4	2	0	2.90	1.64	56.56	1.32
22 1 Oct	62.00	66.00	13.00	39.10	32.36	82.75	27.32
	3	3	3	2.30	1.19	51.63	1.04
23 8 Oct	2.00	57.00	76.00	20.40	26.32	129.03	22.36
	1	3	4	1.50	1.75	116.43	1.50
24 15 Oct	0.00	12.00	0.00	0.00	0.00	0.00	0.00
	0	2	0	0.00	0.00	0.00	0.00
25 22 Oct	30.00	14.00	0.00	12.10	14.73	121.77	12.10
	1	1	0	0.70	0.78	111.58	0.70
26 29 Oct	0.00	4.00	0.00	0.00	0.00	0.00	0.00
	0	1	0	0.00	0.00	0.00	0.00

Continued...

Week ending	83-84	84-85	85-86	XBar	S.D.	C.V.	M.D.
Rainfall	**522.00**	**489.00**	**277.00**				
Days	**43**	**40**	**28**				
27 5 Nov	0.00	30.00	0.00	0.00	0.00	0.00	0.00
	0	1	0	0.00	0.00	0.00	0.00
28 12 Nov	0.00	0.00	7.00	15.60	16.79	107.62	15.12
	0	0	1	0.90	0.94	104.82	0.72
29 19 Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
30 26 Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
31 3 Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
39 28 Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00
48 1 Apr	27.00	24.00	0.00	0.00	0.00	0.00	0.00
	1	1	0	0.00	0.00	0.00	0.00
49 8 Apr	0.00	5.00	0.00	0.00	0.00	0.00	0.00
	0	1	0	0.00	0.00	0.00	0.00
50 15 Apr	2.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	0	0	0.00	0.00	0.00	0.00
51 22 Apr	31.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	0	0	0.00	0.00	0.00	0.00
53 30 Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0	0	0	0.00	0.00	0.00	0.00

Only for the weeks reporting rainfall; week ending dates adjusted for Leap Year.

If kharif irrigation is to be introduced and/or improved either as protective irrigation and/or as productive irrigation considerable change in the design of entire distribution system would be necessary. The present system of irrigation under the scheme is field to field irrigation which naturally results in considerable loss in transmission and distribution. Irrigation through well laid field channels is not possible because of heavy downpour which destroys the field channels during the monsoon season. Under the prevailing system paddy is the only suitable crop. A modified crop-mix to growing long duration perennial cash crops like coconut etc. (wherever possible), in addition to the stable crop of paddy, specially in very high rainfall zone, to give boost to the agricultural economy of the zone can possibly be effected through a change in the design of entire distribution system.

In the case of both assured rainfall zone and less assured rainfall zone though monsoon sets in generally by the third week of June, rainfall cannot be said to be concentrated during any particular period in less assured rainfall zone, whereas it is seen to be concentrated in the months of July and August in assured rainfall zone (Tables 4.9 through 4.12). Some rainfall is also reported in the months of September and October in the latter zone but it is seen to be erratic, irregular and insufficient and in few years very deficient and with long periods of dry spell during the monsoon season.

Very considerable variations from one year to another in the week ending rainfall and number of rainy days are observed in both the zones. This gives rise to uncertainty regarding the period by which the reservoir would be filled to its full capacity as noted earlier. When the rainfall is deficient and there is considerable variations in the week ending precipitation and number of rainy days, as is seen to be the case in respect of the scheme in less assured rainfall zone, the supply situation becomes more difficult.

The date of release of water for first irrigation in kharif season matches farely well with the long and/or short dry spells experienced in rainfall in the command and catchment areas of the scheme. It can also be discerned from the rainfall data that there may not be demand for water in kharif season during the period mid-June to end-August in the assured rainfall zone. The main demand for kharif irrigation, around 3 to 4 waterings, would arise from the beginning of September till the end of first week of November. During this period rainfall is scanty, uncertain and with long dry spell. However, if full storage is to be attained by mid-October for the subsequent rabi and hot-weather irrigation it may not be possible to release required amount of water for kharif irrigation. It is perhaps because of this reason that less than 50 per cent of the area demanded to be irrigated by the irrigators was actually sanctioned and supplied with water during different years' kharif season.

