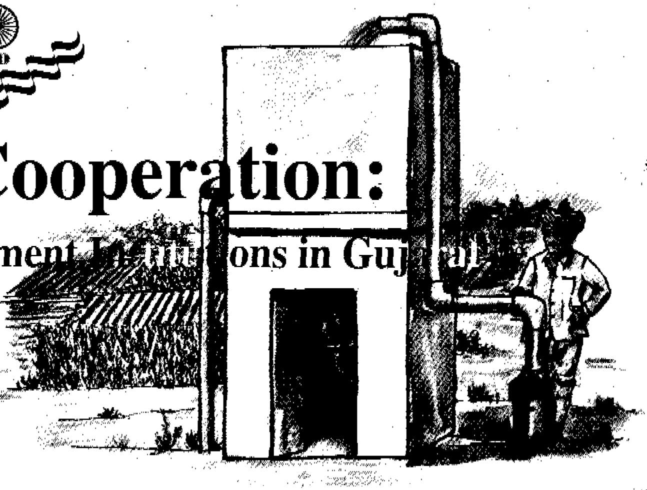
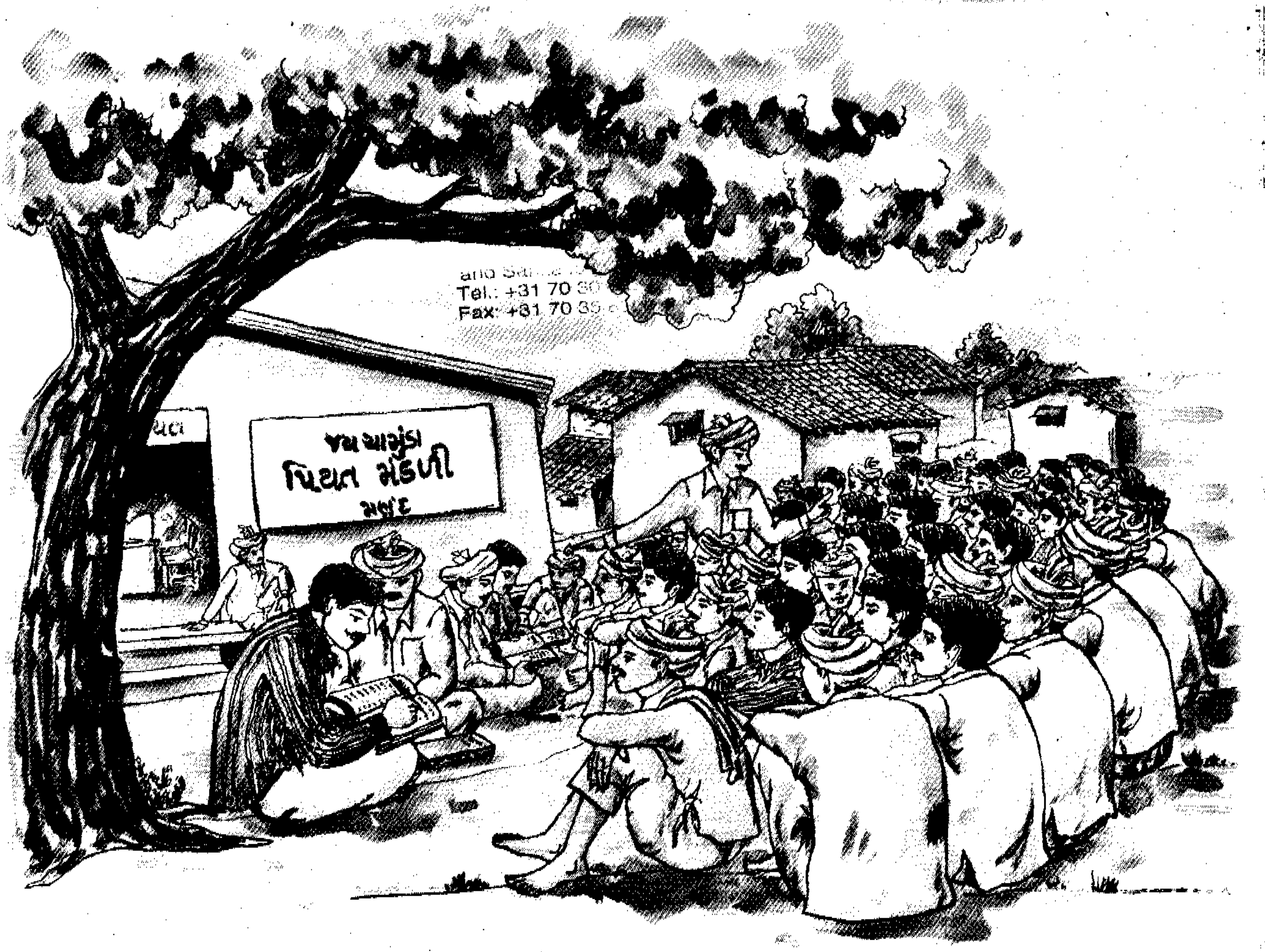


Banking on Cooperation:

A Study of Irrigation Management Institutions in Gujarat



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13 **Banking on Cooperation: A Study of Irrigation Management Institutions in Gujarat** by M. Dinesh Kumar, Shashikant Chopde & Anjal Prakash (E)

E = English G = Gujarati

Banking on Cooperation:
A Study of Irrigation Management Institutions in Gujarat

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Foreword

In the recent past, there has been substantial amount of empirical research on groundwater markets in India. Most of these researches look at the water market configurations, the operating principles and their impacts on access equity in groundwater and the efficiency with which groundwater is used. As a result, there are enough evidences to suggest that different configurations of water markets have differential impacts on access equity in groundwater. The groundwater irrigation organisations in Mehsana district of North Gujarat are found to be different from those operated by private well owners and the private tube well companies in terms of the configuration of water markets and operating principles.

A study was carried out in a village called Manund in Mehsana district of Gujarat where a large number of groundwater irrigation organisations are functioning. The outcome of this study related to physical and organisational features of groundwater irrigation organisations and its institutional characteristics. In addition, the study also focused on the physical & financial performance, equity and efficiency of these groundwater irrigation organisations and also their socio-economic impacts. The study provides fairly deep insights into the factors which are critical to designing irrigation management institutions which can promote equity in access to groundwater and efficiency. I am sure, this study will be of immense use to academicians, researchers, policy makers and field practitioners working on issues related to irrigation management transfer and groundwater management. We would appreciate your valuable comments/suggestions.

Srinivas Mudrakartha
Director

Preface

World over, there has been enormous amount of qualitative and quantitative research on the economics and socio-economic aspects of groundwater irrigation during the past decade or so. In India, groundwater irrigation, which accounts for more than 50% of the net irrigated area and 75% of the agriculture production from irrigated areas, plays a crucial role in the rural economy. Groundwater markets, which are extensive in many parts of rural India, have played a key role in expanding irrigation leading to improvement in the rural economic conditions. In the past, researchers have attempted to examine the configurations and behaviour of ground water markets in different parts of the country.

The growing problems of depletion of groundwater resources occurring in many parts of the country have been attracting increasing attention from researchers and policy makers. Depletion, in the long run, threatens the sustainability of agriculture and the dependent communities as the poor farmers whose wells are affected either have to depend on the neighbouring well owners for water or shift to rainfed agriculture. Now, it is a truism that water markets tend to be more pervasive in areas where groundwater resources continue to be depleted. As a result, the studies on water markets have attempted to examine their potential impacts on access equity in groundwater and the efficiency with which groundwater is used. Today, there are increasing evidences to suggest that different configurations of water markets have differential impact on access equity in groundwater.

Water markets are the organising features of the agrarian economy of Gujarat. Well-developed groundwater markets are existing in north Gujarat for the past few decades. The water markets operated by the groundwater irrigation organisations found in Mehsana district of North Gujarat are different from those operated by individual well owners and the private tube well companies with the configurations of water markets and the price at which water is sold and the operating principles. These water markets are people's institutions. For researchers working on irrigation management institutions, it is of great interest to know the principles on which these institutions are evolved and are functioning to gain insights into the factors which ensure sustainability of the institutions and promote equity and efficiency.

