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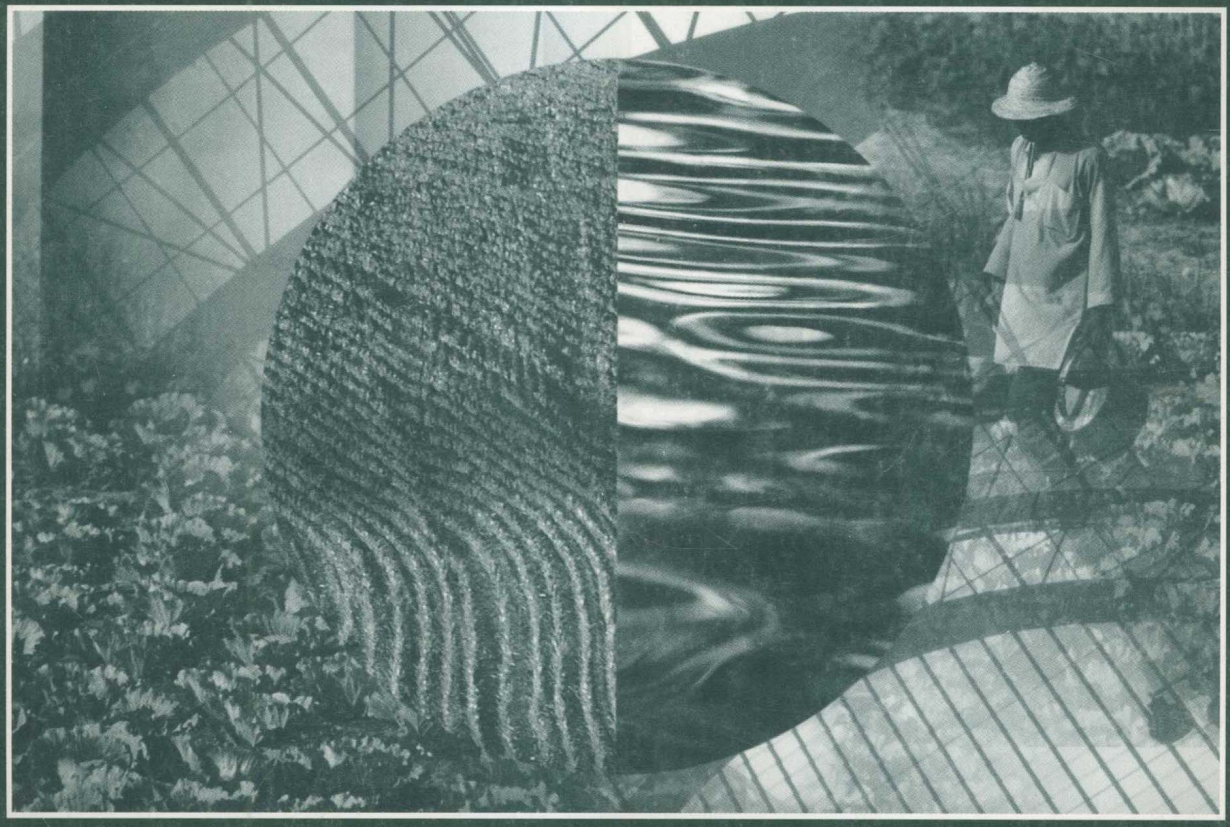
Case Studies in Participatory Irrigation Management

Edited by
David Groenfeldt
Mark Svendsen



WBI LEARNING RESOURCES SERIES

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Case Studies in Participatory Irrigation Management

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World Bank Institute
Washington, D.C.

The World Bank Institute (incorporating the former Economic Development Institute (EDI)/Learning and Leadership Center) was established by the World Bank in 1955 to train officials concerned with development planning, policymaking, investment analysis, and project implementation in member developing countries. At present the substance of the WBI's work emphasizes macroeconomic and sectoral economic policy analysis. Through a variety of courses, seminars, and workshops, most of which are given overseas in cooperation with local institutions, the WBI seeks to sharpen analytical skills used in policy analysis and to broaden understanding of the experience of individual countries with economic development. Although the WBI's publications are designed to support its training activities, many are of interest to a much broader audience.

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At the time of writing, David Groenfeldt was a water resource management specialist and Mark Svendsen was a water resource management consultant in the Environment and Natural Resources Division of the World Bank Institute.

