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Research Report

Impact Assessment of Irrigation Management Transfer in the Alto Rio Lerma Irrigation District, Mexico

Wim H. Kloezen, Carlos Garcés-Restrepo, and
Sam H. Johnson III

International Irrigation Management Institute

Research Reports

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Summary

The economic crisis of Mexico in the 1980s led to radical and extensive reforms in its agriculture sector. Among the most significant institutional reforms was the program to transfer irrigation management responsibilities for large-scale irrigation districts from the sole control of the public sector irrigation agency to a joint management arrangement with newly created water user organizations.

This study reports on the findings of a 2-year field research study started by IIMI late in 1995 in the 112,772-hectare Alto Rio Lerma Irrigation District (ARLID), Mexico. The study tests the hypothesis that, in general, irrigation management transfer (IMT) has positive impacts on operational performance, managerial accountability, O&M budgeting, overall O&M expenditures, cost of water to farmers, and agricultural and economic productivity.

Each of the aspects evaluated was analyzed for the period October 1982 to October 1996, comprising 10 years of pre-transfer information and 4 years of post-transfer information.

The study found that irrigation management transfer has had very little impact, if any, on surface water allocation and distribution, and the use of groundwater. Changes, if any, in agricultural and economic productivity and costs to farmers are related to the wider set of neoliberal agricultural and economic reforms that started in the 1980s, rather than to the transfer program per se. On the other hand, there is strong evidence indicating that transfer resulted in improvements in system maintenance and O&M cost recovery.

Although diverse in the ways it has been implemented by agencies and adapted by users, a number of components characterize the IMT program at ARLID and elsewhere is Mexico:

- IMT did not come alone, but followed, and was part of a wider set of neoliberal economic reforms.
- IMT was made workable as it met with a political commitment at the highest levels.
- IMT was accompanied by the introduction of a new National Water Law that recognizes water rights to water user associations (WUAs), as well as the authority and responsibilities of water users.
- IMT is a rapid top-down process that has met with relatively little resistance from farmers.
- New WUAs were given training on system management.
- WUAs agreed to jointly manage the system with the agency during a fixed and relatively short period of time.
- The Mexican IMT program aims not to maximize direct user participation in O&M, but to involve farmers in representative governance.

WUAs in ARLID are still facing a number of problems that need to be resolved to make irrigation management by WUAs sustainable. These problems include: a water law that does not sufficiently recognize water rights to individual users, fee levels that do not follow inflation, high turnover of staff hired by the WUAs, lack of continuous training, and difficulties in identifying new roles that the agency could take on.

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Introduction

The Government of Mexico responded to the economic crisis of the 1980s with drastic changes in its agricultural and irrigation policies. A cornerstone of the latter was a restructuring and modernization program of the irrigation sector. One of the strategies followed in this regard was developing a government-farmer partnership between the National Water Commission (CNA), the government agency responsible for the operation and management (O&M) of the irrigation districts, and the newly established WUAs. In the first phase of this partnership, CNA remains responsible for management of the head works and the main canals while WUAs take over financial and managerial responsibilities for operating the system below the main canals. In the second phase of the transfer process, responsibility for operating and maintaining the main system is handed over to a Limited Responsibility Society (LRS), which is a federation of the WUAs at the district level. CNA is left with the responsibility for managing the reservoirs and river-surface water pumping plants.

This partnership, which is known as the Mexican IMT program, was started in 1989 and brought significant changes in the way the districts are managed. Given the unsatisfactory level of performance of the agency-managed districts during the pre-transfer period (Palacios-Vélez 1994a), this new approach will be the strategy for the foreseeable future. Consequently, there is a felt need expressed by policy makers, irrigation professionals, and water users to evaluate the consequences of this program countrywide.

Mexico is one of the many countries that has adopted a program that turns over the management authority for irrigation systems from government agencies to local private organizations. The logic, often used to justify irrigation management transfer policies, is described by Vermillion (1997) and summarized below:

1. Direct control by farmers provides them with the incentives to improve operational performance.
2. IMT improves the quality and cost-efficiency of irrigation management and enhances the profitability of irrigated agriculture.
3. Management transfer will save money that can be used elsewhere by the government.

The following hypotheses follow the above argument and are tested in this report:

1. Farmers' increased involvement in control over irrigation planning and operations will lead to managerial changes which aim at a more reliable and timely delivery of irrigation services and better adequacy of the service.
2. Shorter administrative distances between water users and system manag-

ers, introduced by IMT, improve managerial accountability and communication between farmers and system managers, and will lead to greater responsiveness of field staff to farmers.

3. Farmers' direct control over O&M budgets will lead to a better match between available resources to do O&M and perceived needs by farmers.
4. IMT will result in a reduction in expenditure by governments for O&M, in an increase in financial self-sufficiency, and in greater financial transparency.
5. IMT will increase the cost of irrigation services to farmers.
6. Where IMT is one in a larger set of economic and agricultural reforms, it will be difficult to attribute changes in crop diversification, cropping intensities, yields, and agricultural productivity to IMT.

The Mexican Irrigation Management Transfer Program

While underemphasizing the diversity in the ways the program has been implemented and adopted, international organizations have advocated the Mexican IMT program as "**the** transfer model" to other countries, apparently due to the program's scale and speed of implementation. By December 1996, almost 2.92 million hectares had been transferred to 372 WUAs, representing 90 percent of the area served by the 80 irrigation districts in the country (CNA 1996).

The main objective of the Mexican IMT program was to reduce public expenditure on irrigation O&M while promoting greater user participation in the management of irrigation districts. The program also provided assistance, such as on-farm development initiatives to enhance farm-level productivity and water conservation. A further objective was to restore economic growth by using a system of pricing water, based on international prices, marginal costs, or scarcity value (Gorriz, Subramanian, and Simas 1996).

Economic and Legal Contexts

The Mexican IMT program should be viewed in the context of other constitutional, political, economic, and institutional reforms of the late 1980s and early 1990s. One of the major reforms that affected farmer production in the irrigation systems was the revision of Article 27 of the Constitution in 1992, which effectively brought an end to the land reform program resulting from the Mexican revolution in the early part of the century (Ibarra-Mendívil 1996). This revision created the legal foundation for the privatization of the *ejidos* (land reform communities) in all irrigation districts. In addition, the policy of guaranteed crop prices and subsidized credit was substituted for market policies and compensatory services (De Vries 1995; Foley 1995; Nelson 1997; Presler 1997). As a consequence, farmers' access to public agricultural support services became more difficult or simply ceased to exist. Dismantling the public sector, including the public irrigation sector, would not have been possible without the commitment at the highest political levels to reduce staff working in the public sector.

At the same time, the IMT program and other water problems created the necessity to revise the water law (Palacios-Vélez 1994b; Rosegrant and Schleyer 1996). In 1992, a new National Water Act was promulgated, which allows the CNA and private parties such as WUAs to:

1. Sign a tradable water concession agreement, which gives WUAs the right to buy and sell water either within the agriculture sector or with other sectors in the economy.
2. Sign a permit for utilization of the districts' infrastructure, which allows private entities to make use of government property.

The Strategy

IMT has been a top-down process motivated by international development banks and implemented by the Government of Mexico. Six components of the strategy characterize the IMT program and largely explain the high speed of the process and the relatively low resistance by farmers to assume O&M responsibilities.

1. The program was developed on an already existing strong organizational base: the ejidos and the organizations of private growers. Government officials visited the ejidos to inform farmers about the transfer program and told them to select their delegates to the WUAs that were to be newly established. In addition to the ejido delegates, private growers—who normally are organized through their cooperatives and growers' unions (Foley 1995)—were also asked to select their delegates to the WUAs. Subsequently, these delegates were asked to elect from among themselves the president, treasurer, and secretary to each of their WUAs. To most farmers the concept of transfer was completely new and many delegates were hardly aware of what their new role comprised (Whiteford and Bernal 1996).
2. IMT followed a wide set of other neo liberal reforms that had already privatized the provision of many agricultural services. Farmers had also become aware that O&M services traditionally provided by CNA would soon cease to exist. Moreover, the quality of service provided before transfer had declined and CNA tried to convince farmers that WUAs could provide better service at lower costs. CNA was the first to transfer the larger irrigation districts in the north of Mexico, where they knew many large private producers would support this idea, to show that IMT was workable.
3. CNA agreed to work in a collaborative mode for at least 6 months from the time of transfer so that the new WUAs could gain experience before they were left on their own.
4. Unlike in Sri Lanka and Nepal, for instance, the Mexican IMT program does not aim to maximize direct participation in O&M of all users but aims to involve farmers in representative governance.
5. CNA granted concessions to the WUAs to use its machinery and equipment to maintain the canals, which meant that (at least initially) WUAs were not confronted with high capital costs.
6. The government, and later private organizations also, provided extensive training on O&M and financial management to leaders and technical staff of the WUAs (Johnson 1996).

Changes in Roles

As part of the transfer process, hydraulic committees at the district level were introduced to help plan annual and seasonal water allocations. Until transfer, CNA was wholly responsible for these allocations. After transfer these committees comprised CNA representatives, the state government, and each WUA in the district.

Prior to transfer, CNA employed heads of irrigation units[1] and ditch tenders who were responsible for daily O&M at all system levels down to the farm inlets. Farmers had to go to the CNA unit offices to pay their fees and were given water by the CNA ditch tender. After transfer, these units were converted into the modules, which were managed by the new individual WUAs. Out of the fees, which they directly collect from the users, the WUAs now employ their own module managers, ditch tenders, maintenance personnel, and administrative staff. Based on the volume of water a module buys from CNA and on the proportional amount of main infrastructure that serves a module, the modules have to pay a percentage of their total fee collection to CNA.

Although officially CNA's role below the main canals has ceased to exist, observations and press reports show that CNA continues to play an informal (but important) role in setting the O&M fee and planned seasonal water allocation within the modules, as well as conflict resolution within the WUAs. Yet, the traditional CNA-users relationships are weakened. These are being replaced by new networks of leaders of WUAs, users, private international seed and agrochemical companies, and local and state politicians. These actors play a role in setting the market prices for agricultural inputs, electricity, and crop produce. It has become clear that many WUAs want to increase their role in these networks (Kloezen and Garcés-Restrepo n.d.[a]). This has stimulated discussions within the WUAs on whether or not associations should expand their O&M mandate toward the provision of wider agricultural support services, which were earlier provided by the public sector but are now provided by the private sector.

[1]Before IMT, irrigation districts were divided into *unidades* (units), which were more or less independent hydraulic blocks, with sizes ranging from 3,000 to 20,000 hectares. After IMT, units were converted into *módulos* (modules). In some cases, units were split in two or more modules.

Research Setting

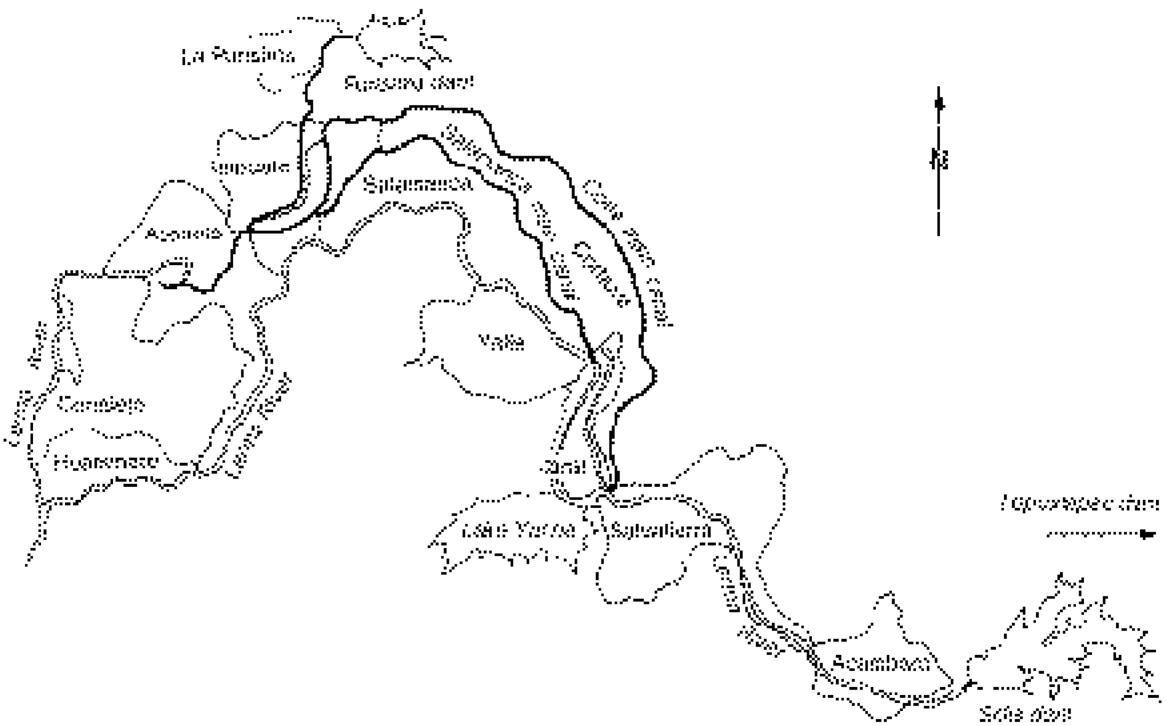
The Irrigation District

Figure 1 shows the general layout of the Alto Rio Lerma Irrigation District (ARLID). This district has a gross area of 112,772 hectares and is located in the State of Guanajuato, Mexico. There are roughly 24,000 water users in the irrigation district, 55 percent of whom are *ejidatarios* (members of the ejidos) of the 281 ejidos within the district and 45 percent are classified as "small private growers."[2] The average landholding in the irrigation district is 5 hectares, with 3.7 hectares, and 7.6 hectares, respectively, being the averages for the ejidatarios and the private growers.

