Irrigation Management Transfer in México: Moving Toward Sustainability

Sam H. Johnson III

International Irrigation Management Institute
c/o CIMMYT, Texcoco, México

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Abstract

Since the early 1900s governments in the Latin American region decided water services should be provided by the public sector. The primary reason presented to justify intervention in the provision of water services was a belief, by both governments and international donor agencies, that government intervention was required in order to ensure economic growth also led to improved economic welfare. Starting in the 1970s in some countries, and in the 1980s in Mexico, this belief was reversed with a change in ideology and a feeling that the private provision of services is the most efficient means of improving both economic efficiency and social welfare. This paper takes this argument one step further and argues that transfer of assets from the public sector to groups of users is not just a means of increasing overall production but is also a necessity in order to ensure sustainability of publicly developed irrigation infrastructure.

Although at present the agricultural sector in Mexico only accounts for about 7% of GDP, it still employees 23% of the economically active population in the country. As part of the revolutionary creed that argued a strong government presence was required to ensure economic growth with equity, the government has used both direct and indirect policies to intervene in the agricultural sector. In the process, the government established marketing and input supply parastatals, imposed import controls, guaranteed producer prices, mandated production targets for growers, invested in irrigation and other infrastructure, restricted land transactions, marketed crops and subsidized fertilizers, farm credit, energy and agricultural water. As a result, in 1991 Mexico had a producer subsidy equivalent (PSE) of US$92 for white maize and US$71 for yellow maize. In contrast the PSE was US$28 in the United States and US$21 in Canada.

México's willingness to join NAFTA and GATT signifies that there has been an ideological change in the country. It is now felt that the government should not be involved in agricultural production; efficiency and welfare will improve with increased private involvement. Under President Salinas de Gortari (1988-94), México instituted bold agricultural reforms, including: privatization of most parastatals; extensive reorganization of the financial sector; elimination of credit subsidies; elimination of marketing monopolies; sharp reductions in public budgets for agricultural research and extension; and gradual transfer of the management of irrigation districts to water user's associations with the introduction of sharply increased fees for irrigation service.

In the early 1960s, farmers were paying about 85% of the actual O&M and administrative costs. From 1952 to 1970, water fees covered 70% of the O&M costs, but by the end of the 1980s, farmer contribution to the budget had fallen to only 15%. The remainder of the budget was being paid by public expenditure, although in most cases, maintenance activities were deferred due to lack of funds leading to deterioration of the irrigation systems. By the end of the decade there were around 800,000 ha of irrigated land out of production or being used only at a reduced level due to deterioration. Another 1.5 million ha required rehabilitation in order to bring overall system efficiency back to its original level.

Recognizing the problems in the irrigation subsector, in 1989 the government instituted the National Program for Decentralization of the Irrigation Districts, or the transfer program, which established a system of co-responsibility between CNA and the water users where the 80 public irrigation systems covering 3.3 million ha would become financially self-sufficient. The transfer program in México took off even faster than planned. Consequently, by the end of 1995 more than 80% of the 3.3 million ha of publicly irrigated land in the country had been transferred to joint management. Water user associations have proven capable of operating and maintaining the modules, even up to sizes in excess of 40,000 ha. Water fees that have increased from around $5/ha to as much as $40/ha have not only supported the module O&M activities but have also funded most of the activities by CNA staff at the main canal and water source levels. This is in sharp contrast to the situation that existed when the systems were heavily dependent upon government subsidies and consequently was deteriorating rapidly due to lack of stable funding.

The number of CNA direct hire staff have been reduced from more than 7,700 to less than 3,000. In most districts, the systems are being operated with less staff, although in many cases the modules have recruited staff with higher levels of training. The elimination of unionized staff has removed one of the major complaints of the farmers. It has been reported that the ability to hire and fire their own staff has improved the responsiveness of the operational staff to the needs of the users. There is no discernable impact of the transfer program in terms of change in area irrigated in the transferred districts. Nor have yields in the transferred areas increased or decreased significantly as a result of the change in management.

However, there are additional changes that need to be made in the irrigated sector to ensure the program is sustainable over time. The system of water tariffs must be changed so that the districts develop a reserve fund. To do this, they need to shift to a system where the module collects a fixed amount to pay the costs of the staff and other facilities of the module as well as a volumetric fee to cover the variable costs of delivering water. The government also has to clarify the terms of the law pertaining to water concessions. With its population growth rate as well as the structural transformation from an agricultural society to an industrial nation, the competition for water is increasing. México's legal system has to be modified to clearly state what water rights exist for irrigated agriculture and how those rights can be protected against demands for water from municipal as well as industrial users. Without a strong legal system that protects the rights of the modules and districts, irrigated agriculture in the country is not sustainable.

Finally, the decision by the government to remove all subsidies has turned the terms of trade against agriculture. Combined with the impacts of NAFTA, and the resulting cheap imports of grains from the US and Canada, irrigated agriculture is under tremendous economic pressure. In the next decade there will need to be radical changes in the irrigated areas, as farmers shift to higher valued crops in order to justify the use of the expensive irrigation water and maintain the infrastructure. These changes will require new agricultural policies, technical assistance and massive amounts of investment in agriculture at interest rates that are competitive with those available in the US, Canada and Europe. Without changes in the water law and the way WUAs charge for water, as well as changes in technology and the level of investment, it is uncertain the transferred systems will remain sustainable.

Irrigation Management Transfer in México: Moving Toward Sustainability[1]

Sam H. Johnson III[2]

Introduction

Since the early 1970's, governments in Latin America, México and the Caribbean have been transferring, in one form or another, many public companies and other state enterprises to the private sector. Such transfers have been especially prevalent in the manufacturing and transportation sectors, but privatization has extended now to almost all sectors of the economy, including the provision of water services such as potable water and irrigation (Economic Commission for Latin America and the Caribbean, 1995). Privatization is usually presented in terms of sale of public property: an airline, a mine, a parastatal to a private investor. However, a more general definition of privatization relates to the transfer of the rights to the net benefits generated by an enterprise from the public to the private sector, which need not involve a change in ownership (Hemming and Mansoor, 1988). Using this definition, there are many forms of transferring economic activities from the state to the individual and groups of individuals and a number of them do not require the actual transfer of physical assets.

Privatization is often defined as a development strategy involving the transfer of function, activity or organization from the public sector to the private sector. Such a strategy emerged in large part, from a conclusion that growth and development inertness are intrinsic to public sector-based activities. As such, it is argued that in their quest for growth and development, developing countries must work proactively to place the so-called "commanding heights" of the economy in the hands of the private sector, with the public sector relegated to the setting of the policy framework and the environment, such that market forces can function (Davis, 1993).

Ironically, from a historical perspective, up to the 1900s most water-based services in Latin America were provided by the private sector. It was only since the 1920s that governments in the region decided water services should be provided by the public sector and only since the 1940s that such services should normally be provided by agencies of the central government rather than by the states (Lee, 1990). Numerous reasons have been presented to justify intervention in the provision of water

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[2]Program Leader, México and Latin America, International Irrigation Management Institute, c/o CIMMYT, Apartado Postal 6-641, 06600 Mexico, D.F., Mexico

services, but the primary one was a belief, by both governments and international donor agencies, that strong government intervention in the economy was required in order to ensure economic growth also led to improved economic welfare. In the 1970s this belief was reversed with a change in ideology and a feeling that the private provision of services is the most efficient means of improving both economic efficiency and social welfare.