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Foreword

Following the publication in 1993 of the World Bank's policy paper on *Water Resources Management*, the World Bank Institute (WBI), formerly the Economic Development Institute/Learning and Leadership Center, initiated a training program on water policy reform, based on the principles outlined in the policy paper. A series of national, regional, and international seminars was organized to disseminate best practices in water resources management and to stimulate high-level policy dialogue on policy options in the water sector.

Within the irrigation subsector, the WBI training program focused on policies that encourage participation of the irrigation users in managing the irrigation systems on which their livelihoods depend. This theme of participatory irrigation management (PIM) has attracted a great deal of interest among government agencies, as well as the farmers themselves. While the basic principles of PIM (outlined in chapter 1) seem intuitively sound and even obvious, there are surprisingly few cases in which PIM policies are adopted and fully implemented at a national level.

In order to understand better the conditions that give rise to PIM implementation and to provide documentation to be used in training courses, the WBI collaborated with the International Water Management Institute (IWMI) in commissioning studies of situations where PIM seems to have worked. These studies, published in this volume, address the political antecedents of PIM policies, the process of implementing the policies, and the second-generation challenges of sustaining PIM. We hope that the hard-won experience documented in these case studies will prove useful to policymakers and irrigation professionals who are facing similar challenges in their own countries.

Electronic versions of the four case studies (chapters 2–5) and the synthesis of benefits and second-generation problems (chapter 6) are available on the website of the International Network on Participatory Irrigation Management (INPIM) at http://www.inpim.org.

Vinod Thomas, Director
World Bank Institute

Acknowledgments

The case studies in this volume had their genesis in the Second International Seminar on Participatory Irrigation Management, held in Antalya, Turkey, in April 1996. In preparation for that seminar, which was jointly organized by the World Bank Institute (WBI) and the Turkish General Directorate of State Hydraulic Works (DSI), a background paper was commissioned on the participatory irrigation management (PIM) program in Turkey. That paper, authored by Mark Svendsen and Gladys Nott, became the model for a series of other cases that the WBI and the International Water Management Institute (IWMI) commissioned on Argentina, Colombia, Mexico, and the Philippines. All five papers were presented and discussed in a workshop in Cali, Colombia, in February 1997. Four of them were later revised for this publication. Chapter 6 synthesizes the lessons gleaned from the workshop's analysis of these case studies.

Many individuals and institutions were involved in the long process of bringing these case studies to light in the present volume. In addition to the acknowledgments made by the authors of each case study, several separate appreciations are due. In Turkey, the DSI foreign relations officer, Mehmet Cagil, and later Hasan Ozlu, offered invaluable encouragement in planning the Antalya seminar and later in facilitating participation of a key DSI official, Savas Uskay, in the Colombia workshop. Within the World Bank, Joma Mohamadi provided encouragement and guidance. In the Philippines, the National Irrigation Administration (NIA) provided help to the case study author in many ways; special thanks go to then administrator, Rodolfo Undan, and his manager in charge of institutional development, Billy Mejia. In Mexico, many officials within the National Water Commission (CNA) and within the Mexican office of the IWMI, notably Wim Kloezen, aided the case study author.

During the Colombia workshop, the 25 participants offered many valuable suggestions and insights, many of which have been incorporated into this text without acknowledgment. Such is the freedom of information sharing! Carlos Garces (IWMI) and staff from the International Center for Tropical Agriculture, the Colombian irrigation agency (INAT), and the Federation of the Water Users' Associations of Irrigation Districts (FERRIEGO) organized the Colombia workshop. Thanks are due to then director general of INAT, Mario Montoya Negrete, and the president of FERRIEGO, Armando Gomez.

Finally, here in the WBI, grateful appreciation is due to then chief of the Environment Division, Hatsuya Azumi, and to the current manager, Dennis Mahar. Special acknowledgment is made to Peter Sun, former WBI task manager on PIM, who helped frame the concepts upon which this volume is based, and to Anju Sharma, who guided the early production phases of this book.