In this context, a study was carried out in a village called Manund in Mehsana district where a large number of groundwater irrigation organisations were found to be functioning. While water markets were just one aspect of these organisations, equity in resource allocation is another aspect. The findings of the study are with regard to the physical and organisational features of the groundwater irrigation organisations (GWIOs), the institutional characteristics, the physical and financial performance, and the equity, efficiency and their socio-economic impacts. The study provides enough insights into the key factors which facilitate emergence of economically and financially viable irrigation management institutions which can promote access equity and efficiency.

Contents

Banking on Cooperation:
A Study of Irrigation Management Institutions in Gujarat

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Abstract

Water markets are the organising features of the agrarian economy of Gujarat. Well developed groundwater markets are existing in north Gujarat for the last many decades. The water markets operated by the groundwater irrigation organisations found in Mehsana district of north Gujarat are different from those operated by individual well owners and the private tube well companies in terms of the configurations of water markets and the price at which water is sold and the operating principles. These water markets being people's institutions are of great interest to researchers working on irrigation management institutions to know the principles on which these institutions have evolved and are functioning to gain insights into the factors which ensure sustainability of the institutions and promote equity and efficiency.

In this context, a study was carried out in a village called Manund in Mehsana district where a large number of groundwater irrigation organisations were found to be functioning. While water markets comprise just one aspect of these organisations, they were also found to be working on the principles of equity. The study shows excellent irrigation, financial & economic performance –high economic outputs & water use efficiency— of these organisations. The study also shows that these organisations display all the characteristics of a strong and effective institution for managing a shared resource with regard to the rules and regulations they frame, the level of awareness among the members of the group about the organisation's functioning, the transparency in decision making and the conflict resolution mechanisms.

The study provides enough insights into the key factors which facilitate emergence of economically and financially sustainable irrigation management institutions which can promote access equity and efficiency in resource use. They are: 1) configuration of the water market; 2) the water rates; and 3) share holding pattern. The water markets are such that they largely provide irrigation services to the member farmers; the percentage non-shareholder farmers covered in the command is very small. The water rates charged by the companies are very much lower than those charged by the tube well companies and reflect only the operational cost of the systems. The share-holdings are more or less even across the irrigated command unlike in the case of private tube well companies where share-holding is skewed towards a few big farmers.

Backdrop

In a rush over the last century to expand the area under irrigated agriculture, governments world-wide have constructed thousands of expensive irrigation systems and have spent roughly US $ 15 billion per annum for irrigation development since 1950s (IIMI, 1993). Irrigated agriculture produces one third of world's food demand and in Asia it contributes to about 40% of the Region's food production (FAO, 1997).

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In our country, in order to achieve self sufficiency in food and boost agriculture production, investment in irrigation was treated as a major development priority. Since 1950, many major, medium & minor irrigation schemes were built in our country. As a result, during the period from 1951 to 1990, the net area under irrigation increased from 21 million hectares (m. ha) to 46.2 m. ha. recording an annual growth rate of 0.625 m ha. The investment made by the country in the irrigation sector during the Eight Plan period to achieve this development was in the order of Rs. 53,900 crores[4] (Vohra, 1994). These include, the major, medium and minor surface irrigation schemes and state owned tube wells.

Of late world-wide, the tide of expenditure for new irrigation development suddenly began to wane. Decreasing funds for agriculture development, disappointment with rapid deterioration of the systems and growing acknowledgement of farmer management capacities, have led to enactment of policies to turn over management of irrigation systems from government agencies to farmers' associations (IIMI, 1993).

The growing inability on the part of the irrigation bureaucracy to run and maintain irrigation systems and provide good quality irrigation services to the farmers has increased the financial liability on the part of the state irrigation departments. Transfer of management functions to farmers' organisations is increasingly being viewed as a viable alternative to addressing many of the problems facing the irrigation sector in the country today. Policies are being framed and enacted by various states across the country to facilitate farmers' participation in the management of large and small surface irrigation systems which is aimed at addressing the issues of access equity and efficiency and sustainability in water use apart from solving the problems of poor system performance.

Such policies have failed to evoke significant responses and create impact in terms of the number and extent of decentralisation and local capacity building which could be facilitated (Kumar, 1996). The state tube well programmes throughout the country are running poorly in comparison to the private tube well owners and water markets (Shah, 1989) in terms of the average area irrigated and the life of the tube well. In many areas, groundwater markets (GWMs) have come up as a response to growing degradation problems and the associated negative social and economic impacts on the agriculture dependant communities (Gass, Kumar & Mac Donald, 1996).

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4 1 Crore = 10 million

Many researchers, in the past, have opined that groundwater markets are "People's Institutions" and have little interface with the State as in the case of canal irrigation and public tube well companies and that they exist in many different configurations. They have largely considered that it is the short term, private, and technical rationality of pump owners and buyers which provide the driving force for such an institution. Again, there is considerable amount of consensus among the researchers that water markets of different configurations have differing impacts on equity and efficiency (Shah, 1995). So far, research on groundwater markets have thrown evidences on the instruments that can be used to influence the behaviour of the farmers and the ways these instruments affect the working of GWMs. Some believe that they could be a powerful institutional mechanism for addressing issues of access, equity and efficiency if water rights are well defined (Kumar, 1997; Chaudhary, 1996).

Parallel to the water markets are the irrigation organisations formed by farmers' themselves. They cater to the needs and interests of a large number of farmers who do not have adequate resources to invest in large and expensive systems for extracting groundwater for irrigation. The configuration of these water markets is different from the conventional groundwater markets (GWMs) operated by individual well owners and tube well companies in a way that most of the farmers who buy groundwater are also shareholders in the well. Nevertheless, water market is just one aspect of these irrigation organisations. Understanding the institutional characteristics of these organisations and the ways in which they function could provide insights into the driving force behind farmer organising— the key criteria for designing effective irrigation management institutions.

While it is understood that such learnings could find immediate takers in surface irrigation, their potential application in the groundwater sector needs to be thought about. This assumes significance in the face of widespread problems of groundwater over-development resulting from lack of any legal or institutional framework to regulate the development and use of the resource by the farmers. The need to involve the communities to manage the resources is increasingly being recognised at various levels.

The groundwater irrigation organisations existing in the village called Manund in Mehsana district of Gujarat display strong and vibrant characteristics of farmers' institutions in irrigation development and management. This is with respect to the rules they frame, the principles on which they function and their physical and financial performance. The paper covers the findings of a study carried out by VIKSAT on 10 such groundwater irrigation organisations which was carried out to understand: 1) the physical features of the systems; 2) the organisational features of the groundwater irrigation organisations; 3) their institutional characteristics; 4) the physical & financial performance; and 4) their socio-economic impact.

Groundwater Irrigation in Mehsana

Physical Setting

Physical Characteristics of Groundwater & Irrigation

Mehsana is one of the intensely cropped districts in Gujarat. Of the total geographical area of 0.901 Mha, the net area sown is 0.605 Mha and the gross cropped area is 0.815 Mha . The net irrigated area in the district is 0.26 Mha. Groundwater accounts for 97% of the irrigated area in the district (GEC, 1993). Most part of the district is underlain by multi-layered alluvial aquifers (with intermediate sandy and clayey layers) extending up to 600 metres in the central part. They form one of the richest aquifer systems in the country like the aquifers of the Indo-Gangetic plains. Extraction of groundwater is mainly through open wells, dug cum bore wells (in the north-eastern part of the district), and deep tube wells. The district is punctured by a large number of deep tube wells (numbering around 12,000) which pump water from depths ranging from 120 metre (400 feet) to 150 metre (500 feet) using pump-sets of capacity ranging from 50-100 H.P.

Emerging Groundwater Problems

Over-development of groundwater for irrigation has resulted in many problems. These include falling groundwater levels and deteriorating groundwater quality. The large drop in water levels in the upper unconfined aquifers have resulted in the drying up of thousands of open wells. Uncontrolled extraction from deeper aquifers through deep tube wells using large capacity pumps coupled with frequent droughts has resulted in mining of aquifers. In parts of Mehsana district, the annual rate of decline of piezometric levels has increased from about 1 m till 1970 to between 5 and 8 m during the last few years (GOG, 1992). This results in perpetuated increase in pumping depths and reduction in well yields. The net effect is the enormous increase in the investment for well construction and cost of extraction of unit volume of water.

