CHAPTER I

INTRODUCTION

1.1. Drinking water sector and farm sector depend upon surface water from the reservoir and groundwater for their water supply. However, with rapid depletion of groundwater resources, reliance of these sectors on surface water has grown. Surface water usage however is characterised by evaporation, conveyance and seepage losses. It is also found that sectoral usage is not efficient which results in waste. Department officials managing the Dharoi Reservoir Project have estimated that 40 per cent of the available water in the reservoir is put to good use while the rest is wasted. The water from the reservoir is delivered to the farm sector and for drinking water. Water distribution in these sectors is governed by institutions; municipalities distribute drinking water and Water Users Associations (WUA) distributes water to the farm sector.

Despite the presence of such institutions, water distribution has remained a contentious issue. Recognizing water as a social good rather than as an economic good, Government of India prioritised the allocation of water to the drinking water sector. At times when there is abundant water both the sectors receive their share without problem but during a period when the water level in the reservoir is low, drinking water sector consumes the bulk of the limited quantity leaving very little for the irrigation sector. Another problem is growth in urbanisation. The present regulation forces the diversion of water to drinking water sector as per the stipulation of Basic Water Norms. This can be seen as overkill and almost always results in waste or inefficiency. In addition to these problems, poorly maintained water networks cause a lot of waste. Due to such dynamics, the drinking water sector has become a major consumer of water and it is here that the need is felt to study the efficiency of water use. It has become necessary to examine whether municipalities are able to perform the role of supplying water and recovering water charges satisfactorily.

Increase in demand for water for drinking purposes adversely affects farm water use especially during the lean period. Experts like Vaidyanathan (1985), Iyer (2003) believe that increase in demand for water in farm sector can be met by increasing the efficiency of water use. While some experts advocated has been to increase water charges arbitrarily and hope that the farmers will pay. It is clear from the above
discussion that a study, which focuses only on agricultural, water practises and policies will turn out to be insular. Since drinking water sector consumes bulk of the water meant for agriculture, it is necessary to study the practises and policies in this sector too. Therefore this study examines both the drinking water sector as well as the farm sector to arrive at a balanced position.

1.2. SCOPE OF THE STUDY

Given the background of uncertain rainfall, depleting groundwater level and multiple users of water, a macro study from the perspective of the reservoir fails to illuminate completely the status of water use in various sectors, its contribution in each sector and the performance in various sectors. Therefore, this study is carried out at two levels.

- We first analyse at macro level the total use of reservoir water for various uses. Macro level analysis helps in understanding dimensions of water related conflicts and inequitable water distribution and use. These aspects are normally not included in sector specific approaches. One of the aims of this study is to measure efficiency of water use at the reservoir level.
- This is followed by a micro level analysis, which examines the extent to which present institutions governing water management in farm and drinking water sector are able to use water efficiently. It also examines status of water-use in farm and drinking water sectors.

By studying macro and micro perspective of water use, this study attempts to understand whether user based institutions in each sector have been capable of negotiating the need of all users and whether they are able to embrace all water sources. This study also discusses problems of water use, improper accounting systems, problems of cost recovery, low revenue compared with costs and ways that would help avoid grim consequences. Study thus attempts to understand the role of institutions in improving efficiency of water use. The feature that separates this study from other studies undertaken previously is that this study is a reservoir level or macro level study with a micro level perspective (like drinking and farm use).

Productive efficiency of water corresponding to its usage in large, medium and small sized farms is found out. Analysis throws up suggestions about the optimum crop
selection, cropping pattern, cropping intensity and level of use of all inputs including water needed to maximise productive efficiency for each category of farmers. Another aim of the study is to determine which of the sources (surface water, ground water and conjunctive usage of both groundwater and surface water) is better in terms of productive efficiency for the farmers of different categories. This study also examines whether WUAs are able to perform the role of supplying water and recovering water charges satisfactorily.

1.3. LITERATURE REVIEW

The literature on allocation, pricing and related issues is vast and growing. Literature that is relevant to this study is mentioned here. It is seen that the demand of water is rising at an astonishing pace. It is estimated that by 2025, the growth in world requirements for the development of additional water supplies would increase by 50 per cent. The complex task of managing existing supplies and additional new arrangements would require design of appropriate institutions (Seckler, et al. 1998). Scholars like Molden, D. J et al., (2000); Svendsen, et al (1997); Saleth et al (1999); Vermillion et al. (1998) emphasise the importance of WUAs and some such as Sargan (1958); Lyman, R.A. (1992) have studied the role of municipalities in distributing water.