This paper takes this argument one step further and argues that transfer of assets from the public sector to groups of users is not just a means of increasing overall production but is also a necessity in order to ensure sustainability of irrigation and drainage infrastructure, particularly that infrastructure developed to provide irrigation water for large-scale irrigated areas. Over time it has been demonstrated that the lack of political will to charge the full operation and maintenance (O&M) costs, not to mention the investment costs, to users of the facilities, complicated by the inability of governments to provide the required O&M funds from the public budget, often results in a situation where public infrastructure is unsustainable over time (World Bank, 1994b). This is particularly true with public irrigation schemes where it is very easy to find cases of schemes that were developed with design lives of 50 years, yet have had to be rehabilitated in less than 10 years (Johnson, 1990). This same situation can be found in other sectors, as well, which has led to programs to privatize many enterprises (Rodriguez, 1992).

In the case of irrigation, after watching this cycle of development and decay for more than 40 years, many governments in Latin America, México and the Caribbean have decided to transfer management responsibility to users associations as a means of ensuring sustainability of the infrastructure (PLANIMAR, 1995). Material presented in this paper details the process of transfer of public irrigation districts in México from pubic ownership to joint management. After describing agriculture and irrigation in the country, the following section describes the irrigation management transfer program in the country. The next section examines if the transfer program is, in fact, increasing the long-term sustainability of irrigation in the country. The section draws on more general data for the entire country as well as specific data from two irrigation districts, Alto Rio Lerma Irrigation District (near Celaya in central México) and Lagunera Irrigation District (near Torreon in northern México), where IIMI is carrying out long-term field research. The final section discusses future changes that are required to improve the long-term sustainability of irrigated agriculture in México.

Mexican Agriculture

Although at present the agricultural sector only accounts for about 7% of GDP, it still employees 23% of the economically active population in the country. Historically, agricultural production has been a central component of México's economic development plans. These plans have been based on cheap energy from México's petroleum reserves, cheap labor from the rural sector and cheap food obtained through the use of highly subsidized agricultural inputs. Since the end of World War II, as part of the revolutionary creed that argued a strong government presence was needed to ensure economic growth also provided increased social welfare, the Government of México has used both direct and indirect policies to intervene in the agricultural sector.

In the process, the Mexican government established marketing and input supply parastatals, imposed import controls, guaranteed producer prices, mandated production targets for growers, invested in

irrigation and other infrastructure, restricted land transactions, marketed crops and subsidized fertilizers, farm credit, agricultural water and crop insurance (Gorriz, et al., 1995a). Until the late 1980s, the main goal of México's agricultural policy was to keep prices low for consumers, yet ensure high prices for producers. Prices were guaranteed for 12 major crops: maize, beans, wheat, barley, rice, sorghum, soybeans, safflower, cottonseed, copra, sunflower, and sesame, as long as they were marketed through a government marketing channel. As a result of various government intervention programs for staple crops, de Janvry, et al. (1995) calculated for 1991 a nominal rate of protection of 77% for maize and a producer subsidy equivalent (PSE) of US$92 for white maize and US$71 for yellow maize. In contrast the PSE was US$28 in the United States and US$21 in Canada.

However, two international accords--The General Agreement in Trade and Tariffs (GATT) and the North American Free Trade Agreement (NAFTA)--have altered trade policy in México. Under NAFTA, 42 percent of tariff codes were liberalized, with tariffs on foodstuffs and cotton to be phased out over a period of 15 to 20 years. The phaseouts are consistent with GATT agreements regarding reduced agricultural protection for developing countries (World Bank, 1995).

México's willingness to join NAFTA and GATT signifies that there has been an ideological change in the country. It is now felt that the government should not be involved in agricultural production and efficiency and welfare will improve with increased private involvement. As a result, guaranteed prices were replaced with agreement prices for all commodities except beans and maize and the government began implementing reforms to reduce general food subsidies. The only basic food products still benefiting from targeted consumption subsidies include maize flour, tortillas, and milk (World Bank, 1995).

It should be emphasized that the Mexican divestment program was not implemented as a result of GATT and NAFTA, but had actually started in 1983. After expanding from 391 enterprises in 1970 to 1,155 enterprises in 1982, the government shifted its view of the role that the public sector should play in the economy. Therefore, starting with the sale of some of the smaller public firms in 1983, the Government instituted a divestment program. The sale of larger firms dates from 1988 when transfer of mines, steel industry, airlines, the telephone company and commercial banks were instituted. As can be seen in Table 1, the number of firms in the hands of the Government was reduced from 1,155 to 247 during the period December 1982 to December 1990.

With almost ten years of experience in privatization, México had confidence in its ability to reduce the Government's role in the economy, including agriculture. Thus, under President Salinas de Gortari (1991), México instituted bold agricultural reforms on many different fronts, including:

- privatization of most parastatals in marketing, fertilizers, seeds, insurance, and the provision of other inputs that were used to transfer massive subsidies to agriculture;
- extensive reorganization of the financial sector with reprivatization of commercial banks;
- elimination of credit subsidies:
- elimination of CONASUPO's monopoly over the marketing of basic foods except maize and beans:

- sharp reductions of public budgets for agricultural research and extension services with private delivery and the charging of user fees expected to substitute for free public extension services; and
- gradual transfer of the management of irrigation districts to water user's associations with the introduction of sharply increased fees for water use.

A number of laws were drafted and modified to ensure these reforms could be implemented. For example, to facilitate the transfer of public irrigation districts, Article 27 of the Constitution was modified so that farmers in communal communities (ejidos) were given the right to form associations and to rent and sell their water and land rights as well as pledge their land as collateral for loans (Foley, 1995). In addition, the national water law was revised so that water rights were clarified and the possibility for selling and leasing water to higher value uses was established (Comisión Nacional del Agua, 1992; Rosegrant and Guzmuri S., 1994a). These measures were meant to encourage investment and productivity on the assumption that security of tenure will ensure capitalization and that productivity gains in agriculture can only be achieved through realizing economies of scale (Salinas de Gortari, 1992).

Irrigated Agriculture

México has a vast land area of approximately two million square kilometers. In excess of 75% of the country is classified as arid and semi-arid and water is the constraining agricultural production factor in many areas. As a result, the total cropped land is only around 20 million ha. With such a large amount of arid land, irrigation plays a critical role in terms of overall agricultural production. Within the agricultural sector irrigated land contributes about 50 percent of the total value of agricultural production and accounts for about 70 percent of agricultural exports. Productivity of irrigated land is 2.3 times that of rainfed land (Espinosa de León and Trava Manzanilla, 1992).