Increasing fluoride content of groundwater due to the recession of water levels is also emerging as a serious problem in many parts of Mehsana district in north Gujarat. This has a strong negative impact on health as continuous human exposure to high fluoride water for drinking leads to health hazards like dental and skeletal fluorosis (Kumar, 1997). Around 600 villages in Mehsana are reported to be facing the problem of high fluorides in drinking water (Bhatia, 1992). Apart from the direct economic impact on the farmers and the health impacts, depletion of groundwater has strong implications for equity also, as the resource poor farmers whose wells are dried up loose their access to the resource.

Social Setting

Water Markets

Water markets are the organising features of agrarian economy of Gujarat. Well developed water markets are existing in Gujarat for the last six to seven decades and have become more pervasive and important after the introduction of modern water lifting devices (Shah, 1989). Groundwater markets are common both in the water scarce Mehsana and in the groundwater abundant Kheda district. But the individual use pattern vary widely. In Kheda district, for instance, selling water is the prime motive behind investment for well construction. While in Mehsana, well owners sell the excess water to the neighbouring farmers who do not have wells or whose wells have dried up. Groundwater depletion has contributed to this widespread phenomenon in areas like Mehsana. With the water levels falling every year, and the investment for well construction touching astronomical levels, more and more farmers become vulnerable to it. The only way they can sustain their irrigated agriculture is to buy water from the neighbouring well owner.

The water markets function in two ways. In the first one, water is sold on hourly basis. The water charges are largely decided by the discharge of the wells which is a function of the pump horse power given that the hydro-geological environment and the other physical characteristics of the wells remaining the same. In such a market, the ability of a buyer to irrigate his/her field depends largely on the sellers' willingness to share water. It has been understood that in situations where the buyer pays for water on an hourly basis, he/she often faces problems with delays in delivery of water in the fields and as a result, crops often gets affected. Due to this reason, the farmers are forced to minimise the watering for their crops at the cost of reduced crop yield.

In the second case, water is sold on crop share basis. Along with water , the well owner provides fertilisers and other essential inputs. Though the option of sharing one third of the crop yield with the well owner guarantees adequate and timely water delivery, this is economically less viable for the buyer. During discussions with some of the farmers in Mehsana, it has been found that large well owners prefer to charge water on an hourly basis and do not care for providing other services to the buyer (Kumar, 1996).

Tube Well Companies

Another social phenomenon which emerges out of groundwater depletion is the tube well companies. This is common in many parts of Mehsana and Banaskantha districts. With the water levels falling and the cost of well construction becoming high, farmers in these areas invest in partnership wells. They lay out underground pipe lines for conveyance of water from the tube well location to the member farmers' fields. The size of share holdings of the partner often depends on the size of the land holding. Tube well companies with a membership of 30 -50 farmers is very common in Mehsana district. These tube well companies are profit making companies, but are not registered under the Companies Act. Each shareholder in the company gets a dividend from the profit every year which is proportional to the value of the share.

In situations where the total land holdings is less than the capacity of the well to irrigate (which is most often the case), water is also sold to other farmers who are not shareholders but whose fields fall within the command of the well. As the marginal cost of extraction under the flat rate system is zero, this is one of the ways of coping with the high cost operation of tube wells. However, with the well yields going down every year, and the power supply restricted to a maximum of 12 hours per day, it becomes practically difficult to provide adequate irrigation to the entire command area. In such cases, water is allocated proportionately amongst the member farmers on the basis of the share-holding size. The water rates were also seen to be fluctuating over seasons. Normally, the buyers are assured of the quantity and reliability in supplies.

In situations of reduced well yields, the irrigation services offered to the small share-holders become unreliable and poor. As a result, they deny the payment of water charges leading to conflicts. The result is the breaking up of partnerships. The farmers who break away from the partnership either mobilise resources to form their own wells, or start buying water from the neighbouring commands to irrigate their fields. It has also been found that profit motivated individuals who could mobilise huge amount of resources invest in deep tube wells and sell water to the needy farmers.

Goal and objectives of the Study

The goal of the study is to understand the range of physical, socio-economic and institutional factors which facilitate the existence of vibrant groundwater irrigation institutions as found in Manund village of Patan taluka of Mehsana district in Gujarat.

The study has the following major objectives:

- to study the physical features and functioning of the groundwater irrigation organisations in Manund;
- to understand their institutional characteristics;
- to study their physical & financial performances for the year 1996-97; and,
- to assess their socio-economic impact in Manund village.

Methodology

The field studies involved 10 tube well irrigation organisations operating in Manund village of Patan taluka in Mehsana district and consisted of personal interviews with the key people in the organisations -including the operators, the shareholder farmers-, and the farmers who are not members but buy water from the tube well company. The study also covered interviews/ discussions with the cross section of the village community which include the farmers who do not get water from the tube well companies and the land-less apart from meeting with key persons in the village. It also involved extensive use of the records maintained by the companies since their inception.

The institutional characteristics of the groundwater irrigation organisations were analysed by studying the organisational features & functioning, the institutional design framework, the degree of equity in resource allocation and resource utilisation efficiencies.

The socio-economic impacts of the groundwater irrigation organisations were analysed by studying: 1) the historical changes in agricultural practices; 2) the direct economic impact of water markets on the farmers; 3) the overall economic performance of the groundwater irrigation organisations; and 4) the social change.

Groundwater Irrigation Organisations in Manund: Historical Foundations of Cooperation

The village Manund is located in the south of Patan taluka in the district of Mehsana. The village has a geographical area of 8,000 *vigha* and a population of around 10,000 people. The cultivated land in the village spreads over an area of 5,000 *vigha* of which 4,000 *vigha* is irrigated. The entire irrigation is from groundwater which is done through 40 odd tube wells spread across the village. It was intriguing to find that of the 40 tube wells, 35 are run by farmers organisations which are locally known as irrigation *mandalis* in spite of the fact that many of the farmers who were members of these organisations are rich enough and had sufficient resources to afford their own tube wells. Each company is named after a god or goddess of worship of the local people. Though they are known as *mandalis* (meaning co-operative), none of them are registered under the co-operative act, but were claimed to be functioning on co-operative principles.

Overall, these tube well irrigation organisations showed major variation from the private tube well companies found elsewhere in Mehsana in terms of the extent and the basic principle on which they operate[5]. Further inquiry into the emergence of these farmers' organisations took us to one of the oldest farmers in the village named Lallubhai Khemchand Patel. Shri Lallubhai Khemchand Patel, a man in his early seventies, was the founder *of Uttar Gujarat Rashtriya Samaj Sewa Mandal*, Manund Village, Patan taluka. Mr. Patel is still active in the development activities of the village with great enthusiasm. The following is the history of co-operative movement in the village as narrated by him, during the discussion.

It was early '60s Shri Lallubhai, inspired by the Sarvodaya Movement, wanted to work for the upliftment of Manund and the neighbouring villages. First, he started talking to the villagers about the different government sponsored rural development programmes. For this, he founded *Uttar Gujarat Rashtriya Samaj Sewa Mandal*. The first question which was confronted by the *Mandal* was the problem of agricultural development in the village for which irrigation was a necessity.

During the '50s and the '60s, there were 60 oil engine operated wells in the village for irrigation. The water was extracted only from a depth of 40-50 feet through shallow open wells. Each well could irrigate around 150 *vighas* of land. But, with the extraction many times exceeding the average annual recharge, very soon the wells got dried up and farmers faced problems in irrigating their crops. In 1962, around 20 farmers came together

5 While the water markets operated by the private tube well companies were largely monopoly markets, those found in the tube well irrigation organisations were competitive.

and constructed four tube wells with financial assistance from the Land Development Bank. They could irrigate around 800 *vighas* of land with these tube wells which were run by them on co-operative principles. This pioneered the system of farmers' irrigation organisations in the village. What followed was the emergence of more number of farmers' organisations in the village on similar patterns in the early '70s.

Discussion

The general features (physical & organisational) of the 10 groundwater irrigation organisations are presented in Table 1.