The climate is moderately subhumid with an average yearly precipitation of 730 mm and an average temperature of 19 °C. Yearly evapotranspiration is approximately 1,900 mm and relative humidity is about 60 percent. The dry winter season, which receives approximately 80 mm of rainfall, starts in November and ends in April. The

[2]The concept "small private grower" (*pequeño propietario*) is a misnomer because in Mexico such user category allows ownership up to 100 hectares for an individual owner.

FIGURE 1.
The Alto Rio Lerma Irrigation District and its 11 modules.



summer season lasts from May until November and has an average of 670 mm of rainfall. Basic climatic data for the district are presented in figure 2.

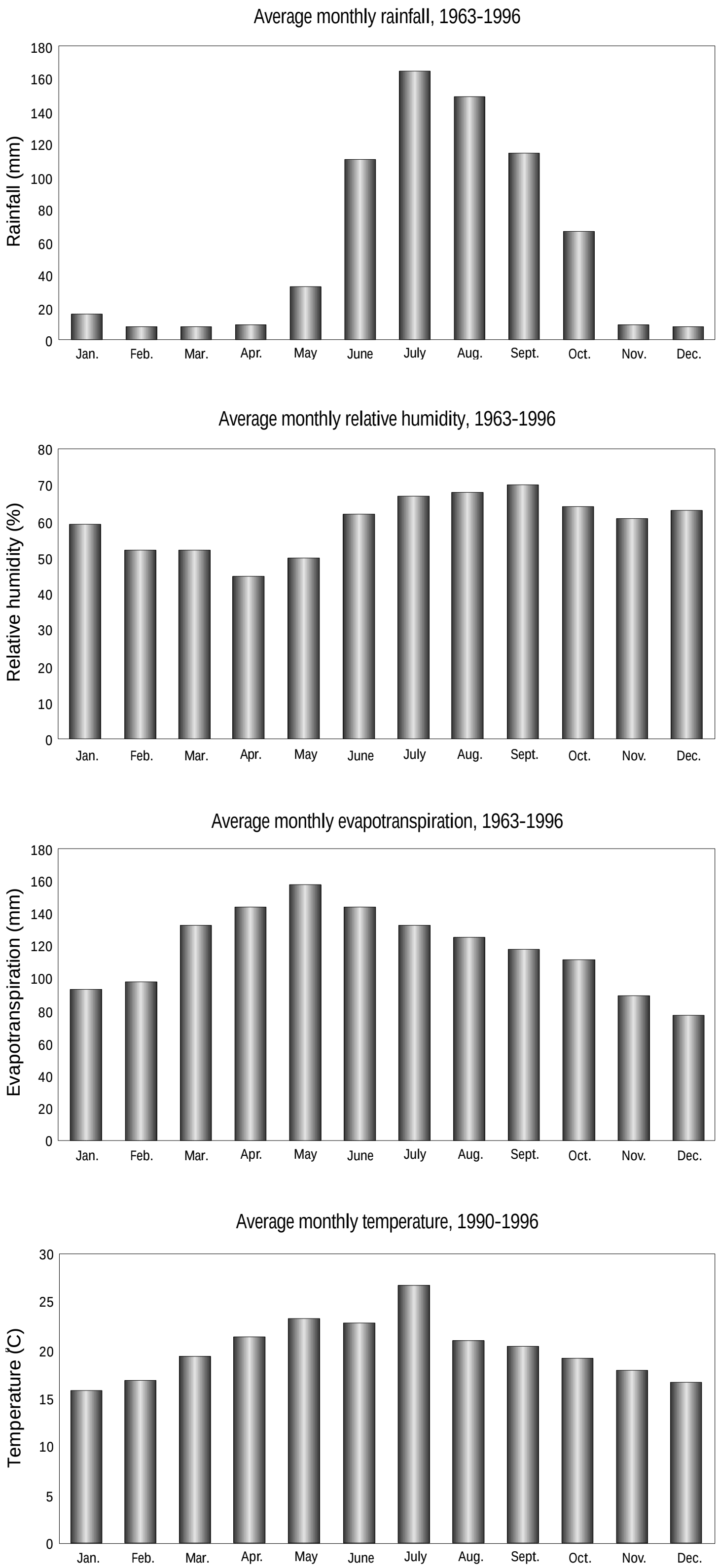
Surface water for the district is provided by four dams with a combined storage capacity of 2,140 million cubic meters serving 77,697 hectares. The storage dams are complemented by five diversion dams located along the Lerma River. The irrigation network comprises 475 km of main canals and 1,658 km of secondary and tertiary canals. Likewise, there is a network of approximately 1,031 km of drainage canals.

In addition to the surface water, there are altogether 1,714 deep wells serving an additional 35,075 hectares within the district; thus the district relies on both surface water and groundwater, with their combined use playing a vital role in system operation. The State of Guanajuato is underlaid by 18 different aquifers, 3 of which are partly exploited by farmers within the ARLID. The estimated total annual recharge of these 3 aquifers is 500 million cubic meters.

The main crops grown during the dry winter season are wheat and barley. During the wetter summer season the main crops are sorghum, maize, and bean. Vegetables are grown by both ejidatarios and private growers, with the latter also producing for the export market. Farmers who use a deep well tend to grow more vegetables than those farmers who depend totally on canal water.

Presently, the irrigation district is divided into 11 modules ranging in size from 1,513 to 18,694 hectares, and each is managed by an individual WUA. Table 1 shows the high diversity in the social (number of private growers v. ejidatarios) and physical

FIGURE 2.
Climatic data for the Alto Rio Lerma Irrigation District.



(infrastructure and irrigation source) characteristics of these modules. The diversity shows the different settings, within one single district, in which the Mexican IMT has been introduced. The post-transfer organizational setup of the district is presented in figure 3.[3] The figure shows that CNA and WUAs are equal parties that share responsibilities for system O&M.

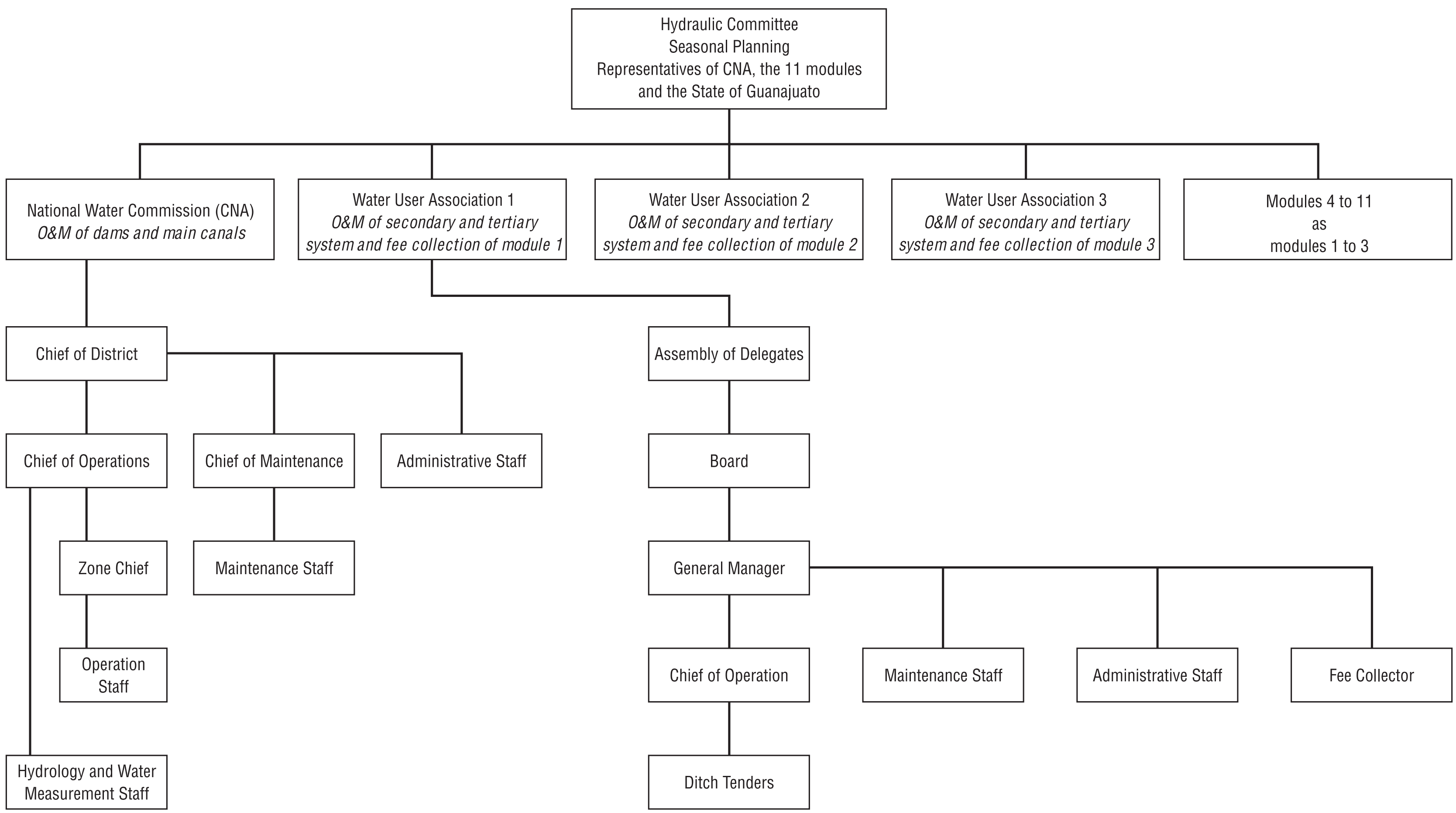
After transfer, by law, at the start of each agricultural year in November the hydraulic committee decides how much area can be safely irrigated in the district and by each module. The area to be irrigated is normally a function of the combined water storage in the four dams. Based on this volume, the hydraulic committee also decides on the number of times irrigation services can be delivered to the users and whether these are for both winter and summer seasons or only for the winter season. Generally, irrigation services are provided three to five times in the winter season while they are provided only once in the summer season. Subsequently, the water available is distributed in strict proportionality to each module's surface irrigation entitlement area. Taking into consideration that the modules can restrict the area to be irrigated by the users, farmers can then request water at anytime during each irrigation period, keeping in mind the number of times of irrigation services to which they are entitled over the cropping season. Fees are normally paid to the WUA prior to each individual irrigation. Farmers receive a receipt of payment which they have to show to the ditch tender before water is allocated to their fields.

[3]This chart does not include the recently created Limited Responsibility Society (LRS). Its role is not described in this report as during the period of this research it had not yet become functional.

TABLE 1.
Salient features of the 11 modules in the Alto Rio Lerma Irrigation District.

Module	Area (ha)			Number of ejidos	Number of users			Area by irrigation source (ha)				Irrigation network (km)			Drainage network (km)		
	Ejido sector	Private growers	Total		Ejido sector	Private growers	Total	Surface	Public wells	Private wells	Total	Main canals	Secondary canals	Total	Main drains	Secondary drains	Total
Acambaro	6,545	2,304	8,849	23	1,622	308	1,930	6,727	257	1,724	8,708	43	101	144	28	96	123
Salvatierra	13,561	2,336	15,897	44	5,082	972	6,054	12,775	565	2,753	16,093	116	120	236	42	176	218
Jaral	3,236	3,453	6,689	16	1,062	401	1,463	4,381	371	1,992	6,744	60	73	134	12	80	92
Valle	7,359	6,319	13,678	31	1,773	536	2,309	7,990	778	3,955	12,723	31	162	193	52	83	135
Cortazar	9,781	8,668	18,448	35	2,169	993	3,162	10,934	1,964	5,796	18,694	75	238	312	23	85	108
Salamanca	5,165	8,992	14,157	37	1,178	1,534	2,712	12,109	573	3,426	16,108	61	174	235	10	91	101
Irapuato	4,078	4,312	8,391	19	984	285	1,269	4,810	688	3,090	8,588	18	102	120	18	43	61
Abasolo	5,229	11,136	16,365	38	1,164	1,259	2,423	10,911	1,152	3,390	15,453	28	141	169	33	39	72
Huanimaro	2,261	1,470	3,731	18	611	229	840	2,802	430	491	3,723	20	20	40	15	41	56
Corralejo	1,219	297	1,516	5	264	11	275	653	643	217	1,513	12	0	12	0	1	1
La Purisima	3,437	982	4,419	15	936	118	1,054	3,605	0	820	4,425	11	52	63	27	27	54
Total	61,871	50,269	112,140	281	16,845	6,646	23,491	77,697	7,421	27,654	112,772	475	1,183	1,658	260	761	1,021

FIGURE 3.
The organizational structure of the Alto Rio Lerma Irrigation District after transfer.