Irrigation has been practiced in México since pre-Hispanic times, with many small diversions and canals being built to meet the agricultural needs of the population. It has been estimated at the beginning of the Revolution there were approximately 1.2 million hectares of irrigated land. Much of this land had been developed by various land companies, mainly American, for the purpose of growing plantation crops such as sugarcane and cotton. The Constitution of 1917 nationalized the country's water resources and all of these irrigation systems became the responsibility of the state. In order to manage irrigation in the country, an Irrigation Directorate was established in the Department of Agriculture and Development, followed by the National Irrigation Commission in 1926 which was given responsibility for all irrigation affairs. During the period 1926 to 1934 the first irrigation districts, including Pabellón in Aguacalientes, Mantes in Tamaulipas, Tula and Metztitlán in Hidalgo, Don Martín, San Carlos and El Nogal in Coahuila, Delicias and Ciudad Juárez in Chihuahua, Culiacán in Sinoloa, Lerma in Guanajuato and Tijuana in Baja California, were established in the country (Comisión Nacional de Irrigación, 1940). Although in the 1930s irrigation development was slow, by 1960 the agricultural census reported a total of 4.3 million ha in the country (Trava, 1994).

The golden era of irrigation development was stopped by the financial and resulting budgetary crisis of August 1982. With the collapse of the peso, and the resulting devaluation, investment funds for new irrigation systems as well as funds for the maintenance of the existing systems were not

available. Throughout the rest of the 1980s public investment funds were scarce such that, in nominal terms, public investment in the sector declined from US$3,600 million in 1981 to US$230 million in 1990. In 1988, investment in irrigation infrastructure was less than 3% of total public investment compared with around 10% in 1978 (Gorriz, 1995b).

Irrigation districts were created and developed as part of the public policy to foster grain self-sufficiency. Initially, the costs of administration and O&M of the irrigation districts were paid by the government and the farmers, the latter through water fees. Over time, the percentage of the farmer contributions declined. In the early 1960s, farmers were paying about 85% of the actual O&M and administrative costs. From 1952 to 1970, water fees covered 70% of the O&M costs (World Bank 1989a), but by the end of the 1980s, farmer contribution to the budget had fallen to only 15% (Espinosa de León and Trava Manzanilla, 1992). The remainder of the budget was being paid by public expenditure, although in most cases, maintenance activities were deferred due to lack of funds (World Bank, 1991). No precise estimates are available for the amounts and volume of works needed for deferred maintenance, although a World Bank (1983) publication estimated the over-all costs would be US$3.5 billion (in 1981 dollars).

The reduction in funding for O&M led to deterioration of the irrigation systems. By the end of the 1980s, many of the irrigation districts were in disrepair and were unable to meet the water requirements of the growers. Due to economic conditions, the government was unable to provide resources needed to properly maintain these systems and, consequently, the systems were deteriorating rapidly (Palacios-Velez, 1995). In some districts unionized employees were starting to demand extra compensation for working in excess of 8 hours during a day while improper use of maintenance had become chronic as lack of budgetary funds resulted in the machinery being used less than 1/3rd of their normally scheduled shift (Trava, 1994). Consequently, at the end of the 1980s, the 3.3 million ha of land served by public irrigation systems were under heavy stress.

Irrigation Management Transfer - México Model

At the end of the 1980s, México had approximately 1,300 storage dams, 2,100 diversion dams, 68,000 km of canals, 47,000 km of drains, 54,000 km of service roads, and in excess of 50,000 deep irrigation wells. The economic crisis not only reduced the availability of funds for new irrigation investment, it also significantly constrained the government funds available for maintenance. By the end of the decade there were estimated to be around 800,000 ha of irrigated land that were out of production or being used only at a reduced level due to deterioration of the infrastructure. Another 1.5 million ha required rehabilitation in order to bring overall system efficiency back to its original level (Figueroa Hernandez, 1992). In 1989, recognizing the problems in the irrigation subsector (World Bank, 1989), as part of the National Development Plan (1989-1994), there was a major modification of the water law of México, included within was the creation of the National Water Commission (CNA). CNA was created with an explicit mandate to define a new policy for the management of the waters of the country. This led to the development of the National Program for Decentralization of the Irrigation Districts under the National Development Plan.

Of the approximately 6 million irrigated ha in México, as stated earlier, 3.3 million ha are in 80 public irrigation districts (see Map 1). Table 2 details the distribution of the public irrigation districts in México by area. The National Program for Decentralization of the Irrigation Districts,

or the transfer program, was designed to establish a system of co-responsibility between CNA and the water users where the 80 public irrigation systems would become financially self-sufficient (Espinosa de León and Trava Manzanilla, 1992).

Phase I of the transfer program gradually shifted government-managed irrigation districts to the water users' associations, with each of the water users associations being responsible for O&M within a module which starts at the secondary canal level and extends to the individual farm intakes. CNA retains responsibility for managing the water source and the main canal. This program was designed to reduce government subsidies to the districts to zero. As a result, it was necessary to increase user water fees to cover all O&M and administrative costs, including the costs incurred by CNA in operating the water source and the main canal.

Phase II of the transfer program creates Limited Responsibility Societies (SLRs), which are federations of the individual modules. SLRs are responsible for operating all the main canals, drains and roads of the irrigation district. The idea is also that SLRs would also pool the maintenance equipment provided to the modules and thus have economies of scale in use of the equipment. Thus, once the SLRs are in place, CNA is responsible for managing the water source itself, as well as playing a larger role in overall water resource planning and development in the country.

The México transfer program is built around the creation of irrigation modules, which are operated by water user associations, legal civil associations under Mexican law. Modules cover a specified service area of from 1,000 to 20,000 ha. The physical boundaries for the modules are based upon the following (Trava, 1994):

Hydraulic considerations	water delivery to the area should be easy and efficient to accomplish and, where possible, fit within existing irrigation sections as the control structures are already in place;
Social aspects	in cases where there were irreconcilable differences between groups, such as between two ejidos or an ejido and a private grower, adjustments were made to try to minimize such conflicts as long as the hydraulic conditions could still be met; and
Economic concerns	as the modules become smaller, they quickly reach an uneconomic size and consequently they cannot pay their O&M costs--in México it was found that around 3,000 ha is the minimum size with larger modules more cost effective as long as they did not get too large with resulting social and organizational problems.

In the early years of the transfer program in México, the modules were relatively small as it was felt these would be easier for the users to manage. However, with experience it became obvious modules that were too small could not afford the fixed overhead costs of administering O&M in the area. The fixed staff and facilities costs were too great for the size of the service area and therefore the water fees were too high for farmers to afford to pay them. Consequently, in order to have a viable management size the districts that have been transferred more recently have much larger modules (5,000-40,000 ha) than the modules in the earlier districts.

In contrast to many countries, particularly those in Asia (Korten and Siy, 1988) that first attempted to create water user associations at the block level (100-500 ha), México decided to form water user associations at the module level and does not have an formal structure below this level. According to Mexican civil law, the General Assembly is the association's supreme authority. However, as the number of users may be in excess of 3,000 farmers and, as it is difficult to bring such a large group all together in an assembly meeting, the law allows for the appointment of delegates representing sub-areas within the module. These delegates represent individual farmer interests at the General Assembly level. Rules to select delegates vary and are decided by the local users. Some possible models are:

- One delegate per ejido and one delegate to represent the private producers;
- two delegates for each ejido and two to represent private producers;
- one delegate per every 100 ejidatarios; and
- two delegates per each irrigation section, one to represent the ejidatarios and one to represent the private producers.

The selection rule for delegates is based on the social structure in the particular module and can vary from module to module within a single district.

