RESEARCH REPORT

69

Tubewell Transfer in Gujarat: A Study of the GWRDC Approach

Aditi Mukherji and Avinash Kishore

International Water Management Institute

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Contents

Summary

In India, public (government) tubewells were built with the intention of providing irrigation to all categories of farmers in a fair, equitable and affordable manner. However, most public tubewell programs across India have failed on all these counts. Efforts to transfer their management to water users too have met with little success. Nonetheless, the Gujarat Water Resources Development Corporation (GWRDC)—a state-owned public company—has achieved rare success in tubewell transfer by transferring around 60 percent of public tubewells in the Gujarat state to user groups. Though the program was launched in 1988-1989, it gained momentum only in 1998. This study analysed the reasons for the sudden turn around in GWRDC's tubewell-transfer program and found that proactive policy changes under a new management helped the agency achieve rare success in tubewell transfer, which had so far eluded them. From 1995-1998, GWRDC accumulated losses worth Rs 206 million and there was pressure from the state treasury to close the corporation. At this juncture, under the leadership of a dynamic managing director, GWRDC simplified the transfer process and more importantly set transfer targets for each section office, thereby motivating the middle- and lower-level staff to seriously pursue tubewell transfer. In addition to policy changes, extreme power shortages and the stoppage of Mahi canal water gave a further boost to the process; due to the water and power crisis situation, GWRDC tubewells became additional sources of water for irrigation.

However, mere transfer of tubewells to farmer groups is not indicative of success. Therefore, this report also evaluated the performance of transferred tubewells against those owned by GWRDC and private operators. The findings, based on a survey of 110 tubewells in Anand district, suggest that turned-over tubewells perform significantly better than GWRDC-managed tubewells and that there is a marked improvement in their performance after transfer. But one of the drawbacks of this program has been the lack of incentives for long-term maintenance of the tubewells. Some of the clauses of transfer, such as short leases and the condition that tubewells must be handed back to GWRDC with all original parts intact (e.g., with original motor and not an inferior substitute) and that there should be no structural damage to the well, discourage farmers from investing in them.

In spite of its best efforts, GWRDC has been able to transfer only around 50 percent of its tubewells in Anand district of Gujarat state. Our study found that transfer is impeded when tubewells are in very poor condition as no one comes forward to take them over. Under such circumstances, we recommend that GWRDC can sell off the defunct tubewells and farmers will be willing to buy these as they come with electricity connections which are at a premium these days due to acute power shortages. Conversely, very good tubewells too cannot be transferred because various groups lay claim on them and in the absence of any consensus between groups, GWRDC cannot hand over such tubewells. We recommend that GWRDC should auction off the so called "good" tubewells (defined as those which operate for more than 2,500 hours a year) to the highest bidder. This will increase the revenue of GWRDC and also help minimize disputes among farmers. Finally, increasing the lease tenure for existing turned-over tubewells to at least 10 years will make the program more attractive to farmers and will also help in ensuring long-term maintenance of the system. Given that the situation in Gujarat is quite unique (both in terms

of relative equity in landholding and centrality of tubewell irrigation) it is not realistic to conclude that the GWRDC transfer program can be directly replicated in other states of India. However, the lessons learnt from the GWRDC experience are nevertheless important because other states could perhaps adapt the GWRDC transfer program according to their agrarian realities.

Despite its relative success, GWRDC's tubewell-transfer program does not qualify as a classic irrigation management transfer (IMT) case. In particular, IMT programs are designed to ensure sustainability of irrigation infrastructure, which GWRDC does not attempt to do. Similarly, most IMT programs such as those in Colombia, Mexico and Turkey focus on governance issues such as organizational structure and legal rights and duties of the water users associations (WUAs), while GWRDC does not concern itself at all with these issues. Thus, GWRDC's attempt does not qualify as IMT in the prevailing sense of the term and in essence is more in tune with some rudimentary form of privatization whereby only the management responsibilities have been transferred without any long-standing legal implications.

Tubewell Transfer in Gujarat: A Study of the GWRDC Approach

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Introduction

Government agencies in many countries of the world have adopted policies to transfer management of irrigation services to farmer organizations. This process, commonly called irrigation management transfer (IMT), has gained popularity in recent years and is seen as a way of reducing pressure on precarious government finances on the one hand and ensuring better irrigation services on the other. Many Asian countries such as the Philippines (Wijayaratna and Vermillion 1994), Indonesia (Vermillion et al. 2000), Nepal (Mishra and Molden 1996) and Bangladesh (Mandal and Parker 1995) have undertaken full-fledged or limited IMT and have met with mixed results. Latin America, Colombia and Mexico were pioneers in IMT. In 1976, the Colombian government turned over management of two canal-irrigation systems to farmers (Vermillion and Restrepo 1996). In Mexico, by 1996, the government had transferred 2.92 million hectare of canal-irrigated area to farmers, benefiting more than 88 percent of the service area in over 80 irrigation districts in the country (Johnson III 1997). New Zealand, on the other hand, took the path of privatization by selling off government irrigation systems to farmers, often at a loss to the public irrigation agency (Farley 1994).

In India, with a view to ensuring equity of access to groundwater, the government invested extensively in tubewell construction and operation. In Gujarat alone, some 4,000 tubewells were constructed by the Gujarat Water Resources Development Cooperation (GWRDC). However, in almost all the Indian states, public tubewell programs failed to provide equitable groundwater access to users and were also poorly managed. A number of studies have analyzed the reasons for the malfunctioning of public tubewells (Asopa and Dholakia 1983; Pant 1993; Kollavalli and Shah 1993) and have recommended transferring management of these tubewells to farmer groups.

The government of Gujarat was one of the first Indian states to realize the urgency of streamlining GWRDC and therefore launched the tubewell-turnover program in 1988-1989. To begin with, there was hardly any enthusiasm among the farmers to take over public tubewells. After the first 5 years of the transfer program, only 8.5 percent of the tubewells could be turned over (Kumar 1996). Earlier studies pointed out varied reasons for the lack of initiative among farmers (Shah and Bhattacharya 1993; Shah et al. 1994; Shah 1996). However, after 1998, there was a sudden increase in the number of tubewells turned over and by the year 2001 GWRDC had turned over almost 60 percent of its tubewells to farmers. This sudden increase in tubewell transfer intrigued us and we decided to study the tubewell-transfer program, especially since it was written off as a failure by earlier studies.

Objectives

The objectives of this report are as follows:

1. To explain the success[1] of GWRDC in handing over tubewell management to farmers in recent years, especially in view of the fact that it had failed in its attempts earlier.

2. To evaluate the performance of turned-over tubewells and compare them with those under GWRDC management and private ownership.

3. To understand the motivation and group behavior of the farmers who have taken over management of GWRDC tubewells.

4. To make policy recommendations for making the turnover process better and assess whether this could be replicated in other states.

Data, Sample Selection and Methodology

This report is based on data collected in Anand district of Gujarat (figure 1). Anand district was chosen for the study primarily for two reasons. In Anand, almost 50 percent of the public tubewells were transferred till 2002. The fact that 50 percent of tubewells still remained with GWRDC made Anand an ideal district to study as it provided scope for analyzing not only factors conducive to transfer but also factors impeding transfer. The second reason for choosing Anand is the centrality of tubewell irrigation in the district, coupled with the fact that this district along with Kheda[2] is the most agriculturally prosperous in the state.

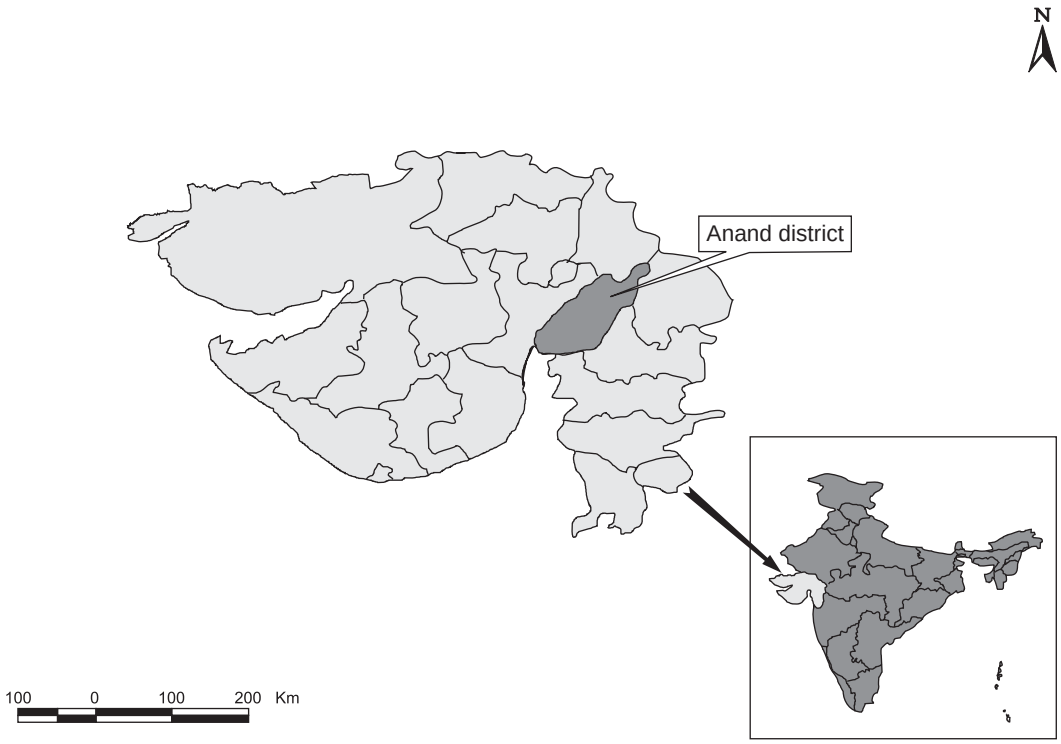
Based on detailed information provided by GWRDC on the village-wise location of tubewells and their current status (whether transferred or not), we drew a sample of 110 tubewells[3] across 43 villages in Anand district. The primary criterion was to select villages which had both GWRDC-operated and transferred tubewells so as to render comparison between the categories easier. In addition, some tubewells were included based on secondary criteria such as: electricity

[1]We have measured the success of GWRDC in terms of two indicators. First the percentage of tubewells transferred and second (in fact more importantly), how these tubewells have performed vis-à-vis public tubewells.

[2]Anand district was carved out of Kheda district in 1998-1999.

[3]Initially, we had chosen 120 tubewells, which included 30 GWRDC tubewells, 50 transferred tubewells and 40 private tubewells. But after the completion of the survey, 10 questionnaires had to be rejected due to inaccuracies of various kinds. Our final sample stood at 110 with 27 GWRDC tubewells, 48 turned-over and 35 private tubewells.

FIGURE 1.
Anand district in the state of Gujarat, India.



charges based on flat tariff;[4] one village *panchayat*[5]-managed tubewell;[6] few tubewells for which the farmers themselves showed all the initiative for taking over without being coaxed by the GWRDC officials;[7] and two tubewells which were closed[8] for over a decade and were taken over by the groups at a concessionary rent of Rs 1,000 per year.[9] These selection criteria were mutually inclusive of each other in a few cases. Two groups of respondents were given questionnaires—the first comprised the service providers such as the tubewell operator for the GWRDC tubewell, the chairman or any management committee member for the

[4]Flat tariff or horsepower tariff is comparatively rare in the case of GWRDC tubewells. Out of around 300 operating tubewells in Anand district, some 20 are flat-tariff tubewells, of which 16 are transferred and the other 4 are still with GWRDC.

[5]*Panchayat* is an elected village council which is empowered to take certain decisions on behalf of the village. It is the lowest tier of the three-tiered *panchayati raj* system in India—the other two being *panchayat samiti* (second level) and *zilla panchayat* (third level).