Abbreviations and Acronyms

AA	Administrative agency (of an LDD)
ANUC	National Association of Rural Users (Colombia)
ANUR	National Association of Water Users (Mexico)
ATP	Accelerated Transfer Program
CDA	Cooperative Development Authority (Philippines)
CIAT	Centro Interacional de Agricultura Tropical (Colombia)
CIS	Communal irrigation system (Philippines)
CNA	Commission Nacional del Agua (National Water Commission) (Mexico)
CNI	National Irrigation Commission (Mexico)
CO	Community organizer
CONPES	National Council of Economic and Social Policies (Colombia)
CONSUAT	Superior Council of Land Development (Colombia)
CORPOICA	Colombian Corporation for Agricultural Research (Colombia)
COTAS	Committees of aquifer-level users (Mexico)
CP	Colegio de Posgraduados (Mexico)
D&C	Design and construction
DGI	Departmento General de Irrigacion
DNP	Department of National Planning (Colombia)
DSI	Devlet Su Isleri (Turkish General Directorate of State Hydraulic Works)
EA	Executing agency (of an LDD)
FAO	United Nations Food and Agriculture Organization
FEDERRIEGO	Federation of the Water Users' Associations of Irrigation Districts (Colombia)
FINAGRO	Fund for Agricultural Financing (Colombia)
FIO	Farmer irrigation organizer
FO	Farmer organizations
FONAT	National Land Development Fund (Colombia)
GATT	General Agreement on Trade and Tariffs
GDRS	General Directorate of Rural Services (Turkey)
GNP	Gross national product
GRU	General Registry of Users
Ha	Hectares
HIMAT	Institute of Hydrology, Meteorology, and Land Development (Colombia)
IA	Irrigation or irrigators' association
ICA	Colombian Agricultural Institute (Colombia)
ICO	Institutional community organizer
ID	Irrigation district
IDB	Inter-American Development Bank
IDD	Institutional Development Division of NIA (Philippines)
IDEAM	Institute of Hydrology, Meteorology, and Environmental Studies (Colombia)
IDO	Irrigator development officer
IFPRI	International Food Policy Research Institute
IG	Irrigation group

IGAC	Agustín Codazzi Geographical Institute (Colombia)
IIMI	International Irrigation Management Institute
IMO	Irrigation management organization (Turkey)
IMT	Irrigation management transfer
IMTA	Instituto Mexicano de Technologia del Agua (Mexican Institute of Water Technology)
INAT	Instituto Nacional de Adecuacion de Tierras (National Land Development Institute) (Colombia)
INCORA	Colombian Institute of Agrarian Reform (Colombia)
INDERENA	National Institute of Renewable Natural Resources and Environment (Colombia)
INIFAP	National Institute of Forestry, Agricultural, and Livestock Research (Mexico)
INPIM	International Network on Participatory Irrigation Management
ISF	Irrigation service fee (Philippines)
IURUDES	Irrigation Units for Rural Development (Mexico)
IVA	Value added tax (Colombia)
IWMI	International Water Management Institute
LDD	Land development district
M$	Mexican pesos (M$1 = US$0.125)
m^3	Cubic meters
NGO	Nongovernmental organization
NIA	National Irrigation Administration (Philippines)
NIS	National irrigation system (Philippines)
O&M	Operation and maintenance
OECD	Organisation for Economic Co-operation and Development
P	Philippine peso (US$1 = P27)
PIM	Participatory irrigation management
PSBR	Public sector borrowing requirement
RADAT	Administration Regulations for Land Development Districts (Colombia)
REPDA	Public Register for Water Rights (Mexico)
RUT	Roldanillo-La Unión-Toro Irrigation District (Colombia)
SAC	Farmers' Association of Colombia (Colombia)
SAGAR	Secretariat of Agriculture, Livestock, and Rural Development (ex-SARH) (Mexico)
SARH	Secretariat of Agricultural and Hydraulic Resources (Mexico)
SAT	Subdirectorate of Land Development
SEC	Security and Exchange Commission
SEMARNAP	Secretariat of Environment, Natural Resources, and Fishing (Mexico)
SENA	National Learning Services
SRH	Secretariat of Water Resources (Mexico)
SRL	Society of limited responsibility (Mexico)
TL	Turkish lira
TSA	Tertiary service areas, command areas of about 40 hectares within an irrigation system (Philippines)
UPRIIS	Upper Pampanga River Integrated Irrigation System (Philippines)
WB	World Bank
WBI	World Bank Institute
WUA	Water users' association