Data Collection Methodology

IIMI started this study in October 1995 with the establishment of project offices in Cortazar and Salvatierra modules. The study combines data from a number of different sources, at different system levels. Time series data for the cropping seasons 1982-96 stem from records kept by CNA at irrigation district, regional, and central levels, as well as from the 11 WUAs at the module level. These data included cropping patterns, crop yields, farm gate prices, climate data from seven selected stations within and near the district, monthly and seasonal canal flows at different system levels, dam storage and releases, cost and volumes of maintenance work done, irrigation fees collected and planned, and actual O&M budgets. Where possible, daily or weekly records were used and aggregated by IIMI, rather than using seasonal or annual summary reports published by the agency and the modules.

CNA as well as most WUAs use computers to enter, monitor, and process their data. IIMI always had full and unconditional access to these as well as other files, which provided excellent transparency of the data used for this study. Several tools were applied to check the quality of the data. Aggregation of module level data provided a cross-check for data collected at the district level. Secondary data were further cross-checked by data collected from other sources like rural development banks. Although not presented in this paper, primary hydrologic data collected for an ongoing performance assessment study (Kloezen and Garcés-Restrepo n.d.[b]) provided a tool to cross-check the quality of officially reported canal flows at different hydrologic control points in the system during a period of four irrigation seasons.

The FAO's CROPWAT and its complement CLIMWAT software packages were used to calculate crop water requirements. Outputs per unit of land and water were calculated following the standardized procedure described in Molden, Sakthivadivel, and Perry (forthcoming). This procedure converts cropping patterns that comprise multiple crops into 'equivalent´ yields and the Standardized Gross Value of Production. The equivalent crops used in this study are wheat for the winter season and sorghum for the summer season.

Open and informal interviews with key informants such as CNA and state officials, module personnel, and farmers were used to better interpret secondary data, as well as to better understand the process and impact of IMT at ARLID. Attendance at CNA, module, hydraulic committee meetings, workshops during the period of study, and a literature review complemented the data collection.

Users' perceptions of the impact of the IMT program were captured by both semi-structured open-ended interviews and a farm survey. For the farmer survey the system was divided into four zones which aggregated modules with similar physical, hydraulic, agronomic, and socioeconomic conditions. Altogether 125 randomly selected farmers within the 4 zones were interviewed through a carefully designed and pre-tested questionnaire. The survey followed the classical head to tail distribution and accounted for land tenure arrangements (ejidatarios v. private growers) and water source (canal v. well).

To enable comparisons across countries and time, IIMI converts local units and currencies to international standard units and constant US dollar prices. Especially the latter proved to be a difficult task for the evaluation of the Mexican IMT program. By

December 1994 Mexico faced an economic crisis, which was followed by a devaluation of the peso against the dollar (from 3.5 pesos per dollar in July 1994 to 7.8 pesos per dollar in July 1996), as well as an inflation rate of approximately 50 percent in 1995. The start of the crisis fell exactly in the middle of the four post-transfer years reported here. In this report, as far as possible, all prices are converted into constant July 1994 dollars. Nominal peso prices are given in addition, but only if these clarify the impact analysis.

IMT Process at ARLID

The IMT process at ARLID started in 1992, with CNA officials paying visits to all the 281 ejidos in the district. During the second half of 1992, each of these ejidos had to select its delegates to the general assemblies of the modules. Subsequently, these delegates elected their boards. Irrigation fee levels were established for each module, using a methodology designed by CNA based on the volume that each module is buying. The percentage of total fee collection to be paid to CNA was negotiated. By November 1992, all 11 modules officially assumed responsibilities for fee collection and O&M of the infrastructure below the main canals. From June 1992 to December 1994, CNA provided 18 training courses where 331 persons participated. These courses were mainly directed to the technical staff of the new WUAs and focused on the concept of IMT, system O&M, and seasonal planning (Kloezen 1997). By November 1992, the new WUAs started hiring their own staff, but until mid-1993 CNA helped the WUAs to manage the distributary canals and those below them.

In 1992, concessions permitting WUAs to use the infrastructure were signed between the WUAs and CNA. By law, these usufructuary rights should be accompanied by volumetric water concessions. In the case of ARLID, these volumetric concessions are based on the average water available in the 4 reservoirs at the start of the agricultural year for the period 1949-94, the total average volume of which is 832 million cubic meters. Each module is entitled to a proportional share of this volume, provided that the volume is available at the start of the season. By law, these volumes should be registered in the Public Registration of Water Rights (REPDA) at CNA. However, by April 1997, although signed by CNA, these volumetric concessions had not been passed on to the Register.

One of the major differences between the previous and the new National Water Act is that under the latter water can be sold, such as from one WUA to another. These sales need the approval of CNA, as well as of the majority of the general assembly of the WUAs involved. In 1995 and 1996, five cases in ARLID were observed where WUAs bought water from other WUAs. The prices paid were negotiated by the WUAs and differed considerably, from US$0.40 per 1,000 m^3 to $0.90 per 1,000 m^3, depending on the distances over which the water had to be transported (Kloezen and Garcés-Restrepo n.d.[b]).

In the case of ARLID, the hydraulic committee has become an effective planning body. Generally, the committee meets three or four times at the start of the season, and again at the end of the season when water becomes more scarce. Although CNA continues to play a major role in assessing the available volume, observations show that in many cases participation of module representatives has led to decisions on area to be cropped and number of times irrigation services are to be provided that deviated from CNA's initial advice. The hydraulic committee has also been a strong platform for the modules to negotiate with CNA to establish the LRS and to determine the percentage of total fee collection to be paid to CNA once the LRS starts functioning. Finally, it has been observed that the modules have also used the hydraulic committee to get better access to State and Federal programs that help the modules to improve water management.

A direct consequence of the transfer is the change in staffing, as all the staff responsible for managing canals—the distributary canals and those below—are now directly hired by the WUAs while staff responsible for main system management continue to be hired by CNA. In general, the managers of the modules are responsible for daily O&M, although they receive guidelines from the board of delegates. In ARLID, WUAs were very reluctant to hire ditch tenders and other technical staff who had been made redundant by CNA as a result of IMT. The respondents mention four reasons that explain this:

1. They wanted to reduce their number to become more cost-effective.
2. Under CNA, the agency had difficulties in controlling ditch tenders, often resulting in bad performance, lack of accountability, and rent-seeking behavior.
3. Modules wanted to hire their 'own people,' which in some cases led to hiring relatively young ditch tenders, who were well-trained but who lacked experience.
4. To eliminate union involvement in the management of the modules.

TABLE 2.
Staff levels before and after transfer, the Alto Rio Lerma Irrigation District.

	Before (8/92)	After (8/96)		
	CNA	CNA	Modules	Total
Governance	4	3	11	14
Operation	155	70	94	164
Maintenance	81	19	46	65
Administration	30	15	41	56
Monitoring and evaluation	3	2	0	2
Other	0	7	0	7
Total	273	116	192	308
Canal irrigation area (ha)	85,118			85,118
Area (ha) per staff member	312			276

Table 2 shows that CNA staff levels were reduced from 273 in 1992 to 116 in 1996, a reduction of almost 60 percent, which means a considerable saving for the government. On the other hand, the remaining 116 CNA staff are responsible for the dams and the 2 main canals only. This relatively large number explains why total staff numbers (CNA plus modules) have increased by 13 percent after transfer. Especially the modules feel that an unspecified percentage of these CNA staff are residual personnel that for political and labor-union-related reasons remain within the agency with no specific task. This has been one of the major reasons why the modules wanted to create the Limited Responsibility Society (LRS) which will take over management of the main system. They feel that this will be much more cost-effective than the current arrangement. In February 1997, the LRS was established. Consequently, soon CNA's role will be further reduced. It is believed that by the end of 1997 CNA´s staff in the district will be reduced to 30 persons or less, down from 273 staff in 1992, and 116 staff in 1996.

Before transfer, users were mainly organized through the ejido, production cooperatives, and farmer unions (Foley 1995). The new WUAs cut across these traditional organizational lines. As the examples of the establishment of the LRS and the negotiation of the percentage of total fee collection to be paid to CNA show, WUAs have become powerful actors in the political and economic arenas. Some modules in ARLID are very market-oriented and aim to commercialize agriculture to a higher level. Presidents of these modules are generally influential private growers who use and expand their networks with private companies and politicians to obtain better prices and services. In other modules, decision making on staff policies and resource allocation is determined more by party and ejido politics.

Evidence from other countries indicates that users are not always aware of the change in management in their systems (Vermillion and Garcés-Restrepo 1996). The farmer survey done at ARLID, however, shows that 94 percent of the users know irrigation management has been transferred from the government to the WUAs; 63 percent of the respondents indicate they know the names of the presidents of the WUAs; and 80 percent know who their delegate is. On the other hand, only 33 percent of the farmers surveyed are familiar with the process of electing the president; and 57 percent of the farmers know how their own delegates to the assembly were chosen.

Impact on Water Allocation and Distribution

IMT has not resulted in major changes to the way seasonal planning is done. At the district level, the hydraulic committee adopted the same planning method used by CNA (as described above). Also, modules continue to follow the methodologies established by CNA before transfer.

FIGURE 4.
Cropping intensity versus dam storage, the Alto Rio Lerma Irrigation District, 1982–1996.

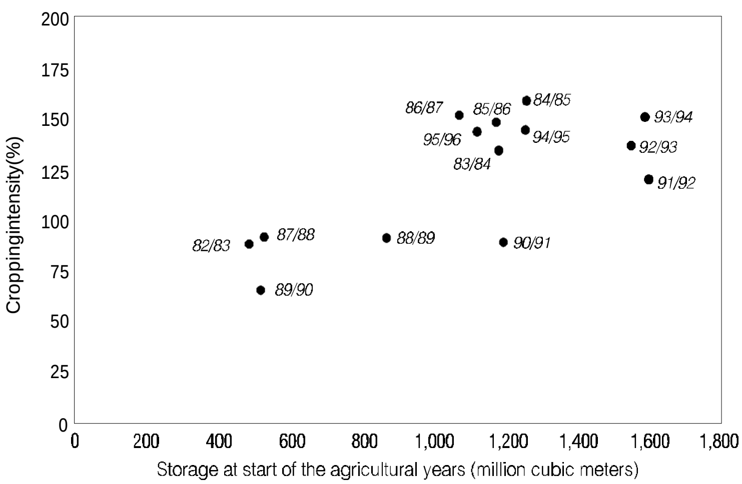
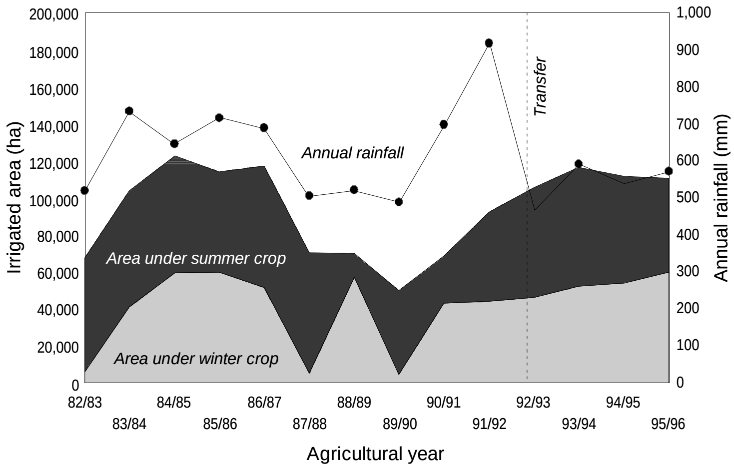


Figure 4 shows the relationship between cropping intensity and dam storage at ARLID for the period 1982–1996. This relationship highlights how annual storage management has changed as a result of transfer. The area values refer to the total area irrigated for the two seasons during a particular year. The graph indicates that if dam storage at the beginning of the season exceeds 1,100 million cubic meters, the cropping intensity response curve is rather flat, with an average cropping intensity of 137 percent although for different reasons, this flat response has not changed after IMT. Before IMT, CNA tried to keep water in storage (at the cost of increasing the irrigated area) to avoid running out of water at the end of the season and lose their accountability with the users. After IMT (and especially in the previous 2 years) water users exerted much pressure on the WUAs and consequently on the hydraulic committee and CNA to increase the number of

FIGURE 5.
Total irrigated area per season and annual rainfall, the Alto Rio Lerma Irrigation District, agricultural years 1982–1996.