Physical Characteristics of the Systems

The wells

The system comprises of a tube well with depth ranging from 180 metre (600 feet) to 210 metre (700 feet). The diameter of the well also varies from 20 cm (8 inch) to 24 cm (10 inch). The depth of water level in the well was said to be varying from 120 metre (400 feet) to 135 metre (450 feet). The pump horse power varies from 60 H.P. to 75 H.P. with 75 H.P. pumps found in four cases. The hours of power supply often vary from 10 to 12 hours a day and the time schedule changes once in every fortnight from between 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m. As regards the age of the systems, the oldest system is 13 years old and the youngest one is just 2 years old. Many of the new systems are re-drillings of the old ones. This is evident from the fact that all the eleven blocks (talukas) in Mehsana district are falling in the "over-exploited[6]" category due to which electricity connection for new wells is denied by the State Electricity Board.

Command Area

The command area of the wells was found to be ranging from a minimum of 100 *vighas* to a maximum of 210 *vigha*. This variation can be attributed to the variations in the physical characteristics of the system such as the well depth, well diameter, pump horse power, pump efficiency, pumping depths etc. While most of the irrigation takes place during winter, a small area (mostly fodder crops) is irrigated during summer and there is no irrigation during Kharif season.

6 The blocks where the estimated average annual extraction exceeds estimated average annual recharge.

Distribution Network

The wells have a very dense distribution network which consists of underground pipelines, division and diversion boxes. Each system was found to be having four distribution lines, but only two lines are on at a time with the division box splitting the discharge into two portions (*rela*). The number of diversion boxes (to divert the water from the distribution line to the field) is sometimes as high as 75. The total length of the distribution lines varies from 1.2 km to 3.0 km and the diameter of the pipe is normally 25 cm (10 inches) to 30 cm (12 inches).

The density of distribution network was found to be much higher than found in the case of the tube well irrigation systems set up by GWRDC[7]. The dense distribution network helps reduce the time lag in watering across farms significantly and thereby increases the ability of an individual farmer to provide timely and adequate watering to his/her crops. This, to a great extent, prevents crop failure due to delayed watering. Contrary to this, in the case of GWRDC tube wells, the tube well command area and the number of beneficiaries are often large. As a result, the farmers in the tail end fields are forced to delay the first watering by a few weeks, since the starting of irrigation for the season, which is at the cost of adequate number of watering for the crop and crop production.

Crops & Cropping Pattern

The crops grown in the command areas of the irrigation systems in different seasons show a mix of food crops, cash crops and fodder crops. In Kharif, bajara and juwar are sown. In winter, wheat and mustard are grown. In summer, farmers grow alfalfa in small patches for fodder. The cropping pattern is skewed towards food crops in Kharif which is fully dependant on rainfall. It is a common phenomenon in the area that Kharif crops fail due to lack of adequate and timely rains. The winter cropping patterns are skewed towards oil seed cash crops.

Features & Functioning of the Irrigation Organisations

Shareholders/*Bhagidars*

The irrigation organisations found in Manund are mostly constituted by shareholders. The value of each share is decided on the basis of the total investment required for the system and the approximate potential irrigated command area and is calculated by dividing

7 In the case of GWRDC tube wells, only one distribution line was found to be running against two in the case of the tube wells in Manund.

the system cost by the potential command area. The number of shareholders in the groundwater irrigation organisations studied vary from a minimum of 23 to a maximum of 76.

Each share purchased by the farmer gives the right to irrigate one *vigha* of land. Therefore, the total number of shares is equal to the total land area (in *vigha*) of the shareholders to be irrigated by the system. In another pattern of irrigation organisations found in the same village which is locally known as *Bhagidari* system, the value of each share is fixed and the number of shares purchased by the farmer/ individual does not necessarily indicate his/her land holding in the command.

The shareholders constitute the general body of the organisation. The general body normally meets once in an year. Important matters like the constitution of the management committee, water charge fixing, water distribution pattern etc. are discussed and finalised in the annual general body meeting. The company's annual accounts statements (profit/ loss, balance sheet) are also presented in the meeting.

Other Beneficiaries

The farmers whose lands are falling within the command of the irrigation system, but are not shareholders are the other potential beneficiaries of the irrigation system. However, water is sold to them at a price higher than that of the shareholders. All the irrigation organisations surveyed were found to be selling water to the non-shareholder farmers too. It was interesting to note that in the case of *Bhagidari* system, the price of water is same for both shareholders and non-shareholders.

Shareholder Land Holdings

One of the interesting features of the groundwater irrigation organisations was that the land holding size of the shareholders is very small and again the ownership of the entire command is skewed towards the small land holders. Many of the shareholder farmers were found to be having land-holdings close to an acre and less. As regards the land ownership pattern, the analysis of hard empirical data show that the shareholders with less than 5 % shares constitute 75% to 100% of the total number of shareholders.

To cite examples, we would like to present the case of two irrigation cooperatives. In one of the irrigation cooperatives *Jay Shree Bajrangbali Khedut Irrigation Mandali* with a shareholding of 149 and a total of 53 shareholders, number of shareholders with less than 5 *vigha* (i.e. 3.4 % share each) is 47 and constitute 77% of the total shareholding. Only 7 farmers have more than 5 *vigha* shareholding. In another irrigation cooperative *Shri Bhagyoday Khedut Irrigation Mandali* with a total share of 210 vigha and 62 sharehoders, the number of shareholders with less than 2 *vigha* holding (i.e. 1% share) is 19 constituting 10% of the share. Overall, those farmers with less than 10 *vigha* share (i.e. 5% share) is 60 constituting nearly 85% of the total share. This is a clear indication of the fact that small farmers have a greater stake in the irrigation cooperative.

Management Committee

Every irrigation organisation has a Management Committee (MC) including the Secretary and President. The Management Committee is responsible for running the company and is nominated by the general body. The number of members in the MC was found to be varying from 7 to 11 including the President and the Secretary. In many companies the management committee changes every year with one third of the members getting replaced. The committee deals with matters such as maintenance & repairs of the system, appointment of operator, revision of water charges, water allocation (fixing criteria), transfer of shares, payment of dividends and approval of budget & accounts. The committee meets whenever there is a need to take decisions regarding any of the above stated matters.

In some cases, the Secretary (who is a paid employee of the organisation) is a non-shareholder. The Secretary is responsible for collection of water charges, maintaining the accounts of all expenses, payment of discounts etc. The Secretary is a paid employee of the company and the annual salary of the Secretary ranges from Rs 2000/- to Rs 3000-

Water Allocation

Generally, the size of share-holding becomes the basis for water allocation among the shareholders. Every farmer is entitled for as much water as required to irrigate his share of the total share-holdings (in land area) in the command. The extra water, if available after allocating among the shareholders, is given to the non-shareholder farmers. However, in situations of poor monsoon (which results in increase in watering requirement per unit area) and cuts in power supply (which is most often the case), the companies are forced to cut down the irrigation service to the shareholders. Such decisions are always at the discretion of the management committee. In such cases, the *hours of watering* is fixed for each share (in land area). In many cases it was found to be varying from 4-5 hours per *vigha* of share-holding. This helps maintain equity in access to the resource when it becomes scarce.

It was found that the non-shareholders are also provided with irrigation services for all the years. The hours of watering for non-shareholders expressed as a percentage of the total hours of watering for the entire system was estimated to be varying from a minimum of 0.4 to a maximum of 31.1 across the irrigation organisations for the year 1996-97.

Water Delivery & Delivery System

The distribution lines which consist of underground pipelines take water from the main outlet to inlets of different fields. Diversion boxes kept near each field inlet (an individual land-holding will have at least one diversion box) are used to divert water from the distribution line to different field inlets one after the other. The use of underground pipelines help prevent seepage and evaporation losses during conveyance of water from the well outlet to the field inlets which otherwise would be very high if open channels are used as the distance of conveyance is mostly very long.

As two distribution lines are running at a time, the discharge at the delivery point will be half of the actual well discharge (half *rela* in the local language). An important observation made with regard to water delivery was that, in all cases, the delivery pattern changes periodically. While the delivery starts from head end to tail end in one year, it is from the tail end to the head end in the next year. This is made possible by the pressure flow maintained in the distribution system by the use of underground pipelines. Such a pattern of water distribution helps maintain equity in water allocation as the tail end farmers do not always suffer from delay in water delivery.

The water from the field inlet is taken to different plots in the field using field channels. The width of the field channels vary from 30 to 50 cm. The farmers were found to be using small level borders for irrigating the crops for the field crops such as wheat, mustard and alfalfa. The use of small level borders help achieve high field efficiencies—the field efficiencies include water distribution efficiency, water application efficiency and water storage efficiency—which are often as high as 80%.