Apart from surface water, farmers rely on groundwater for their requirement. The major groundwater extraction mechanisms are dug wells, bore wells and tubewells. Mehasana has the highest density of both dug wells and tubewells followed by Sabarkantha (Hirway, 1999). Over exploitation of groundwater lowered the groundwater table and increased the cost of pumping water. As a result, tubewell companies were formed to distribute and manage scarce groundwater. Shah (1993) and Dubash (2000) have studied these companies in detail. In a situation where both surface and groundwater co-exist in the basin, the tubewell companies follow the policy of dynamic pricing. They increase their prices when there is a limited supply of surface water and decrease prices in case of abundance. According to Sargan (1958) the neglect of pricing and costing matters has produced the general under-pricing of urban water service. Others have expressed similar concerns, suggesting that, practically water service prices were invariably less than marginal opportunity costs (Martinez-Espiñeira, R., 2002; Moncur, J 1987; and Lyman, R.A.1992). Vidyanathan (1983) and Dinar et al. (1997) note that because of such pricing farmers cultivating irrigated crops reap much greater rewards than those growing unirrigated crops.

Gulati et al., (2005), ICWE (1992), Hearne et al. (1997), Easter et al (1986b), Easter et al (1997); Winpenny, (1994) and Bhatia et al., (1995) who have studied irrigation projects, advocate considerable upward revision of water charges. Because of poor recovery of water charges and high operation and maintenance costs and high costs associated with treatment, storage, monitoring of capital assets, a large share of meagre fees is spent on paying salary to staffs. All these problems lead to deterioration in the condition of the canals and increase in wastage of water. Bhatia et al., (1995) have also echoed Gulati et al. (2005) and argue for higher water prices leading to water use efficiency. Of course if the prices were to rise, there would be more funds available for better management of irrigation projects.
One of the major problems encountered while deciding about the price of water used in irrigation is the difficulty in measuring correctly the volume of water that each farmer receives. To circumvent this problem, some scholars advocate user-based allocation rules such as cost recovery based on water deliveries to an entire village or to a water user association. In most cases this is found to be inadequate. Limited experience with user-based allocation suggests that under appropriate set of incentives, this might be a preferred water pricing mechanism, achieving higher efficiency than the traditional non-volumetric water pricing mechanisms. Rogers, et al (1997), Winpenny (1994) and Bhatia et al (1995) suggest that to improve efficiency of water use, the prices should cover not only the operation, maintenance and capital costs but also opportunity cost of its use. Their idea is schematically delineated in the following figure 1.1.

These authors define full cost as a sum of full economic cost; and the full environment cost. However, where water use efficiency from the reservoir is only 40 per cent, this kind of pricing will burden the user with increasing cost of improper management. Moreover, stress on pricing and cost recovery fails to consider lacunae in accounting system of water availability, water use by various sectors, losses, level of efficiency in various uses, capital and operation and maintenance costs for providing water to various uses.

Several studies also advocate different approaches to pricing (Renzetti, 2002, Renzetti, 1992), peak load pricing (Feldman, Breese, and Obeiter (1982); Hanke et al 1982), as optimal solutions to pricing-investment problem (Dandy et al 1997;
Herrington, 1997; Hanke, 1984; Kindler et al, 1984). However, OECD, (2003), states that in many cases social, economic and political constraints fail to dissociate the resource cost from the production costs.

In case of India, for quite sometime now, the government's operational capacity has been tested to the limit and found wanting as far as water use efficiency and water distribution are concerned (Parthasarathy and Pathak, 2003). Across different systems and states in India, governments have experienced shortage of funds needed to carry out repair and rehabilitation (R&R) work. At many places, canals were laid at uneven level and structures were in bad shape, which resulted in frequent breaches of canals. Consequently, reliability of water schedule was adversely affected. If adequate supply is not available, it is seen that farmers usually do not pay water charges. India is not unique. Hardly any country has fared well in recovering even operation and maintenance costs of the canal water.

During the last few decades, the development literature has been stressing the importance of social groups and communities to solve a wide range of problems, which the state alone cannot tackle effectively. It is expected that by improving water delivery, decentralised delivery service would provide an incentive to farmers to cough up higher charges for water. It is emphasised that by increasing water charges and subsequently recovering them would guarantee financial sustainability of such institutions. Hooja et al., (2000); Vaidyanathan (1999) Raju (2000); Vermillion, (1997); OECD, (1999 and 2003) therefore advocate the need for user based management to improve the efficiency of water use. Most of the studies have discussed the need to use water efficiently in specific sectors. There is an acute dearth of literature looking at the problem in its totality. This study attempts to study the macro as well as micro level water use and thus provides a comprehensive view.