Another unique aspect of the Mexican model is that the water concession granted by the government is part of the legal agreement between the government and the module (the water users association). As such, the users do not have individual water rights but instead each association has a proportional right (where the proportion is based on area) to the supply of water (normally the surface water) available to the district for that season. Concessions are for a fixed time frame, 5 to 50 years, and can be taken away if an association does not fulfill its agreement with the government (CNA). It must be emphasized that even after an SLR is formed, the concession is still in the name of the association and the SLR is granted authority to manage water by the individual associations.

At the beginning of each season it is the responsibility of CNA to estimate overall water availability for the coming season (including groundwater quantities). This information is provided to the district. A Hydrologic Committee that includes the head of the district and head of operations from CNA as well as a representative from each module is responsible for coming to agreement concerning the water allocation plan for the season or year, as the case may be, and also developing a water program for irrigation deliveries. In addition, when there is a critical decision required, usually the hydrologic committee meets to make this decision, although normally they only meet 2-4 weeks before the beginning of the season to develop the seasonal plan.

Many of the districts also have conjunctive groundwater systems, including both private wells as well as public wells (that are usually included in the transfer program), and it is not unusual for a district to have access to water from more than one reservoir. Groundwater well concessions are granted by CNA and each concession is supposed to restrict the total amount of pumping from individual wells. The concessions granted are designed to reflect the estimated annual recharge and thus maintain a steady groundwater level. Since groundwater levels are falling in almost all the major agricultural areas in the country, this system is not working (Cummings, et al., 1989). In addition to unlicensed wells, the wells with concessions are not strictly monitored and thus the actual pumping from a well is usually unknown (although with access to good energy use data, it is

theoretically possible for CNA to determine pumping quantities). With the removal of the subsidies on electrical energy, and the subsequent steep increase in energy costs, there has been a dramatic decline in the use of wells, particularly those of the ejidos where they are growing lower-value food crops such as beans and maize.

Also as part of the transfer program, CNA transferred the majority of the maintenance equipment to the modules so that they would have the equipment required to maintain their respective ditches and drains. As much of this equipment was very old and in poor condition, many of the modules purchased additional equipment for maintenance as well as equipment for carrying out agricultural tasks such as laser land leveling to help increase irrigation efficiencies in the module.

Results of The Transfer Program

The decision to implement the transfer program was made at the highest level of the government, the Office of the President. In general, this decision was strongly supported by the farmers in the more commercial irrigated areas in the country, primarily in the North and Northwest where 53% of the irrigated area in the country is located. In fact, in a number of these districts, groups of growers had approached the government and requested that management responsibility for O&M of the public irrigation districts be transferred to the water users.

Consequently, when the transfer program was started, the initial systems transferred were concentrated in the more commercial areas. The clear bias toward larger systems in the North and Northwest is obvious from the data presented in Table 3. As can be seen in Table 3, while most of the transferred districts in the NW were around 100,000 ha and larger, only the Alto Lerma in the Lerma-Balsas region was in excess of 100,000 ha.

By concentrating on an area where the program had strong local support as well as an area where the systems were relatively large, México was able to jump start the transfer process. They proved that transfer of O&M responsibility to the associations was a viable strategy and were able to transfer more than 2.45 million ha between 1990 to 1994 against a target of 1.96 million ha (Comisión Nacional del Agua, 1995a).

By July, 1995 under the transfer program 2,584,421 ha had been transferred to 329 modules. This represents 80% of the service areas in the 80 irrigation districts and involves 352,990 users. In 43 districts, the government has transferred responsibility for O&M and administration for all the secondary and below canals and drains and roads to 249 modules. In another 15 districts the government is in the process of transferring management responsibility and has organized 80 modules covering 61% of the area of these districts (Comisión Nacional del Agua, 1995b).

Additionally, the program has created 7 SLRs that have grouped together 98 of the modules in 7 of the larger districts in the country. These cover in excess of 705,000 ha of irrigated land. The government has also created a National Association of Users of Irrigation (ANUR), an organization created for grouping the modules together. When active, it is planned that ANUR will serve both as an official voice for the modules as well as help with human resource development. ANUR is also expected to serve as a mechanism for the modules to access credit and technical assistance.

Financial Impacts

A major aspect of the transfer process was to ensure the water user associations had adequate financial resources to be self-sufficient. This meant that the irrigation fees or water tariffs had to reach a level where the costs of operation, administration and maintenance at the module level were covered. In addition, the water tariffs had to be sufficient to meet the modules' share of the costs of operations, administration and maintenance at the main canal and water source level as well. This requirement is clearly stated in the concession agreement signed between each association and CNA. Table 4 illustrates the impacts of this aspect of the transfer program for the entire country.

As can be seen in Table 4, the transfer program and the associated increases in water tariffs have allowed the irrigation districts to go from 43% self-sufficiency to 78% self-sufficiency. This has been accomplished with a decline in federal government subsidies from 40 million US dollars annually to zero.

Beyond any doubt, the transfer program has resulted in a much more stable financial position for the districts. This has been particularly obvious during 1995 when, due to the financial crisis, the Government has provided almost no operating budget to the line agencies such as CNA. In contrast to the 1982 financial crisis, when the districts almost stopped operating due to a lack of funds and all maintenance was deferred, during 1995 funds from the users not only kept the modules operating, they actually carried out some of the deferred maintenance. The percentage of the water tariffs that went to CNA provided critical funds to ensure that CNA could carry out O&M at the main canal and water source level. Removing such a heavy dependancy upon the vagaries of the federal government has improved overall financial sustainability of the transferred districts.

Staffing Impacts

As was designed in the transfer process, responsibility for O&M from the secondary canals down was transferred to the modules. In the process the employees that worked for CNA were to be hired by the modules if they felt they were needed and were competent, or they were to be released. In many cases, the modules realized they could not afford all the staff that were being funded by CNA. In other cases the staff were considered dishonest or incompetent and in other cases they were too expensive. Where the unions were very strong, the modules did not want to hire union employees as this was one of the major problems they had with CNA's operation of the irrigation system.

Therefore, one clear impact of the transfer process is a reduction in the number of CNA employees working in O&M in irrigation (see Table 5).

This reduction did not just impact on CNA management at the secondary canal level, it also significantly reduced CNA's staffing levels at the district level. In some cases this just meant a well needed reduction in administrative personnel but in other cases it actually eliminated some of the more experienced personnel in the district, with direct impacts on the management of the water source and main canal. In addition, with the new government program to decentralize CNA's responsibility for irrigation O&M at the source and main canal level to the respective state governments, it is expected that the actual number of CNA staff will be reduced even further.

However, in all cases the reduction did not necessarily mean a reduction in overall staff, it simply meant a change in the number of public employees. For example, in the Lagunera Irrigation District

in 1990 there were 90 ditch tenders and 324 other employees--all public employees of CNA. After transfer, in 1995 there are now 107 ditch tenders employed by the respective modules and 49 ditch tenders still employed by CNA. There are also 219 other employees by CNA and 119 by the modules. Thus, instead of reducing the total number of employees, after transfer there are now 494 employees in Lagunera compared to 414 prior to transfer. It must be pointed out that only 15 of the 20 modules have been transferred in Lagunera and thus the number of CNA employees is higher than it is expected to be after complete transfer. A more typical example is in Cortazar module in Alto Rio Lerma Irrigation District. In this module, after transfer the number of ditch tenders was reduced from 16 to 10 and the overall staff was cut in half.