Similarly in the case of less assured rainfall zone the date of release of water for first irrigation varies considerably from year to year and matches well with the on set of monsoon every year. Although the demand for kharif irrigation is likely to be more in the last week of September and the whole of October, irrigation water would also be in demand during the months of July, August and early September because of short and long dry spells during these periods every

year, when the standing kharif crops need protective irrigation. Again, if full storage is to be created for rabi and hot-weather irrigation every year by mid-October, which itself is an uncertain proposition as seen earlier because of less assured rainfall, the possibility of releasing required amount of water for protective kharif irrigation would be remote. This seems to be the reason why only a small proportion of area demanded to be irrigated by the irrigators is actually sanctioned and supplied with water.

The other aspect of demand for kharif irrigation water from surface sources is the availability of well water. It is argued that if adequate well water is available the irrigators will not demand canal water for protective irrigation. But the available evidence suggests that the main crops irrigated by wells in these two zones are sugarcane, wheat, gram, groundnut and vegetables. Although there is some well irrigation in kharif season too, it can safely be assumed that available well water is not largely used for protective irrigation in kharif.

Finally, another important aspect affecting the demand for kharif irrigation is whether there is significant adverse impact on the yield of crops because of not providing kharif irrigation. It has been reported from both the zones that the yield of cotton, groundnut, hybrid jowar etc., sown in June and raised with protective irrigation give yields which are 30 to 50 per cent higher than those grown under unirrigated condition. Such a yield difference suggests the importance of providing protective irrigation for kharif cultivation and should normally induce the farmers to demand water for kharif irrigation. But, they do not do so because of the experience of no certainty of getting water at the required time and in required quantity which in any case would affect the yield of these crops adversely.

In scarcity zone the rainfall is more uncertain, irregular and scanty. Although the rainfall is spread over a period of three and half months of mid-June to end-September long and short dry spells appear almost during every month in most of the years (Table 4.13). The year to year variations in week ending, number of rainy days and amount of precipitation are considerably large in the scarcity zone leading to considerable uncertainty regarding the intensity of rainfall and its distribution thereby affecting the period by which the reservoir is filled to its capacity every year (Table 4.5).

The date of release of water for first kharif irrigation varies considerably from year to year and generally coincides with the dry spell occurring in July. However, since long and/or short dry spells keep on occurring during almost all the months in monsoon demand for kharif irrigation is likely to spread over the months of July, August, September and first week of October. However, if full storage is to be created for rabi irrigation and subsequent hot-weather crops it may not be possible to release timely and adequate water for protective irrigation in kharif. This results into a very unsatisfactory, uncertain and irregular supply of water for such protective irrigation during kharif season which makes the farmers turn away from resorting to irrigation for kharif crops. Number of wells in the command area of the scheme has increased substantially. So is the area under well irrigation and the farmers do irrigate kharif crops with the well water although the extent of such irrigation is not very high. It is also reported that

hybrid jowar and bajra grown in kharif season under protective irrigation give yield which are 20 to 30 per cent higher than those grown under unirrigated condition. As mentioned earlier, such a yield difference should normally induce the irrigators to demand water for kharif irrigation, but a large number of them do not do so because of the experience of uncertain and irregular supply of canal water from the irrigation system. This in any case affects the yield of the crops adversely.

From the above discussion it is clearly borne out that there is a need to provide protective irrigation to kharif crops in assured rainfall zone, less assured rainfall zone and scarcity zone and that the reasons for particularly low level of kharif irrigation utilisation arise mainly out of supply factor. In order to encourage irrigators to resort to protective irrigation in kharif season they have to be fully assured about the timely availability of the required quantity of water. Particularly supply of water for early kharif sowing in the first week of June and then making water available during the dry spells in the months of June, July, August, September would give a fillip to kharif irrigation in these areas. Early sowing of kharif crops without waiting for the onset of monsoon with the help of pre-sowing irrigation and irrigation thereafter during dry spells would not only improve the productivity of kharif crops but would also ensure timely sowing of rabi crops. This may however give rise to the problem of trade off between using irrigation water for productive irrigation in rabi and specially in hot-weather season and for protective irrigation in kharif season.