Water Charges & Recovery

Each organisation charges on hourly basis for irrigation service. Again, it was found that the water charge normally fluctuates from winter to summer and minimum charge is levied in summer. The hourly water charges (for half *rela*) during winter was found to be varying from Rs 30/- to Rs 45/- for members and Rs 36/- to Rs 45/- for non-members. The water charge for summer was found to be varying Rs 15/- to Rs 24/- for members and Rs 18/- to Rs 24/- for non-members. The volumetric rates for water was estimated to be varying from a minimum of 0.07 to a maximum of 0.10 paise[8] per litre during winter for members against a minimum of 0.08 to a maximum of 0.11 for non-members across organisations. In summer the charges vary from 0.03 to 0.05 paise per litre for members where as it varies from 0.04 to 0.07 paise per litre for non-members.

Interestingly, it was found that the water charge is much higher than the normal rates in two situations. The first case is that of water being used by non-shareholders for growing cumin (*jeeru*). The reason is that farmers give only one or two waterings for cumin. The second case is that of water being used for non-agricultural purposes like brick-making.

Another interesting observation with regard to water charge is that they are generally much lower as compared to those found in the case of private tube well companies in Mehsana. A study, done in the year 1996, of 15 representative samples of private tube well companies spread across Mehsana district had shown that the hourly water rates are based on pump horse power (generally one rupee per unit horse power of the pump-set) and ranges from Rs 50- to Rs 90/ for pumps of capacity ranging from 50 to 90 H.P. (Agarwal & Raj, 1996).

Records of watering are maintained by the operator who is responsible to see that all fields get water as per the scheduling fixed. These records are then given by the respective farmer to the Secretary who collects the water charges. Payment of water charge is to be made before the *Vaishakh Poonam* which comes in the Month of May. However, those farmers who make the payment within 5 days of watering, gets a discount of 5% in the water charge. The discounts paid against early payment of water charges during the last year correspond to 7.9%, 14.1%, 20.2%, 23.4% and 11.3% respectively of the total water charges collected during the year for 4 irrigation organisations for which data were available.

In case, water charge is not paid before *Vaishakh Poonam*, the farmers have to pay the interest at a rate of 12%. Those who do not pay the water charges are denied of irrigation service in the next winter.

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8 100 paise = 1 Rupee.

Institutional Characteristics

The institutional characteristics of the irrigation organisations are studied by analysing the following attributes: 1) awareness; 2) rules and regulations; 3) equity in water allocation and efficiency in resource use; 4) transparency in decision making; and, 5) crisis management.

Rules and Regulations

All the irrigation organisations were found to have framed certain rules and regulations for their smooth functioning. The rules are with regard to water allocation, water charge, seasonal variations in water charges, payment of water charges (penalty for delayed payments & discounts for timely payments); payment of dividends; constitution of the management committee. The rules framed by these irrigation companies largely reflect the local specific situation.

Rules regarding seasonal water charge is a case to be cited here. One of the means by which the organisations can generate profits is to maximise the hours of irrigation & irrigation performance. But, the fact that the demand for water is only during winter reduces their ability to increase irrigation acreage to a great extent. As a result, they offer irrigation services at a highly discounted prices for both shareholders and non-shareholders. Again, some companies offer water at the same price for both shareholders and non-shareholders.

It was found that the rules are more or less strictly followed by the shareholders. In one case where the operator was found to have done malpractice in providing watering to the farmers, a penalty of Rs 50/- was levied on him and was subsequently removed from service.

Awareness

In general, it was found that the members are very well aware of, the physical characteristics of the irrigation system, the features & functioning of the organisation (in respect of the number of shares and shareholders), constitution of the management committee, the rules governing the company/organisation, (water allocation, water charges & their seasonal variations, water delivery pattern followed in each year, discount rates, annual rate of dividends), and overall financial status/ performance of the organisation.

Apart from this, the members are also aware of the resource degradation problems. They expressed their great concern for the issues related to the sustainability of the irrigation systems and the resource which are emerging out of the resource degradation problems. They were also found to be very keen on taking up measures to manage the resource (shift to efficient irrigation technologies from the conventional ones currently used). However, they had expectations from the government in terms of financial assistance so as to enable them carry out such practices.

Transparency in Decision Making & Functioning

The chances of success or failure of an organisation depends on the trust members have over the executive committee. This again depends largely on the transparency with which decisions are taken and the degree of involvement members have in the decision making process. Generally, it was found that the members are periodically updated about the major decisions regarding the running of the company (change in water charges, change in operator, increase in operator's salary, change in water delivery schedule, if any, change in Secretary, repairs or replacements of wells and distribution lines), and organisation's balance sheets through annual general body meetings and special meetings in case of emergency.

All the companies were found to be keeping the following records:

- salient features of the irrigation system and their cost aspects;
- details of shareholders (name of the shareholder, his/her survey number, the size and total values of shares);
- irrigation service provided to each shareholder on each day (in hours and minutes) and the water price;
- records of all repairs and maintenance and the costs for the same; and,
- annual balance sheets.

These records were available with many of the companies for all the years starting from their inception. The Secretaries and some of the key members of the tube well companies whom the investigators met during the field work were found to be very enthusiastic about sharing all relevant information regarding the functioning of the company including yearly profit and loss accounts.

Crisis Management

Conflicts are common in the functioning of an organisation. Such conflicts have potential for adversely influencing the performance of the organisation. The strength of an organisation would depend, to a great extent, on the ability to manage the conflicts. In the case of the irrigation organisations studied, the potential sources of conflicts are:

- pump breakdown due to burning of the motors, failure of electrical systems etc.;
- failure of the tube well; and,
- major breakage in the distribution network.

They often lead to prolonged interruptions in water delivery. It was found that the organisations have devised ways & means to tackle such crisis situations which help them avoid conflicts which might arise out of such situations.

As regards replacement of entire tube well, many companies plan them out well in advance. Wherever such replacements are required, they were found to have taken enough precautions by allocating a major share of their net annual income for meeting the replacement cost without distributing the dividends. If the amount is not sufficient, they also sell new shares to the old shareholders. As a result, the companies easily leverage large funds when required and the performance of the system gets unaffected.

In the case of system breakdown, the operator along with some of the management committee members takes up the responsibility of getting it repaired. They get them repaired within a day or two. This was found to be true even for major repairs.

Breakage of pipelines is one common problem which the companies have to face. Breakage often leads to water gushing into the fields and damaging the crops. The water delivery needs to be stopped for doing the replacement. However, the affected farmers instead of asking the operator to stop the pump, sacrifice the damage caused to his/her field and allow the water delivery along the entire distribution line to be completed before the broken pipes are replaced.

Equity in Water Allocation

Largely, the irrigation organisations in Manund function on the principles of equity. This is evident from the following facts:

- each company has many shareholders and non-shareholder beneficiaries;
- majority of the shareholders are small and marginal farmers;
- most of the time, the share-holding is decided by the size of the land-holding each farmer has in the well command and not the financial capability of the farmer;
- water allocation per share is fixed for all shareholders at times of scarcity;
- the water delivery pattern changes between *head to tail* and *tail to head* as a result of which the tail end farmers also get the opportunity of timely irrigation; and,
- the large time duration is available for payment of water charges due to which the cash poor farmers get enough time to sell their produce in the market at their choice and pay the water bill.

Efficiency in Water Use

Like equity, one of the important factors which influence the sustainability of a common property resource management institution is the efficiency in resource use. In order to have insights into the efficiency with which water is used by the farmers in the command (i.e. to examine whether farmers grow the crops which give maximum economic returns or those which are efficient from the point of view of water use) the cropping pattern is examined from the point of view of economics and efficiency. Efficiency here refers to the water use efficiency[9] and is expressed as a ratio of the crop yield and volumetric water use. The efficiency values estimated for different crops (for 15 farmers who receive water from the irrigation co-operative) are given in Table 3.