In terms of sustainability, the modules have established their water tariffs so that they will cover the administrative costs for the module staff. In most cases this has resulted in a reduction in the number of employees to a level that can be supported with the available funds. Therefore, the module level organization is more sustainable, although as detailed in the next section there are exceptions.

Economic Impacts

In line with the policy of making irrigation districts more financially sustainable, it was recognized that the users would have to pay the real O&M costs for their irrigation service. This meant that the costs of water for the farmers was going to increase significantly as prior to transfer, most farmers were only paying about 15% of the actual O&M costs. Table 6 illustrates the fact that, as planned, water costs increased significantly in all of the districts.

Although increased water costs are important, what is equally important is the change in costs as a function of the overall costs of production. In Table 7, these changes are illustrated for the case of the Rio Mayo and Delicias, large districts in the NW and N, respectively and some of the districts that were first transferred.

As can be seen in Table 7, although costs of water with respect to the costs of production have increased since transfer, the percentages are still in the range of 3-8% which is not unusual for irrigated agriculture. These figures are complicated by the increases in production costs that have resulted due to the removal of many subsidies on other agricultural inputs.

Therefore, although the cost of water relative to the total production costs have not increased significantly over the past 10 years, the terms of trade of agriculture have changed drastically. With the removal of the subsidies on inputs and the elimination of most price guarantee programs, profitability of grain crops has declined by more than half. As can be seen in Figure 1, in the Rio Lerma the net returns for maize, wheat and sorghum have suffered a serious decline over the past ten years (1984-1994). This trend poses a threat to the sustainability of the transferred irrigation systems as it reduces the ability of the users to maintain the system and will encourage them to underfund O&M.

Production Impacts

As the transfer program is only a few years old--five years at the oldest--it is unlikely that we will find much in the way of production impacts as a result of the program. Poor management of the modules could possibly result in reductions in harvested area. Unfortunately, production data for irrigated areas are not reported by transferred and untransferred irrigated areas, thus, macro data are

not availablet have macro data to determine if there has been any changes in harvested area. Using data from the two research systems, as can be seen in Figure 2, although there has been a variation from year to year, there is no clear trend toward reduced harvested area. In fact in the Alto Rio Lerma the harvested area has increased since transfer while in the Lagunera annual planted and harvested area fluctuates due to the rainfall, or with the drought, the lack of. As both systems have access to groundwater wells, this will also serve to mask changes in surface water availability and timing.

It can also be hypothesized that changes in quality of irrigation service will reduce the yields and, hence, gross returns. However, as can be seen in Figure 3 gross returns (in constant 1982 dollars) have been very constant in the Alto Rio Lerma. They have declined over time in Lagunera, but this reflects the movement out of cotton due to pest problems rather than irrigation problems. In both areas the yields for the major grain crops have not changed. However, cropping mixes have changed to reflect shifts in output prices. For example, in Alto Rio Lerma the area planted to vegetables for export has increased from 10,000 ha to 40,000 ha over the past five years. In 1995 sorghum prices were unusually high and as a result a large amount of land that is normally in wheat was shifted to sorghum as sorghum yields are very good (in excess of 7 tons) in the Rio Lerma area. By shifting crops the farmers in the region have been able to maintain more or less stable gross returns even in a time of falling grain prices due to the impacts of NAFTA.

Transfer Problems

The transfer program started in 1990 and thus the government and users now have five years of experience with the program. Approximately 60 districts are all, or almost all, transferred. The government now has to focus on the last 20 districts that are all problematic, either because they are located in an area where there is civil unrest such as in Chiapas, the irrigation infrastructure has structural problems and the farmers refuse to accept it before it is rehabilitated or there are serious water quality problems such as in Tula Irrigation District.

In addition, the government is starting to face some second generation problems with the transferred districts. This is not particularly surprising, given the speed with which the program was implemented. The long-term success of the irrigation sector and the sustainability of the transferred districts will depend upon how the government addresses these second generation problems.

Financial Sustainability

As illustrated above, the transfer program has increased significantly the actual funds available for O&M. In most districts these funds have been obtained by a change to volumetric prices for water as has been recommended by CNA. In most districts the users pay their water fees and then present the receipt to the ditch tender who in turn schedules delivery of their water. By paying before they receive water, this system minimizes problems associated with trying to encourage farmers to pay after they have already received the water or at the end of the season.

There are two interlinked weaknesses in the present water tariff system:

(1) In the districts there is normally no reserve fund--the fees are set at a level just sufficient to pay the day-to-day expenses for the modules. The modules are literally living hand-

to-mouth by collecting the fees for one irrigation cycle just in time to pay the salaries and expenses for the next month. Therefore, they are not prepared to deal with an emergency.

(2) The idea of charging on a volumetric basis seems logical, but it assumes that the districts will always have water. The lack of any kind of base fee that is charged to all users separate from the volume delivered, means that any time a module cannot deliver water, their income drops to zero. Without a reserve fund the module basically goes into bankruptcy.

Clearly, the modules are going to have to change to a system of a base fee for all users in the system (probably based on land owned in the module) and a volumetric system based on the actual volume of water received, or the number of ha irrigated as a proxy. Without this they are going to face the same problems that have already hit a number of the modules in the North as a result of the present drought. In the Bajo San Juan, Bajo Rio Bravo and Zacatecas, a number of the modules either went broke or were on the verge of going broke as they did not have sufficient volume of water to deliver in order to raise the funds needed to meet their basic operating costs.

Water Law

As stated earlier, the government passed a new water law to help address some of the problems associated with the transfer program, and the change to more commercial agriculture in general. The water law was passed in 1992 and the regulations that support the law were passed in 1994. Together, the two documents form the basis for the transfer program as well as providing the legal framework to allow the sale of water to higher value uses (Comisión Nacional del Agua , 1994a).

Within a district water user associations within the individual modules are granted concessions once they fulfill all the filing and registration requirements. In effect, this entitles them to a proportional share of the water available for each season to the land in the district. One would assume that the associations within a district would want to ensure they receive their fair share of the available water, yet in the data provided by CNA and the individual districts, there is no way to document this. Therefore, as one exercise in Lagunera, IIMI staff collected the data to determine how equitable the distribution of water has been within the district as a whole before and after transfer. In order to make the comparison more or less equal, 1987 data was compared with 1994 as these two years had a similar volume of water.

As can be seen the volumes delivered and the standard deviations are basically the same between the two years. In fact, the average standard deviations for six years before transfer and the two years after transfer are 2.46 and 2.64. The two undades that received less water, Tlahualil and San Jacinto, are the same before and after transfer. As these *unidades* can pump water directly from the river as well as having access to canal water, their volume is not really as short as it seems from the data. Concessions are for 5 to 50 years and are renewable if concession holders have not taken any actions that would be cause for termination as specified in the law. However, as can be seen in the selected quotations drawn from the actual cncession title for the Rio Yaqui, nowhere in the concession does it actually specify the volume of water associated with the concession (Gorriz, et al., 1995a, Annex 2).