Summing Up

The objective evaluation of the factors responsible for particularly low utilisation of kharif irrigation potential based on the analysis of data collected from the schemes in different rainfall zones indicate that the main reason for such a state of affair in the assured rainfall zone, less assured rainfall zone and scarcity zone is the uncertain supply (availability) of canal water in adequate quantity, particularly when required, from the distribution system. In other words, the reasons for particularly low utilisation of kharif potential is rooted into the supply factors and not so much into the demand factors. Lack of demand for kharif irrigation, even of protective nature, is very much related to the inadequate and uncertain supply of canal water in respect of these schemes. Under this situation the questions of using irrigation water for productive irrigation versus protective irrigation arise to some extent because the availability of water is uncertain and is not always adequate and meeting the pre-monsoon (pre-sowing) kharif water requirement alongwith providing protective irrigation in kharif may adversely affect the supply of water mainly for hot-weather irrigation of cash crop like groundnut.

In the case of very high rainfall zone, however, the main reason for the absence of kharif irrigation is the availability of heavy and fairly well distributed rainfall in the command area of the scheme and hence it is the demand factor which is mainly responsible and not the supply constraint for such underutilisation.

Chapter 5

Summary and Concluding Remarks

The study mainly deals with the subjective and objective evaluations of utilisation of kharif irrigation potential in order to identify the main factors responsible for particularly low utilisation of kharif irrigation potential in respect of schemes from different agro-climatic and rainfall zones in Maharashtra. Five such agro-climatic zones are identified in consultation with the Department of Irrigation, Government of Maharashtra, for this purpose, and one scheme each from the five said zones is selected for detailed study. The purpose of enlisting irrigation schemes from different agro-climatic zones of the State is to ensure the inclusion of different rainfall patterns which are likely to have impact on utilisation of kharif irrigation potential differently in different zones. In other words, it is expected that each scheme so selected from a zone is representative of the schemes in that zone.

Before we go into the main findings of the study it would be instructive to make a few observations about the representative nature of the schemes mentioned earlier. It may not be necessarily correct to say that each of the five schemes selected for study is representative of the schemes in a given agro-climatic zone. This may be particularly true of the scheme selected from very heavy rainfall zone of Raigad District. The scheme selected from this zone is a minor irrigation scheme and is located around the ghat section connecting Pune with Bombay. The agro-climatic conditions in respect of this scheme cannot be said to be similar to those prevailing in the coastal area of Konkan region, although the rainfall is very heavy like in the entire Konkan region. Similarly, to a lesser extent, the schemes selected from other agro-climatic zones may not in every respect be representative schemes of the respective zones and to that extent there is limitation in generalising the findings of the study.

As mentioned earlier, the study pertains to the evaluation of the factors responsible for particularly low utilisation of kharif irrigation potential, but, in order to do that it is necessary to examine the extent of utilisation in rabi and hot-weather seasons also. The necessity for doing so arises not only because a comparative picture of the extent of utilisation in each season is to be presented

with a view to see if the same is particularly low in kharif season, but also because release of water for kharif irrigation is very much conditional to the stipulated requirements of water storage for rabi and hot-weather irrigation.

The extent of utilisation has been measured in two ways, one by comparing the area actually irrigated with area proposed to be irrigated and the other by water actually released with the water proposed to be released. Our estimates by both the methods show that the extent of utilisation is particularly low in kharif season in all the agro-climatic zones except in high rainfall zone.

The extent of utilisation in the zone of high rainfall is around 95 per cent in kharif. Paddy is the only crop grown in kharif and the irrigators get full protective irrigation for this crop during two and half months from the middle of August to the end of October under a long term agreement. The subjective evaluation and the objective evaluation clearly show that the demand for water by the irrigators and its periodicity and the supply of water through the distribution system and its periodicity match very well. The irrigators depend on rainfall for the sowing and transplantation of paddy and also for initial growth of crop upto mid-August or so and thereafter demand water when the rain begins to recede and dry spells begin to appear. This observation based on the opinion survey of the irrigators is also borne out by the objective evaluation of rainfall data and the dates of release of water for kharif irrigation. The objective of providing protective irrigation to monsoon crop, mainly paddy, is largely fulfilled.