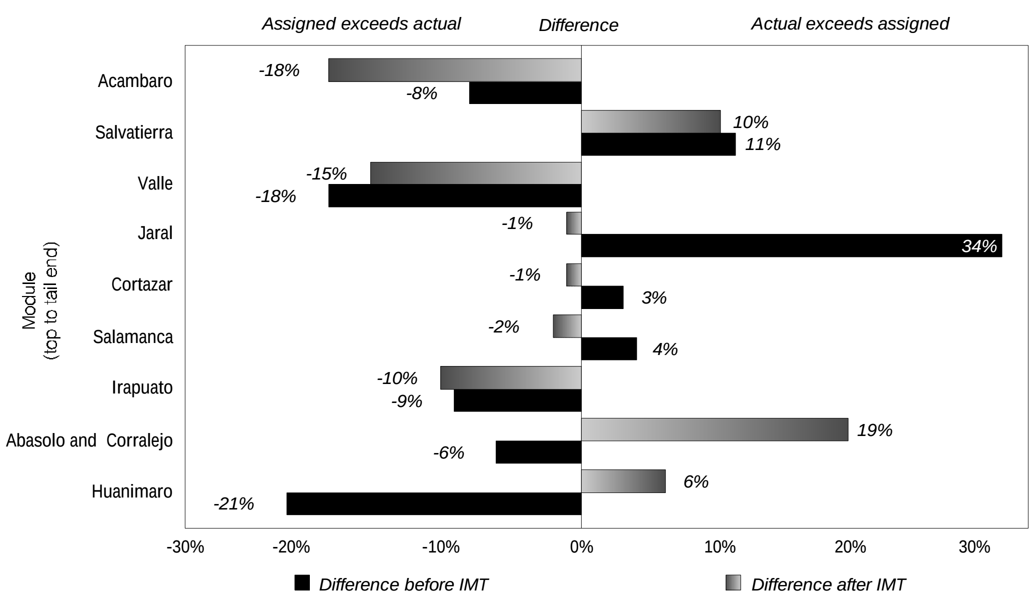
times irrigation services are provided for the winter season to guarantee a good wheat crop at the cost of growing sorghum or maize with irrigation services provided only once during the summer season. As a consequence, although recent years have had a relatively higher storage, cropping intensities have not increased.

Figure 5 indicates that no impact in the total area irrigated can be attributed to the IMT program. As explained above, this is more dependent on annual rainfall and dam management policies than on managerial changes invoked by the transfer. While the graph shows an increasing trend in area irrigated after transfer, given the area fluctuations in previous years, and the very low values of the winter seasons of 1982/1983, 1987/1988, and 1989/1990, no further conclusions can be drawn as yet.

With respect to water distribution between the modules, figure 6 provides the average differences between actual volumes supplied and assigned to the modules for the periods before transfer (1982 to 1991) and after transfer (1992 to 1996).[4] The figure shows that the differences between planned and actual volumes have been slightly reduced after transfer, most notably in the

[4] La Purisima module has been excluded from this graph as it has its own dam which it does not share with other modules. Abasolo and Corralejo were taken together as they share the same canal control point where measurements for this graph were taken.

FIGURE 6.
Average difference between actual supply and assigned volumes, before (1982–1991) and after (1992–1996) IMT.

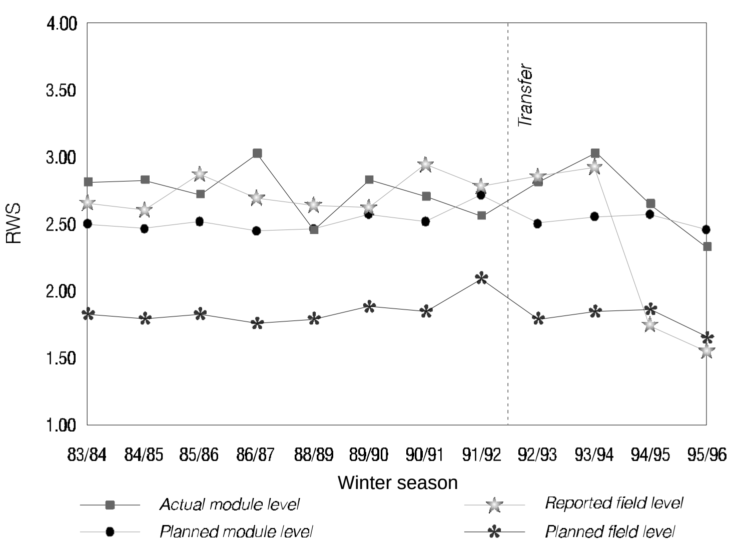


Jaral module. Six of the nine cases show the difference has decreased, while three cases show the difference has increased. Before IMT, 2 modules stayed within the 5 percent difference range, while after transfer the number increased to 3 modules. Whereas prior to transfer 2 modules exceeded the 20 percent difference, none of the modules exceed this range after IMT. This moderate improvement reflects an effort by the hydraulic committee to be more equitable in the allocation of water, a concern that is fueled by the participation of all modules in controlling water allocation at the district level. Each module insists on receiving the volume it has been assigned and has paid for. The sum of the absolute value of the differences before and after transfer is -10 percent and -12 percent, respectively, which shows that in both cases modules get normally slightly less water than they have been assigned to.

[5] Here Relative Water Supply or RWS is defined as the ratio of total water supply (irrigation + total rainfall) to crop demand at field level. Because there are no historical data, crop demand only includes consumptive use and does not consider nonbeneficial ET, losses to drains, and net flow to groundwater. RWS is a nondimensional parameter.

To assess the impact of the irrigation management transfer program on the use of canal water, the variable Relative Water Supply[5] (RWS) was used. Actual values for RWS were obtained from flow and rainfall data and cropping patterns at the module level and were compared with planned and reported values. The latter values for canal water were aggregated at system level from both module-level and ditch tenders' field-level reports. The results are presented in figure 7. The average of the RWS values is 2.7 for the pre-IMT as well as the post-IMT period. This suggests that there is no discernible differences between pre- and post-transfer. However, the graph shows a clear downward trend after 1993, with 1996 having the lowest value (2.4) of the recorded period. This reflects the increasing effort by several modules to come as close as possible to their irrigation plans. For the most recent 2 years there is a greater match between the planned and reported values at the field level. Detailed comparison of actual flows measured by IIMI with ditch tenders' flow reports affirms the observation of some module leaders and CNA staff that inexperienced ditch tenders have difficulties assessing the volumes they supply to the farmers. They tend to report values which are close to the planned target rather than actual values (Kloezen, Garcés-Restrepo, and Marmolejo 1996; Kloezen and Garcés-Restrepo n.d.[b]). As irrigation services are provided only once during the summer season, RWS values are generally lower than during the winter season. The average RWS summer value shows a moderate reduction after IMT. For the pre-IMT period the value was 2.1, while the average post-IMT summer value was 1.9.

FIGURE 7.
Planned, reported, and actual RWS values, the Alto Rio Lerma Irrigation District, winter crop 1983–1996.



The modules advise about, but do not have control over, cropping patterns. As the planned irrigation depths are calculated on the basis of water requirements of the major crop (resulting in rather flat planed-RWS curves, see figure 9A), any deviation in cultivation from the main crop will result in further mismatch between the actual water

FIGURE 8.
The change in cropping pattern in the Salvatierra module, winter crop 1985–1996.

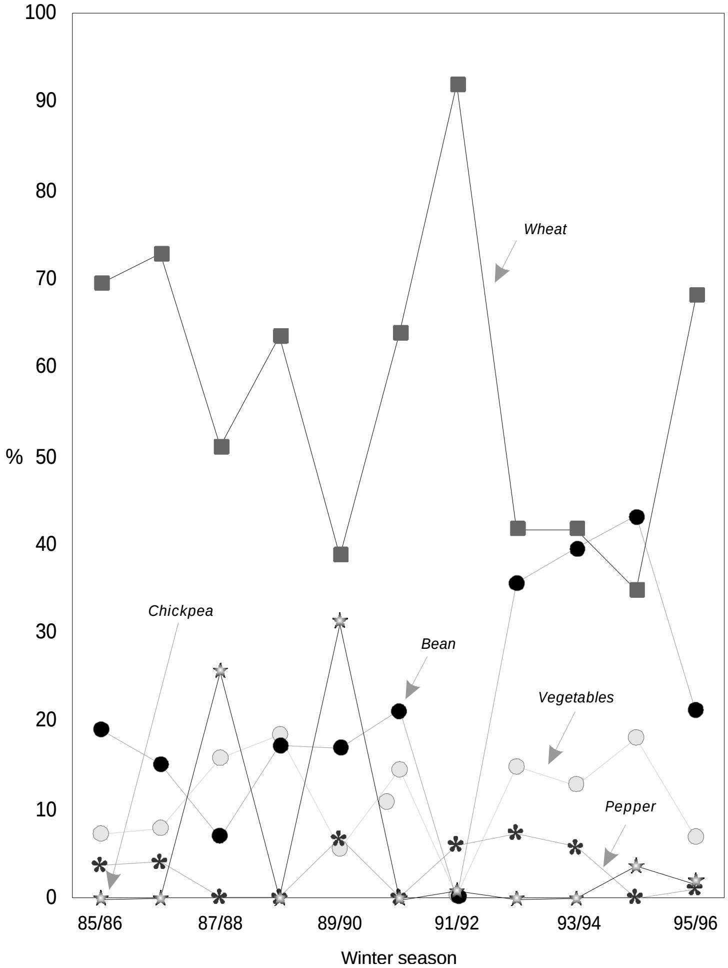
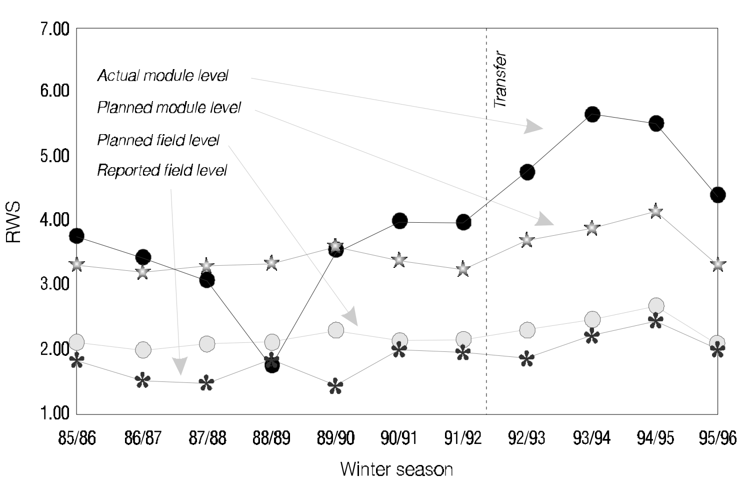


FIGURE 9A.
Planned, reported, and actual RWS values, the Salvatierra module, winter crop 1985–1996.



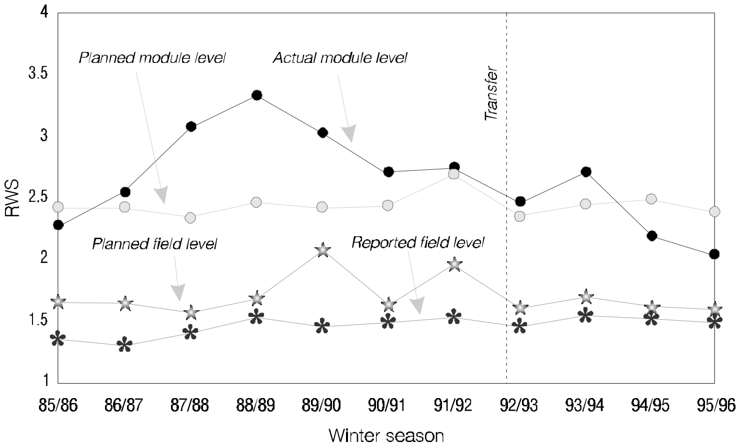
demand and the amount supplied. This system of seasonal irrigation scheduling has significant implications for modules whose cropping pattern deviates from the main crop, as is the case in the Salvatierra module. Since 1992, the area grown under bean has become more and more important at the cost of the main crop, wheat (figure 8). Even so, the WUA continues to do its irrigation scheduling as if the entire area were under wheat. Since bean and vegetables require less water than wheat, the RWS values increased dramatically (figure 9A), without the module addressing adequately to this situation. Note that the module has attempted to correct this situation in the last 2 years.