Glossary

agency	A public-sector organization that develops and/or manages irrigation systems.
articles of association	The legal document establishing the formation of an irrigation association as a legal entity in Turkey. It sets out all of the provisions for the membership, administration, and dissolution of the association. Also referred to as statutes.
assembly	A group of elected representatives.
association	An association of irrigation users.
barangay	A *barrio* or village and the lowest unit of government (Philippines).
barrio	A village (Philippines).
bayanihan	A system of exchange labor and mutual help (Philippines).
branch office	A DSI office, below the Regional Office level, responsible for the administration of a number of irrigation schemes (Turkey).
council	A group of elected representatives consisting of less than 10 people (Turkey).
decare	A tenth of a hectare.
district	Irrigation district, a management unit comprising an entire irrigation system (Mexico).
ejidatario	A small farmer who works land held collectively as an *ejido* (Mexico).
ejido	A landholding, and the corresponding group of farmers, that is owned by the state and worked by *ejidatarios* who have use rights to the collective landholding (Mexico).
federation	An apex-level body established by a group of irrigation associations to support them and to represent their interests.
general assembly	The governing plebiscite of an irrigation management association. It is composed of members who represent the interests of their constituent irrigators (Turkey).
gross irrigation area	The total area supplied with irrigation facilities.
imece	A traditional form of communal labor (Turkey).
irrigated area	The portion of the irrigation area actually irrigated in any given irrigation season.
irrigation area	The portion of the potential scheme command area that the irrigation network has the capacity to irrigate.
irrigation association	An institution formed for the purposes of irrigation operation and maintenance on units covering more than one administrative unit (village or municipality)—the Turkish term is *Sulama Birligi*, which is sometimes translated as a water users' association (WUA).
irrigation group	An institution formed by the DSI to operate and maintain irrigation facilities at the village level. The *muhtar* or mayor is the designated head of an irrigation group.
kanalet	An irrigation channel constructed out of u-shaped concrete segments joined together and sealed with bitumenized cord. The segments are of varying sizes depending on the water capacity required. They are often supported above the ground by concrete frames, but they may also be positioned at or below ground surface level.

lamina	The planned water duty to be supplied to a particular irrigated area (Mexico).
management committee	A group composed of members selected from the general assembly plus an appointed secretariat. Its function is to advise and support the chair in the matters related to the day-to-day administration of the IMA. Also referred to as a council (Turkey).
mayor	The elected administrative head of a municipality or city.
module	A subunit of an irrigation district (Mexico).
muhtar	The headman of a village (Turkey).
net irrigation area	The portion of the gross irrigation area remaining after deducting land under roads, water bodies, houses, and so on. The DSI calculates net irrigation by multiplying gross irrigation area by a factor of 0.864.
pakikisama	Smooth interpersonal relations (Philippines).
region	A geographic area defined according to specified administrative, agroclimatic, or other features. DSI-defined regions are different from agroclimatic regions.
scheme	An irrigation development sharing a common controlled water source (for example, dam, regulator, or pumping station) (Turkey).
statutes	A term sometimes used as equivalent to articles of association.
unit	A hydrologic segment of an irrigation scheme (for example, left bank, right bank).
units	Small irrigation systems operated by users (Mexico).
usufructuary	Resource rights that convey permission to use the resource, but not ownership (Mexico).

Contents

1

Introduction: A Global Consensus on Participatory Irrigation Management

David Groenfeldt

Around the world, countries that once promoted more government involvement in irrigation management are adopting new policies that do just the opposite, creating incentives for farmers to take over the management of operations and maintenance, while government agencies focus on improving the management of water at the main system level. Is this just another management fad? Will the pendulum that is now swinging toward greater management control by farmers soon swing back the other way, toward greater state control? There is strong evidence that the current fad of participatory irrigation management (PIM) is here to stay. Governments cannot do everything, and there are some things that they are simply not very good at doing. Farmers who depend on irrigation water for their livelihoods have the strongest incentive to manage that water carefully. No public sector agency could ever match the discipline that farmers impose on themselves when they manage their own irrigation systems.

One of the most impressive examples of PIM is in Mexico, where the government adopted a new water policy in 1989 that included a resolve to transfer large irrigation districts to user management. The success of Mexico's program on irrigation management transfer has proved inspiring to several other countries and has in large part served as the core model for the World Bank Institute's (WBI's) training program on PIM.

Most of the industrial countries adopted PIM policies some time ago as a matter of fiscal necessity. Australia, Japan, Spain, and the United States are just some of the countries where irrigation management has largely been transferred from government agencies to the control of the users themselves. In the United States, for example, the government has promoted the management turnover of irrigation systems that were built and operated by the Bureau of Reclamation. Individual farms have become members of large irrigation districts, and the engineers who now operate the canals and distribute water to each farmer are the employees of the farmers whom they serve.