1.4. OBJECTIVES OF THE STUDY

Selecting Dharoi reservoir as a case, the study attempts to understand the contribution and performance of water use in various sectors and examines the impact of institutions on sustainability of water resource.
Specifically, the aims are

- to examine ways in which the quantum of water in the reservoir influences water distribution practices in farm and non farm sectors;
- to understand the nature and extent of water use in agricultural and drinking water sectors;
- to identify options for improving the performance of water use in both these sectors
- to review the existing water rate structure and the extent of subsidy in surface water for agricultural and non agricultural use;
- to examine possibility of improvements in performance of water use in water using sectors and the impact of the same on financial performance;
- to analyse how far community managed institutions have been successful in improving efficiency of water use and in providing financial sustainability of institutions by raising water charges and
- to indicate possible policy interventions (issues) for sustainable water resource use.

1.5. CONCEPTUAL AND THEORETICAL FRAMEWORK

Performance in water use in various sectors is studied by examining efficiency of water use in water using sectors. From the time authors like Debreu (1951), Koopmans (1951), Farrell (1957), or Bauer (1990) introduced the analysis of efficiency in economic literature, there has been a numerous and wide ranging collection of papers and articles devoted to the measurement of Productive efficiency. Productivity is defined as the ratio of outputs to inputs. This ratio is easy to calculate if a unit uses one input to produce one output. But, it is more common that a unit uses more than one input, so that these inputs must be aggregated in some sensible fashion. The concept of productivity is widely accepted as a key performance benchmark for entities. Rising productivity implies increasing profitability, lower costs and competitiveness.

1 Productive efficiency is an economic concept, which deals with the need to maximize the value of an output in relation to a specific level of inputs. So, productive efficiency is similar to technical efficiency, except that technical efficiency is concerned with physical production in relation to inputs and outputs, while productive efficiency measures inputs and outputs in terms of their value.
Productivity in the study is analysed at various levels - reservoir level and sectoral level. As drinking water use is prioritised, there is an absence of market pressures for an efficient water use by municipalities. Thus, economic performance measure is analysed by studying the financial revenue and cost of supplying water. Irrigation sector becomes the recipient of water from the reservoir after meeting claims of drinking water sector. In agricultural sector, water is one of the most vital inputs used in crop cultivation. Thus, the concept of production function is used to understand more about productivity of water use in agricultural sector. A production function describes the relationship between the output (gross returns from crops) and the inputs (seed, fertiliser, material inputs, machine inputs, labour, bullock hours and so on). Exogenous factors like policy of water allocation, water prices and so on are beyond our control and cannot be studied. The nature of the output-input relationship depends on the particular production technology that is used to convert inputs into outputs.

There has always been a close link between the measurement of efficiency and the use of frontier functions. Some of the major approaches that have been developed for measuring them are (1) Index numbers, (2) Least-squares, (3) Data Envelopment Analysis (DEA) and (4) Frontier. The first two approaches measure 'productivity' under the assumption that all firms are technically efficient, while the latter two approaches do not make such an assumption. Thus DEA and Frontier analysis can be used to study productive efficiency of water use.

Different techniques have been utilised to calculate or estimate these frontier functions. For an analysis designed to measure productive efficiency, Aigner et al. (1977) and Bauer, (1990) use stochastic frontier production function by incorporating efficiency change into a model of productivity growth. This approach was introduced by Michael Farrell. He defined efficiency as the ratio of observed output to the maximum potential output that can be attained from given inputs. If a firm’s actual output is below the maximum potential output, the shortage is regarded as an indicator of inefficiency. It seems appropriate to apply Farrell’s approach to water resource where market failure is prevalent and the government deeply intervenes in the market. Fan (1991) used this approach to measure productive efficiency improvements in China’s agricultural production growth from 1965 to 1985. Farrell (1957) has defined productivity efficiency as the ratio of the firm’s actual observed output to its own maximum possible frontier output for a given level of inputs.
Following Farrell (1957), we in this study examine productivity efficiency at the macro level and micro level. Given various social and political constraints, at macro level this method evaluates efficiency of water-use from the reservoir by multiple uses. This measure attempts to find out the deviation of actual water use from the so-called maximum (frontier) use of water that can be realised. It is, therefore, important to know how far one is off the production frontier at any point in time, and factors that would assist to reach the frontier. The same procedure is adopted to examine performance of water use in agricultural sector.