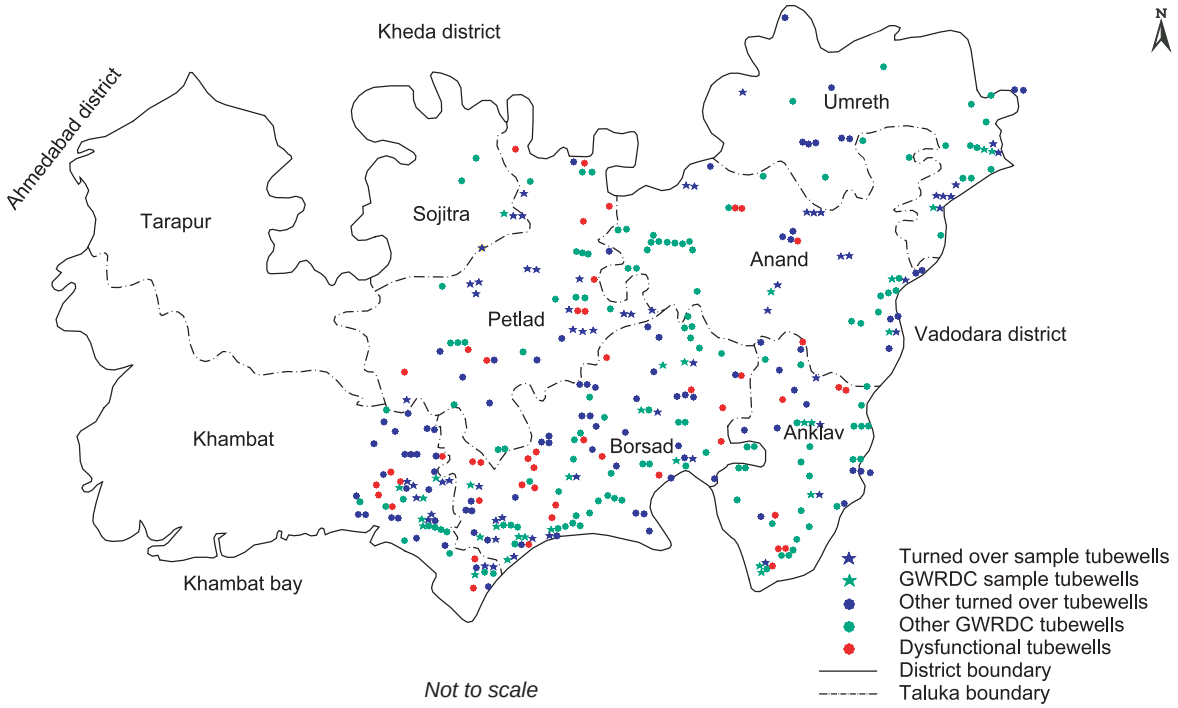
[6]Only one tubewell has been taken over by a village *panchayat* to grow fodder for livestock.

[7]There were only 6 such tubewells for which the initiative had come from the farmers' side and all were included in the sample.

[8]There are four such tubewells, which were closed for a long time and later taken over by farmer groups; two were included in our sample.

[9]US$1.0 = Indian Rs 48.3 (rate for March 2003).

FIGURE 2.
Location of sample tubewells (GWRDC and turned-over) and other (GWRDC and turned-over) tubewells in Anand district.



transferred tubewell and the tubewell owner for private tubewells. The second group was "pure" users who had no involvement in day-to-day management of the tubewells. Qualitative information was gathered from farmers in 10 out of 43 villages. Distribution of all GWDRC, transferred and defunct tubewells in Anand district, as well as GWRDC and transferred tubewells, included in our survey are given in figure 2. Sources of data include:

1. Secondary data from GWRDC for all 309 operating tubewells in Anand district.

2. Primary data collected using a questionnaire for tubewell operators of GWRDC tubewells, chairmen/secretaries of the management committees of turned-over tubewells and owners of private tubewells for the selected 110 tubewells in 43 villages in Anand district.

3. Qualitative (perception-based) data collected through a questionnaire was given to 50 respondents, of whom 8 were directly or indirectly involved in management of the transferred tubewells, and another 42 were "pure" users without any management role. These 50 respondents were randomly selected from 10 villages.

4. Informal focused group discussions with water users (of government, private and transferred tubewells), members of the management committee of the transferred tubewells, government tubewell operators, private tubewell owners and GWRDC engineers.

The GWRDC Tubewell-transfer Program

GWRDC is a government-owned company that was set up in 1971 but only began functioning in 1975. It is one of the four water-resource-related public companies in Gujarat under the control of the Secretary of the Ministry of Water Resources, Government of Gujarat. The original objectives of GWRDC were to increase the area under irrigation through installation of government tubewells and ensure equity in distribution of water, particularly for resource-poor farmers (Shah and Ballabh n.d.). The corporation has constructed over 4,000 tubewells to date of which around 3,000 are operational. In addition, GWRDC also undertakes the scientific assessment of groundwater resources in the state, though its primary job is to operate and maintain state-constructed tubewells. However, after a decade of operation, it was felt that the corporation would not be financially viable in the long run, mainly because of high operational costs (Asopa and Dholakia 1983).

Under increasing pressure from the state's political leadership in the late 1980s, GWRDC decided to turn over tubewells to farmers in the command area. The tubewell-transfer program was initiated in 1988-1989. To begin with, the rent was fixed at a nominal rate of Rs 11 per year, but in 1998 it was raised to Rs 5,000 per year. At the outset, the policy of the corporation was to hand over only inefficiently operating tubewells—the ones that operated less than 500 hours a year. In 1992-1993, there was a policy shift and the corporation decided to handover all tubewells (irrespective of their performance) to farmer groups that came forward to manage them. Similarly, the earlier mandatory clause of forming a cooperative to take over a tubewell was also relaxed. This clause, however, is still a part of the turn-over agreement forged between the corporation and a group of farmers, a minimum five farmers in the case of an informal group or *juth* and 11 farmers in the case of a cooperative.[10] But it is rarely adhered to in practice. Some of the terms and conditions of the transfer program are as follows:

1. The tubewell will be given on rental basis for 1 year to unregistered groups (*juths*) of at least five members and for 5 years to a registered cooperative of at least 11 members against a security deposit of Rs 5,000 and a rent of Rs 5,000 per year.

2. Before handover, a declaration has to be signed by at least two-thirds of the farmers in the command area of the tubewell declaring that they have no objection if a certain group of people (from within the same command) take over management responsibility of the tubewell.

[10]The basic difference between a registered cooperative and an informal group or *juth* is that while the former has to register itself under the Gujarat Cooperative Societies Act of 1961, the latter needs no registration. Thus, while the cooperative is a formal legal entity, the *juth* is not. Depending on whether the tubewell is taken over by a registered cooperative or a *juth*, the terms and conditions of agreement differ. For example, a cooperative gets a five-year lease for the tubewell, while a *juth* gets a lease of one year only. For forming a *juth*, a group of five willing farmers suffices, but for a cooperative, at least 11 farmers have to give their consent. Another difference is related to maintaining a compulsory bank account and a regular audit of finances by a government auditor. While a cooperative is subject to both these conditions, a *juth* is not. However, in every other respect, such as day-to-day operation of the tubewell and mode of water distribution, both function identically.

3. All members of the *juth* or cooperative must be landowners within the command area of the tubewell.

4. The *juth* or cooperative will be responsible for day-to-day operation and maintenance of the tubewell and will collect irrigation fees from farmers.

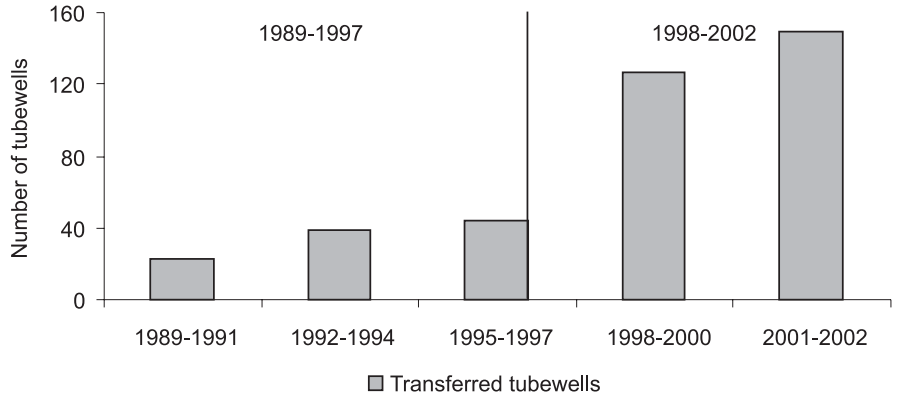
5. Farmers who have defaulted payments to GWRDC would not be given water by the *juths* or cooperatives unless they clear their dues to GWRDC.

6. Farmers who have taken over the tubewell have to ensure that they hand back the tubewells with all parts intact (e.g., original motor and not an inferior substitute) and that no structural damage is caused to the tubewell. In case the group wants to alter any of the tubewell installations (such as change motor capacity, repair distribution pipelines, etc.), they must obtain prior written permission from the corporation.

7. If the *juth* or cooperative does not abide by the rules laid down by GWRDC, or if farmers in the command area register complaints against the *juth* or cooperative, after due investigation, the corporation reserves the right to take back the tubewell without any prior notice.

This program gained momentum only during the last 5 years or so, when almost 60 percent of the total tubewells were successfully transferred to farmer cooperatives and *juths*. Tables 1 and 2 show details about the number of tubewells transferred for all districts in Gujarat and all *talukas*[11] in Anand district. Figure 3 shows the time trend of transfer of tubewells in Anand district from 1989 to 2002. Tables 1 and 2 and figure 3 show that the pace of tubewell transfer picked up after 1998.

FIGURE 3.
Transfer of GWRDC tubewells to farmer groups, 1989 to 2002.



Source: GWRDC, Anand district office.

[11] *Taluka* is an intermediate administrative unit in India (also called blocks or *mandals* in some states). Hierarchically, it lies between a village and a district. Thus, several villages (40 to 100 or more) form a *taluka* and a few *talukas* (6 to 15 or more) form a district. There are eight *talukas* in Anand district.

TABLE1.
Number of tubewells transferred by GWRDC, 1994 and 2001, by district.

District name	Total number of tubewells	Percentage of turned-over tubewells	
		1994-1995	2000-2001
Ahmedabad	244	5.7	61.1
Anand	312	NA	51.0
Banaskantha	593	8.4	48.2
Baroda	330	7.3	43.0
Bharuch	114	8.8	63.2
Bhavnagar	3	ND	100.0
Gandhinagar	137	3.7	43.8
Junagadh	1	100.0	100.0
Kheda	299	24.4	46.2
Kachchh	140	6.4	96.4
Mehsena	390	13.3	84.1
Narmada	64	NA	39.1
Navsari	3	NA	66.7
Panchmahals	17	5.9	58.8
Patan	281	NA	91.8
Rajkot	4	ND	75.0
Sabarkantha	87	ND	23.0
Surat	10	10.0	40.0
Surendranagar	45	26.7	91.1
The Dangs	1	ND	100.0
Valsad	7	ND	85.7
Total	3,082	8.2	59.8

Notes: NA stands for not applicable. These districts were created after 1994-95. Anand, Narmada, Navsari and Patan were designated as new districts in 1998-1999 and were respectively carved out from parts of Kheda, Baroda, Surat and Mehsena districts, respectively.

ND stands for no data. Figures for 1994-95 are based on Kumar 1996 and data from these districts are missing.

Source: GWRDC, Anand district office and Kumar (1996).

TABLE 2.
Tubewells transferred by GWRDC in Anand district, 2001, by *taluka*.