Figure 9B shows a different pattern for the case of the Cortazar module: a downward trend since the transfer of management, something which can be explained by the continuous efforts of the leadership in Cortazar to verify the volumes supplied, improve the performance of ditch tenders by training them and firing those that perform poorly, and make physical improvements to the canal and drainage networks. These two examples show the different reactions of the two modules to IMT within the same district.

Pre-transfer data on water distribution between farmers within modules do not exist, hence a "before-after" comparison cannot be made. A detailed study of water distribution under post-transfer conditions shows that in the sampled study area there is no clear bias towards head- or tail-end farmers and that all farmers receive sufficient water to meet crop requirements (Kloezen and Garcés-Restrepo n.d.[a]).

Results from the farmer survey on farmers' perceptions on changes in system operation are summarized in table 3. Thirty-six percent of the farmers perceive that water adequacy at the field level has improved

FIGURE 9B.
Planned, reported, and actual RWS, the Cortazar module, winter crop 1985–1996.



as a result of transfer while 23 percent report that it has become worse. The answers related to timeliness of water distribution and farmers´ access to the ditch tender show similar results. Thirty percent of the farmers feel that distribution among farmers has improved while 22 percent perceive that distribution was better before transfer. For all these services approximately 60 percent of the farmers are satisfied with the current situation. The only service that shows considerable improvement is the service provided by the ditch tender: the way he attends to farmers´ requests, the way he solves problems, and the decrease in bribery. Most farmers report that, in particular, the attitude of ditch tenders towards users has improved. The survey also shows that 83 percent of the farmers believe that the WUAs should be responsible for operation of the main and secondary systems while CNA should continue to be responsible for dam operations.

In summary, analyses of dam management, water allocation between modules, and water use by the modules indicate that there has been very little impact on water management and use as a result of irrigation management transfer in ARLID. This is because the water allocation and irrigation scheduling practices have not changed since the WUAs took over these tasks from CNA. On the other hand, observations of meetings and discussions with WUAs and the LRS suggest that WUAs are getting more and more concerned about the relatively high water usage; something which has become very apparent since some modules had to start buying water from other modules and even from private well owners. After taking office, the new president of the recently established LRS publicly stated that looking for better ways to use and conserve water would be one of the major priorities of the federation.

TABLE 3.
Farmers' perceptions of the change in system operation as a result of IMT (%), n=125.

	Water adequacy at field level	Timeliness of water delivery	Water distribution among farmers	Access to ditch tender	Service provided by ditch tender
Poor before and after IMT	2	2	8	4	2
Poor before, good after IMT	36	30	34	31	40
Good before and after IMT	26	34	31	32	32
Good before, poor after IMT	23	22	15	20	14
Other*	13	12	12	13	12
Total	100	100	100	100	100

* "Other" includes 'don't know,' 'no response,' and 'not applicable because respondent only uses a private well.'

Impact on Groundwater Use

The State of Guanajuato has a high concentration of deep wells. Approximately 20 percent of all the wells in Mexico are found in Guanajuato. Groundwater is available through 18 different aquifers, 3 of which are relevant to ARLID: Valle de Acambaro, Zona Presa Solis, and Irapuato-Valle Santiago. The total area underlaid by these three aquifers is 277,200 hectares, which includes the district under study, with an annual recharge of 500 million cubic meters. Groundwater table fluctuations in the state are monitored by CNA and point towards an annual overexploitation of the aquifers of 829 million cubic meters, with 117 million cubic meters corresponding to the ARLID-related aquifers (Muñoz 1996). These values correspond to overexploitation of the aquifer at the rate of 40 percent and 20 percent for the state and the district, respectively (Kloezen and Garcés-Restrepo n.d.[b]).

Generally, modules exclude irrigation areas that have access to wells from canal water service, although there is no provision in the Water Act to that effect. However in practice, many well users make use of the canal network to transport the water they pump to their fields. This practice has increased after transfer. Prior to transfer the CNA-operated "public wells" were only used to supplement surface water in times of water stress. CNA transferred these public wells to the WUAs that subsequently assigned areas to each of these wells. Users within these areas are supposed to use pumped water only. However, for almost all these areas, water users have to make use of the canal network to transport their water. On the other hand, farmers report that unauthorized use of canal water by owners of private wells has decreased since transfer as the modules have more control over the ditch tenders who sometimes allow these practices in turn for some financial gratuities from well owners.

Figure 10 illustrates seasonal and total volume pumped by private wells within ARLID for the period 1982 to 1996. The volumes pumped in the dry winter season are higher than in the summer season. The increase in volume pumped since 1983 can be explained by two factors: the relatively dry years of the early 1980s and, in 1982–1983 the initiation of a program to grant concessions to new wells. The reduction in volume pumped that followed this period can be explained by the dramatic fall of the static water table, which by 1996 was 2 to 5 meters per year. Although new concessions are not granted anymore, a program to upgrade existing pumps and wells started in 1995.

Figure 10 also shows information on the estimated annual recharge for the entire three aquifers that serve the district as well as the estimated annual recharge for those parts of these aquifers that underly ARLID,[6] being 500 and 205 million cubic

[6]The two levels indicated in the graph are based on recent data collected by CNA. Although annual recharge will vary as a consequence of changes in annual rainfall patterns, reliable historical data on this variation are not available.

FIGURE 10.
Seasonal and total volumes pumped by private wells in relation to aquifer recharge, the Alto Rio Lerma Irrigation District, agricultural years 1982–1996.

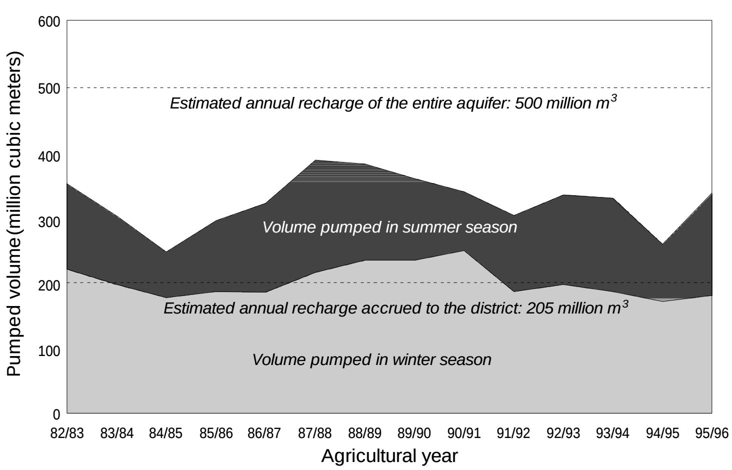
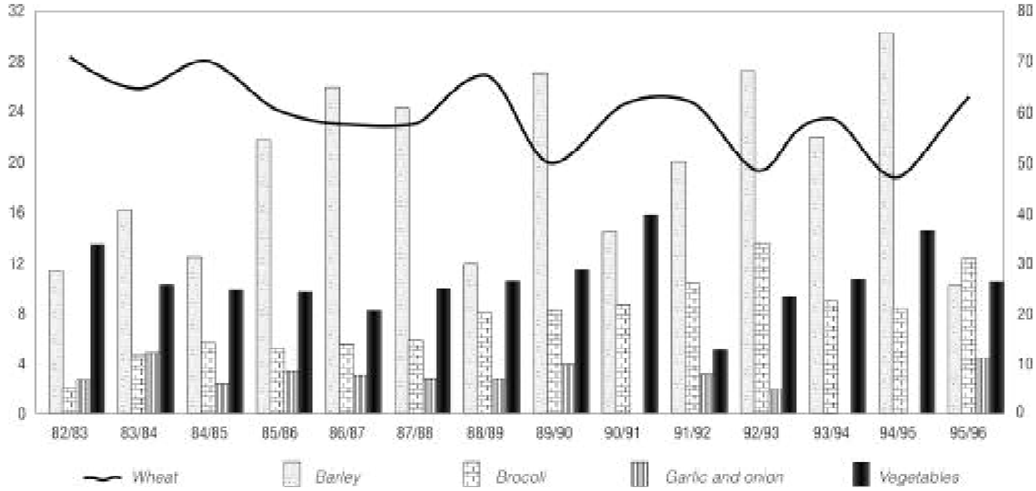


FIGURE 11.
The change in cropping pattern of private wells in the Alto Rio Lerma Irrigation District, winter crop 1982–1996.

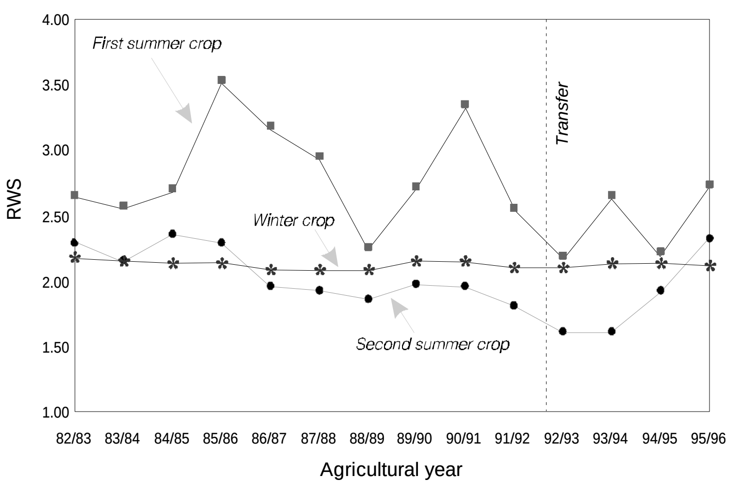


Note: Values of the right hand y axis refer to the curve for wheat.

meters, respectively. Comparison between these recharge levels with the total volumes pumped points to overexploitation of the aquifer. The graph shows that the withdrawal during the winter season almost exceeds the annual recharge to the district, meaning that for the remainder of the year the district mines groundwater at the cost of aquifer users outside the district area. This leads to high competition with domestic and industrial users in urban areas near the district.

[7]There are no data on how much of this excess water recharges the aquifer.

FIGURE 12.
Seasonal actual RWS values for private wells, the Alto Rio Lerma Irrigation District, agricultural years 1983–1996.



Contrary to popular belief about ARLID, cropping patterns of areas irrigated by wells have not changed as a result of transfer or other agricultural reforms (figure 11). Figure 12 shows that there has been hardly any change in RWS values for the winter season. This continues to be around 2.25, which again indicates the alarming high level of excessive groundwater use.[7] Fluctuations in values for both the first and second summer crops are explained by the fact that well users generally try to avoid the risk of late onset of rainfall and start pumping as soon as possible. This leads to high RWS values in years with normal to high rainfall.

The lack of impact on groundwater use as a result of transfer is something that could have been expected. The transfer program primarily affects the administration of facilities and resources related to the use of surface water. Yet, the question remains whether the WUAs can play a role at all in controlling groundwater mining. Managers of the modules complain about their lack of control over private well owners. These owners are also those who use the canal network and surface water without paying for it. Although CNA remains the entity responsible for controlling the aquifers, modules could play a more powerful role than they have done so far in monitoring the exploitation of groundwater.

Impact on System Maintenance

As a result of transfer, modules also had to take over responsibility to maintain the secondary canals and drains and associated infrastructure. The general belief among farmers was that transfer of these responsibilities should have been accompanied by an intensive system rehabilitation and modernization program. However, this was not done in ARLID.

One of the preconditions for transfer was that CNA should grant concessions to the WUAs to use almost all of its heavy machinery, such as draglines and hydraulic excavators. In total, 25 pieces of equipment (including some relatively new pieces), with a total estimated cost of 1.7 million US dollars, have been transferred to the modules. However, some of this machinery was in severe disrepair and modules felt that maintenance of this machinery would cost them more than buying new equipment. As a consequence, during the period December 1992 to July 1995, the modules bought 29 pieces of heavy machinery. These were paid for out of fees collected from the users. In addition, three modules received new equipment, such as land leveling equipment, as part of a World Bank assisted program for on-farm water management improvement (PRODEP).

In the 3 years preceding transfer (1989-1991), 48 percent of O&M expenditures by CNA went to maintenance of the dams, and main and secondary canal infrastructures. The average maintenance expenditure per hectare was US$24/ha (July 1994 dollars). After transfer, maintenance costs have been shared between CNA and the modules. CNA pays for maintenance of the dams, the five main diversion structures, and main canals and drains. The modules pay for maintenance of all secondary canals, irrigation canals, and drains. After transfer, 63 percent of the total O&M expenditures went to maintenance, which was an increase by 15 percent compared to pre-transfer years. After transfer, 82 percent of the total maintenance budget has been spent within the modules, while 18 percent has been spent for maintenance of the dams and the main system. Also in the 3 years after transfer, the average cost of maintenance was US$24/ha (July 1994 dollars). This suggests that the level of maintenance investment has remained the same.[8]

One problem with the above comparison of expenditures before and after transfer is that it conceals an important impact: the higher quality of maintenance services provided following transfer (Svendsen 1996). The constant US$24/ha expenditure level could mean that no real improvements have occurred; it could also mean that the modules use their staff and machinery more efficiently. The total number of staff responsible for maintenance decreased from 81 be-

[8]Expressing expenses in dollar terms only masks the improvements made by the WUAs under conditions of the economic crisis that followed the devaluation of the peso in 1994. In constant pesos terms, maintenance expenditures have increased from 56 pesos/ha in the pre-transfer years to 108 pesos/ha in the post-transfer years, which is an increase of 93 percent.