Efficiency cannot be measured directly and inefficiency is inherently unobservable. This means that estimates of efficiency and inefficiency have to be derived indirectly, after taking account of observable phenomena. In crude terms, this involves the following process:

- measuring observable phenomena (outputs, inputs);
- specifying some form of relationship between these phenomena;
- predicting ‘efficient’ behaviour, according to the definition of productivity function;
- calculating the difference between each unit’s observed data and the maximum achievable as predicted by the specified relationship;
- defining this difference (or some proportion of it) as inefficiency.

Given this background, Frontier method is used to study productivity of water use. According to the frontier approach, inefficiency is identified with the error terms in a regression model. A frontier model can be written as:

\[ Y_t = \alpha + \beta X_t + \varepsilon_t \]

where \( Y \) indicates output, \( X \) is a vector of explanatory variables, and the residual \( \varepsilon \) represents the deviation between the observed data and the relationship predicted by the independent variables in the model. \( \varepsilon_t \) represents inefficiency. Here the estimated parameters or function represents ‘best practice’ technology. To estimate frontier, one has to

- Identify a dependent variable – output (\( Y \))
- Specify a set of explanatory variables (\( X \)) that are thought to explain or predict differences in output.
- Interpret residual differences between observed and predicted output as arising
from either measurement error or inefficiency ($\varepsilon$).

This model can be expressed in linear form as follows. In our final model we consider

$$\hat{Y}_t = \alpha + \sum \beta_i X_t$$

Where the equation below will give the error term ($e_i$) between the actual and the estimate

$$Y - \hat{Y}_t = e_i$$

$e_i$ (error term) Maximum error if added to the intercept determines the frontier level of production.

$$\hat{Y}_{t \text{max}} = (\alpha + e_{it \text{max}} + \sum \beta_i X_{it})$$

The final major decision concerns how to interpret the residual $\varepsilon$ from the estimation model. The residual captures the difference between observed output and that predicted by the set of independent variables included in the model. In most applications of multiple regression, the residual is not afforded special attention, interest being focussed on the relationship between the dependent and independent variables. But in the parametric approach to efficiency analysis, special attention is placed on the residual, which is interpreted as representing inefficiency. But the precise interpretation depends on whether the model is estimated using Corrected Ordinary Least Square (COLS) or Stochastic Frontier Analysis (SFA).

**Figure 1.2**

**Illustration of a Stochastic Frontier**

Under the COLS approach, the organisation with the highest residual value is defined as being fully efficient – its output is both higher than that predicted by the model and higher than that for any other observation, holding constant the variables in the model. This implies that the efficiency frontier is located by shifting the regression line so that it passes through this fully efficient observation. This is illustrated in figure 1.2, where curve of the frontier (FF") is efficient. The inefficiency of the remaining observations can be measured by their vertical distance from this frontier, as shown for observation A and C.

The problem with the COLS approach is that it fails to recognise that the residual may be contaminated by measurement error. If so, it would be inappropriate to interpret the entire residual as representing inefficiency. SFA has been developed as a means to separate the residual into two components, inefficiency and error. Figure 1.2 provides a simple illustration of the technique. The stochastic frontier (FF") has two notable features. First, it does not correspond to the ‘line of best fit’ through the observations that would be produced by a simple linear regression model. Second, the frontier does not (necessarily) pass through the observation that produces the maximum level of output conditional upon input (observation C). This is because the frontier is estimated after recognising that the difference between observed output and the level of output predicted by the explanatory variables is not due solely to inefficiency. Some of the difference may be due to measurement error and omitted variables. In the figure below, observation C lies above the estimated frontier. The distance of this point from the frontier is attributable to measurement error. For observations lying below the frontier, the distance comprises both measurement error and inefficiency, as illustrated for observation A.