Name of *taluka*	Total number of tubewells	Percentage of tubewells managed by GWRDC	Percentage of tubewells turned over to groups	Percentage of tubewells closed down[a]
Anand	56	53.6	43.4	3.0
Anklav	51	56.8	32.5	10.7
Borsad	118	43.2	48.5	8.3
Khambat	59	30.5	64.7	4.8
Petlad	49	32.7	58.9	8.4
Sojitra	6	50.0	50	0
Umreth	31	51.6	48.4	0
Total	370	37.4	49.5	13.1

a. In the Anand district, only 13.1 percent of GWRDC tubewells was closed down, while the average figure for the state is around 25 percent. This is because most of the tubewells that have been closed down are located in water-scarce north Gujarat and the western districts of Saurashtra and not in relatively water-abundant areas such as Anand.

Source: GWRDC, Anand district office.

Comparison of Performance: GWRDC, Turned-over and Private Tubewells

In this section, we will compare the performance of turned-over tubewells with those that are under GWRDC management and those that are privately owned. Vermillion (1997) recommends that for a good turnover-impact study, there is a need to compare the systems in terms of certain performance indicators such as operational efficiency, financial viability, cost of irrigation to government and farmers, economic returns to farmers and quality of maintenance of the system. Therefore, we will assess the following in this analysis:[12]

[12]The issue of profitability of irrigated farming has not been dealt with primarily because the tubewell transfer has had hardly any impact on profitability of irrigated agriculture as a whole. This is because public tubewells are small in number compared to private tubewells and, in general, farmers depend on more than one tubewell for irrigation. After transfer however, there has been a drop in water charges but these were not substantial enough to make a huge impact on crop economics. On the whole, irrigation charges constitute 15 to 20 percent of the total input costs, though it is quite difficult to make an accurate calculation given that a large number of tubewell owners are charged a fixed electricity tariff irrespective of hours of operation.

1. Operational efficiency, calculated by area irrigated and hours of operation

2. Financial viability

3. Physical maintenance of the tubewells

This will be carried out with the help of two kinds of comparisons:

1. With-without analysis

2. Before-after analysis

Equity issues have time and again come forth in discussions about any successful IMT. Many scholars have implied that the relatively well off siphon away the benefits of transfer, leaving the majority of the poor at their mercy. This study addresses the issue of equity by comparing the profiles of farmers who are beneficiaries of GWRDC and turned-over tubewells and identify if the interests of the small and marginal farmers have been compromised after the transfer of GWRDC tubewells.

Comparison of Operational Efficiency

GWRDC, Turned-over and Private Tubewells

It is expected that management of public tubewells will be better after turnover for a variety of reasons. First, repair work will be done quickly. For example, on average it takes 3 to 8 days to replace a burned motor under GWRDC management. Once the tubewell is transferred, it takes only a day or two for the repair work. Second, delays due to excessive procedures will be eliminated. For example, the procedure for getting irrigation water from GWRDC is rather cumbersome. The farmer must fill in a demand form in triplicate, submit a copy at the section office (which might be located 10-20 km from his village), deposit an advance at a designated bank, and get water in accordance to a strictly maintained schedule. When transferred, this process becomes very simple. Third, given the widespread rationing of power, transferred tubewells (especially those with low-power pumps like 15 or 20 hp) can illegally use capacitors to increase their hours of pumping,[13] and this gives them a slight edge over GWRDC tubewells. However, this illegal tapping of electricity can be done only to a limited extent. Therefore, given a modicum of managerial skills, along with incentive to economize, and some tampering with rules, a turned-over tubewell will perform much better than a GWRDC-operated one.

Anand and Kheda districts[14] have a long tradition of groundwater-based irrigated agriculture. In every village, for every one or two

[13]Capacitors help convert two phase domestic power supply into three phase agricultural power supply. While domestic power (two phase) is available 24 hours a day, agricultural power (three phase) is supplied only for 8 hours. Therefore, using capacitors, farmers convert two phase power to three phase so that they can run their tubewells on domestic power supply any time they want. However, this can be done only for a limited period, as overloading the transformer will lead to burnouts.

[14]Until 1998-1999, Anand district was a part of the Kheda district.

TABLE 3.
Comparison of basic performance indicators between GWRDC and turned-over tubewells, Anand district, 1999-2001.

Tubewell status	Number of tubewells	Planned Command area (ha)	Horsepower	Discharge (m^3/hour)	1999-2000		2000-2001	
					Area irrigated (ha)	Hours operated	Area irrigated (ha)	Hours operated
GWRDC	155	98	25	117	42	1,435	44.4	1,481
Turned-over	149	97	24	116	54	1,569	57.7	1,631

Source: Based on data provided by GWRDC Anand district and Borsad *taluka* offices.

TABLE 4.
Comparison of basic performance indicators: GWRDC, turned-over and private tubewells, Anand district, 2000-2001.

Tubewell status	2000-2001				
	Sample size (No. of tubewells)	Horsepower	Average depth of tubewell (feet)	Average gross irrigated area (ha)	Average hours of operation
GWRDC	27	26	383	43	1,440
Turned-over	48	20	380	60	1,698
Private	35	14	275	25	1,841
All	110	20	346	43	1,567

Source: Primary survey of 110 tubewells in 43 villages in the Anand district.

GWRDC tubewells, there are 15-20 private tubewells. These figures could be higher if the village is large or prosperous. Private well operators sell water. According to an estimate, tubewell companies of Mehsana district earned gross returns of around Rs 70,000 per tubewell per year and their net returns were in the range of Rs 26,000 per tubewell per year in the 1991-1992 period (Shah 1996). At the state level, while there are over 2 million wells and tubewells, GWRDC's share in it is a mere 3,000 tubewells, thus making it a small player, with hardly any impact on the overall groundwater situation in the state. Thus, the justification for tubewell transfer is not as much to improve the groundwater management situation in the state, but more to recover the already invested capital of the government for better use. In this scenario, if turned-over tubewells also serve farmers better than public tubewells, the transfer program can be said to have adequately met its objective. Table 3 shows the comparative performance of GWRDC and turned-over tubewells for the 1999–2001 (based on data obtained from GWRDC) and table 4 shows the comparative performance of GWRDC, turned-over, and private tubewells (based on a sample survey of 110 tubewells in Anand district).

In Anand district, GWRDC tubewells operated for only 1,450 hours a year compared

to 1,600-1,700 hours for turned-over tubewells, while private tubewells operated for more than 1,800 hours. Given that there are 8,760 hours in a year, the above figures might seem very low. However, one has to keep in mind that in Gujarat, agricultural power supply is available only for 8-10 hours per day—that too in an erratic fashion. This seriously limits the number of hours of pumping. Turned-over tubewells also irrigate more area than either GWRDC or private tubewells. Private tubewells with much lower horsepower and bore depth, run longer than either GWRDC or turned-over tubewells. This can be partly attributed to the profit motive of the private tubewell owners, and to the fact that they are able to use capacitors to increase the effective power availability for pumping. The main constraint for the turned-over tubewells is their poor condition. In many instances, the outlets are broken and the farmers, because of the short lease tenure, do not think it wise to repair them. One interesting aspect is the mismatch between planned command area and actual area irrigated as seen in table 3. First, there is a certain amount of overestimation of the command area of tubewells in the first place, partly due to usual governmental compulsions of showing inflated command area figures (a similar problem is seen in canal commands as well) and partly due to inappropriate siting of tubewells in certain cases. But more important than this is the fact that over the years, many private tubewells have come up in areas adjacent to the functional command area of public tubewells and, given that GWRDC's service is inferior to private tubewell operators' service, actual irrigated area fell much shorter than the planned command area. In addition, over the years, underground distribution pipelines and surface outlets have deteriorated in the absence of any civil repairs[15] by GWRDC, thereby further limiting the command area. This has lead to distributional inefficiencies.

Some background about irrigated agriculture in general and tubewell irrigation in particular in Anand district will be relevant in this context. This region is highly dependent on tubewell irrigation. Tubewells are the sole source of irrigation water during *rabi* (short winter cultivation season) as well as the summer cultivation season. Tubewell water is used for supplementary irrigation in *kharif* (long monsoon-based cultivation season). Tubewell water is also used conjunctively with canal water in many of the villages in Anand district, as it falls within the command area of a large canal-irrigation scheme called the Mahi-Kadana project. However, since 1999, due to various reasons, canal water has not reached any of the villages included in our sample. The main crops grown in this district are paddy, tobacco and coarse cereals in the kharif season, tobacco and wheat in the rabi season and banana throughout the year. In terms of area, tobacco, paddy and banana are the three most important crops. All these crops are water intensive and need at least 5 to 7 irrigations during the growing season. Rabi tobacco needs 10 to 12 irrigations and the banana crop is irrigated 35 to 40 times in a year. Time needed to irrigate one hectare varies from 5 hours for coarse cereals such as pearl millet or bajri to 15 hours for paddy. In all the three management regimes, water is distributed on a rotational basis, mostly on a "first-come-first-served" basis. This aspect of water distribution and scheduling will be dealt with in greater detail later. As already mentioned, tubewells are the backbone of irrigated agriculture in Anand district. GWRDC tubewells as well as private tubewells have a depth ranging from 200 feet to over 500 feet, depending on the location of the tubewell. A majority of the tubewells are powered by electric

[15]GWRDC carries out two types of repair, electrical repairs (motor burn-outs, short circuits, etc.) and civil repairs, which means brick and mortar work for repairing storage tanks, the building in which the tubewell is housed, the outlet vent, etc. GWRDC has not done such brick and mortar repairs for the last 10 years and now carries out only electrical repairs.

pumps ranging from 10 to 40 horsepower (hp). All tubewells have underground distribution pipes spread across a radius of 0.5 to 2 km. There is an overhead tank to which water is first lifted. From this tank water is distributed through underground pipelines to various fields. There are strategically located water outlets as well as air vents spread across the command area of a tubewell. In terms of physical features, private tubewells are similar to GWRDC tubewells, except that the former have generally lower depths and lower pump horsepower. Figure 4 is a schematic diagram of a typical tubewell command in Anand district.

We ran a regression with a dummy variable (GWRDC vs. turned-over tubewells) using secondary data provided by GWRDC to see the impact of transfer of tubewells on basic performance indicators such as area irrigated and hours operated. We formulated our model so that the area irrigated (ha) by a tubewell was a function of the hours of operation of the tubewell with the dummy variable indicating whether it is a GWRDC tubewell or a turned-over one. Since the same set of tubewells was considered (before and after transfer), the need to control pump horsepower did not arise. The result is shown in table 5. Turned-over tubewells irrigate a significantly higher area than GWRDC tubewells, the areas being 17 and 9.5 ha, respectively. The negative coefficient of the interaction between the dummy variable and hours of operation shows that turned-over tubewells take marginally less time to irrigate the same amount of land. This further confirms our overall finding that turned-over tubewells have performed better than GWRDC tubewells in terms of hours of irrigation and area irrigated.

FIGURE 4.
Schematic diagram of a typical tubewell command of a public tubewell in Anand district.