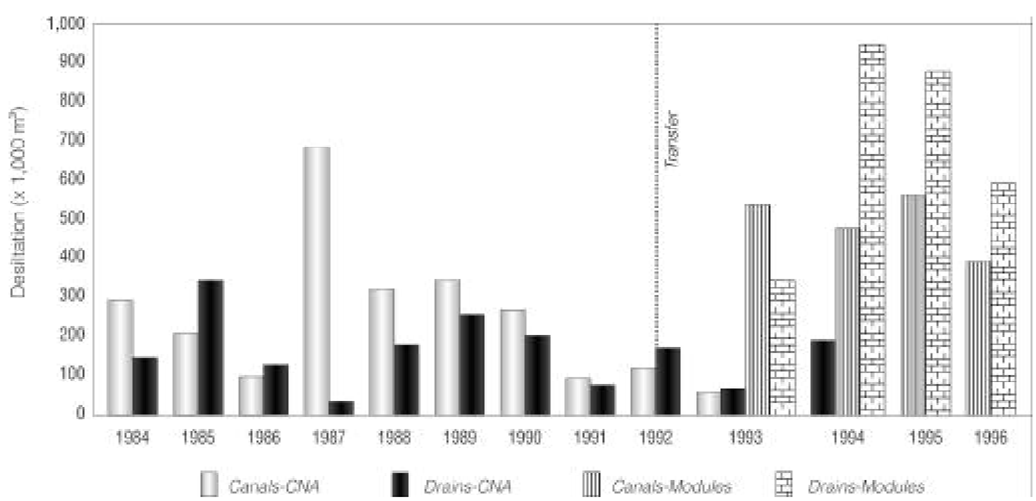
fore transfer to 65 after transfer, with 19 staff still being employed by CNA and 46 by the modules (table 2). This would suggest that after transfer the same level of maintenance is achieved with fewer staff.

Another approach is to compare actual quantities of maintenance work before and after transfer. Figure 13 shows such a comparison for the example of total desiltation work done by CNA and the modules. The figure clearly shows the tremendous increase in total volume of desiltation done in primary and secondary canals and drains after transfer: 438,581 m^3/year (average of 1982–1992) compared to 1,257,421 m^3/year (average of 1993–1996). Moreover, the figure shows that CNA had virtually stopped desilting the main canals after 1993, although officially it was still under CNA's responsibility. Finally, the figure demonstrates that the modules have been particularly concerned with cleaning the drains, including the main drains that still fall under CNA's responsibility. The observations suggest that not only is there an increase in volume of work done, but also that maintenance work has shifted proportionately more towards lower system levels—the secondary canals and the drains—and away from main canals.

Neither of the two approaches discussed above measures the impact of these observed changes in maintenance on the ability of the system to transport and control water (Svendsen 1996). Unfortunately, accurate and reliable data on the physical condition of the system before transfer are not available and hence making a before and after comparison is not possible.

Interviews with system managers and farmers reveal how they perceive maintenance work has affected system performance. Module field staff and managers alike report that farmers were very dissatisfied with the level of maintenance done by CNA before transfer, especially at the level of the drains. They mentioned that there was a felt obligation to meet their commitment to the users to first clean the drains as soon as possible after transfer. However, some CNA staff (while acknowledging the enormous increase in volume of desiltation

FIGURE 13.
Desiltation of canals and drains by CNA and the modules, the Alto Rio Lerma Irrigation District, 1984–1996.



done by the modules) felt that most of the desiltation done (especially in the drains) has been redundant and has had no impact on the hydraulic performance of the system. Some module managers supported this perception but reported that farmers like to see the canals and drains to be cleaned and had put pressure on the modules to do so. These managers justified their high investment in desiltation by seeing this as a way to gain credibility among the users and to show users that they are accountable to the requests of the users.

Table 4 shows the results of the farmer survey on farmers' perceptions about the change in maintenance as a consequence of transfer. More than 70 percent of the farmers reported that the condition of irrigation network has been good after transfer, while 64 percent of the ejidatarios and 47 percent of the private growers felt that the condition has improved after transfer. With respect to the drainage network, 54 percent of the ejidatarios and 38 percent of the private growers affirmed that the condition has improved as a result of transfer. Only 11 percent of the farmers reported that there were no major maintenance problems before transfer. Fifty-five percent perceived there were no such problems after transfer. These percentages show the high level of satisfaction about current maintenance work done by the WUAs.

Comparison of maintenance levels among the 11 modules shows the variation in the way modules deal with system deterioration. Figure 14A shows that modules desilt their canals approximately once every 3 years (135% in 4 years). Some modules do it every 2 years while others have cleaned only 60 percent or less of their network during the 4 years after transfer. Similarly, figure 14B shows the variation in maintenance levels per module. The figure shows a striking decline in total maintenance expenditures per hectare from head-end to tail-end modules. The two exceptions are Cortazar and Salamanca modules, which make more use of the two main canals than any of the other modules. Although not their responsibility, both modules invested heavily in maintaining these main canals in addition to their assigned reaches, to guarantee a reliable supply to their secondary canals. The decline in expenditures from head to tail cannot be explained by different levels of

TABLE 4.
Farmers' perceptions of the change in maintenance service as a result of IMT.

	Ejidatarios (n=90)		Private growers (n=35)	
	Condition of the irrigation network (%)	Condition of the drainage network (%)	Condition of the irrigation network (%)	Condition of the drainage network (%)
Poor before and after IMT	7	3	6	0
Poor before, good after IMT	64	54	47	38
Good before and after IMT	11	33	24	41
Good before, poor after IMT	9	1	6	9
Other*	9	9	17	12
Total	100	100	100	100

* "Other" includes 'don't know,' 'no response,' and 'not applicable because respondent only uses a private well.'

FIGURE 14A.
Percentage of canal network desilted by the modules, the Alto Rio Lerma Irrigation District, 1993–1996.

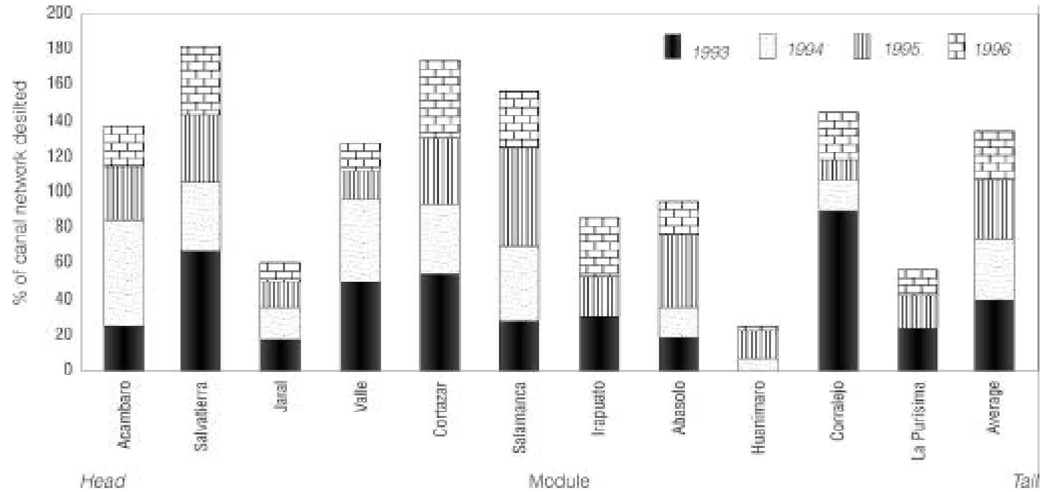
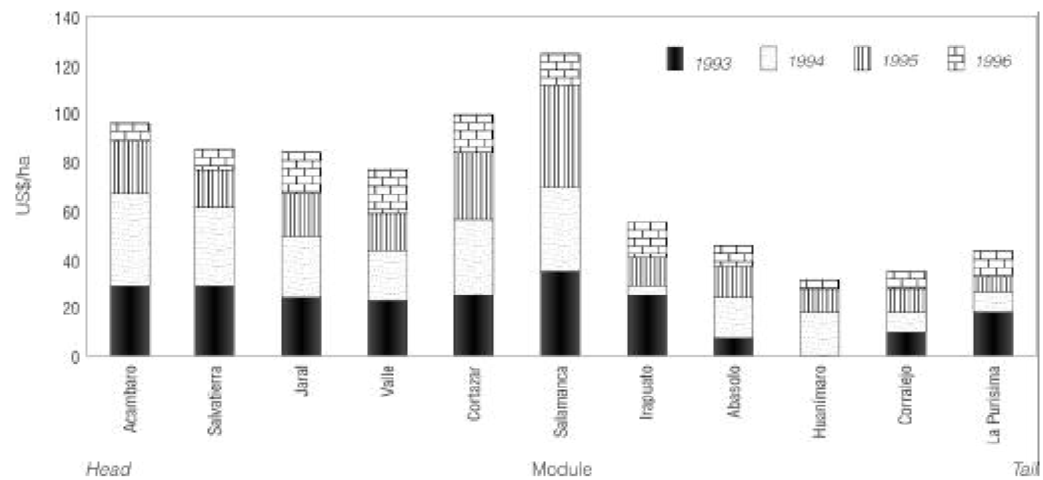


FIGURE 14B.
Comparison of maintenance expenditures (July 1994 US$) per hectare by modules, the Alto Rio Lerma Irrigation District, 1993–1996.



fee collection rates (see figure 16 in the next section), nor by the fact that these modules have less of a problem with siltation since they are further away from the dams. Comparison of module data indicates that tail-end modules are relatively smaller and have relatively less infrastructure to maintain: on average, 40 meters of canal and drainage network per hectare for the 6 head-end modules versus 30 meters per hectare for the 5 tail-end modules. Furthermore, data show that some of these modules spend relatively more on operational and energy costs as some pump directly from the Lerma River.

Impact on O&M Financing and Financial Management

Prior to transfer, farmers had to go to the CNA Unit offices to pay their irrigation fees. Interviews with CNA officials and farmers indicate that many farmers did not pay their fees for several reasons. These include: the long distances that farmers had to travel to these offices; the long hours farmers had to wait in line to pay their fees; the extra unofficial transaction costs farmers had to pay to the fee collectors; the practice of bribing the ditch tenders directly rather than paying the official fee; and, the little power to sanction that CNA had over farmers who did not pay. After transfer, farmers pay the WUAs directly. Only 2 percent of the farmers surveyed say that payment is more difficult after transfer. Forty percent report that the process of paying has become much less cumbersome after transfer; the most important reasons mentioned by farmers are:

1. Shorter administrative and physical distances, because of more offices where farmers can make their payments.
2. Better financial transparency because of the use of computers.
3. Better personal service by and reduction in unauthorized payments made to the administrative staff that collects the fees.

Sixty-nine percent of the farmers report that the practice of bribing the ditch tenders has been reduced as a result of transfer. The reason for this is, that in comparison with the situation prior to transfer, distances between users and management are much shorter. A year and a half of participatory observation in two modules has revealed that many farmers come to the module office to complain about rent-seeking attitudes of ditch tenders. This has often resulted in ditch tenders being fired by the module leaders. The high turnover of ditch tenders and their frequent rotation over different sections within the module area help prevent the creation of patron-client relationships between ditch tenders and users. However, this does not mean that rent-seeking behavior has ceased to exist; 30 percent of the farmers report that they still bribe ditch tenders, for instance to irrigate more than the entitled area or to get water at different times than programmed.

One major reason why farmers agreed to take on O&M responsibilities was that this would give them direct control over the fees collected from them. The new module leadership realized that to sustain the system, the first challenge was to improve the fee collection rate and to try to at least maintain the level of the irrigation fee. Table 5 shows the development of the fee per hectare that a farmer pays every time the irrigation service is delivered, before and after transfer. To prepare farmers to paying fees that better reflect the actual O&M cost, 2 years before transfer, CNA increased the charge by approximately 400 percent, which explains the sudden increase observed in figure 15. After transfer the modules did not succeed in keeping up with inflation rates, which explains the fall from approximately US$17 per hectare of irrigation services in 1993 to about $8 in 1996.[9]

Figure 15 shows a similar decline in fees paid by farmers after correction for inflation. The fee dropped in terms of total cost per hectare per season, and as a percentage of gross value of output (GVO). The figure indicates that the cost of irrigation to farmers has declined from almost 6 percent of the GVO in the year of transfer to 2 percent in 1996. Yet, 62 percent of the farmers report they perceive that the cost of irrigation water has increased after transfer.