Table 3 Water Use Efficiency & Water Use Economics

Name of Crop	No. of Waterings	Hours of Watering per Vigha	Water Use Efficiency (Kg/M^3)	Yield per Vigha (Kg)	Net Income per Vigha (Rs)	Net Income per M^3 of Water (Rs)
Wheat	5.4	28.5	1.00	1072	5069	4.8
Mustard	3.4	15.5	0.70	400	2617	4.7

9 The most efficient use of water for irrigation is the one in which the yield reaches a optimum.

Since the crops are of different types, a comparison of water use efficiency in terms of Kg/M^3 is unrealistic. Instead, a comparison of net economic return per unit volume of water (by taking into account the market price of the crop) would give a realistic picture of the water use efficiency. In that case, the water use efficiency, expressed in rupees per cubic metre of water, is worked out to be 4.8 for wheat and 4.7 for mustard. The difference in water use efficiency values between wheat and mustard here, however, is statistically insignificant. As regards crop economics, wheat is found to be the most economical crop as it gives higher returns per *vigha* (Rs 5069/- per *vigha* against Rs 2617/- for mustard).

If the farmers choose crops on pure economic considerations, then wheat seems to be the most preferred crop. But, the analysis of cropping pattern for the sample farms shows that the average area under mustard (which is a much less water requiring crop as compared to wheat) is more than that under wheat crop. The area under mustard (expressed as a percentage of the total irrigated area) was found to be ranging from 44.4% to 100% with an average of 68.4%, while for wheat the values were ranging from 0 to 50% with an average of 27%. Hence, it should be believed that the farmers choose crops & cropping pattern on the following considerations: 1) the net income from crop production per unit volume of water; and 2) crop water requirements & overall water availability situation.

Irrigation Performance

The physical performance of the irrigation systems can be expressed in terms of the gross area irrigated and the total hours of irrigation. Given the fact that the power supply availability is controlled or limited (for 8-12 hours a day), increasing the irrigation performance requires very strong and effective organisations which can ensure timely and adequate irrigation services and can attend to each and every fault which tends to reduce the performance of the system.

The details of physical performance of the groundwater irrigation organisations are presented in Table 2. The total area irrigated (for the year 1996-97) ranges from 100 *vigha* to 195 *vigha*.

Given the fact that the discharge varies from system to system and the water requirement is different for different crops, the irrigation performance is also expressed in *hectare-metre* watering. However, attributes like area irrigated and hours of watering also become indicators of the overall performance.

The area irrigated by non-members as a percentage of the total irrigated command ranges from a minimum of 4.0% to 33.3% with an average of 16.3%. Again, the percentage hours of irrigation by members during summer as a ratio of their total hours of irrigation ranges from a minimum of 0% (only in one case) to a maximum of 28.7%. For the non-member farmers, it varies from 0% (in only one case) to 86.9%. This means that summer irrigation (for fodder crops) is a significant portion of the irrigation for non-shareholders while it is not much significant for shareholders.

The total watering was computed to be varying from 12.88 to 22.27 with an average of 16.85 *hectare metre*. It is found that as far as the irrigation performance is concerned, these organisations are performing excellently. A first cut comparison of the irrigation performance of these systems with those turned over to farmers' organisations in Mehsana will elucidate this. A study of performance of 15 systems turned over to farmers' organisations in Mehsana showed a maximum hectare metre watering of 22.23 and a minimum of 1.79 Ha. with an average of 8.36 (Source: Tube Well Turn Over: A Study of Groundwater Irrigation Organisations in Mehsana; by M. Dinesh Kumar, 1996, VIKSAT Monograph).

An attempt was made to understand the historical changes in irrigation performance of the companies. It was understood that generally the irrigated command and the hours of irrigation have not changed since late eighties when many of the present companies were formed. This is in spite of the fact that the water levels/ piezometric levels have been falling alarmingly during the past couple of decades in the area. The key reason why these companies could maintain their performance was that they were able to upgrade the system of pipes higher capacity pumps, increasing the pumping depths by adding extra columns of pipes[10].

The linkage between water charge and irrigation performance across irrigation organisations was also analysed. This is based on the assumption that increase in water charges can lead to reduced use of water for irrigation. The analysis showed that the water charge (volumetric) does not have any influence on the irrigation performance (ha-m). This could be due to the reason that shareholders constitute lion's share of the irrigated command for each system and are willing to pay higher water charges. This in turn helps meeting their operation and maintenance cost of the system to run the company smoothly without incurring financial losses.

Financial Performance

The financial and economic performance of the irrigation organisations can be

10 It was learnt during the survey that on an average, 2 additional columns of 1 10 feet (3 metre) length each are added in a tube well every year to take care of the dropping water levels.

assessed by taking into account the company's annual expenses and incomes from all sources.

The irrigation company's potential sources of income are: 1) sale of water; 2) interest from delayed payment of water charges; 3) sale of assets (old electrical and mechanical equipment, cement pipes etc.); 4) charges for transfer of shares; and 5) bank interest. Of these, the largest source is sale of water. The income from sale of water was found to be varying from a minimum of Rs 89, 915/- to a maximum of Rs 1,57,152/-. The ratio of income from water charges (both current year and the delayed payments of previous year) to the total annual income of the company varies from *73.7%* to *98.0%*.

There are a variety of expenses incurred by the Companies. They can be classified into:

- **Operation and Maintenance Costs**: This includes the electricity charges[11], cost of repairs (replacement of old underground pipelines, repair/ replacement of electric equipment like starters and pump-sets, and adding extra columns in the tube well), and salaries of operator and accountant. The cost of maintenance and repair is very nominal in the first 3-4 years of installation of the system. Thereafter, the cost goes up gradually. For systems which are as old as 10 years, the maintenance and repair cost constitute a major share of the total annual expenditure. The average annual cost of maintenance and repairs was found to be Rs 1,21, 639/- with a minimum of Rs 63,672/- and a maximum of Rs 3,23, 360/-

- **Tube well Replacement**: The life of an average tube well is 10-15 years now. The cost of replacement is often very high in view of the fact that many components of the system like the submersible pump and starter which need to be changed are very expensive. One tube well co-operative which is functioning since 1971 and replaced their old system with a 210 metre (700 feet) deep tube well and 60 H.P. pump in 1985 is now planning to replace the system again with a 300 metre (1000 feet) deep tube well with a 80 H.P. pump. The cost of replacement was estimated to be Rupees 7 lakhs in this case!

- **Discount in Water Charges**: In case of early payment of water charges, the water buyers are paid a discount of 5% of the water charge. 10-20% of the farmers pay charges on time and enjoy the discount. The annual discounts paid on water charges were found to be Rs 497/-, Rs 1114/- and Rs 1063/- and Rs 1,510 for 4 co-operatives for which complete break-up of the expenditure are available.

11 The annual electricity charge is worked out on the basis of the pump horse power at a rate of Rs 600/horse power per year.

- **Payment of Dividends**: Most of these irrigation companies make profits from the sale of water. An important feature of these companies is that they pay annual dividends to the shareholders based on the share value. The rate of dividend varies from 5- 10% according to the net profit generated by the company during the year. It was found that out of the 10 irrigation organisations surveyed, 8 have made profits during last year and out of which 6 have paid the dividends. Though this is one of the expenses for the company this is not included in the cost for carrying out benefit analysis.

Based on the values of the total annual returns and expenditure, the cost/benefit ratio was estimated for each of the company and are presented in Table 2. The B/C ratio varies from a minimum of 0.46 to 1.91. It was seen that the B/C ratio was highest in the case of organisations which incurred minimum expenses for maintenance and repairs. As seen in Table 2, the B/C ratio is less than 1 in only two cases. In the first case, the company has expended Rs 3,23,360/- against replacement of the tube well. In the second case where the B/C ratio was 0.74, the company has spent Rs 91,587 /-against annual maintenance including replacement of the pump.

Socio-economic Impact

A number of parameters and attributes were used to analyse the socio-economic impact of groundwater irrigation organisations and the water markets. They are: social attributes (education, literacy); and the purely economic attributes (economic production). The overall impact is analysed by studying the socio-economic changes and the direct economic impacts.

Direct Economic Impact

The emergence of irrigation organisations had a significant impact on the economic status of the farming community in the area. It is a truism that access to irrigation water increases the agriculture productivity and production. The farmers in the area owned shallow open wells in the fifties and the sixties. However, they all got dried up by the early seventies. Some farmers in the area were buying water from some of the tube well owners at a price of Rs 75/- per hour and the market was highly monopolised as the irrigators did not have options in choosing sellers. The tube well owners used to exploit the farmer. The rest were dependant on the vagaries of monsoon and grew only rain-fed crops. However, with the emergence of many tube well co-operatives in the area, most of the farmers in the area either became shareholders or buyers.