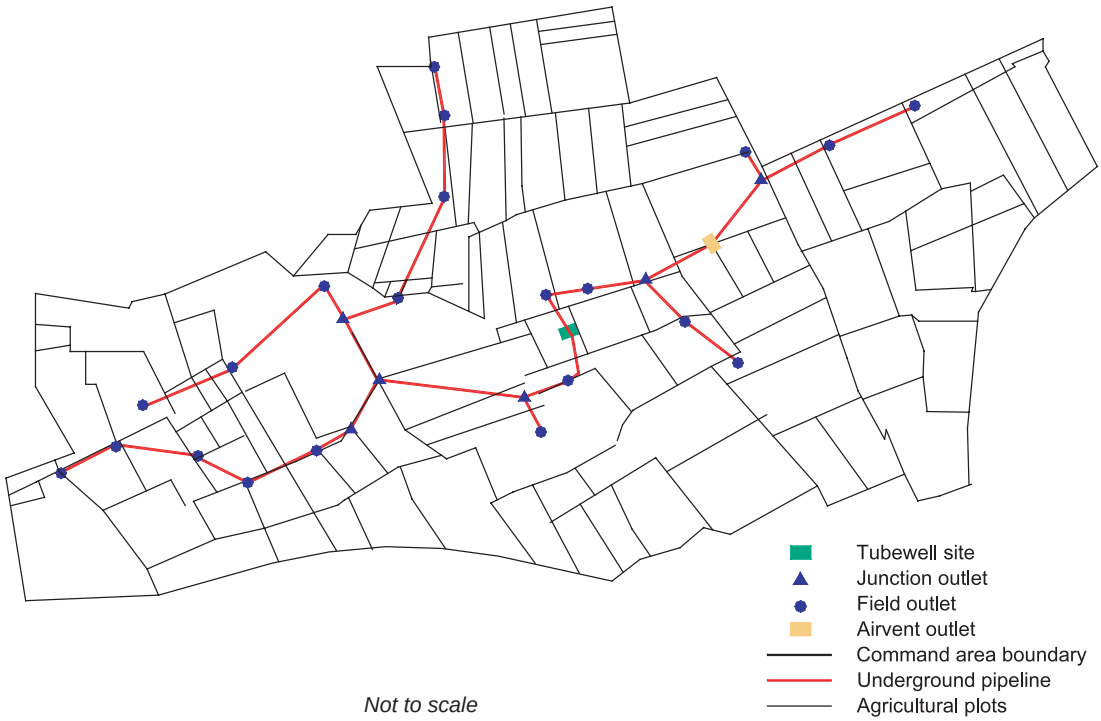


TABLE 5.
Determinants of area irrigated by GWRDC and turned-over tubewells in Anand district, 1999-2001.

Variables	Regression coefficient
Hours of operation in an year (X1)	0.02306* (0.678)
Dummy, D (0 = GWRDC; 1 = Turned-over)	17.047* (0.365)
D*X1	-0.004626** (-0.182)
Intercept	9.510*
R^2	0.461
Number of observations	596

Notes: * and ** indicate coefficients significant at 1 and 5 percent levels of significance, respectively, for the two tailed t-test.
Figures in parenthesis are standardized beta values.

Source: Based on data provided by GWRDC Anand district and Borsad *taluka* offices.

Performance of Turned-over Tubewells Before and After Transfer

Before-after comparisons are a must for analyzing the impact of any IMT, because they give us an idea of how the system performed before it was turned-over. At times, it so happens that the so-called "good" systems (i.e., the ones that have already been working well) are transferred first and comparing their performance with the "not so good" systems that were not transferred distorts the picture in favor of turned-over systems. Before-after analysis of the same set of systems helps in making a fair evaluation of the impact of transfer. Table 6 sums up the basic performance indicators of the turned-over tubewells for two years before turnover and the last two years after transfer. Since the tubewells were transferred in different years, the before data does not refer to the same years in every case, while the after data relates to the last two irrigation years, viz., 1999-2000 and 2000-2001. Table 6 clearly brings out the improvement in basic performance indicators of the tubewells after they were transferred. While interpreting this data, one has to keep in mind that the performance of all tubewells, including GWRDC tubewells, has been better in the last two years owing to higher water demand generated by the stoppage of Mahi canal water. Even after discounting this factor, turned-over tubewells have performed much better in terms of area irrigated and hours operated after transfer. Before transfer, the average irrigated area was only 35 to 39 ha, but in the last two years (1999-2001) it was 54 to 58 ha, an increase of almost 55 percent (figure 5). Even the maximum hours of operation have increased from less than 2,000 hours or so to more than 3,000 hours after transfer (figure 6).

Some 50 farmers chosen randomly from 10 villages were asked, among other things, their perception about the adequacy and timeliness of irrigation water supply before and after transfer. Of these, eight were directly or indirectly associated with the management of the tubewell (as chairman or member of the management committee) and were therefore service providers. In order to remove any possible positive bias that might creep in if they were asked to assess their own services, they were taken out of the sample and our findings are based on 42 "pure" users, who were in no way associated with the

TABLE 6.
Comparison of basic performance indicators for turned-over tubewells before and after transfer.

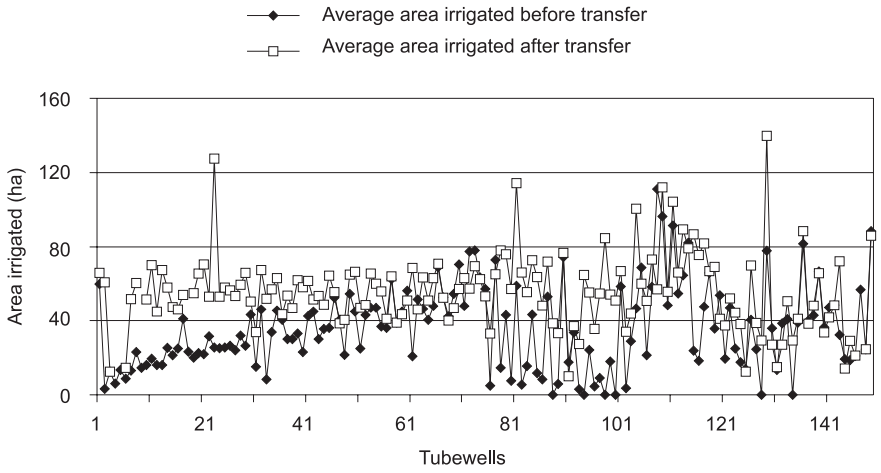
	Performance during 2 years prior to turnover[a]				Performance during 2 years after turnover			
	Two years before transfer		One year before transfer		1999-2000		2000-2001	
	Area irrigated (ha)	Hours operated[b]	Area irrigated (ha)	Hours operated	Area irrigated (ha)	Hours operated	Area irrigated (ha)	Hours operated
Observations	143	74	143	74	143	143	145	145
Mean	39	790	35	702	54	1,569	58	1,631
Standard deviation	24	462	22	467	25	713	19	573
Minimum	3	11	1	17	4	120	11	92
Maximum	149	1,846	103	2,273	175	3,493	123	3,706

a. Data for before transfer does not refer to the same set of years for all the tubewells; it refers to figures for two years before transfer. For example, if a tubewell was transferred in 1997-1998, before data refers to the years 1995-1996 and 1996-1997. Whereas if a tubewell was transferred in 1988-1989, the before date relates to years 1986-1987 and 1987-1988.

b. Hours of operation were obtained from the Anand subdivision office for 74 tubewells under its jurisdiction. Similar data for another 69 tubewells under the Borsad subdivision was not available. Anand district has two GWRDC offices, one at Anand and another at Borsad towns and they maintain separate data for tubewells under their jurisdiction.

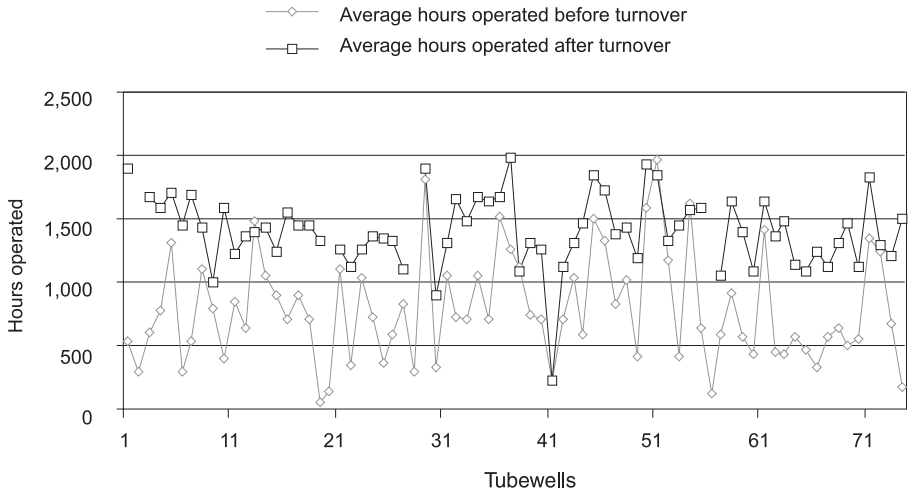
Source: Based on data obtained from GWRDC Anand district and Borsad *taluka* offices.

FIGURE 5.
Average gross irrigated area before and after transfer.



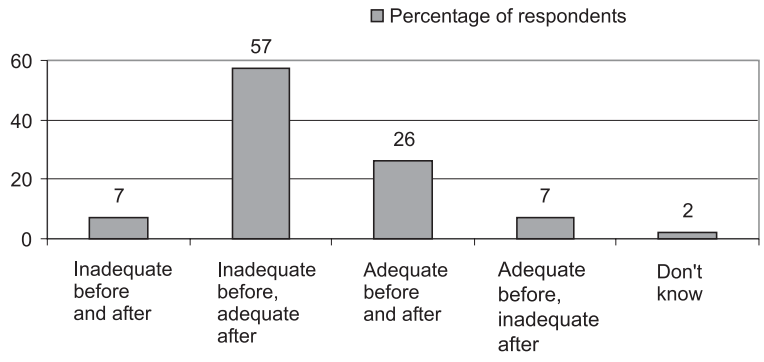
Source: Based on data obtained from GWRDC Anand district and Borsad *taluka* offices.

FIGURE 6.
Average hours of operation before and after transfer.



Source: Based on data obtained from GWRDC Anand district and Borsad *taluka* offices.

FIGURE 7.
Farmer perception on adequacy of irrigation supply from tubewell before and after transfer.



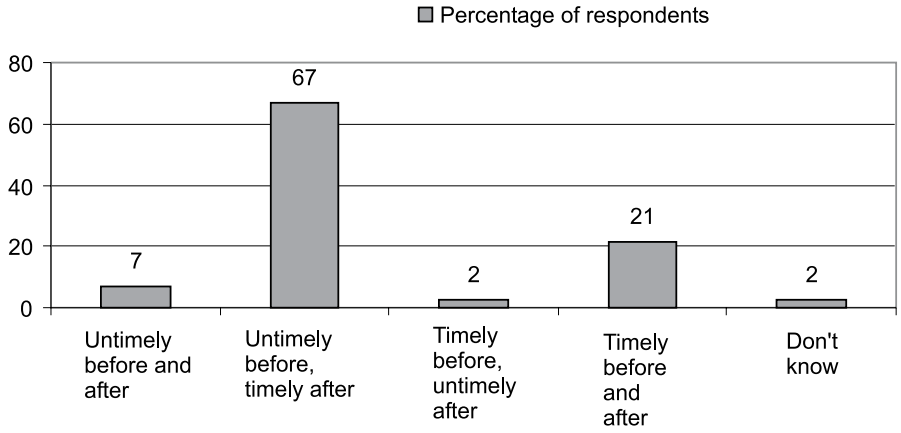
Note: Based on responses of 42 "pure" users in 10 villages.

provision of the service. Around 57 percent of the users reported that adequacy of water was better after transfer, while 67 percent reported improvement in timeliness after transfer. Figures 7 and 8 show the farmer responses about timeliness and adequacy of service before and after transfer.