DECLARATIONS

1. The National Water Commission, an administrative organ of the Secretariat of Agriculture and Hydraulic Resources, created by Presidential Decree published in the Official Gazette of the Federation on January 16, 1989, hereafter called "the Commission," hereby grants a concession for the use of water for irrigation purposes, as well as a permit for the use of irrigation infrastructure, to the Rural Development Module or Unit "Farmer-Users Association, Irrigation Unit K-95, Upper Main Canal, Irrigation District No. 041, Rio Yaqui, A.C.," forming part of the above-mentioned Irrigation District, hereinafter called "the Concession Holder."

Under the Conditions specified in the Concession, the first condition stipulates

1. The purpose of the present Concession is to authorize the use of national water resources for purposes of irrigation of the Concession Holder to use national water resources to supply water for irrigation in the above-mentioned module, prior to bulk water delivery of water by the Commission.

The seventh condition stipulates the length of the concession:

7. This Concession and Permit are granted for 20 years from the date of issue, which period may be extended.

The eighth condition details the functions and obligations of CNA:

8. The Commission shall have the following functions and obligations:

   I. Determine and publicize at the beginning of each agricultural cycle the volume of water available for formulation of the District irrigation plan, this enabling the Concession Holder to formulate its own irrigation plan, based on the volume allocated to it under the Operating, Maintenance and Management Instructions and submit this plan through the Company (SLR) to the Commission for authorization.

   II. Deliver water in bulk through the Company (SLR) to the Concession Holder to be piped to the control point(s) set up, and ensure that this piping and distribution of water by the Company is performed efficiently so that each Concession Holder receives its allocated volume at the appropriate time.

   III. Ensure that water distribution by the Concession Holder to the interior of the Module takes place efficiently so that users receive their allocated volumes at the appropriate time; enforce applications of the regulations governing use of water for irrigation purposes, depending on the quality of the water and destination of the crops concerned.

The ninth condition stipulates the functions and obligations of the Concession Holder:

   II. Prepare the irrigation plan along the lines set forth in Condition VIII.

   III. Receive water in bulk through the Company at its control point(s) and distribute it among the users of the Module in the appropriate volume, using metering structures to be installed by the users on their intake structures, supervised by the Concession Holder, all necessary technical assistance being furnished by the Company and the Commission.

   IV. Provide users with an efficient irrigation service, delivering water in accordance with the programmed demand in the volume and at the time required.

   XI. Supervise the use of irrigation water in each plot, in terms of volume and timing, so as to upgrade the production and productivity of the crops concerned.

Without a firm volumetric water right, the actual operating procedures are left to the districts and CNA, but this fails to provide any guarantee of quantity of water for those that buy or rent water rights. In contrast to the California system, México does not provide water on a priority basis, but the water right is effectively define as proportional to streamflow, stored amount or canal flow. For example, if streamflow is 20 percent below normal[2], each right holder will receive 20 percent less water (Rosegrant and Gazmuri S., 1994b).

In addition to not actually granting a volumetric right, the law defining concessions also is unclear on priority in case of shortage. Under the sections on agricultural and urban use no priorities are defined but under the section titled Basin Councils Article 13 states, *Within the scope of the basin councils, the Commission shall agree with the users on any temporary limitations to existing rights in the event of emergencies, extreme scarcity, over exploitation or declaration of protected areas. In such circumstances, residential use shall have priority* (Gorriz, et al.,1995a, Annex 1 National Water Law).

Based on this interpretation the state of Nuevo Leon and the city of Monterrey have diverted the water of the Rio San Juan into the Cuchillo Dam (Arreola, 1996). Yet, the water user associations in the Bajo Rio San Juan Irrigation District have valid concessions that have been approved by CNA for this water and also have a 1952 agreement signed by the President of México stating that this water belongs to Tamaulipas and the Bajo Rio San Juan Irrigation District.

Also due to water scarcity, this agricultural season in the Lagunera system CNA has effectively taken control of the entire District. This action recognizes that maintaining the normal proportional water deliveries to the respective modules would result in very high transmission losses and individual irrigated areas too small to be economically viable. The decision to serve water to a compact area of only four modules out of the 20, means that even with a legally established concession, the other associations are not going to receive any water. In order to implement such a drastic program, CNA has worked with the ejidos to sell this approach. They have not worked with the modules and, in fact, have deliberately chosen to more or less ignore the legal entities, the water user associations. In the four modules that are to receive water CNA will, in effect, take over control of the management of the system, therefore circumventing the operational responsibility of the Board of Directors of the module.

Both of these cases, as well as similar problems due to the continuing drought in the north, have brought to question the effectiveness of the water law and the regulations that exist to implement the law. This is particularly worrisome as the water law is the legal basis for the transfer program (Comisión Nacional del Agua, 1994a).

Conclusions

The transfer program in México took off even faster than planned. Consequently, by the end of 1995 more than 80% of the 3.3 million ha of publicly irrigated land in the country had been transferred to joint management. Water user associations have proven capable of operating and maintaining the

[2]Note: the Title of Concession does not clearly define normal flow.

modules, even up to sizes in excess of 50,000 ha, and water tariffs collected by the users have not only supported the module O&M activities but have also funded most of the activities by CNA staff at the main canal and water source levels. This is in sharp contrast to the situation that existed when the systems were heavily dependent upon government subsidies and consequently was deteriorating rapidly due to lack of stable funding.

The number of CNA staff have been reduced significantly and, in most districts, the systems are being operated with less staff, although in many cases the modules have recruited staff with higher levels of training. The elimination of unionized staff has removed one of the major complaints of the farmers. It has been reported that the ability to hire and fire their own staff has improved the responsiveness of the operational staff to the needs of the users. There is no discernable impact of the transfer program in terms of change in area irrigated in the transferred districts. Nor have yields in the transferred areas increased or decreased significantly as a result of the change in management. Therefore, the transfer program has created a situation that is much more sustainable than the situation in the irrigated sector prior to transfer.

However, there are additional changes that need to be made in the irrigated sector to ensure the program is sustainable over time. The system of water tariffs must be changed so that the districts develop a reserve fund for emergencies, future replacement and rehabilitation. They also need to shift to a system where the module collects a fixed amount to pay the costs of the staff and other facilities of the module as well as a volumetric fee to cover the variable costs of delivering water. It is also possible that the development of a reserve fund and the implementation of a system that covers costs even during a water scarce year can be accomplished in the same manner.

The government has to clarify the terms of the law pertaining to water concessions. When a major city in the country can expropriate the total water supply from an irrigation district that is working under the legal statutes without apparent legal recourse, than the irrigation districts are in a very vulnerable position. With its population growth rate as well as the structural transformation from an agricultural society to an industrial nation, the competition for water is increasing. México's legal system has to be modified to clarify what rights exist for irrigated agriculture and how those rights can be protected against demands for water from municipal as well as industrial users. Without a clear legal system that protects the water rights of the modules and districts, as well as providing for the opportunity to trade and sell water, irrigated agriculture in the country is not sustainable.