Farmers in industrial countries enjoy high levels of education and strong support services through both the private market and the public sector (such as the agricultural extension service). Does a management approach that works well in an industrial country setting have any relevance to developing countries where literacy rates may be low and support services unreliable? Participatory irrigation management may be even more important in a developing country context for the following reasons:

- **Cost**—Countries incur a high financial and a social cost when government agencies assume irrigation management functions that farmers could otherwise handle themselves.
- **Incentives**—Irrigation users have stronger incentives to manage water productively than does a government bureaucracy.
- **Efficiency**—When management is decentralized to users, they can respond more quickly to problems or changes in the system.

Aside from the theoretical arguments in favor of PIM in both industrial and developing countries, there is the empirical fact that participatory management approaches are becoming accepted policy in more and more countries.

What exactly do we mean by the term PIM? Participatory irrigation management, or PIM, refers to the involvement of irrigation users in all aspects and at all levels of irrigation management. "All aspects" includes the initial planning and design of new irrigation projects or improvements, as well as the construction, supervision, financing, decision rules, operation, maintenance, monitoring, and evaluation of the system. "All levels" refers to the full physical limits of the irrigation system, up to the policy level in the capital city. Any management function, including the setting of policies, can and should have a participatory dimension to it.

Can irrigation users—farmers—perform the sophisticated management functions necessary to operate a large, modern irrigation system? The answer to this question depends on the management role we are talking about. Can farmers perform irrigation engineering functions? Probably not. But neither can most of us repair the engine of our car if it needs major work. Our lack of knowledge about mechanical engineering does not prevent us from driving the car or owning the car. We make our own decisions about when and from whom to seek technical assistance. The same type of relationship applies to farmers who control the operation of their irrigation system. They need not do the technical work themselves. They can employ specialists who work on their behalf.

Is participation always necessary? Does participation interfere with efficient management in some circumstances? Do we have to allow farmers to come into our board rooms and advise us on how to do our jobs? Are there some natural limits to what irrigation professionals should be responsible for and what farmers should become involved in?

A good rule of thumb is that a participatory dimension is important to all management functions. PIM means "participation" not only in operation and maintenance (O&M) and financing, but in making any decision that will affect system operation and performance, including design choice, contracting arrangements, or O&M costs or financing that farmers will be responsible for under PIM. Farmers should participate in decisions about both the physical design (layout, type, and placement of structures, and so on) and the institutional design (type of organization and its functions) of their irrigation system. Let farmers suggest and decide on the roles that they would like to perform and the roles that they want government to perform.

The focus on participation within the field of irrigation management has emerged naturally from a concern about management functions. The question that participation addresses is "Who is best suited to carry out which management functions?" When this question is asked objectively by someone with a knowledge of comparative experience from such countries as Mexico and Turkey and who is familiar with locally managed traditional irrigation systems in many countries, the answer involves a greater degree of user participation than is typically the case at present. The emphasis on participatory irrigation management is an attempt to rationalize the present lopsided management arrangement between government agencies and farmers. Governments are trying to do too much and have far exceeded their realm of comparative advantage. Farmers have been excluded from irrigation management decisions that they can and should—from an efficiency perspective—be involved in.

This volume reports on four countries where the state's role in irrigation management has undergone fundamental change and where the result has been a much greater management role for farmers. Are we placing an onerous burden on the farmers, or are we creating an opportunity for a new type of productive partnership to emerge between the community of irrigators and the state?

In the cases presented in this volume, the net result for most farmers is clearly positive. Overall, farmers are receiving better service in return for their involvement in system management. Farmers are paying more for this service than they did under the government's management; in some cases (Mexico) they are paying much more. But the results appear to be worth it. So far we do not see irrigation system management reverting back to the state once transfer has been made to the irrigators. The experience, as the case studies show, is not without problems, and it is fair to say that full management transfer to farmers is not the appropriate solution in every case. But it is clear that a participatory approach to irrigation management can help revitalize the irrigation sectors in many countries. The cases in this volume have much to teach us.

2

Benefits and Second-Generation Problems of Irrigation Management Transfer in Mexico

Enrique Palacios V.

Summary

Mexico has served as a model for other countries considering irrigation management transfer programs. The transfer program there began in 1988 following a set of sweeping economic reforms that were introduced in 1986. A powerful new water resources agency, the National Water Commission (CNA), was created in 1989; a new water law was enacted in 1992 and approved by Congress in early 1994. By the end of 1996, 87 percent of the area under medium and large irrigation districts in the country had been transferred to users' associations to manage.