Financial Implications

One of the major objectives of the turn-over program was to reduce the huge financial losses incurred by GWRDC. It is expected that IMT will save money for the government as GWRDC divests itself of the responsibility to finance routine costs of operation and maintenance (O&M) of irrigation systems (Vermillion 1997). At the same time, farmers who have taken over the tubewells would be expected to make profits, as their overhead costs would be much lower than that of government agencies. We have analyzed the financial returns of tubewells under three different management regimes: GWRDC, turned-over (both cooperative and *juth*) and private. We have also analyzed the returns under two power tariff systems, flat rate and unit rate. Table 7 summarizes our findings. Figure 9 clearly shows that GWRDC tubewells make huge losses, which are certainly more than what is reported here, because we have not included overheads at the office level. On an average, a GWRDC tubewell incurs an expenditure of Rs 70,000-90,000 while it earns only Rs 40,000-60,000. Expenditure for each category of tubewell is calculated under three heads: electricity bill, operator's salary and repair and maintenance work undertaken in 2000-2001. The operator's salary component of GWRDC is as high as Rs 60,000 per tubewell (at Rs 5,000 per month per operator). Incidentally, GWRDC's gross revenue is one of the highest among all the categories. This is attributable to the higher water rates charged by the corporation as compared to others. Figure 10 shows the average water rates for different categories of tubewells. At the other extreme are private tubewell operators, who charge the least rates and earn the maximum profits of around Rs 30,500 per tubewell. This is because they incur much less expenditure on O&M and pay lower electricity bills as most of them have flat-rate connections with smaller pump sets (14 hp). Moreover, private tubewells are generally newer and in better condition. Quite predictably,

FIGURE 8.
Farmer perception on timeliness of irrigation supply from tubewell before and after transfer.



Note: Based on responses of 42 "pure" users in 10 villages.

metered-tariff tubewells earn less profit than flat-tariff ones, the average being Rs 19,000 and Rs 24,000, respectively. Based on table 7, water charges work out to approximately Rs 1,172 per hectare and Rs 877 per hectare for GWRDC and turned-over tubewells, respectively. Expressed in terms of water charge per cubic meter of water, the corresponding figures are Rs 3.3 and Rs 3.7, respectively (estimated discharges for GWRDC and turned over tubewells are 117 m^3/hour and 116 m^3/hour, respectively—see table 3). Though water charge per cubic meter has gone up very marginally, the total irrigation expenditure of farmers has gone down because area-wise (per hectare) charges have decreased significantly after transfer.

Two measures of success of turnover programs are the reduction in cost of irrigation to the public agency and increased profitability to farmers to whom the system has been handed over. This transfer qualifies to be called "successful" on both counts. GWRDC saves Rs 20,000 to Rs 35,000 on repair and electricity bills of these systems per year besides earning an annual rent of Rs 5,000, which brings up the savings to Rs 25,000 to 40,000 per tubewell per year. According to present top-level GWRDC officials (Trivedi and Yagnik 2002),[16] in the three financial years preceding 1998, GWRDC as a whole had incurred a cumulative loss of around Rs 206 million. However, after renewed emphasis on the tubewell-transfer program as well as other cost-cutting ventures such as voluntary retirement schemes, curtailment of contingent expenditure, etc., GWRDC was able to register a modest profit of Rs 91,000 in 1998-1999 and Rs 24 million in 1999-2000.

Profitability to farmers, too, has seen a positive change. First, the water users (as well as service providers because they too are users) pay lower hourly rates, and second, the service providers earn profits ranging from Rs 18,000 to 20,000 per tubewell per year. In most cases, profits are not distributed among cooperative or *juth* members, but are retained as a corpus fund to be used for repair and maintenance work, especially the ones involving heavy expenditure. The managers of turned-over tubewells earn less

[16]K.B. Trivedi and V.M. Yagnik are Superintending Engineer and Managing Director of GWRDC, respectively.

profit than private tubewell owners because they have to spend considerably higher amounts on repair and maintenance of old GWRDC tubewells. However, if they have a secure lease for over 5 years or so, they could invest more on proper maintenance of the tubewells and recover their capital costs through selling greater volumes of water. The importance of a longer lease is partially indicated by the relatively higher profits earned by the cooperatives compared to *juths* (table 7).

Quality of Operation and Maintenance

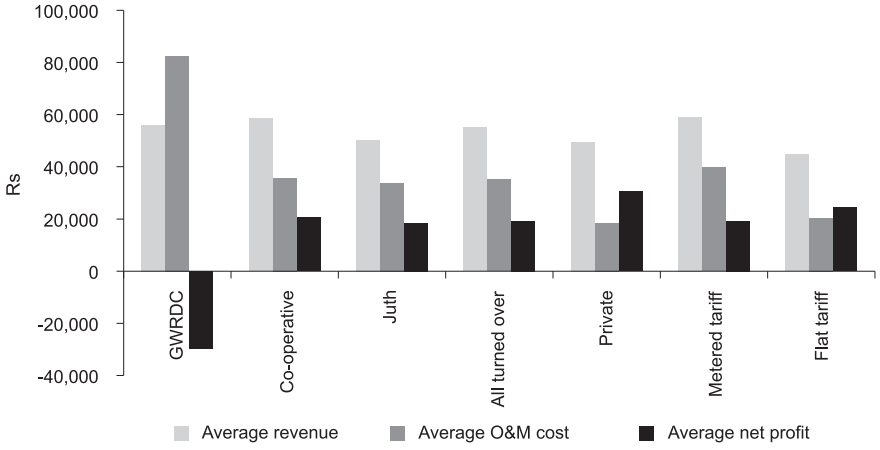
One of the important reasons cited for IMT is that it improves the quality of O&M of irrigation infrastructure (Vermillion 1997). In our study, we have tried to evaluate the O&M of the tubewells before and after transfer by posing qualitative questions to our respondents. We also inspected some of the tubewells under GWRDC management and some turned-over and private tubewells. On the whole, it emerged quite clearly that farmers perceived GWRDC tubewells being worse off in terms of repair and maintenance. Based on our questionnaire survey, we found that during the 2000-2002 period, a GWRDC tubewell has broken down on average three times and every time it took 3-8 days to repair it. The number of days needed to repair were only 2.5 and 1.7 for turned-over and private tubewells, respectively. Similarly, a majority of the farmers felt that maintenance of tubewells improved after they were turned-over to farmers. GWRDC has stopped all civil repairs for the last 10 years. A few of the tubewells we visited were in a dilapidated condition, with leaks in the overhead storage tank and broken outlets. One group in the Navakhal village returned the tubewell to GWRDC because of its poor physical state. Since the lease time is only 1 year at a time,

TABLE 7.
Details of net and gross income for various categories of tubewells, 2000-2001, Anand district.

				2000-2001				
Category	Sample size	Horsepower	Area irrigated (ha)	Hours operated	Water charge (Rs/hour)	Average revenue (Rs)	Average O&M costs (Rs)	Net profit (Rs)
Based on management regime								
GWRDC	27	26	43	1,440	35	55,953	82,476	-29,631
Turned-over	48	20	60	1,698	31	55,156	35,204	+19,219
Cooperative	16	22	58	1,497	30	58,584	35,686	+20,668
Juth	32	19	55	1,570	30	50,150	33,889	+18,495
Private	35	14	25	1,841	25	49,483	18,445	+30,511
Based on tariff system (does not include those tubewells operated by GWRDC)								
Flat-rate	32	18	46	1,682	27	44,746	20,394	+24,353
Metered	51	20	56	1,792	32	59,091	39,867	+19,225

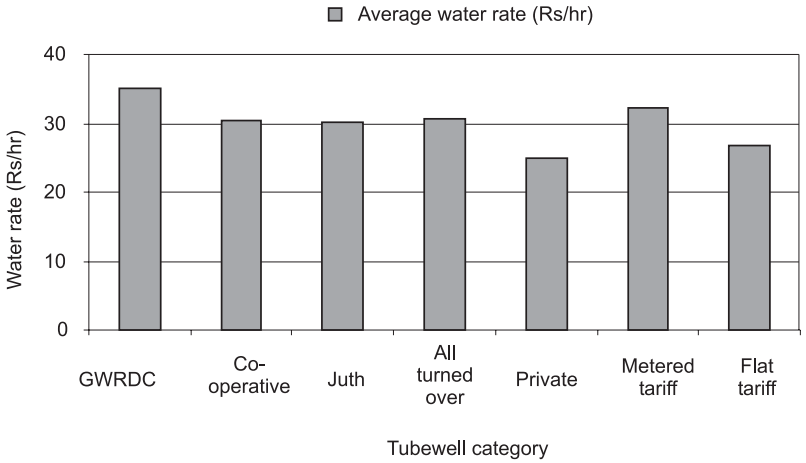
Note: Average O&M costs include electricity charges, operator's salary and repair and maintenance costs undertaken in the year 2000-01.
Source: Primary survey in 43 villages and 110 tubewells in Anand district.

FIGURE 9.
Gross returns, operating costs and net returns (Rs) for various categories of tubewells, 2000-2001.



Source: Primary survey in 43 villages and 110 tubewells in Anand district.

FIGURE 10.
Average water rates for different categories of tubewells (Rs/hour).

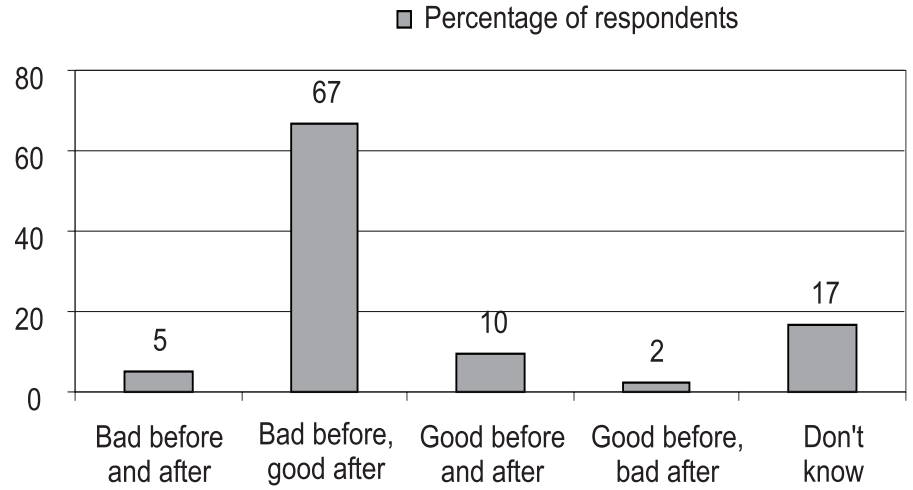


Source: Primary survey in 43 villages and 110 tubewells in Anand district.

farmers do not want to invest in fixed assets such as repair of water distribution networks or punctured bores, as they are not sure if they can recover these costs. However, farmers are prompt enough to change and repair the pump motor as and when needed because they can disconnect the pump from the tubewell and sell it off in case the lease is not renewed. A majority of the farmers (67%) thought that the tubewells were better maintained after turnover, while only 2 percent thought that maintenance was better before turn over (figure 11).

We also studied management practices such as norms for distributing and scheduling water, payment of water fees, penalties imposed for non-payment and conflict-resolution mechanisms adopted by these three management regimes. The most obvious differences surfaced between the GWRDC rules for procuring water and those for turned-over and private tubewells. As already explained, GWRDC follows a cumbersome process for water allocation. Besides, it insists on advance deposits to be paid at a designated bank. Against this, a farmer is issued a water indent form. Thus, a farmer has to travel to the nearest GWRDC office at least twice every irrigation season to get his allocation sanctioned. After this, he has to show the water indent form to the government tubewell operator in his village and get water according to a strictly maintained irrigation schedule. Problems arise when the tubewell operator is not available at his post, which is quite a common phenomenon. After transfer, water allocation becomes simple. All that a farmer needs to do is to walk down to the chairman (of the tubewell committee) or the operator's house and book his irrigation time. Generally, a first-come-first-served principle is followed for water distribution in all the three management regimes. While GWRDC follows a strict water schedule, it is much more flexible in private and turned-over tubewells because schedules can be rotated through mutual understanding. Water charges are generally paid only at the end of the irrigation season and after crop harvesting. However, the option of paying in small installments is open to farmers buying water from private or turned-over tubewells.