Finally, the decision by the government to remove all subsidies and withdraw the government from agricultural production has shifted the terms of trade against agriculture. Combined with the impacts of NAFTA, and the resulting cheap imports of maize, soybeans and wheat from the US and Canada, irrigated agriculture in Mexico is under tremendous economic pressure. In the next decade there will be radical changes in the rural areas, as farmers shift to higher valued crops to pay for the use of expensive irrigation water and infrastructure. These changes will require new policies as well as requiring access to massive amounts of investment in agriculture at interest rates that are competitive[3] with those available in the US and Canada.

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[3]As a result of the government's attempt to solve the financial crisis by March 1995 interest rates were allowed to increase to 100%. In January 1996, agricultural interest rates had declined

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Table 1. México: Changes in the Role of the Public Sector
December 1982-1990

	1982	1983	1984	1985	1986	1987	1988	1989	1990
Decentralized Institutions	102	87	95	96	94	94	89	88	82
Firms with Major State Participation	744	700	703	629	528	437	252	229	147
State Trust Funds	231	199	173	147	108	83	71	62	51
Firms with Minor State Participation	78	78	78	69	7	3	0	0	0
Total	1155	1074	1049	941	737	617	412	379	280

Source: Rodriguez (1992), pg. 158.

Table 2. Distribution of Irrigation Districts in México by Size

Range of Area (ha)	No. of Districts	Total Area (ha)
<10,000	24	131,900
10,001-50,000	39	980,821
50,001-100,000	9	690,256
100,001-200,000	3	374,817
>200,001	5	1,158,377
Total	80	3,336,171

Source: World Bank, 1994a

Table 3. Program of Transfer (1990-1992)

District No.	Region	District Name	Total Area (ha)	Transferred (ha)
10	NW	Río Culiacán, Sin.	272,807	272,807
14	NW	Río Colorado, B.C. y Son.	206,350	38,447
38	NW	Río Mayo, Son.	97,046	97,046
41	NW	Río Yaqui, Son.	232,944	232,944
63	NW	Guasave, Sin.	100,125	100,125
75	NW	Río Fuerte, Sin.	207,888	207,888
76	NW	Valle del Carrizo, Sin.	43,259	43,259
108	NW	Elota-Piaxtla, Sin.	18,256	18,256
01	NE	Pabellón, Ags.	11,938	11,938
05	N	Delicias, Chih.	75,220	75,220
17	N	Región Lagunera, Coah. y Dgo.	94,670	28,377
26	NE	Bajo Río San Juan, Tamps.	86,102	84,984
11	L-B	Alto Río Lerma	112,772	112,772
13	L-B	Estado de Jalisco	51,110	29,618
23	L-B	San Juan del Río, Qro.	11,048	10,447
85	L-B	La Begoña, Gto.	10,823	10,823
87	L-B	Rosario-Mezquite, Mich.	67,570	12,530
94	L-B	Jalisco Sur, Jal.	12,346	9,817
		Total	1,712,274	1,397,298

Source: Comisión Nacional del Agua (CNA). 1995b

Table 4 Irrigation Budgetary Changes As a Result of the Transfer Program (1989-1993) (Millions of Constant 1993 US Dollars)

(1) Year	(2) Required Budget	(3) Federal Fiscal Funds	Water Tariffs from Users			(7) Availability of Funds (3)+(6)	(8) Deficit (2)-(7)	(9) Degree of Self-Sufficiency (6)x100 / (2)
			(4) Collected for CNA	(5) Collected for Association	(6) Sum (4)+(5)			
1989	185	40	24	55	79	119	66	43
1990	185	31	39	58	97	128	57	52
1991	185	26	52	62	114	140	45	62
1992	185	24	45	88	133	157	28	72
1993	185	0	38	106	144	144	41	78

(2) Annual budget for operations, maintenance and administration--no funds for improvements and rehab.
(4) The portion of funds collected for CNA or 100% if not yet transferred.
(5) The portion o f the tariffs for the association as well as any direct inputs by the association.

Source: Comisión Nacional del Agua, 1994b.

Table 5 Changes in Staffing Before and After Transfer

Region	Personnel Before Trnsf 1990	Personnel Required After Trnsf	Personnel Retired or Reduced	Personnel to be Retired or Reduced	
				Union	Non-Union
Northwest	3,467	1,023	1,660	774	10
North Central	1,798	525	696	633	27
North East	423	137	75	194	17
Lerma Balsa	1,604	363	682	551	1
Valley of Mexico	313	80	149	84	0
South East	137	16	30	90	1
TOTAL	**7,742**	**2,134**	**3,292**	**2,326**	**56**

Source: Comisión Nacional del Agua, 1994a.

Table 6 Water Fees for Selected Districts and Modules (US$/1,000 m^3)

District	Modules	Region	1992	1993	1994	% Increase 1992-1994
Don Martin	7	Northwest	5.11	5,78	7.43	57%
Culiacán-Humaya	III-2	Northwest	5.27	5.20	7.79	59%
Edo. De Zacatecas	6	North	3.10	3.07	5.33	85%
Bajo Rio San Juan	IV-1	North C.	0.86	2.22	2.25	180%
Tulancingo	II	Valle Mex	4.41	4.37	5.94	45%
Metztitlan	I	Valle Mex	2.94	2.91	4.88	79%

Source: Gorriz, *et al* 1995a.

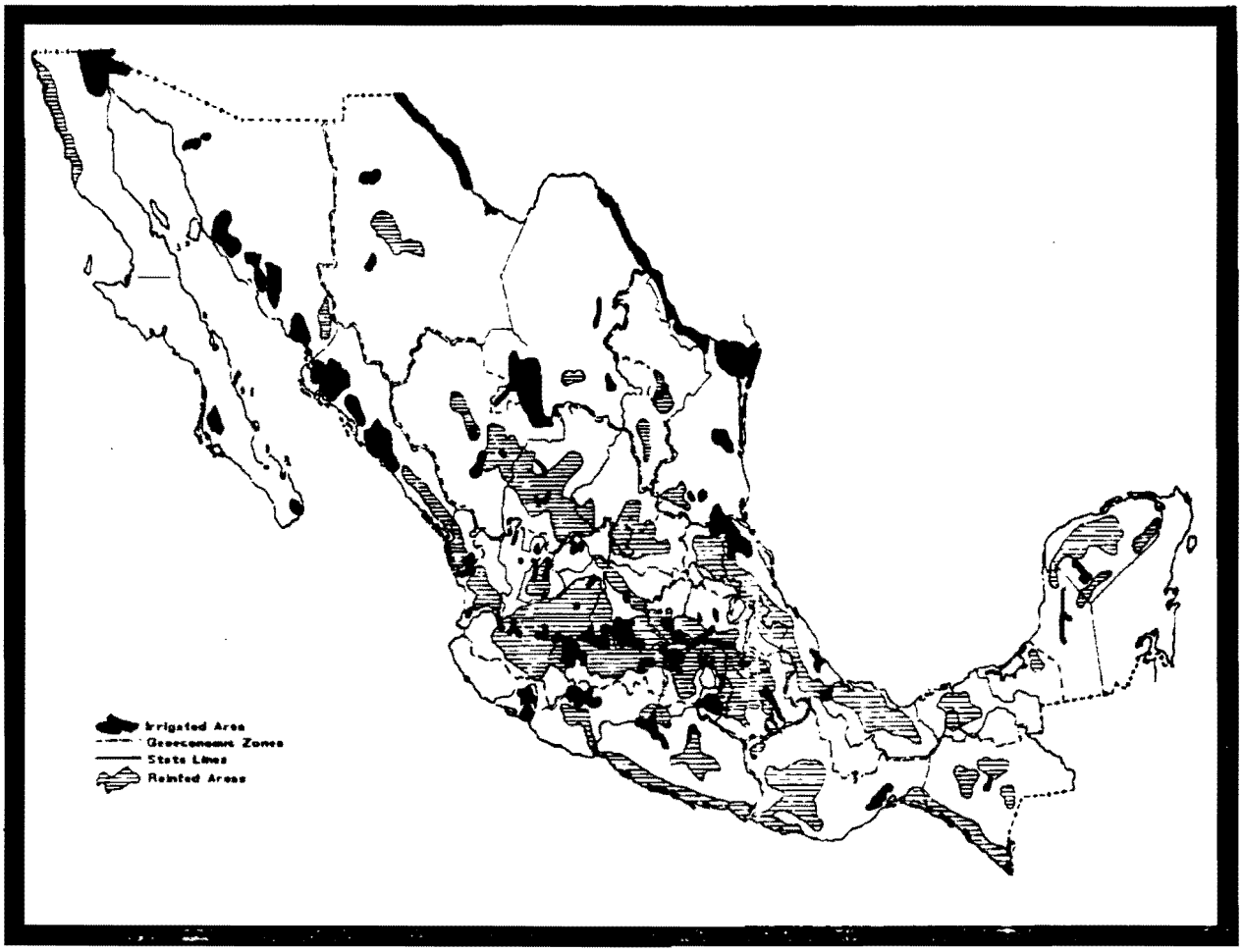
Table 7 Percentage Changes in the Cost of Water with Respect to Total Production Costs