1.6. METHODOLOGY OF THE STUDY

Selection of the reservoir for this study is done after analysis of all multi purpose projects in Gujarat. Before a reservoir project could be selected for study, two conditions had to be met. Firstly, water must be a scarce commodity and secondly there should be competitive claims on water. The Dharoi reservoir project has been chosen for this study because inherent in it are all sorts of phenomena associated with the water sector like water scarcity, multiple claims on the use of water from irrigation and drinking sector, depleting groundwater level, along with dynamics of water distribution by user based institutions like WUAs and municipalities. This project has a total catchment area of nearly 22 thousand sq. kms, out of which 18 thousand sq. km
is in the state of Gujarat and the rest in Rajasthan. In Gujarat, the drainage area of the
river covers parts of Sabarkantha, Banaskantha and Mehasana districts. Out of the
total water available in the reservoir, major share is consumed by the agriculture and
drinking water sectors. Map 1 shows catchment area of the Dharoi Reservoir Project

Data Collected from Municipalities: Local bodies are involved in the management of
water in the drinking water sector. Case studies on water use in drinking water sector
are used to examine water use from the Dharoi reservoir. These are: (a) Unjha
Municipality (b) Kheralu Nagar Panchayat (c) Siddhpur Municipality (d) Vadnagar
Nagar Panchayat (e) Palanpur Municipality. Information like water demand, supply to
various uses, water withdrawals from various sources, water charges collected and so
on was sought with the help of structured survey schedule after a series of interviews
with Chief Executive Officers of various municipalities. In addition, secondary
information on Ahmedabad city and other towns and villages of the study area were
collected from Public Health Department (PHED), Palanpur and Gujarat Water Supply
and Sanitation Board (GWSSB), Visnagar. Information on costs and revenue earned
from various sources were also sought. Data on population of urban towns was
collected from the Census of Gujarat.

Agricultural Data: In order to examine the performance of water use in agricultural
sector, primary survey of households was undertaken. As Government of Gujarat is in
the process of passing legislation to transfer irrigation management to WUAs,
households from WUAs were selected. Three WUAs were chosen. The location of
these WUAs in the canal command formed one of the criteria of selecting these
WUAs. WUAs in the head reach, middle reach and tail reach were given proper
representation. Other criteria of selection are degree of dependence on canal and
groundwater and at least two years of experience in managing water distribution by
farmer members. Total of 90 households were selected, thirty in each WUA for the
extensive household study. For the selection of the sample household, stratified
random sampling of members of WUAs was considered. They can be divided into
three categories - (a) operational holding up 1.0 hectare; (b) 1.01- 2.50 hectare; and,
(c) 2.51 and above. In each WUA, 10 households each were interviewed in each of the
three land-size classes. In the event of inability to locate thirty households among the
categories a and b, the sample size was complemented by interviewing households in
the lowest range of the next category of households. In all categories interviews were
held with the member of household actively engaged in farming.
In order to study contribution of water to farm households, the study examines gross return obtained from crop production by households. In order to probe further, the analysis is based on the cost of cultivation data in *Kharif, Rabi* and *summer* season for the normal agricultural year (2003-2004). The data regarding farm inventory like cropping pattern, labour employment, variable cost, farm product, expenditure on fertilisers, manures and so on were collected. Crop wise data was collected for all seasons and farm sizes along with detailed information of inputs and outputs. Information of irrigated and unirrigated crops was obtained separately. Information on cost incurred on various inputs like labour (hired and family), machinery, fertiliser, pesticides, manure, seed, and water was obtained. Information on yield of main crop and by product along with its price, quantity used for home consumption and sold in the market was obtained separately.

Farm sector uses canal and groundwater for irrigation. Both these sources are managed by different institutions i.e., WUAs are in charge of distribution and management of canal water and tubewell companies for ground water. Therefore, there was a need to seek information on performance of water use in both these institutions. A rapid assessment of WUAs formed in Dharoi canal command was undertaken. Selection of WUAs was based on stratified random sampling method. This was followed by pre-testing of questionnaires. We took one third of the total 40 WUAs in the canal command for an in-depth survey. WUAs were selected in proportion to the total number of WUAs lying in the head; middle and tail portions of the irrigation systems. Thus, 13 WUAs were selected: Kiyadar and Malekpur in the head reach of the canal, Rangpur, Upera, Hajipur, Umata WUA in the middle reach and Thalota, Jetalvasana, Hasanpur-Khodiyar, Khandosan, Dasaj, Rajgadh, Khandosan, Vanagla in the tail reach of the canal command (shown in Map 2). Performance of these WUAs is studied by examining indicators that throw light on processes and the impact of IMT. These indicators are grouped under two heads namely (1) institutional enabling indicators and (2) institutional sustaining indicators. Data related to financial status, membership, command area, problems pertaining to command area, methods adopted to solve them and other related details of selected WUAs were corroborated from discussion with committee members and presidents of the respective WUAs. This along with other information about their perception about change in situation before and after WUA in activities like water distribution and management, role of WUAs in water distribution and management, farmer’s perception regarding role of pricing in improving efficient use of water and so on are sought in detail.
Determinants of Water Use in Agricultural Sector and Drinking Water: Sector wise analysis gives various determinants of water use in agricultural and non-agricultural sector. Water use for drinking water purpose is influenced by several factors such as population density, income and water prices. Information is sought for total demand and amount supplied by the department along with water rates fixed, water charges for various uses, water withdrawals from various sources, solid waste and effluents discharged in water bodies along with its impact on water quality.