FIGURE 11.
Farmer perception of tubewell maintenance before and after transfer.



Note: Based on responses of 42 "pure" users in 10 villages.

GWRDC, on the other hand, offers credit for two irrigation seasons, but starts levying a 12 percent interest on the outstanding balance from the third season, after which, if repayment is not complete, it stops water all together. Though bribing is not a major issue, cases where a farmer has given a sack of rice or potato to a GWRDC official in return for some favors is not unknown. In one of the villages, farmers told us that they once got together and collected money to bribe an official so that a quick repair to the pump could be done to save a standing crop of tobacco. Repairing pumps is a major problem in GWRDC tubewells. First, the farmers have to report the damage (if the operator has not already done so), then an engineer visits the site, assess the damage and sends the pump for repair to the single GWRDC-owned workshop in the district. Predictably, it takes 3 to 8 days for a pump to be repaired. Under private or group management, repair is done faster through private mechanics.

However, the GWRDC tubewell-transfer program has a number of restrictions that impedes long-term sustainability in terms of good maintenance of the systems. As of now, the farmers only incur damage-control type of expenditure (such as repairing a burnt motor) and do not invest in improving the system. The reasons for this lie in the rather restrictive terms and conditions imposed by GWRDC, such as a short and relatively insecure lease and the condition that the tubewell must be handed back to GWRDC with the original parts intact and that there should not be any structural damage. Similarly, there is no requirement that the lease holders plough back some of their profit for maintaining and improving the system, which is in contrast to the system in China (Johnson III et al. 1996) where lease holders have to agree to invest a certain amount either in cash or labor to improve the system. This could lead to serious sustainability problems in the future.

Collective Action and Group Dynamics

GWRDC had envisaged the entire transfer program in a participatory management mode. The clause which stipulates that at least 5 to 11 villagers must form a *juth* or a cooperative before the tubewell can be handed over shows that the agency tried to encourage group management of these tubewells. Similarly, rules were laid down to encourage participation of people from backward castes and tribes as well as women through their compulsory inclusion in the management committee of the tubewells. Therefore, in our study, we wanted to examine the group behavior of farmers managing these turned-over tubewells. However, in the course of our extensive field work, we found that in most cases, the groups formed are merely “dummy” groups—while the locus of control lay with one or two key persons. These key persons took all the initiatives, from taking care of all the legalities of transfer to the collection of required funds for transfer (in many cases, they bore this expenditure themselves and recovered it from water charges), and looking after the day-to-day operation of the tubewell once it was transferred. The key persons, as we shall see later, were not necessarily the largest land owners, but were more frequently entrepreneurial farmers seeking profit and prestige. Our conversations with dormant members of the management committee and other water users revealed that the majority of them were quite satisfied with the arrangement as it meant hassle-free irrigation.

This informal and often undemocratic way (because it is not under the control of all the users) of managing *juths* and cooperatives does not pose any serious problems in tubewell management in most instances. This can be partly explained by the rules and regulations laid down by GWRDC, which stipulate that the management committees of turned-over tubewells have to supply water to all farmers in the command area in an unbiased way. As and

when complaints arise, GWRDC officials promptly visit the site and try to solve problems amicably. In most cases, this amicable arbitration by GWRDC officials works. In cases where it does not work, GWRDC cancels the transfer agreement and takes back the tubewell. The threat of losing the tubewell after paying the rent and electricity bills discourages the management committee members from playing foul. Besides, this region has a long history of water markets and there are established mechanisms for sorting out irrigation-related problems and this makes conflict resolution easier and the intervention of GWRDC less necessary.

Equity Issues

Concerns about equity and provision of irrigation to the resource poor were reasons for government investment in public tubewells. However, it is apparent that the government has not succeeded in either of these. In Anand, for example, hourly water rates of GWRDC tubewells are considerably higher than those of private water sellers. It is often feared that through programs such as tubewell transfer, the relatively better-off farmers will usurp benefits, creating adverse effects on the resource poor. An analysis of the land size of beneficiaries of turned-over and GWRDC tubewells shows that turned-over tubewells performed better in terms of selling water to small and marginal farmers than government tubewells. Our interviews with the management committee members revealed that they were under constant pressure to sell water so as to recover the initial costs like rent, deposit to GWRDC, repair costs, etc. In the event that they cannot sell water to cover all these costs, they have to share the losses among themselves. In Anand district, the average landholding size is less than one hectare and large landholdings are rare. In our sample, none of the farmers, (not even the chairmen of the managing committees) had large landholdings. Had it been so, there might have been a possibility of monopolizing the asset. However, given that most landholdings are small, it becomes imperative on the part of the committee to sell water to all to recover the initial investment.

Water rates also decline once the tubewells are turned-over. An earlier study in the district found that water rates had dropped from Rs 25 per hour to Rs 15 per hour in Anand district after turnover (Shah et al. 1994). Our study confirms this finding, water rates dropped after turnover from an average of Rs 35 per hour to Rs 30 per hour. This is certainly beneficial to all farmers, more so to poor farmers. Table 8 shows the number of farmers served and the percentage of farmers served in each category based on the survey. After transfer, not only does a tubewell serve a greater number of farmers in its command area, but the representation of small and marginal farmers also goes up. Even in the management committee of turned-over tubewells, almost 72 percent of the members have less than 1 ha of land in the command area, while another 23 percent have landholdings between 1 and 2 ha and only 5 percent have landholdings between 2 and 10 ha. None of the farmers in our survey area had land-holdings of more than 10 ha. However, in areas where landholding disparity is very pronounced (Bihar, Orissa, Rajasthan), there is a distinct possibility that turned-over tubewells might be captured by the rural elite and the poor might be excluded.

The tubewell-transfer program seems to have satisfied almost all criteria suggested by Vermillion (1997) to be called a “success.” One significant exception to this is the long-term maintenance of the asset. Without any explicit provisions or incentive for maintenance of the turned-over tubewells, it is unlikely that the farmers will invest in them and it is likely that after 5 to 10 years most transferred tubewells may deteriorate further. However, on the whole, the turned-over tubewells have performed better than the GWRDC-owned tubewells in terms of operational, financial and equity indicators.

TABLE 8.
Number and category of farmers served by GWRDC and turned-over tubewells, Anand district, 2001.

Category	Sample size (number of tubewells surveyed)	Average number of farmers served per tubewell	Percentage of marginal farmers (less than 1 ha) per tubewell	Percentage of small farmers (1-2 ha) per tubewell	Percentage of medium farmers (2-10 ha) per tubewell	Percentage of large farmers (above 10 ha) per tubewell
GWRDC	27	26.5	76.2	18.2	5.6	0
Turned-over	48	35	83.9	14.8	1.3	0

Source: Based on a primary survey of 27 GWRDC and 48 turned-over tubewells in Anand district.

What Encouraged and Impeded Tubewell Transfer?

Why was 1998 "decisive"?

From 1998 onwards, there was a sudden increase in the number of tubewells that were turned-over in Anand district as well as in the whole of Gujarat (figure 3). This leads one to ask what exactly happened around this time that led to a dramatic rise in the number of turned-over tubewells. This also leads to the first objective of the study—to analyze the reasons for the sudden increase in farmer groups who were willing to take over the management of tubewells, especially when they were not so willing earlier. Our analysis based on conversations with GWRDC officials, Gujarat Electricity Board officials, and most importantly the farmers, helped us identify three probable reasons for this phenomenon. The first reason, (probably the main reason) was the policy shift in GWRDC under a new management[17] which pursued tubewell transfer with commitment. The second reason was the increasing power crisis in rural areas, while the third was the sudden stoppage of Mahi canal water from 1999. The three reasons are enumerated in detail below.

1. GWRDC's commitment to transfer (only after 1998).

   GWRDC initiated the turn-over scheme in 1989 under pressure from the government to reduce its financial losses. However, it seems that that top management had not internalized the need for doing so. To compound the problems, turn-over procedures and conditions were not lucrative enough in the beginning. The insistence on forming

[17]Mr. M.S. Patel, the present Water Resources Secretary of the Government of Gujarat, was appointed Managing Director of GWRDC around this time. He was instrumental in formulating target-oriented marketing policies, which eventually turned around the transfer program from a usual lackadaisical government program to a dynamic, and one of the most effective programs of tubewell transfer ever launched in India.

cooperatives[18] and not supplying water to those who had defaulted payments to GWRDC took its toll on the schemes' overall performance in the initial years. Fortunately, GWRDC learnt from this experience and relaxed the rule about compulsory formation of cooperatives in 1993. However, the turning point came in 1998, when under a new and dynamic management GWRDC started setting targets for each section office. This was done because it was realized that if the business-as-usual attitude continued, GWRDC would face a real threat of being discontinued. As already mentioned, GWRDC's financial status became precarious in the years preceding 1998. At this juncture, there was increasing pressure from the state treasury to discontinue GWRDC. In this context, the section officers (middle-level staff) were asked to turn over tubewells to farmers and to pursue these targets in earnest. This is one of the central principles of any successful turnover program—the commitment of the agency to turn over irrigation systems to farmers.

2. The deteriorating power situation in Gujarat.

   Like most other state electricity boards, Gujarat Electricity Board too incurs huge losses, which have reached an almost unsustainable level. The agricultural power supply has been severely curtailed and power is provided only for 8 hours a day, but uninterrupted power is available only for 4-5 hours in a day. Coupled with this is the difficulty in getting new electricity connections for tubewells. GEB has two schemes under which it sanctions new connections. One is the normal procedure, under which a farmer gets a flat-rate connection but after a waiting period of up to 10 years. The other is the *tatkal* or instant connection, under which the farmer has to bear the full cost of the connection, including the cost of electric wires to the poles and even new transformers if need be. The expenses are prohibitively high and the waiting period is between 6 months and 2 years. In this scenario, taking on rent a GWRDC tubewell that already has an electric connection seems a very good and sensible option for farmers. The last three drought years (2000 to 2002) also made it imperative for the farmers to accumulate as much pump capacity as they could. Strict rationing of power coupled with the difficulty in getting new connections and the assurance about continued (though rationed) power supply are enough incentives to farmers to take over GWRDC-operated wells.

3. Stoppage of Mahi right bank canal (MRBC) water.

   Most of Anand district falls within the command area of the MRBC, a large irrigation canal. However, for a variety of reasons, MRBC water has been stopped from 1999. This has led to a sudden increase in demand for tubewell irrigation and even the GWRDC-managed tubewells have operated for more hours in the 2000-2002 period (almost 50% more). Due to the stoppage of canal water, tubewells have become more

[18]Registering a cooperative is a very cumbersome business in most parts of India due to the legal hassles involved and the almost arbitrary powers of the registrar, which puts the cooperative at his mercy.

central to irrigated agriculture. This certainly explains why turnover has witnessed an increased pace in recent years.

Strengths of the GWRDC Tubewell-Transfer Program

The GWRDC tubewell-transfer program has a few in-built merits that possibly led to the increase in the number of successful transfers at a time when many other states have failed to implement similar programs. Perhaps the most important strength of the program is the responsiveness of the GWRDC officials to farmers' demands and their ability to modify the program as and when needed. The merits of the GWRDC transfer program are given below.

1. Simple process: GWRDC adopted a very simple, quick and direct process for transfer. This involved an application for taking over the tubewell from the farmers' side and the entire transfer process could be completed within 10 to 15 days, without the farmers having to visit the GWRDC office even once. In most IMT programs, considerable time and effort are spent to form water users associations and capacity building among farmers to manage the systems. However, GWRDC did not follow this long and often-unsuccessful process and decided to turn over the tubewells directly to user groups.