The CNA had the lead responsibility for carrying out the transfers of management responsibility. They held extensive preliminary meetings with both ejidatarios and landowners, touting better and more responsive service and greater efficiency before the user' associations were formed. They also promised government assistance with system rehabilitation and equipment purchases, promises that were only partially kept.

Because of tensions between ejidatarios and landowners, an arrangement was worked out whereby a representative of one group served as the president of the board of directors of the association, while the post of treasurer was filled by a representative of the other group. These posts alternate between groups at every election. A general assembly, usually made up of all landowners and representatives of the various ejidos involved, elects the board of directors. The capability and energy of the directors selected by the general assembly have been critical determinants of association effectiveness and sustainability.

Federations of users' associations are being established at the whole system, or district, level to manage the main system. A representative nationwide federation has also been established to represent the irrigator's interests.

In a farmer opinion survey, about four farmers out of five indicated they thought irrigation service and maintenance had improved since the transfer. Data on water use, however, indicate that, on average, systems are using somewhat more water per unit area after the transfer than before. Systems are generally in poor condition and in need of rehabilitation.

The most dramatic results of transfer have been financial. In the early 1980s, the government was providing about 80 percent of the funds needed for system operation and maintenance (O&M). Today the figure is about 25 percent. At the same time, irrigation fees have increased more than fourfold. Many associations are branching out into other economic ventures, including credit provision, joint input purchase, and farm equipment rental to members.

Second-generation problems are emerging. These include conflicts over water, often with municipalities, due to poorly specified rights; insufficient revenue to support proper O&M; poor accounting and bookkeeping practices; widespread firing and hiring of staff when directors change; nepotism in staff appointments; and the use of director positions as political springboards. Other problems stem from the poor condition of the irrigation infrastructure and the failure of the government to fulfill rehabilitation and modernization commitments and duplication of effort and poor coordination between associations and the CNA. After its downsizing, the CNA is top-heavy with managers and directors and requires a thorough reorganization to adjust its structure to its new role.

Introduction

The climate and soil conditions in most of Mexico are not suitable for rainfed farming. Almost two-thirds of the country is arid or semiarid. Average expected annual rainfall with a 50 percent likelihood is 684 millimeters, whereas the average evapotranspirative demand is around 1,400 millimeters—twice the demand of rainfall. Rainfall is generally distributed in the summer and early fall months.

As to the soils, the conditions are not favorable either. Thus despite the nearly 2 million square kilometer surface of the country, two-thirds of the surface is mountainous or hilly with steep slopes unsuitable for agriculture, and another portion is desertlike. Only 30 million hectares (ha) have suitable slopes for farming, most of them in barren lands. Under these conditions, irrigation is essential to obtain economically productive harvests. Table 2.1 shows production data for 1993.[1]

The value of the irrigated yield is 56 percent of the total, though the irrigated harvested area is only 29 percent. The productivity of irrigation farming is 3.2 times that of rainfed farming, which shows the importance of irrigation to the supply of food and raw materials.

The area under irrigation is divided into two types: irrigation districts and irrigation units. The irrigation districts, of which there are 82, encompass about 3 million hectares.[2] The size distribution of the 79 completed districts is shown in table 2.2. District irrigation is also called *la grande irrigación* (large irrigation) and was, until recently, managed by the government. There are more than 30,000 small irrigation units with a nominal area of about 2.5 million hectares. Unlike the irrigation districts, such units have always been operated by their users.

According to the Federal Water Law of 1971, irrigation districts should be managed by the federal government. However, by the end of the 1980s the government was subsidizing almost 75 percent of the

Table 2.1. *Production Data, Mexico, 1993*

Type	*Area cultivated (hectares)*	*Area harvested (hectares)*	*Value of production (millions of US$)*	*Productivity (US$/hectare)*
Rainfed	13,967,621	12,393,870	3,078	250
Irrigated	5,238,254	5,029,456	3,997	795
Districts	3,100,662	3,004,142	1,970	656
Units	2,137,595	2,025,314	2,027	1,000
Total	19,205,875	17,423,326	7,075	406

Source: SARH (1994).

Table 2.2. *Sizes of Irrigation Districts*

Irrigated area (hectares)	*Number of districts*	*Total area*
Less than 10,000	23	131,900
10,001 to 50,000	39	980,821
50,001 to 100,000	9	690,256
100,001 to 200,000	3	374,817
More than 200,000	5	1,158,377
Total	79	3,336,171

Source: Author's research.