The main crop grown in this zone is paddy, even the second crop grown in fair weather (rabi + hot-weather) is paddy. Over the last 50 years or so the irrigation development has taken place in such a way that only paddy is suitable in this zone; soil is also not suitable for growing any other crop. Balance of water, if available, is used for providing irrigation to summer paddy and a part of it is also carried forward for providing irrigation for the sowing and transplantation of paddy in the next monsoon season in case the monsoon is delayed.

In the very high rainfall zone there is absolutely no utilisation of water for kharif irrigation. There is no demand for water from the irrigators during the monsoon season and as such there is no supply either from the distribution system. The issue of not utilising irrigation water for kharif crop seems to mainly arise from the demand factors.

The subjective evaluation based on the opinion survey of the irrigators indicate that there is no demand for irrigation during kharif season because of adequate and well distributed rainfall. The objective evaluation of the rainfall data from the command area of the scheme also shows that the rainfall is heavy and fairly well distributed every year. Although in some years short dry spells appear in between the season, the irrigators manage to take care of those short dry spells by providing accumulated water from *Nalas* to the low lying paddy fields.

The irrigations tend to concentrate their attention to the irrigated paddy cultivation in the non-monsoon season locally called *Konkan Hangam* extending from November to April. The canal authorities also accordingly concentrate their distribution programme during this period to meet the irrigators' demand.

It is reported that yield of paddy grown in *Konkan Hangam* with irrigation is 50 to 60 per cent higher than grown in monsoon season, hence the irrigators concentrate their resources and attention to growing paddy in this season.

Balance of live storage at the end of the irrigation every year indicates the possibility of providing water for early sowing of kharif paddy so that the irrigators do not have to depend upon the monsoon for sowing but, the objective evaluation suggests that this would be possible only if the irrigators agree to raise paddy seedlings in the contiguous blocks mainly in the upper reaches of the distribution system. Early beginning of kharif season would also ensure timely sowing of crops in the following seasons.

As the situation exists paddy seems to be the only crop suitable in this zone. The irrigation provided is field to field irrigation during the non-monsoon season. During monsoon season there is likely to be demand for water during the dry spells in the first fortnight of June and in the month of October. It is possible to supply water during these periods of dry spells by proper water planning as the balance of live storage is seen to be remaining unused. This would certainly improve the productivity of kharif paddy. What is needed is to convince the irrigators of the utility of such irrigation along with an assurance that their demand for water in *Konkan Hangam* would not be affected because of this.

The present system of field to field irrigation leads to considerable loss in transmission and distribution. Irrigation through well laid out field channels is not possible because of heavy downpour which destroys the field channels during the monsoon season. A change in the crop-mix to growing long duration perennial cash crops like coconut, arecanut, etc., wherever possible, in addition to the staple crop of paddy to give boost to the agricultural economy of the command area requires a change in the design of the entire distribution system. Controlled water distribution required for this change would involve laying down water pipe lines for irrigation. This would call for a major change to fulfill the objective of productive irrigation leading to more efficient use of irrigation water and by implication better utilisation of the same in very high rainfall zone. Without such an attempted change, no purpose is served in earmarking irrigation water for kharif season under the existing situation and then raising questions as to why water is not used by the irrigators in kharif season in this zone.

In respect of the assured rainfall zone, less assured rainfall zone and scarcity zone the extent of utilisation is particularly low in kharif season. As is evident from the subjective evaluation based on the opinion survey of the irrigators, there is hardly any demand for water from the irrigators for irrigating kharif crops. The main reason assigned for such a state of affair is uncertain, unpredictable and inadequate supply of canal water from the distribution system. It is not as if the irrigators do not need irrigation water during the kharif season. The irrigators are quite aware of the adverse impact of the long and short dry spells on the standing kharif crops. But they are of the opinion that even if they resort to kharif irrigation (i.e., demand irrigation water for kharif crops) the supply from the distribution system is so uncertain and unpredictable, particularly during the dry spells, that crop output gets affected adversely anyway. Further, they opine that with such an uncertain supply if they have to pay irrigation charges

for the entire season and sometimes for two seasons, if the watering for kharif crops extends over to rabi season, they would rather not demand water for kharif irrigation.