Farmers who were not members of any of the co-operatives but had their land in the periphery of well commands had the choice of buying water from the co-operative of their choice. On the basis of the price at which water is sold and the configuration of the co-operative (number of shareholders and the command area which is an important factor influencing the availability and reliability of water to the farmer), the farmers decide from whom the water is to be bought.

Now the price at which water is being sold by the co-operatives to shareholders is much less than that existing in the case of many of the private tube well companies in Mehsana. In the case of tube well companies, the hourly water rates vary according to the pump-set capacity of the tube wells and are generally found to be ranging from Rs 50/- to Rs 90/- for tube wells with pump-set capacity ranging from 50 H.P to 90 H.P, while in the case of the co-operatives, water rates are found from Rs 30/- to Rs 45/-. This is apart from the greater assurance of timely water delivery which again ensures increased crop yield. They were made possible through the co-operative action which increased the irrigated command area and ensured high gross returns from the sale of water.

Another direct economic impact is the saving in the cost of drilling wells. As on date, the investment for a tube well runs to 6-7 lakh. The O & M cost per year comes out to an average of Rs 50,000/-. This means the system will be viable only for a farmer who has sufficient land holding. Some back of the envelope calculations on the economics of tube well systems showed that for a system to be economically more viable for an individual farmer to own and run it, S/he should be able to irrigate at least 200 *vigha* of land. No farmer in the village has this much amount of land at the same location. The large number of tube well co-operatives in the village (which is not found anywhere else in the entire Gujarat state) has enabled farmers with highly fragmented land holdings to irrigate all their pieces of land with a very low investments (equal to that of the share value) which otherwise would not have been possible.

The tube well co-operatives also resulted in some intangible economic benefits to the non-shareholder farmers. Prior to the emergence of these organisations, a large percentage of the farmers in the area used to purchase water from the private well owners who used to charge exorbitantly for the water and the farmers' ability to irrigate their crops was fully dependent on the willingness of the seller. However, with the formation of the tube well co-operatives, the monopoly markets existing in the village gradually got replaced by the more competitive markets. As a result, the water prices have come down. While the water rates charged by the private well owners in the same village and also in the neighbouring village named Balusana is in the range of Rs 60/- and Rs 75/-, it is in the range of Rs 36/- and Rs 45/- for the farmers who do not own shares in the irrigation co-operatives.

Again, an individual farmer's decision to buy water from a particular well depends upon many more factors such as the quality of irrigation service offered and the water price besides the geographical positioning of his/her land. Analysis of data shows that out of 15 farmers who were surveyed, one farmer is buying water from 7 tube well co-operatives. Another farmer is having shares in 5 tube well co-operatives. Four farmers were found to be having shares in 3 co-operatives each. Three were members of 2 tube well co-operatives each. The rest are members of only one co-operative.

Socio-Economic Changes

The rapid and sustained growth of irrigation facilities made possible through the initiation of irrigation organisations by farmers have contributed significantly in bringing about socio-economic changes. With increased access to irrigation facilities the farmers could shift from partly and fully rainfed agriculture to irrigated agriculture. The cropped and irrigated area also increased substantially over the years. While the area under irrigation was only 800 *vigha* in the early '70s, it has increased to around 4,000 *vigha* by now. It is needless to say that almost 90% of it is contributed by the irrigation co-operatives. The increase in irrigated area has rendered manifold increase in agriculture production and micro-economic growth.

This has particularly benefited the small farmers who do not have the financial and economic resources to invest in expensive irrigation systems. Many of the farmers who are at present either shareholders in the irrigation co-operatives or are buyers of water from the irrigation co-operatives used to own their own private wells. All the 15 farmers surveyed had open wells till the early '70s. However, as the shallow aquifers in the area— which these wells used to tap— got dried up, these farmers lost access to irrigation. Subsequently, access to irrigation facilities offered by the irrigation co-operatives ensured income from agriculture which otherwise was highly sensitive to the vagaries of monsoon.

Analysis of cropping pattern has shown that the major irrigated crops farmers (both shareholders and non-shareholders) grow are wheat and mustard of which mustard is the largest grown crop. All the 15 farmers surveyed were found to be growing mustard. The percentage area under the crop was found to be varying from 44 to 100 (in 3 cases).

Out of 15, 12 farmers are growing wheat and the percentage area under the crop was found to be varying from 20.2 to 50. While wheat meets the subsistence needs, mustard takes care of the cash needs of the farmers. The values of average net economic return[12] from wheat and mustard are presented in Table 4.

Table 4 Crop Economics

Name of Crop	Average Yield per Vigha (Kg)	Net Income per Vigha (Rs)
Wheat	1072	5069
Mustard	400	2617

As seen in Table 3 (in Section titled Equity and Efficiency), the net income (Rs) generated from one cubic metre (1000 litres) of water for wheat and mustard is 4.80 and 4.70 respectively. On the basis of these figures and also on the basis of the average volumetric pumping, the net economic production from a well command is estimated. In an average year, the net economic returns to the farmers —after deducting all input costs like water charges, labour charges, cost of fertilisers and pesticides— in the well command from crop production alone is worked out to be approximately Rs 8,01,000/- which is higher than the total cost of the entire irrigation system. If one makes a very conservative estimate of the total life of the system as 10 years, this means that the entire cost of creating the irrigation facility could be recovered or the resources for creating a new irrigation facility could be mobilised if the farmers pay only 10% of the net returns to the irrigation organisation every year.

These estimates of crop economics are based on the assumption that the entire pumped water is used for growing wheat and mustard. Actually, every farmer who owns a buffalo grows alfalfa fodder in his/her field which is irrigated. The irrigated fodder crops become important input for milk production. It was found that the average livestock holding is 4.1 including buffaloes, cows and bullock. Every farmer having a buffalo is growing alfalfa, which is a highly valued fodder crop, in his/her fields irrespective of the fact that the water use efficiency (expressed in Kg/M^3) is very low for this crop. The water use efficiency for alfalfa crop is estimated to be 0.21 Kg/M^3 against 1.0 Kg/M^3 and 0.70 Kg/M^3 for wheat and mustard respectively. The economics of water use in the case

12 The net economic return from crop production is estimated by subtracting all input costs (water charges, fertiliser & pesticide cost and labour charges) from the market value of all crop outputs.

of alfalfa works out to be 2.05 which means that one cubic metre of water can produce alfalfa worth Rs 2.05 which is much less than that for wheat and mustard. But, the fact that alfalfa is grown by farmers as an essential input for cattle to sustain milk production thereby claiming a higher economic value than the market price justifies the selection of this crop by every farmer. The gross income from sale of milk was found to be ranging from Rs 43/- per day to Rs 168/- per day for the farmers.

These estimates, however, do not take into account the social cost of pumping water from underground. This is significant in view of the fact that the groundwater resources are being mined (as there is no replenishment of the deeper aquifers which are being exploited) and the water being pumped today is not going to be available to the next generation. However, these dimensions are beyond the scope of this study to investigate. What is being looked at, are the immediate changes the increased use of the resource has brought out in the social and economic status of communities which are dependant on it.

Another important aspect which needs to be considered in the discussion on water use economics is the environmental cost of degradation or depletion of the resource. Pumping of water from the underground aquifers — which is not followed by annual matching replenishment from rainfall— is resulting in mining of the resource. Groundwater being the drought buffer, mining of aquifers increase the area's vulnerability to droughts thereby causing serious damage to the ecosystem and the environment. The environmental cost of pumping water from the deeper aquifers varies across regions depending on the geo-hydrological environment and the climate. It is potentially very high in a semi-arid area like Mehsana where groundwater is the only source of water for drinking & domestic uses and for maintaining health & hygiene.

A major positive impact of the improvement in economic condition of the farmers is on the social status. The living condition of the people in the villages has substantially improved over a period of time and is understood to be much higher than that in any of the villages in the area. While the overall literacy level in the village was very impressive[13], those who belong to the new generation were found to have good education. It was learnt from group meetings that around 60% of the adults from the village have migrated to cities and towns in search of career opportunities and many of them are well employed. The income from services substantially increases the farmers' ability to make investments in agriculture and allied activities.