1. This chapter uses an exchange rate of US$1 = M$8.
2. Three irrigation districts are under construction and only partly operational.

costs of operation, maintenance, and administration of the districts. This fact, contrasted with the total absence of support to the users of the smaller irrigation units, created a privileged group of producers in irrigation districts. Moreover, in spite of the large governmental subsidy, districts were not receiving adequate maintenance, causing deterioration of their infrastructure. Mainly for these reasons, beginning in 1988 the federal government decided to transfer responsibility to operate, maintain, and manage the irrigation districts to organizations of users.

Many problems arose as the transfer process began, as discussed later. The most important problems are the following:

- The Water Law forced the irrigation agency to divide districts into smaller irrigation units that would later be called modules in order not to confuse them with units.
- Water charges were raised more than 400 percent in order to achieve financial self-sufficiency as a precondition for transfer.
- Opposition arose within the National Water Commission (CNA), because staff thought they would be negatively affected by the transfer.[3]
- Organizing water users' associations (WUAs), which would be in charge of operating the modules, was difficult.
- The process of dividing the irrigation districts into modules proved to be challenging.

Despite initial difficulties, the process has been carried out successfully, and so far (1997) more than 88 percent of the districts' area has been transferred. However a second generation of problems is being detected. These problems require study, analysis, and action to resolve.

National Context

After the convulsive phase of the Mexican Revolution from 1910 to 1920, another 20-year period of adjustments and socioeconomic changes followed, during which an industrialization policy was formed, and major hydraulic works were begun. These innovations allowed agricultural production to increase. In the 1950s, a stabilizing period of growth began. Financial, fiscal, and monetary policies suppressed inflationary pressure and created a suitable atmosphere for increased internal savings and expanded private and foreign investment. A change in agriculture took place in this period with the advent of the green revolution, which led to significant increases in the production of food and raw materials and kept the peso stable (Wionczek 1971).

However, from the 1960s on, the Mexican government pursued a closed economic policy in order to strengthen national industry. In the agricultural sector, a policy of subsidies was defined, both for inputs and outputs. During the 1970s, the policy of subsidies was expanded, along with government takeover of many companies. This provoked a significant increase in the government's internal and external debt. The resulting instability of the peso brought about its devaluation, after being stable for more than 20 years.

These policies compelled the government to increase significantly the external debt; it grew from US$4 billion in 1970 to more than US$80 billion in 1982 when government subsidies were covered mostly with the funds obtained from foreign credits. The discovery of large oil reserves in the southeast of the country provided collateral for borrowing; however, when the price of oil fell, the ability to borrow was reduced.

By the end of 1981, the economic situation was serious, with an overvalued peso and a large government debt that required foreign currency for the payment of the interest. This forced the government to devalue the peso once again in early 1982. Eventually, the government could not pay its international

3. Most of the acronyms for names of Mexican organizations represent the Spanish names rather than their English equivalents and thus do not correspond with the translations given. The reason for this is that the acronyms have often become words in themselves and would be unfamiliar to both Mexican and international readers if they were changed to represent the translation.

creditors, and another devaluation took place that affected the entire national economy. Nevertheless, policies of protectionism and subsidies were retained for another five years. The price was a considerable increase in the rate of inflation, which reached an annual rate of 200 percent in early 1988, and a contraction of the gross domestic product (Inter-American Development Bank 1984).

This dire situation forced the government to modify its economic policies significantly. Starting in 1986, a series of changes was introduced—economic liberalization, entry into the General Agreement on Trade and Tariffs (GATT), reduction of subsidies, fiscal policy reform, and the initiation of a privatization program.

As the six-year presidential term (1988–94) started, the new National Plan of Development 1989–94 was presented, and a new economic program to open all sectors of the economy was ordered. The plan also called for the privatization of most state companies. These policies served as the basis for a change in agricultural policy. Based on the new National Plan, the Integral Program for Agricultural Modernization 1990–94 was elaborated.

Among the most noteworthy changes in agricultural policy, the modification of Article 27 of the constitution stands out. The outcome of this change was a policy that allowed *ejidatarios* to become owners of their plots and to form mercantile associations with private entrepreneurs for the exploitation of their lands. Another change in the Water Law allowed the creation of a market of rights to water and established a Public Register for Water Rights (REPDA). Moreover, fiscal policy was significantly modified to support the processes of privatization. One consequence of those changes was the government's decision to transfer the operation, maintenance, and management functions of irrigation districts' infrastructure to organizations of users created for that purpose.