Most of the irrigators mention that increasing number of irrigators would resort to kharif irrigation, if irrigation water is provided for early sowing of kharif crops and also if the timely supply of adequate quantity of water during dry spells is fully ensured. However, at the same time they also mention that they would not like the supply of canal water to get adversely affected in rabi season because of this change. This is particularly the opinion of the irrigators in the scarcity zone of the state where traditionally rabi crops enjoy more importance.

There is a clear correspondence between the main reason given by the irrigators and the reason arising out of the analysis of secondary data collected from the official records. Analysis of the rainfall data show that there are considerable variations in the amount of precipitation and in number of rainy days in a month and that there are periods of long and short dry spells during the kharif season when the standing kharif crops need watering. Analysis of the data on water content in the reservoir indicates that the possibility of supply of water for early sowing in kharif (pre-monsoon) and during the long and short dry spells is remote, particularly after meeting the full water requirements of rabi and hot-weather seasons. This would naturally lead to uncertain and inadequate supply of water during kharif season from the distribution system.

In respect of assured rainfall zone, the monsoon generally sets in by the third week of June, it is concentrated in the months of July and first 2 to 3 weeks of August and starts receding from the end of August. There are very few short dry spells during this period. Rainfall during the months of September and the first 2 weeks of October seems to be erratic, irregular and insufficient. Standing kharif crops, mainly hybrid jowar and cotton, would need irrigation in these months during the dry spells (at least 3 waterings). Water planning and distribution mechanism should be such that it should be possible to supply required quantity of water during these periods as part of protective irrigation. The storage requirement for kharif is estimated to be only 2.30 Mm^3 in respect of the particular scheme under study when the total water requirement for kharif crops is estimated to be 11.53 Mm^3. Actual release of water varies between 0.22 Mm^3 and 2.83 Mm^3 during different years. This seems to be on the lower side if the entire kharif potential created is to be given protective irrigation.

The balance of storage available at the end of irrigation season in most of the years is hardly more than the dead storage required to be maintained in the reservoir, hence there is remote possibility of providing water to the irrigators for early sowing of kharif crops under the existing set up. There seems to be a trade off between making irrigation water available for early kharif sowing along with protective irrigation during dry spells and allowing for full irrigation provision for rabi and hot-weather season crops.

Similarly, in the scarcity zone of the Western Maharashtra, the monsoon generally sets in by the middle of June and is spread over three and half months upto end of September. A few showers also occur during October and even in

early November. Long and short dry spells occur almost every year during the months of July and August. Standing kharif crops, mainly bajra, groundnut, cotton and vegetables would require irrigation (around 3 waterings) during these periods of dry spell. Water planning and distribution should be so organised as to meet the requirement of water during these periods as part of protective irrigation. The storage requirement for kharif is estimated to be only 1.46 Mm^3 of water when the total water requirement for kharif season is estimated to be 7.30 Mm^3 in respect of the particular scheme under study in this zone. Actual release during different years is even lower than that, around 1 Mm^3. This seems to be very much on the lower side considering the amount of precipitation and its distribution, if the entire kharif potential created is to be given protective irrigation.

Balance of storage available at the end of irrigation year in four out of nine years is adequate only to meet the dead storage required to be maintained in the reservoir; in other years the live storage remaining unused varies between 2 Mm^3 and 5 Mm^3. Therefore, there does not seem to be any assurance of supply of water to the irrigators for early sowing of kharif crops and also to meet the full water requirement for protective irrigation during dry spells in kharif season.

It may also be noted that although no provision was made for hot-weather irrigation in the project water planning, in actual practice water is being released for hot-weather crops perhaps at the cost of irrigation in kharif season. This policy is contrary to the objective of providing protective irrigation particularly in scarcity zone.