[9] In actual peso terms the fee has remained the same.

TABLE 5.
Historical development of the irrigation fee for canal irrigation in the Alto Rio Lerma Irrigation District.

Year	Season	Fee (Nominal pesos/ha of irrigation service)	Fee (1994 US$/ha of irrigation service)	Produce in kg/ha of irrigation service	
				Sorghum	Wheat
1983	Winter	0.3	6.10		23
	Summer	0.7	10.00	54	
1984	Winter	0.7	7.69		28
	Summer	0.7	6.00	24	
1985	Winter	1.0	7.14		27
	Summer	1.0	5.39	26	
1986	Winter	1.4	5.63		23
	Summer	1.4	3.64	19	
1987	Winter	3.0	5.39		20
	Summer	3.0	2.18	19	
1988	Winter	10.0	7.26		30
	Summer	10.0	6.60	34	
1989	Winter	9.6	5.90		24
	Summer	9.6	5.35	28	
1990	Winter	42.0	20.64		76
	Summer	42.0	18.48	127	
1991	Winter	49.6	19.56		76
	Summer	49.6	18.14	113	
1992	Winter	49.6	16.86		81
	Summer	49.6	16.16	127	
1993	Winter	55.8	17.22		93
	Summer	55.8	16.58	151	
1994	Winter	55.8	16.10		93
	Summer	55.8	15.62	140	
1995	Winter	55.8	11.96		67
	Summer	55.8	10.52	60	
1996	Winter	55.8	8.77		29
	Summer	64.0	7.31	64	

Irrespective of the recent erosion of the per hectare-irrigation fee, for reasons explained above, the modules succeeded in dramatically increasing the overall collection rate. Table 6 shows the development of both the self-sufficiency (actual collection over actual expenditure)[10] and the fee collection rate (actual collection over planned collection). Clearly, one of the major impacts of transfer in ARLID is the enormous improvement in self-sufficiency: from about 50 percent in the 3 years preceding transfer to over 120 percent in the post-transfer years. Data on planned fee collection for the pre-transfer period are not available, but data for the 4 years that follow transfer show an average collection rate of 120 percent.[11]

[10]The actual O&M expenditures after 1992 do not include the cost of the staff still employed by CNA as these are all paid out of federal funds rather than out of the fees collected from farmers.

[11]The planned fee collection is based on the planned acreage irrigated and the planned number of irrigations for a particular year, multiplied with the current per ha-irrigation tariff, and hence does not reflect the required sum needed to manage the district optimally. Under this methodology any change in the number of irrigations actually delivered changes the collection rate.

FIGURE 15.
Seasonal irrigation fee (July 1994 US$) per hectare and as percentage of GVO, the Alto Rio Lerma Irrigation District, winter seasons 1982–1996.

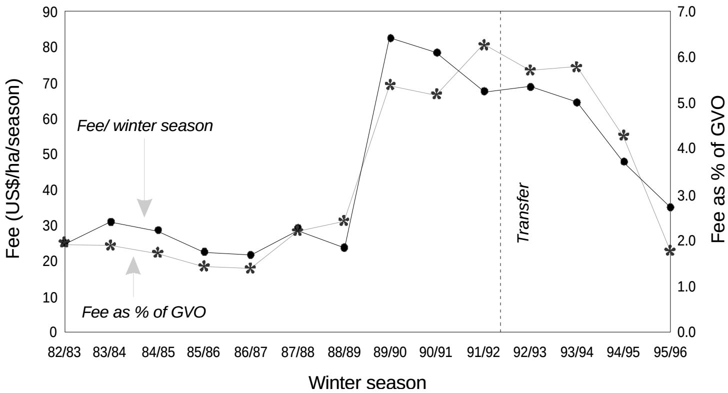
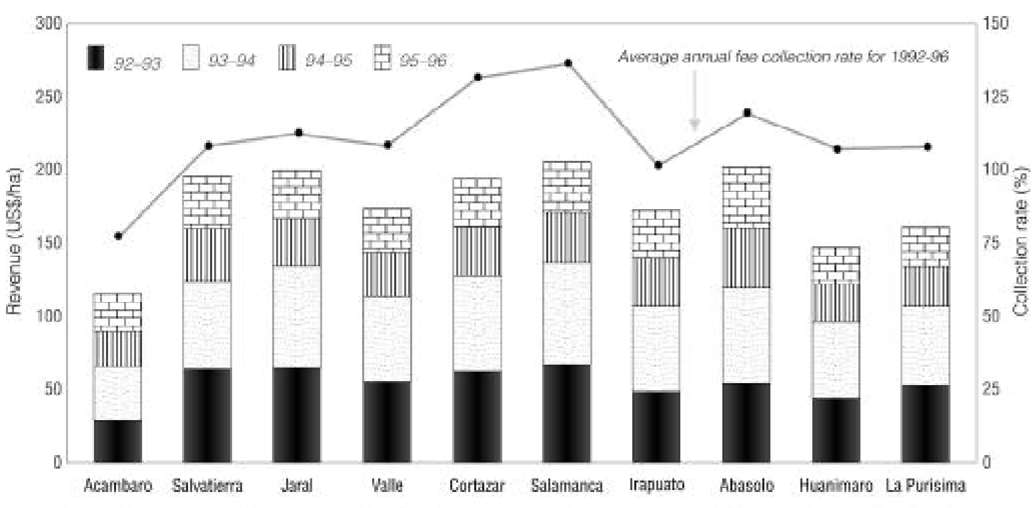


Figure 16 shows the difference between modules in revenue mobilized per hectare from irrigation fees. These revenues range from US$116 to $205 per hectare for 4 years, with an average of $182 per hectare (1994 dollars). The Acambaro module, because of its higher elevation and cooler climate, gets by with the provision of one less irrigation service and consequently collects less revenue from the fee. The figure also shows the historical decline in fee revenue as a consequence of the economic crisis that followed the December 1994 devaluation of the peso. Finally, the figure shows that most modules succeeded in maintaining a fee collection rate above 100 percent.[12]

Table 7 shows an example of how two modules have allocated their financial resources. The first observation is that in both modules real O&M expenditures have increased, particularly in Cortazar, mainly as a consequence of high investments in rehabilitating the modules´ public deep tube wells and the increase in energy costs for operating these wells.[13] From its creation in 1992 onwards, the Salvatierra module has always had difficulties with balancing its income and expenditures, resulting in a total positive balance of only 9 pesos/ha over 4 years. Three reasons explain this fragile situation:

1. Salvatierra has a large number of farmers with relatively small landholdings,

FIGURE 16.
Fee revenue (July 1994 US$) and average annual collection rate, the Alto Rio Lerma Irrigation District, 1992–1996.



Notes: Values on the right hand y axis refer only to the curve for average annual fee collection rate for 1992–96.
The Corralejo is not included here because no data are available for this module.

[12]This was possible because modules often could provide more irrigation sessions over and above the amount upon which the planned collection target was based.

[13]Since the early 1990s, the Government of Mexico has been phasing out subsidies on energy. An evaluation of the consumption and operational costs of private and public deep tube wells is given by Kloezen and Garcés Restrepo (n.d.[b]).

TABLE 6.

Change in self-sufficiency and fee collection rate, the Alto Rio Lerma Irrigation Department, 1989-1996 (in nominal pesos and constant July 1994 US dollars).

	1	2	3	4	5	6	7	8	9	10	11
	Actual O&M expenditure			Planned fee collection			Actual fee collection			Self-sufficiency	Fee collection rate
	Pesos	Pesos/ha	July 1994 US$/ha	Pesos	Pesos/ha	July 1994 US$/ha	Pesos	Pesos/ha	July 1994 US$/ha	% (7/1)	% (7/4)
1989	6,633,603	79	44	na	na	na	3,305,590	39	22	50	na
1990	8,433,104	100	44	na	na	na	3,545,013	42	19	42	na
1991	12,664,518	151	55	na	na	na	7,440,000	88	32	59	na
1992	14,107,094	168	55	na	na	na	na	na	na	na	na
1993	12,514,641	149	44	13,018,285	155	46	16,086,021	191	57	129	124
1994	14,669,207	174	49	16,066,900	191	53	18,280,700	217	61	125	114
1995	15,758,926	187	35	13,958,243	166	31	17,164,590	204	38	109	123
1996	15,596,666	185	26	16,300,483	194	28	19,876,120	236	34	127	122

Note: na = Data not available.

TABLE 7.

Per hectare O&M expenditure and income (real pesos) and distribution of categories, the Salvatierra and Cortazar modules, 1993–1996.

	Salvatierra Module					Cortazar Module				
Expenditures	1993	1994	1995	1996	Total	1993	1994	1995	1996	Total
Total O&M cost (pesos/ha)	221	225	211	250	908	165	250	228	330	973
System maintenance (%)	43	44	35	31	38	17	20	23	19	20
System operation (%)	19	17	23	22	20	11	18	17	13	15
Administration (%)	14	15	17	17	16	16	15	14	14	15
O&M of official wells (%)	12	11	10	16	12	13	14	15	26	18
Depreciation of heavy machinery (%)	0	1	1	3	1	7	6	5	8	7
Fee payment to CNA (%)	12	10	11	11	11	33	24	25	19	24
Others (%)	1	1	4	1	2	3	3	0	1	2
Income										
Total income (pesos/ ha)	202	202	269	244	917	247	271	277	287	1,083
Irrigation fees (%)	100	100	72	96	90	97	97	89	93	94
Rent of machinery (%)	0	0	22	0	7	0	0	0	0	0
Bank interest and others (%)	0	0	6	4	3	3	3	11	7	6
Self-sufficiency										
Income - Expenditure (pesos/ha)	-19	-23	58	-6	9	82	21	49	-43	110

Note: US$1.00 (July 1994) = Pesos 3.5.

making it necessary to employ a larger number of ditch tenders (as shown in table 1).

2. Much of the module's infrastructure is in disrepair, resulting in higher maintenance cost.

3. The module is known for its internal political problems, resulting in "favoritism" in the module's staff employment policy and relatively high salary costs for management staff.

Particularly in its first year of operation, Cortazar succeeded in keeping its costs low while achieving high revenue from fee collection. As a consequence, the module immediately bought its own heavy machinery. The module succeeded in maintaining this situation till 1996, when expenditures started exceeding the module´s income. These two examples show that, over the first 4 years of their operation, the modules could maintain financial self-sufficiency, but in 1996 even a business-oriented module like Cortazar started to have difficulties maintaining its financial viability.

All modules acknowledge that this situation could jeopardize their financial sustainability. By the end of 1996, all modules started to rethink the situation, which resulted in two strategies. First, the modules used the hydraulic committee to negotiate an increase of the fee to US$11 per hectare of irrigation services for the 1996–97 winter season. Even so, interviews with managers of several modules and CNA staff reveal that this amount is less than half of what they feel they should collect to manage the modules at optimum level. Second, modules have pushed CNA to transfer O&M responsibilities for the main system to them. This resulted in the establishment of the LRS in February 1997 and a reduction in the average percentage of the fee paid to CNA, from 25 percent to 9.5 percent of the total fees collected.

As demonstrated in table 7, a major weakness in the financial management systems of the 11 WUAs in ARLID is that the associations rely almost entirely on irrigation fees for their revenue. Moreover, fee revenue is totally dependent on the availability of water, as farmers are charged per number of irrigation services provided. This means that in dry years WUAs will not have sufficient income to maintain their regular staff or even keep their offices open. None of the 11 WUAs in ARLID maintain a contingency fund that could help them to overcome any kind of financial shortfall or to have a financial reserve for emergency repairs. When asked why such a fund was not kept, leaders of WUAs mentioned two reasons. First, annual inflation rates of more than 50 percent are not an incentive to save money. Second, building a contingency fund is only possible by charging a flat fee on top of the fee per number of irrigation services provided. The current agreement between the WUAs and CNA says that the WUAs have to pay CNA a fixed percentage over all the fees they collect, including any extra fee. For this reason, WUAs are reluctant to charge a fee other than the per hectare of irrigation services fee.

[14]The "standardized" value refers to the process of converting all crop yields to an "equivalent" yield of a base crop as a function of farm gate prices and areas (percentages) grown.

Impact on Agricultural and Economic Productivity

To assess the impact of the IMT program on the agricultural and economic productivity of ARLID, change in crop yields (tons/ha), standardized gross value of output per unit of water supplied, and standardized gross value of output per irrigated cropped area[14] are used (Molden, Sakthi-vadivel, and Perry, forthcoming).

FIGURE 17.
Average yields for major crops, the Alto Rio Lerma Irrigation District, winter seasons 1982–1996.