Agriculture

Water is a vital element for agricultural production and for economic development in general. However, the spatial and temporal distribution of water in Mexico restrains its use. Because of this distribution, it has been necessary to build a large infrastructure to capture, store, and allot this element among water users.

PROFITABILITY. Table 2.1 illustrates the importance of irrigation to the country's agricultural production. More than half of agricultural production is obtained by irrigation farming, though the harvested area represents less than 30 percent of the total. The productivity of irrigation farming is 3.2 times that of rainfed farming. Economic productivity in irrigation units is 50 percent greater than in irrigation districts, both because the cultivation patterns are more profitable (table 2.3) and because their smaller size and reliance on groundwater induces them to use resources more efficiently. Nevertheless, productivity in the smallest units is low, removing them from the range of market profitability.

Table 2.3. *Distribution of Crops in Irrigation Districts and Units, 1993*

Crop	*Irrigation districts (percent)*	*Irrigation units (percent)*
Basic grains	49.2	41.5
Oil seeds	15.2	3.6
Sugarcane	3.0	6.2
Vegetables	3.8	6.3
Orchards	3.5	14.2
Forage	14.0	21.8
Fibers and tobacco	2.7	1.2
Other crops	8.6	5.2
Total	100.0	100.0

Source: Author's research.

Agricultural productivity has increased in recent years for two reasons: first, less efficient producers have gone out of the market, which can be confirmed because harvested areas have decreased since 1987 in both the rainfed and irrigated areas. Second, producers have acquired better technology to compete in the North American market. However, due to the intense competition in this market, the withdrawal of subsidies, the decrease in the prices of many products, and a raise in input costs, many producers are facing serious financial difficulties.

HOLDING SIZE AND LAND TENANCY. As shown in table 2.4, 536,438 users on 3,522,323 hectares were registered in irrigation districts in 1993. Of those users, nearly three-quarters are *ejidatarios.*

The average areas per user are relatively small, particularly in the irrigation units. However, disparities in holding size are pronounced, because both *ejido* and private plots of less than one hectare per user are common. At the same time, many landowners have farms of more than 50 hectares. And when family firms are established by combining the landholdings of individuals, land areas may surpass 500 hectares. According to the new Agrarian Law, it is now possible to establish family farms with areas of up to 2,500 hectares. Sometimes small farmers do not earn enough profit to make a living from agriculture, so they take other off-farm jobs to increase family income.

WATER COST. Because water is a scarce resource in many parts of the country, its marginal cost should be very high. When water comes from overexploited aquifers, such as those in the Lagunera region or in the Bajio, pumping depths are often greater than 100 meters, and the total cost of water supply, including fixed and variable costs, can be over US$15 per thousand cubic meters.

In spite of water's value, the cost for gravity irrigation service is relatively low. This is because, first, water is generally not priced by volume, and second, even when it is priced by volume, the cost is less than US$4.40 per thousand cubic meters.

Water Resources Development

Starting in 1947, the government defined a clear policy of water resources development and management and founded a state secretariat for that purpose, the Secretariat of Water Resources (SRH). The SRH was divided into three undersecretariats, one of which was responsible for irrigation. All decisions about the use, exploitation, and management of water were concentrated in this agency. In 1976 the secretariat was merged with the Secretariat of Agriculture and Livestock into one single secretariat, the Secretariat of Agricultural and Hydraulic Resources (SARH). In subsequent years, more changes followed as secretariats disappeared and new ones were created every six years (in accordance with the presidential cycle) until 1989. In that year, the National Water Commission was created with a mandate that encompassed most aspects of hydraulic policy, similar to the situation that existed under the SRH many years earlier.

Table 2.4. *Land Tenancy in Irrigation Districts and Units, 1993*

	Area (hectares)			*Users*			*Area/user (hectares)*	
System type	*Ejido*	*Private*	*Total*	*Ejido*	*Private*	*Total*	*Ejido*	*Private*
Districts	1,948,423	1,573,900	3,522,323	388,712	147,726	536,438	5.0	10.7
Share (percent)	55.3	44.7	100.0	72.5	27.5	100.0		
Units	1,070,395	828,270	1,898,665	378,453	140,518	518,971	2.8	5.9
Share (percent)	56.4	43.6	100.0	72.9	27.1	100.0		

Note: Units not registered are not considered. Area without irrigation rights is considered to be within the irrigation district.
Source: CNA (1995).