In respect of less assured rainfall zone, the monsoon normally appears to break in the 2nd or 3rd week of June every year and continues up the middle of October. But, there occurs a number of dry spells, short and long, during almost every month. Standing kharif crops mainly hybrid jowar and bajra, would need irrigation during these dry spells (at least 3 waterings). Water planning and distribution should be geared towards meeting the water requirement during the dry spells in kharif season. For illustration purposes it may be noted that in respect of the scheme under study from this zone the storage requirement for kharif season irrigation is estimated to be 3.30 Mm^3 when the total water requirement for kharif season crops is estimated to be 16.17 Mm^3. Actual release during different years varies between 3.39 Mm^3 and 0.82 Mm^3 except the first two years. This seems to be very much on the lower side to provide protective irrigation to the entire kharif potential created, particularly considering the amount of precipitation and its distribution during the rainy season every year.

Balance of storage available at the end of irrigation every year is 5 Mm^3 to 13 Mm^3 more than the dead storage required to be maintained in the reservoir. This unused surplus live storage can conveniently be used for providing irrigation to early sown kharif crops along with providing protective irrigation during the dry spells. This should be possible even after meeting the full water requirement of rabi season and hot-weather season, although hot-weather season irrigation was not provided for in the project cropping pattern.

The above observations clearly indicate that particularly low utilisation of irrigation potential in kharif season in the assured rainfall zone, less assured

rainfall zone and scarcity zone of the State mainly arises out of supply constraint. Lack of demand for irrigation water by the irrigators in these zones are rooted into the uncertain and inadequate supply of water from the distribution system during dry spells and also into the general practice of not supplying water for early sowing (pre-monsoon) of kharif crops.

Under the existing set up the main concern of the irrigation system in these zones seems to be assuring water supply during fair weather, particularly during rabi season. As a matter of fact, over the years the practice of releasing water for hot-weather cash crops, mainly groundnut, is gaining importance, presumably as a result of pressure from the relatively better off farmers from the head reaches and middle reaches of the distribution system. This practice is most likely to restrict the possibility of providing irrigation water for early kharif sowing.

It seems there is a trade off between growing early sown kharif crops with protective irrigation and growing hot-weather crops. It may be instructive to note that the main crops grown in these zones in kharif are foodgrain crops, like hybrid jowar, bajra, etc., and cotton in some areas, whereas the main crop grown in hot-weather under irrigation is a very important cash crop like groundnut. Hot-weather groundnut is reported to be very high yielding crop and is also reported to be highly profitable. Available water released for hot-weather irrigation is enough only to meet the requirement of a small proportion of the entire irrigable command area, that too in the upper reaches of the main distribution system, presumably dominated by the better off farmers having considerable say in actual water distribution.

In the very high rainfall zone of the State on the other hand, virtual absence of kharif season irrigation mainly arises out of the demand factors. The available evidence suggests no supply constraint even for early kharif sowing. Under the existing set up and the type of irrigation development that has taken place over the year, paddy is the most suitable crop to be grown year round. The irrigators are quite convinced that there is no need for irrigation in kharif because of adequate and well distributed rainfall. Entire demand for water is concentrated in fair weather.

The practice of irrigation over the years has inadvertently developed in tune with this demand pattern and the whole effort in water distribution is concentrated during fair weather. Farmers need to be convinced of the utility of irrigating standing paddy crop during dry spells which do occur every year during the monsoon season, the possibility of which seems to be remote as the situation exists.

Under the existing situation the practice followed is field to field irrigation which naturally leads to considerable loss in distribution and transmission. Possibility of creating demand for kharif irrigation and also of improving the overall irrigation efficiency may be explored by attempting on an experimental basis the introduction of long duration perennial cash crops like coconut, arecanut, etc., in addition to the staple foodgrain crop like paddy. This would require considerable change in the design and in the organisation of the distribution network. Until then, as mentioned earlier, there is no reason why irrigation water need be earmarked for kharif irrigation in the storage planning.

The irrigation systems created and designed to provide protective irrigation, particularly in assured rainfall zone, less assured rainfall zone and scarcity zone are also being required to fulfil the requirement of high intensity productive irrigation. A conflict in objectives under such a situation naturally arises. These ought to be examined in proper perspective in order to achieve a higher level of irrigation efficiency along with the equitable distribution of water from the irrigation systems.

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