In agricultural sector, efficiency equation throws light on productive efficiency of production of crops by household by adopting best practice techniques, which involve efficient use of inputs. Enterprise demonstrates productive efficiency if a given level of output is produced using least cost methods of production. Such an analysis reveals the ability of farmers to pay for water by examining factors governing gross return. This helps to understand measures required by households to arrive at the production frontier. Factors considered a priori affecting the gross returns from growing crops can be broadly classified into three groups: (a) material inputs include seeds, fertilizers, and pesticides; (b) machine inputs like tractors, thresher and other equipments used during agricultural activities and (c) other factors like use of bullock hours, yield per hectare, total watering, standard labour days and cropping intensity. Productivity efficiency is analysed at crop level. Crops grown in all seasons and by all size groups are aggregated at the household level.

On the aspect of understanding impact of water on crop cultivation, crops are divided into two heads; viz. irrigated crops and unirrigated crops. The crop level analysis is carried out for major crops grown by various farm size groups using water from various sources. Such an analysis will complement findings from household level analysis.

1.7. ORGANISATION OF THE STUDY

Along with the present chapter, the study is divided into seven chapters;

Chapter 1 begins with the introduction of the present situation and subsequently talks about the scope of the study, objectives of the study, literature review, conceptual framework and issues related to methodology.

Chapter 2 discusses the characteristics of the Dharoi Reservoir Project. Using aggregate data at the macro level, an analysis of factors associated with water use at...
the Project level is presented. We also explore some of the existing water allocation patterns at the reservoir level during peak and lean periods. Clear tradeoffs between agricultural and non-agricultural water use were evident in lean period. This chapter also shows the gap between actual and potential water use at the reservoir in lean and peak seasons.

Chapter 3 examines the contribution and performance of water use in municipalities in improving the efficiency of water use. The performance of water use in drinking water sector is examined with the help of case studies. Results of this classified analysis not only point out the relative performance of municipalities but also the intra-municipal dependence and conflicts. Performance of water supply is observed by identifying variables like water revenues earned, cost incurred in supplying water, demand and supply of water among its users and so on. We also examine the effects of supplying water as per the Basic Water Requirement (BWR) norms on water use efficiency and poor recovery of water charges on operation and maintenance of water networks.

Chapter 4 analyses performance of water use at farm level. Performance indicators show the efficiency in resource use and assess the potential outcomes that can be achieved under given institutional conditions. Household level analysis throws light on productive efficiency of farmers and explains best techniques that could bring about efficient use of inputs. Such an analysis shows the ability of farmers to pay for water by examining factors governing gross return. Water is one of the inputs in production of crops so its contribution along with that of other inputs to gross returns is examined. This chapter also points out that intervention like participatory irrigation management can be complemented by improving extension services, market access and market-related facilities which are inadequate at present. Such services, it is believed will be able to improve the bargaining power of farmers in the input and output markets.

Chapter 5 examines productive efficiency of crops cultivated by farm households. With the help of crop level analysis, the chapter tries to understand water use details from various sources and analyse factors influencing it. Analysis shows that productive efficiency of farmers relying on both canal and tubewell is marginally better than that of crops depending solely on canal source. This chapter focusses on the need to reorient extension workers so that they could provide specialised and more focussed information to farmers regarding new technologies and resources and also advice about judicious utilisation of scare resources.
Chapter 6 addresses specific issues of sustainability and replication possibilities of IMT programmes. More particularly, this chapter analyses conditions that constrain the functioning of WUAs and the need for reform measures. We also examine type of institutional conditions that are conducive to sustain high performance in gravity irrigation systems, which are currently owned by government but managed by WUAs.

Chapter 7 summarises the main findings and discusses some ideas that could be implemented to promote efficient water use. This study stresses conflicts over farm and drinking water use and suggests devices for resolving these constraints.