2. Flexible approach: GWRDC kept learning from its experiences and making changes in the process wherever necessary. Its initial insistence on forming cooperatives was diluted in later years when they realized that farmers were not willing to register themselves into a formal cooperative. Instead, it allowed any informal group or *juth* to take over a tubewell. This helped in overcoming farmer inhibitions and speeding up the turnover process. GWRDC's transfer policy still favors cooperatives by giving them the management authority for a tubewell for 5 years while juths have to get their lease renewed every year. Yet, in this case, farmers prefer independence to security, which is evident from the fact that of 149 tubewells transferred in Anand district, 109 (73.15%) were taken over by *juths* while only 40 (26.85%) were taken over by registered cooperatives. This is because farmers perceive (perhaps truly) that registering into a cooperative increases transaction costs several times and brings them under the ambit of the often arbitrary powers of the registrar and other government officials.

3. Low interference: Once a group takes over a tubewell, it enjoys total freedom in O&M. There is hardly any interference from GWRDC in day-to-day affairs. The group is free to appoint its own operator, design the irrigation schedule, undertake repair and maintenance, and even replace the pump set with a new one of different make and capacity. It can adopt a different pricing system and revise water prices. This kind of autonomy builds a sense of ownership and encourages farmers to invest in the systems to improve viability and performance.

4. Good monitoring: The group is required to maintain daily records of power consumed, area and crop irrigated and total water pumped in a simple format prescribed by GWRDC. This data is presented to the local GWRDC office

every fortnight. It helps in monitoring the performance of the particular tubewell and tubewell performance at an overall level. Monitoring is also done to ensure that the groups do not sell water to farmers who have not cleared their earlier dues to GWRDC and that they do not defer or default on electricity bill payment. The monitoring process is "smart and simple" and it does not cramp the mode of functioning of the group, but at the same time serves GWRDC's purpose very well.

5. Relatively secure lease: Though the lease is for one year, in most cases the lease gets renewed if the group performs well. The agreement is terminated only in rare cases when a group fails to pay its electricity bills or does not resolve conflicts and grievances within the group. This security of lease gives the necessary credence and authority to the groups in their domain and sends positive signals to beneficiaries in command areas of other tubewells to come forward for take-over.

6. No encumbrances: Many IMT projects have failed to take off because governments tried to pass off their accumulated losses and dues to the new owner. For example, the Orissa Lift Irrigation Cooperative (OLIC) has huge electricity dues on each of its units and any agency that wants to take over these units have to clear a part of these dues before power connection is restored and systems become functional. This is one of the biggest deterrents to the transfer program in Orissa. Tubewell transfer in GWRDC comes with no such hangover.

Enabling Factors in Context

In the tubewell-transfer program in Anand, well-meaning policies and a professional approach by GWRDC have been complemented by a set of positive factors in the context of the transfer program, which helped make it a relative success.

1. Demand for tubewells: Reliable irrigation is the most critical input to the predominantly cash-crop-oriented agriculture in Anand. Over the last few years, the power supply has deteriorated and rationing has increased. Farmers have an urgent need to expand the pump density but new connections are costly and difficult to come by. This increases demand for public tubewells.

2. Centrality of irrigated agriculture: In other areas (particularly eastern India) the unfamiliarity of farmers and local technicians with the technology of submersible pumps and buried pipeline distribution systems and lack of experience in distributing water to a large number of farmers over a relatively large command area are obstacles to the tubewell-transfer program. Farmers in Gujarat have no such obstacles as they are well versed with the technology and management of deep tubewells. They have been using such systems for more than seven decades in many parts of the state.

3. Manageable pump-size: In states like Andhra Pradesh, public irrigation systems have pumps of very large capacity (150-250 hp) for large command areas running into hundreds of hectares.

Such systems have diseconomies of scale in management, which make them very difficult for small farmer groups to run. An average public tubewell pump in Gujarat is 20-30 hp with a planned command area ranging from 100 to 150 ha, though the actual irrigated area is much lower due to reasons explained before. This makes it a manageable asset for even an individual or a small group of farmers. The preference of farmers for smaller and better tubewells is evident from the fact that the tubewells taken over in the first wave of transfer (from 1988-1989 to 1992-1993) were essentially the small ones with small command areas and high discharge rates. Similarly, almost 60 percent of the fixed-tariff (12 out of 20) tubewells was transferred in the first 5 years, but only about 5 percent or so of metered tubewells could be transferred during that period. Table 9 makes this point clear.

4. Presence of competition: Public tubewells in Gujarat face stiff competition from private tubewells. In most cases, private owners sell water at lower prices and on better terms. This helps in checking the monopolistic exploitation of beneficiaries by the new managers after transfer.

5. Equitable landholding: The overwhelming majority of farmers in the command area, of public tubewells where we conducted our survey (89%) were small and marginal farmers and they hold the majority of land while medium and large landholdings are rare. The land distribution pattern is similar among the *juths* and cooperatives. This makes it very difficult for an individual or a small group to takeover the management of a tubewell and monopolize its use, which is a distinct possibility in areas like Bihar where landholding sizes are highly inequitable. The operating groups in Gujarat are under pressure to sell water to cover their costs and make the systems viable for them. This promotes equity and better client servicing while keeping a check on oligarchic tendencies.

TABLE 9.
Comparison of horsepower, command area and metering regime of GWRDC tubewells transferred during the periods 1988-1993 and 1993-2001, Anand district.

Year	Number transferred	Average horsepower	Average command area (ha)	Percentage of fixed tariff tubewells transferred[a]	Percentage of metered tubewells transferred [b]
1988-1993	26	24.9	96.o	60 (12)	5 (14)
1993-2001	118	27.8	111	20 (4)	41 (115)
All	144	27.7	108	80 (16)	46 (129)

Note: Figures in parenthesis are the actual number of tubewells transferred in each category.

a. In the Anand district, there were only 20 fixed-tariff tubewells with GWRDC, of which they transferred 12 (60%) during the first 5 years of the transfer program.

b. In Anand district, GWRDC had about 280 functional metered tubewells. Of these, only 14 or 5 percent could be transferred during the first 5 years of the transfer program.

Source: Data provided by GWRDC Anand district and Borsad *taluka* offices.

What Drives Farmers to Take Over Public Tubewells?

Many researchers contend that farmers come forward to take over the management of public irrigation systems only when they are threatened with closure of the system. The whole process, according to them, is coercive. Sharma (2002) in his study of a similar GWRDC transfer program in Vadodara district has come out with similar conclusions. However, our study in Anand points out to factors other than coercion and persuasion.

If coercion or threat were the main drivers, we would expect the person having the largest landholding in the command of the tubewell to take over the tubewell and be the chairman of the managing committee. This is because he has the largest stake in the system. But it is generally not the case. Two examples from our study area will illustrate this point. In the Kanba village in the Borsad *taluka*, the de facto operator (*sanchalak*) of the tubewell does not have any land in the command area. Of course, he could not legally take over the tubewell as the transfer condition makes it mandatory for him to have land within the command area. Five farmers who had land in the tubewell command area took over the tubewell and handed over the responsibility of operating it to him. He had actually collected the necessary Rs 10,000-15,000 required for the transfer. In another village called Kathana (Borsad *taluka*), a schoolteacher who had only 0.4 ha of land took over the tubewell. His main source of income was his salary and not agriculture.

In both the cases, closure of the respective tubewells would have had hardly any affect on the persons who took over the tubewells. Yet they took the initiative and made investments and efforts for take over. These are by no means isolated cases. In most of the cases, the person or group taking the initiative is not the largest stakeholder but the one who is most enterprising and venturesome and sees an opportunity in converting GWRDC assets into viable income sources. Control over a tubewell offers two things cherished by all enterprising people:

1. Profit: In our study, we found that a typical tubewell earns an annual profit of Rs 18,000-19,000 on an initial investment of around Rs 10,000-15,000 in the first year of lease and Rs 5,000 per year thereafter. Management requirements of a tubewell are not very exacting and can be easily delegated to a salaried operator. Cooperatives make marginally more profit than *juths* and tubewells with flat-rate connections earn 25 percent more profit than the metered ones (Rs 24,353 and Rs 19,225 respectively, per tubewell per year). It is no wonder that even in the first 5 years of the transfer program, when the turnover rate was quite slow, tubewells with flat-rate connections had greater acceptability among farmers (tables 7 and 9).

2. Prestige and social influence: Tubewells form the backbone of the agrarian economy of Gujarat. With the decline in power availability and restrictions on new connections, a tubewell has become an even more valuable resource. Consequently, control over a tubewell brings enviable power, prestige and goodwill to a person in rural Gujarat.

The findings of this study support the view that it is lure of profit and not the fear of loss that is the main driver for farmers who come forward to take over these tubewells.

What Impedes Transfer of Public Tubewells?

With GWRDC's professional approach notwithstanding, only around 60 percent of all tubewells have been transferred to date in the Gujarat state. Out of 354 functioning tubewells in Anand district only 149 (49.5%) have been transferred while another 155 are still with GWRDC. A study of the transfer process is incomplete if the factors that have impeded the transfer of the rest of the tubewells are not identified.

A large number of tubewells that have not been transferred as yet can be classified into two categories: 1) tubewells in very good operating condition and 2) tubewells in extremely poor physical condition.

The very good tubewells could not be transferred because they offer an excellent opportunity to make profits at a very low initial investment and O&M cost, thereby attracting competing claims from more than one group in the command area. We visited one such tubewell in the village of Duleta of the Umreth *taluka*. This tubewell operated for more than 2,000 hours and irrigated over 50 ha of land in the 2000-2002 period, thereby generating revenue of Rs 55,000 per year for GWRDC (based on GWRDC data). These figures are higher than the average hours of operation and area irrigated by a GWRDC tubewell, which are around of 1,400 hours and 35 ha, respectively. In this village, two competing groups have applied to takeover the tubewell. However, without any consensus among them and GWRDC, the tubewell could not be handed over.

On the other hand, tubewells in extremely poor condition require high investments to make them functional and viable. Even the O&M cost of such tubewells is liable to be high. This means that a group that takes over such a tubewell will earn less on a higher investment, making it a poor business proposition. For example, in the village of Navakhal in the Anklav *taluka*, a group had returned a tubewell only a few days before we visited the village. The group operated the well for a year and realized that it was beyond its means to repair the punctured bore of the tubewell. In the last year (2000-2001), the well could run for only 280 hours, which did not even recover the rent (Rs 5,000) the group had to pay to GWRDC. Therefore most of the wells in poor condition had no takers. Such dilapidated systems are by no means a rarity. GWRDC has stopped all civil repairs for the last 10 years or so and most of the public tubewells are in a bad state. It is only in a few isolated cases that tubewells haven't been transferred because of the absence of an enterprising individual in the command area or failure of farmers to come together to form a group.

All in all, our assessment of the entire transfer process is positive. We contend that GWRDC in the last few years has met with relative success in turning over public tubewells. Such success still eludes public tubewell-transfer programs in Kerala, Haryana, and Bihar, which have been trying in vain to turn over public tubewells to village *panchayats* (Brewer et al 1999) for the past decade.

Conclusions and Policy Implications

Despite its relative success, GWRDC's tubewell-transfer program does not qualify as a classic IMT case. In particular, IMT programs are designed to ensure sustainability of irrigation infrastructure. In GWRDC's case the short lease period and the requirement to return the tubewell with all original parts intact (e.g., original motor not substituted by an inferior one) and no significant damage to the well structure, does not ensure long-term sustainability in terms of maintenance of the systems. Similarly, most IMT programs such as those in Colombia, Mexico and Turkey focus on governance issues such as organizational structure and legal rights and duties of the water users associations (WUAs), while GWRDC does not concern itself at all with these issues. Thus, GWRDC's attempt does not qualify to be called IMT in the prevailing sense of the term and in essence is more in tune with some rudimentary form of privatization where only the management responsibilities have been transferred without any long-standing legal implications. Our findings should be interpreted in this context.