13 During the field work, many of the elderly farmers and the key members of the irrigation cooperatives were enthusiastic in communicating with the team in English in spite of the fact that the members had a good command over Gujarati.

Another phenomenon which is significant from a purely social perspective is the greater social cohesion due to frequent interaction among the farmers. The community feeling was found to be quite strong in the village and there was a great amount of willingness to co-operate and work together. One important observation which supports this statement is that many tube well co-operatives in the village have common office premises and common Secretaries. Another observation is the widespread sale of assets (pipes, pump-sets etc.) taking place across the tube well co-operatives. One main reason for this can be the social homogeneity as the entire village is dominated by the agricultural community known as Patels (approximately 98% of the village population).

Sustainability Impact

The level at which groundwater resources are being developed throughout Mehsana is highly unsustainable. The area being studied is also facing the problems of sharp decline in water levels like any other part of Mehsana. When the first tube well in the area was drilled in 1962, the water level was about a hundred feet deep. At present, water is being pumped from a depth of around 450 feet. Manund has 35 tube wells which run on an average of 1500 hours per year. If one takes an average discharge of 15,000 gallons per hour, the total extraction is worked out to be 3.78 Million Cubic Metres (MCM) per year. This is equivalent to around 275 mm depth of water column being pumped out from the entire area! If one considers an average rainfall of 550 mm for Mehsana and assumes that 5% (which again is highly exaggerated due to the fact that a large percentage of the water which infiltrates down through the soil mass does not reach the groundwater table as the unsaturated soil zone is very deep) of the rainfall percolates down to the groundwater reserves, then the recharge rate is 27.5 mm which is just 10% of the average annual extraction levels.

Quality deterioration is another problem which is as serious as depletion. The deeper aquifers in the area have fluoride and other minerals. As more and more water is being pumped from deeper aquifers, the level of contamination of groundwater due to fluorides and other salts also increases due to geo-hydrochemical processes. During the field work, the farmers in the area were complaining about problems of fluorides and the contamination of their drinking water sources. It was also understood that the water pumped from deep aquifers is not suitable for irrigating grams and millets. If pumping continues at the current rate, in a very short span itself, the groundwater will become unusable for irrigation. Nevertheless, it is wrong to assume that water markets alone have caused unsustainable use of groundwater in Mehsana. On the contrary, it is the unsustainable use of groundwater—which resulted in poor farmers loosing access to the resource— which has facilitated emergence of groundwater irrigation organisations and water markets. Further, evidences suggest that water markets of the nature found in Manund promote efficient use of water which in turn has a positive impact on sustainability.

Summary

The major findings of the study can be summarised as follows:

1. The groundwater irrigation organisations in Manund display unique institutional characteristics which are very different from the tube well companies some of which are: a) configuration of water markets; b) the water rates; and c) share-holding pattern. The water markets are such that they largely provide irrigation services to the member farmers and the percentage non-shareholder farmers covered in the command is very small. The water rates charged by the companies are very much lower than those charged by the tube well companies and reflect only the operational cost of the systems. The share holdings are more or less even across the irrigated command unlike in the case of private tube well companies where share-holding is skewed towards a few big farmers.

2. The physical, financial and economic performance of the groundwater irrigation organisations are much better as compared to the tube well co-operatives promoted by GWRDC and the private tube well companies.

3. The extensive and well developed water markets have brought about very positive social changes.

4. Groundwater irrigation organisations in Manund have significantly contributed to improving the socio-economic conditions of the farming community while creating a positive impact on access equity & efficiency in groundwater use.

Policy Perspective

The following findings which emerge out of the study have major policy implications with regard to irrigation management transfer and promotion of water markets:

- irrigation management institutions which represent homogeneous communities (in terms of their water use priorities) are likely to succeed.

- irrigation management institutions with evenly distributed share-holdings are more likely to succeed than those with uneven share-holdings;

- irrigation management institutions —those promoted by government— are more likely to sustain and succeed if they have autonomy and there is lesser government intervention in matters such as irrigation command, allocation & transfer of shares, fixing of water rates, replacement of old systems, system redesign, and financial dealings.

- water markets promoted through irrigation organisations will have greater positive socio-economic and equity impacts in access to resource if they are extensive.

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Selected Titles on *Forestry* from VIKSAT

Publications

1. Trees and Plantation Techniques (G)
2. Nursery Techniques (G)
3. Fruit Nursery (G)
4. Grasses For Wasteland Development
5. Nursery and Plantation Calendar (G,E,H)
6. Byelaws of Tree Growers' Cooperative Society (G)
7. Development of People's Institutions for Management of Forests (E)
8. *Naseeb Nu Pandedu-* Manual on Timru leaves Collection (G)
9. Footprints in Forest Protection (E,G)

News letter on Natural Resource Management

NIYATI- Bi-monthly (G)

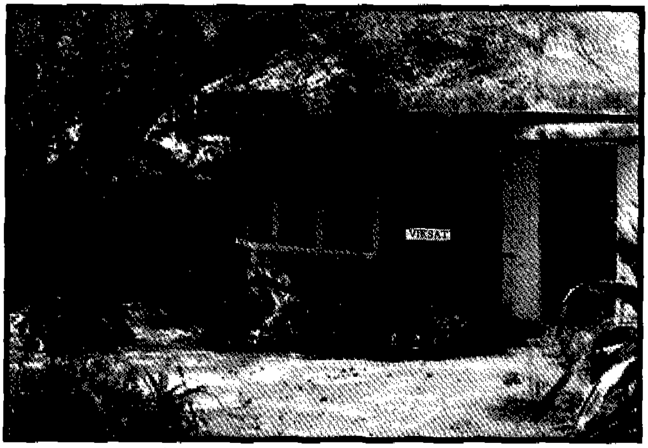
Video

1. *Ekta No Vagdo* (People's Forest)- 20 Min (G,E)
2. *Jaja Hath Raliyamana* (Joining Hands Together)- 20 Min (G,E)
3. Nursery: Planning & Management - 20 Min (G)
4. *Sapnana Vavetar* (Microplanning Processes) 20 Min (E,H,G)

Slide Show

1. Nursery: Planning & Management- 55 Slides (G)
2. Soil-Water Conservation Techniques- 55 Slides (G)
3. Wastelands: Causes & Effects - 77 Slides (G)

G = Gujarati E = English H = Hindi



VIKSAT

VIKSAT was set up in the year 1977 as an activity of the Nehru Foundation for Development (NFD), a registered public charitable trust, founded by Dr. Vikram A. Sarabhai. VIKSAT's activities are governed by a Council of Management consisting of eminent persons in the field of natural resource management.

MISSION

VIKSAT aims, through interaction with Government Organisations, NGOs and People's Institutions, at promoting and strengthening People's Institutions with active involvement of men and women from all sections of the community for equitable, gender sensitive and sustainable development and management of natural resources.

ACTIVITIES

VIKSAT's major programme areas are Joint Forest Management (JFM) and Participatory Groundwater Management. At the grassroots level, VIKSAT works with the village communities in its field projects in Bhiloda taluka of Sabarkantha district and Kheralu taluka of Mehsana District in Gujarat.

The role of VIKSAT in the field programmes is to facilitate emergence of People's Institutions, build their technical and organisational capacities through training, enable their increased access to government schemes and assist them in implementing resource management activities. The focus of field programmes is to expand the scope of participatory natural resource management both in magnitude and quality.

VIKSAT also performs the role of a Resource Centre. VIKSAT provides support to NGOs, Government Organisations and People's Institutions working in the state through newsletters, publications and audio-visuals for information dissemination, training for capacity building and process documentation for experience sharing.

VIKSAT publishes a bimonthly newsletter ***NIYATI*** in Gujarati for wider dissemination of knowledge about issues, concepts and practices in environment and natural resource management. In 1995, VIKSAT initiated ***SAKSHAM*** - a network of People's Institutions and NGO's working in the forestry sector in the state - with a view to promote and strengthen People's Institutions.

VIKSAT is the Regional Resource Agency, appointed by the Ministry of Environment and Forests, for facilitating the National Environment Awareness Campaign (NEAC) in the state of Gujarat since 1988.