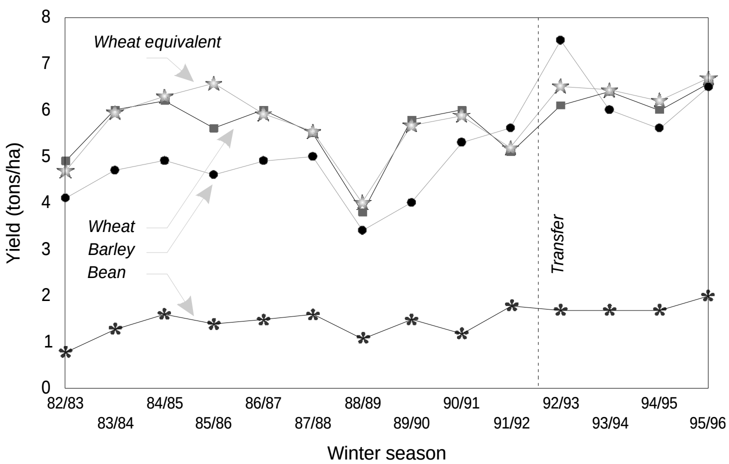


FIGURE 18.
Standardized gross value (July 1994 US$) of output per unit of water supplied, surface irrigation, and wells, the Alto Rio Lerma Irrigation District, 1983–1996.

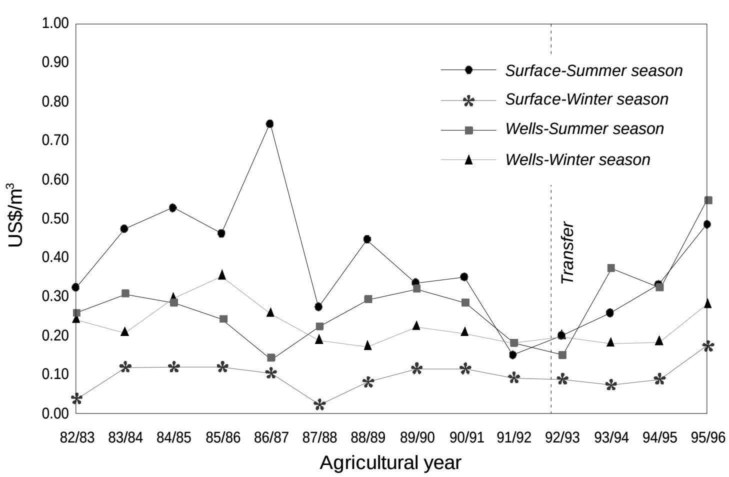
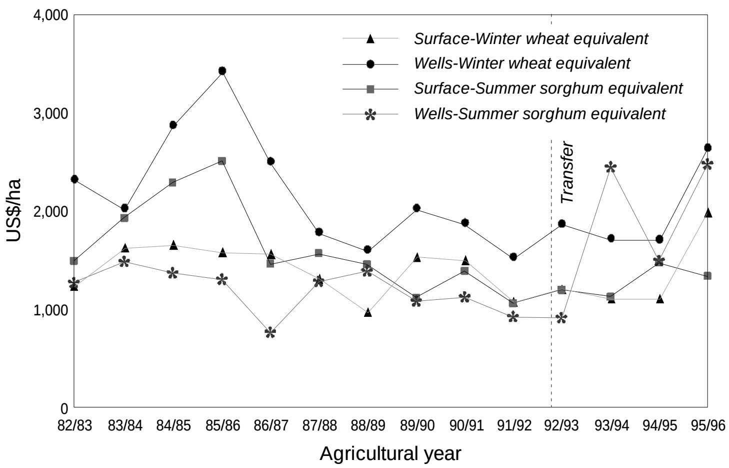


Figure 17 shows the trend in yields for the major winter crops at ARLID. Data are analyzed in terms of "wheat equivalents," which allow standardized comparison of productivity over time. This facilitates comparison between different modules, irrigation districts, and irrigation sources (Kloezen and, Garcés-Restrepo n.d.[b]). In this case, the base crop is wheat. The figure shows an upward trend for wheat and barley yields which started in about 1988 and continues to date. Since transfer in ARLID did not take place until the end of 1992, the improvement cannot be attributed to the transfer process. On the other hand, it can also be argued that the IMT has not resulted in yield declines for these crops, which is—given the increase in the cost of agricultural inputs—a positive outcome.

The agricultural productivity per unit of water supplied for both surface irrigation and wells at ARLID is shown in figure 18. Comparison of the two seasons suggests that productivity per unit of water supplied is lower in winter than in summer but has less variation since more irrigation water is supplied in winter. With respect to the post-transfer period, no definite trend can be observed for the winter productivity values. The upward trend for both summer and winter after 1995 can be attributed to higher commodity prices in those years. For instance, world wheat prices increased from US$150 per metric ton in 1991 to $262 per metric ton in July 1996. Mexican farm gate prices for wheat, sorghum, and maize followed a similar upward trend.

Similarly, the agricultural productivity values related to groundwater use during winter do not show much variation while summer presents a definite upper trend owing to the same reasons explained for canal water. The water productivity values for

FIGURE 19.
Standardized gross value (July 1994 US$) of outputs per hectare cropped, for wheat and sorghum, surface irrigation, and wells, the Alto Rio Lerma Irrigation District, 1983–1996.



ARLID, ranging from US$0.05/$m^3$ to $0.35/$m^3$ as shown are on the higher end of the range found for systems around the world (Molden, Sakthivadivel, and Perry, forthcoming).

The standardized gross values of output per unit of land for both cropping seasons and the two water sources are presented in figure 19. The values fluctuate between US$1,000/ha and $2,000/ha for surface irrigated fields and between $1,000/ha and $3,300/ha for the wells that normally irrigate higher-value crops. For the same reasons as explained above, the graph does not show a particular trend that can be attributed to the transfer program.

To summarize, productivity values of both land and water are high at ARLID compared to other systems studied by IIMI (Molden, Sakthivadivel, and Perry, forthcoming). Fluctuations in these values, however, cannot be related directly to the transfer program but have to be viewed in the context of other economic changes that have occurred as a result of the agricultural price policies followed since the 1980s.

Conclusions

The Mexican IMT program is known and advocated as one of the most ambitious and successful of its kind worldwide, not only because of the large scale of its irrigated area and the speed of its implementation, but also because of the positive impacts claimed to be the result of the strategy followed (see e.g., Ujjankop 1995). However, hardly any information has been provided on the characteristics of the program and no convincing evidence has been published to support the claim that the Mexican IMT model leads to positive results, in Mexico or worldwide. This study has aimed to fill part of the gap in information and evidence and to test the hypotheses given above.

IMT in ARLID has been a rapid top-down process that met with relatively little resistance from farmers. This rapid process was made possible because, amongst others, the following conditions were clearly met. Some of these characteristics can be found in some Asian and Latin American IMT programs, as well as in the more recent IMT example of Turkey (see Vermillion 1997 and Svendsen, Trava, and Johnson 1997 for overviews).

1. The IMT program did not come on its own but followed and is part of a much wider set of agricultural and political liberalization policies.

2. IMT was accompanied by a new law that not only supported the transfer of authority and responsibilities to the us-

ers but provided them concessions to use the infrastructure and machinery.

3. A high political commitment to make public agency staff redundant as needed.

4. WUAs were not forced to hire ex-agency staff.

5. Leaders and staff of newly established WUAs were given professional training.

6. WUAs agreed to jointly manage the system with the agency during a fixed and relatively short period of time.

7. The Mexican IMT program aims not to maximize direct user participation in O&M, but to involve farmers in representative governance.

It is important to understand that this specific set of conditions could be met in Mexico only because of the distinctive organization of Mexican irrigated agriculture. Hence, not all of them could be readily adopted in settings which have different agrarian structures. For instance, the political commitment to devolving authority to users and to downsize a public agency should be understood in the context of the neoliberal developments that started in the early 1980s and the political wish to reform the ejido sector. Likewise, the speed of implementing the IMT program can partly be explained by the existence of a strong social and institutional network: the ejidos and the several institutions that organize private growers.

The case from ARLID shows the importance of allowing diverse ways in which IMT can be implemented among the modules within one single district, as well as the heterogeneity in which WUAs may adapt the program to suit their needs, the flexibility of the government in allowing the users to modify their organizations, and the O&M strategies they follow. These differences normally follow historical differences in farmers´ experiences with forms of collective action and building social capital from below (Fox 1995 and 1996), and of relationships between different groups of users (ejidatarios v. private growers), as well as between the users and the irrigation agency.

The following are the main impacts of the IMT program at ARLID.

1. Farmers' increased control has not led to major improvements in operational performance. Although the hydraulic committee has become an important institution in which users participate in planning the use of and control over the water source, there is no evidence that transfer has resulted in significant improvements in the way water is allocated and distributed. With the exception of some modules like Cortazar, generally modules have so far followed the same allocation and distribution principles and practices as used by CNA. As a result, RWS values at all levels continue to be high. Similarly, no changes in the area irrigated or cropping patterns can be attributed to transfer.

2. Farmers' increased involvement in decision making and control has increased managerial accountability. Even so, the farmer survey shows the majority of farmers perceiving that the quality of system operations has either remained the same or has improved. Farmers are particularly positive about the improvement of services provided by the ditch tenders as they feel that, compared to the pre-transfer period under CNA, WUAs have more control over the ditch tenders' work and rent-seeking behavior.

3. As the transfer program mainly aimed at improving the use of surface irrigation, it was not expected that major changes in groundwater use would occur as a result of transfer. Yet, it is apparent that the alarming level of overexploitation of aquifers by well owners in ARLID is not being reduced. Although CNA will continue to be the authorizing institution that controls the aquifers, transfer has resulted in a considerable reduction in the role and mandate of CNA in the State of Guanajuato. As a consequence, it will become more and more difficult for CNA to adequately monitor aquifers. WUAs do not seem to have the interest, nor the legal power to assume that role.

4. IMT has led to a better match between actual expenditures and farmers´ perceived needs, especially in the field of maintenance. One of the most positive impacts of the IMT program in ARLID has been the considerable improvement in maintenance services, especially at lower system levels. Other improvements include: the purchase of modern machinery by the modules; a moderate increase in the proportion of the total O&M budget spent on maintenance; and maintaining the level of maintenance expenditures per hectare in constant dollar terms, or doubling this level in real peso terms. These improvements are clearly acknowledged by the farmers surveyed. Soon after transfer in 1992, CNA stopped cleaning the main canals as well, which caused much concern among the WUAs and eventually led to the WUAs taking over responsibility for managing the main system as well as the distributary subsystem. As a result, payment of the modules to CNA has been reduced from 25 percent to 9.5 percent of the total fee collection. While it is apparent that the amount of maintenance work has increased since transfer and has helped the modules to increase their credibility, it is not clear what this has meant for the physical capability of the system to transport water to farms.

5. Another apparent improvement that resulted from the transfer program is the increase in financial self-sufficiency from around 50 percent in the years preceding transfer to around 120 percent in the post-transfer years. This is mainly due to the ability of the WUAs to achieve fee collection rates of over 100 percent. Moreover, all modules at ARLID hired highly professional administrative staff and use good computer software to handle daily financial administration. This has resulted in improving the financial transparency of the WUAs.

   A post-transfer period of 4 years is not enough to assess whether these rates are enough to guarantee long-term sustainability of the system. Although the actual O&M expenditures per hectare have almost doubled in terms of real pesos, the devaluation of the peso in 1994 and the high inflation rates that followed this devaluation explain why O&M expenditures have dropped by almost half in constant dollar terms.

6. IMT has not resulted in an increase in the cost of water to farmers. Although the cost of irrigation to farmers remains low after transfer (less than 5% of the GVO), WUAs find it very difficult to convince farmers that irrigation fees should be increased to keep up with inflation. Furthermore, none of the mod-

ules created a contingency fund for future emergencies or basic repairs.

7. The study does not provide convincing evidence that there has been any effect of the transfer program on agricultural and economic productivity. Although fluctuations can be observed, even after transfer, it is believed that these are related to other recent developments in the agriculture sector such as the dismantling of credit and subsidy systems, input price policies, and, most of all, price changes in the world commodity markets.

Finally, although 4 years of experience with IMT in ARLID shows positive results, the main impacts summarized above suggest that WUAs are facing several problems listed below, which are common among many newly created WUAs worldwide (Fox 1995 and 1996).

1. Although, the IMT program was accompanied by a new National Water Act, this act does not sufficiently provide water rights to individual users, nor does it provide mechanisms that allow prioritizing among different types of uses in times of water scarcity.

2. None of the WUAs have established effective mechanisms to cope with high annual inflation rates and potential financial shortfalls. This could jeopardize the sustainability of WUAs.

3. Although good training was provided to most WUAs at the time of transfer, the high turnover of staff calls for continuous staff training. With the agency´s role in irrigation management being reduced, it becomes more and more difficult for WUAs to obtain good training.

4. Downsizing the number of staff of the agency does not mean that the role of the agency ceases to exist, but it is observed that it is difficult to identify new roles that the agency could take on (especially in training and monitoring) and to start upgrading the agency´s capacity to provide technical support to the WUAs.

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