There are three main conclusions drawn by our study. First, the tubewell transfer program of GWRDC has achieved relative success since 1998. This is specially so when compared with its performance before 1998. In fact, till then this program was branded as another case of governmental failure (Shah et al. 1994). The factors that Shah et al. (1994) list as being responsible for the failure of the scheme are, among other things, compulsory formation of cooperatives, undue interference by GWRDC officials (especially those of lower ranks), limited autonomy, token rent and low exit cost, etc. However, our analysis shows that many of these impeding factors have been removed since 1998.

Our second and most important finding is that government commitment to the transfer program is at the core of this success. This willingness was manifested after 1998, when GWRDC started setting targets for turn-over for each section office. Top management not only realized the urgent need for tubewell transfer, but also successfully induced the lower-level management staff to support it.

The third finding relates to what can be done to make this program more attractive to farmers. We contend that perhaps few more changes in the GWRDC's transfer method will make tubewell transfer more attractive for farmers. We make three recommendations in this regard.

First, GWRDC should consider longer leases for the turned-over tubewells. Our study shows that cooperatives have made greater capital investments in the system and were able to irrigate a larger command area than the *juths* (57.9 and 55 ha, respectively) with lower pumping hours (1,570 hours compared to 1,698 hours of *juths*). A secure long-term lease (around 10 years) will instill a sense of ownership and confidence in the lessee to make investments. This will further improve the performance of the system, perhaps making it a better business proposition than even the private tubewells.

Second, GWRDC's inability to turn over so called "good tubewells" owing to multiple applicants from the command area can be overcome by introducing a process of "transfer to the highest bidder." We suggest that instead of giving the tubewell for a fixed rent of Rs 5,000 per year, GWRDC should award the management contract to the highest bidding group or even individual through an auction open to all beneficiaries. This will induce the lessee to be efficient and expand his water-selling market.

Apart from earning higher returns for GWRDC, this will also ensure that local political dynamics do not frustrate the transfer process.

Third, by selling dilapidated or defunct tubewells (there are almost 48 defunct tubewells in Anand district alone) GWRDC can recover its losses. Private investors will be willing to invest in such units because these tubewells come with an electricity connection which is at a premium as new connections are costly, time-consuming and difficult to get. GWRDC must devise proper pricing for defunct tubewells. One such estimate by Shah and Ballabh (n.d.) suggests that it would be fair to sell off a defunct and closed tubewell for Rs 10,000 since, in all probability, its book value would be near zero. A good case can be made even for selling off all the functioning tubewells along with the dysfunctional ones, which would at least ensure that farmers will have incentive to invest in maintaining and improving the system. As already pointed out, under existing conditions, the long-term sustainability of GWRDC tubewells are at stake and most of them might be closed down in another 5 to 10 years. If needed, payment for functioning tubewells can be spread over a number of years.

GWRDC's performance over the last 4 years has set a successful example in tubewell transfer. The essence of GWRDC's success lies in simplicity, speed, scale, frugality (of institutional investment) and stability. Any agency trying to replicate its success must have commitment to the transfer process and adopt a professional approach towards it. It would be naïve to expect people in the lower hierarchies of the relevant agency to volunteer to support the process as it might entail a direct threat to their jobs. Top management should take the lead and communicate it clearly through unambiguous policies and action. GWRDC, quite admirably, has managed the transfer program like a marketing project. The centrality of the customer is the distinctive element in this marketing approach. The "marketeer" (GWRDC) has developed a valuable proposition that is attractive to its customers (farmers). Most irrigation transfer projects are designed only to shift the management costs and responsibility to farmers without offering commensurate returns and authority. After developing a solid and valuable proposition, GWRDC adopted a target-oriented approach with an emphasis on speed and scale. Speed and scale can be achieved only if the marketing process is simple and direct and not process intensive. They also adopted a flexible approach that allowed them to take the feedback from farmers and make necessary changes. GWRDC has successfully adopted this approach with the result that almost 60 percent of the public tubewells in the state of Gujarat have been transferred and are being voluntarily and successfully managed. Given that the situation in Gujarat is quite unique (both in terms of relative equity in landholding and centrality of tubewell irrigation) it is not realistic to conclude that the GWRDC transfer program can be directly replicated in other states of India. However, the lessons learnt from the GWRDC transfer program are nevertheless important because other states could perhaps adapt a similar transfer program according to their agrarian realities.

Literature Cited

Asopa, V.N; Dholakia B.H. 1983. *The Performance Appraisal of Gujarat Water Resources Development Corporation, Volume I, Summary and Recommendations.* Ahmedabad, India: Centre for Management in Agriculture, Indian Institute of Management.

Brewer, J.; Kolavalli, S.; Kalro, A.H.; Naik, G.; Ramnarayan, S.; Raju, K.V.; Sakthivadivel, R. 1999. *Irrigation Management Transfer in India, Policies, Processes and Performance.* New Delhi, Calcutta: Oxford and IBH Publishing Co.

Farley, P. J. 1994. *Privatization of Irrigation Schemes in New Zealand.* Short Report Series on Locally Managed Irrigation, Report No. 2. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI).

Johnson III, S.H. 1997. *Irrigation Management Transfer in Mexico: A Strategy to Achieve Irrigation District Sustainability.* Research Report 16. Colombo, Sri Lanka: IIMI.

Johnson III, S.H.; Vermillion, D.; Svendsen, M.; Xinyuan, W.; Xiying, Z.; Xuesen, M. 1996. *Management Reform and Performance Changes in Two Irrigation Districts in the North China Plains.* Short Report Series on Locally Managed Irrigation, Report No. 16. Colombo, Sri Lanka: IIMI.

Kolavalli, S.; Shah, N. 1993. "Management of Public Tubewells in Uttar Pradesh." In *Groundwater Irrigation and the Rural Poor- Options for Development in the Gangetic Basin*, eds., K. Friedrich and G. Levine. Washington D.C.: The World Bank.

Kumar, D. 1996. *Tubewell Turn Over: A Study of Groundwater Irrigation Organisation in Mehsena*. VIKSAT Monograph. Ahmedabad: VIKSAT.

Mandal, M.A.S; Parker, D.E. 1995. *Evolution and Implications of Decreased Public Involvement in Minor Irrigation Management in Bangladesh.* Short Report Series on Locally Managed Irrigation, Report No. 11. Colombo, Sri Lanka: IIMI.

Mishra, V.S; Molden, D.J. 1996. *Management Turnover in the West Gandak Irrigation System, Nepal.* Short Report Series on Locally Managed Irrigation, Report No. 14. Colombo, Sri Lanka: IIMI.

Niranjan, P. 1993. "Performance of the World Bank Tubewells in India." In *Groundwater Irrigation and the Rural Poor-Options for Development in the Gangetic Basin*, eds., K. Friedrich and G. Levine. Washington D.C.: The World Bank.

Shah, T. 1996. *Catalysing Co-operation, Design of Self-Governing Institutions.* New Delhi: Sage Publications Private Limited.

Shah, T.; Bhattacharya, S. 1993. *Farmer Organisation for Lift irrigation: Irrigation Companies and Tubewell Cooperatives of Gujarat*. ODI Irrigation Management Network, Paper No. 26.

Shah, T. Ballabh, V. unpublished. Redesigning Gujarat's Public Tubewell Turnover Programme. Institute of Rural Management, Anand.

Shah, T.; Ballabh, V.; Dobrial, K.; Talati, J. 1994. "Turn over of State Tubewells to Farmers Cooperatives, Assessment of Gujarat's Experience, India." Paper presented at the *International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September, 1994*.

Sharma, S.C. unpublished. *A Study of GWRDC's Tubewell Transfer Programme in Vadodara District, Gujarat.* Draft report submitted to International Water Management Institute, India Programme Office, Anand, India.

Trivedi, K.B. Yagnik, V.M. unpublished. Participatory Irrigation Management in Groundwater: Success Story of GWRDC. Internal report of GWRDC, presented at IWMI-Tata Annual Partner's Meet, 27-29 January, Anand, India.

Vermillion, D. L. 1997. *Impacts of Irrigation Management Transfer: A Review of the Evidence.* Research Report 11. Colombo, Sri Lanka: IIMI.

Vermillion, D.L.; Garces-Restrepo, C. 1996. *Results of Management Turnover in Two Irrigation Districts in Colombia.* Research Report 4. Colombo, Sri Lanka: IIMI.

Vermillion, D. L.; Samad, M.; Pusposutardjo, S.; Arif, S.S.; Rochdyanto, S. 2000. *An Assessment of the Small-Scale Irrigation Management Turnover Program in Indonesia.* Research Report 38. Colombo Sri Lanka: IWMI.

Wijayaratna C.M.; Vermillion, D. L. 1994. *Irrigation Management Transfer in the Philippines: Strategy of the National Irrigation Administration.* Short Report Series on Locally Managed Irrigation, Report No. 4. Colombo, Sri Lanka: IIMI.

56. *Hydronomic Zones for Developing Basin Water Conservation Strategies.* David J. Molden, Jack Keller, and R. Sakthivadivel, 2001.

57. *Small Irrigation Tanks as a Source of Malaria Mosquito Vectors: A Study in North-Central Sri Lanka.* Felix P. Amerasinghe, Flemming Konradsen, Wim van der Hoek, Priyanie H. Amerasinghe, J. P. W. Gunawardena, K. T. Fonseka and G. Jayasinghe, 2001.

58. *Fundamentals of Smallholder Irrigation: The Structured System Concept.* B. Albinson and C. J. Perry. 2001.

59. *A Gender Performance Indicator for Irrigation: Concepts, Tools and Applications.* B. van Koppen. 2001.

60. *Institutional Alternatives in African Smallholder Irrigation: Lessons from International Experience with Irrigation Management Transfer.* Tushaar Shah, Barbara van Koppen, Douglas Merrey, Marna de Lange and Madar Samad. 2002.

61. *Poverty Dimensions of Irrigation Management Transfer in Large-Scale Canal Irrigation in Andra Pradesh and Gujarat, India.* Barbara van Koppen, R. Parthasarathy and Constantina Safiliou. 2002.

62. *Irrigation Sector in Sri Lanka: Recent Investment Trends and the Development Path Ahead.* M. Kikuchi, R. Barker, P. Weligamage and M. Samad. 2002

63. *Urban Wastewater: A Valuable Resource for Agriculture.* Wim van der Hoek, Mehmood Ul Hassan, Jeroen H. J. Ensink, Sabiena Feenstra, Liqa Raschid-Sally, Sarfraz Munir, Rizwan Aslam, Nazim Ali, Raheela Hussain and Yutaka Matsuno. 2002.

64. *Use of Untreated Wastewater in Peri-Urban Agriculture in Pakistan: Risks and Opportunities.* Jeroen H. J. Ensink, Wim van der Hoek, Yutaka Matsuno, Safraz Munir and M. Rizwan Aslam. 2002.

65. *Land and Water Productivity of Wheat in the Western Indo-Gangetic Plains of India and Pakistan A Comparative Analysis.* Intizar Hussain,R.Sakthivadivel, Upali Amarasinghe, Muhammad Mudasser and David Molden. 2003.

66. *Agro-Well and Pump Diffusion in the Dry Zone of Sri Lanka: Past Trends, Present Status and Future Prospects.* M. Kikuchi, P. Weligamage, R. Barker, M. Samad, H. Kono and H.M. Somaratne. 2003.

67. *Water Productivity in the Syr-Darya River Basin.* Hammond Murray-Rust , Iskandar Abdullaev, Mehmood ul Hassan, and Vilma Horinkova. 2003.

68. *Malaria and Land Use: A Spatial and Temporal Risk Analysis in Southern Sri Lanka.* Eveline Klinkenberg, Wim van der Hoek, Felix P. Amerasinghe, Gayathri Jayasinghe, Lal Mutuwatte and Dissanayake M. Gunawardena. 2003.

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