Delicias			Rio Mayo		
Crop	1990	1992	Crop	1990/91	1992/93
Alfalfa	6.2	9.1	Alfalfa	7	10
Cotton	1.1	2.3	Beans	3	3
Maize	1.9	3.8	Maize	4	8
Wheat	1.9	3.2	Wheat	3	8
Soybeans	2.1	4.5	Soybeans	6	6
Chiles	1.6	2.6	Barley	3	5
Peanuts	1.0	3.6	Sesame	2	5
Pecans	2.6	6.7	Tomatoes	2	6
Oats	2.6	4.4	Watermelon	2	3
			Squash	2	4

Source: Valdivia Alcala, 1994

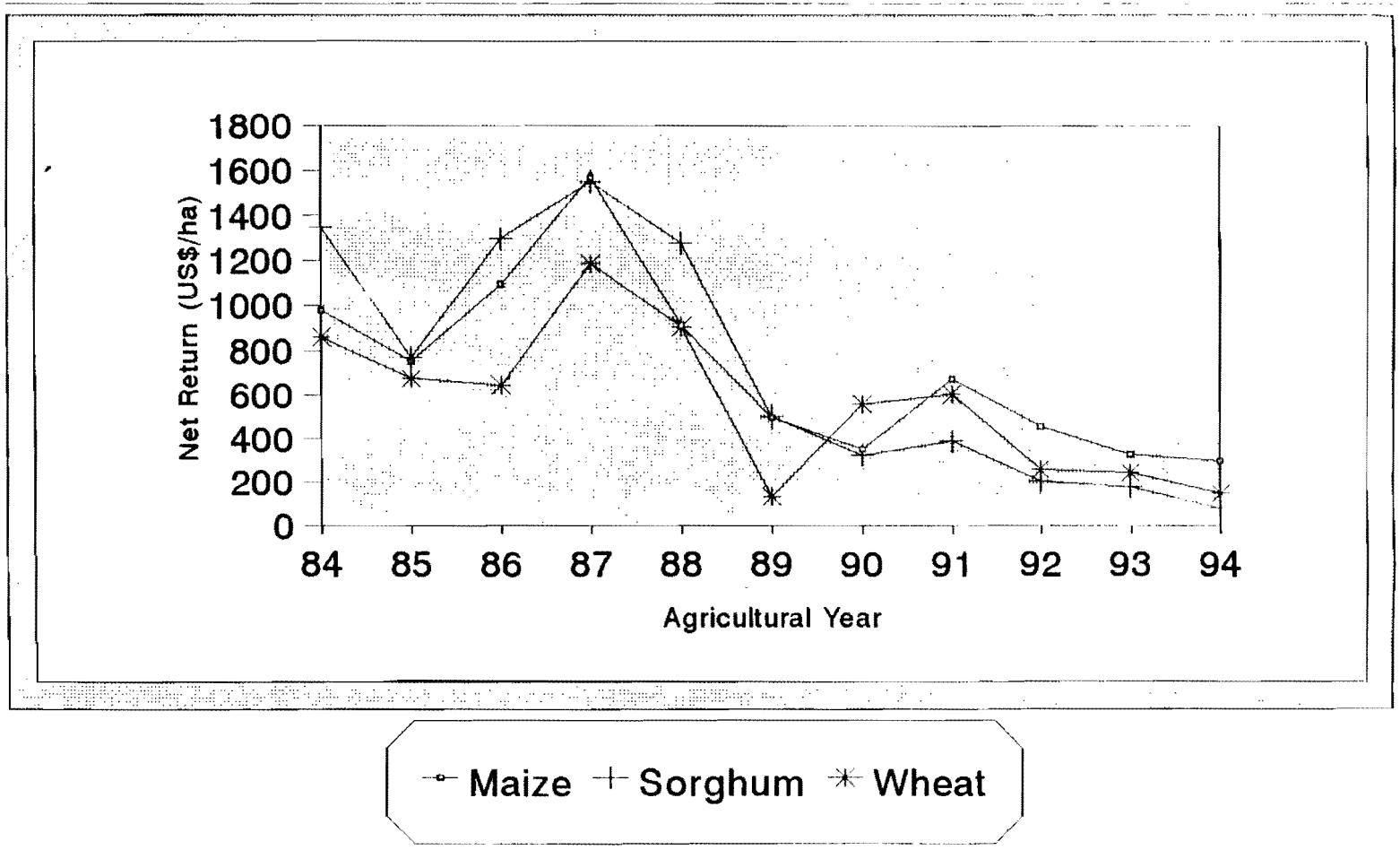
Table 8 Annual Volume of Water per Ha in Lagunera by *Unidades*

Post Transfer 1994		
Unidad	**Volume/ha (m3/ha)**	**Diff. from Average**
San Pedro	14,090	-0.26
Madero	17,180	2.83
Matamoros	16,490	2.14
Tlahualli	10,200	-4.15
Jerusalem	16,310	1.96
San Jacinto	11,830	-2.52
Average	14,350	
STD	2,580	
Pre Transfer 1987		
Unidad	**Volume/ha (m3/ha)**	**Diff. from Average**
San Pedro	16,330	2.05
Madero	17,570	3.28
Matamoros	15,680	1.39
Tlahualil	12,450	-1.83
Jerusalem	13,420	-0.87
San Jacinto	10,260	-4.02
Average	14,280	
STD	2,490	



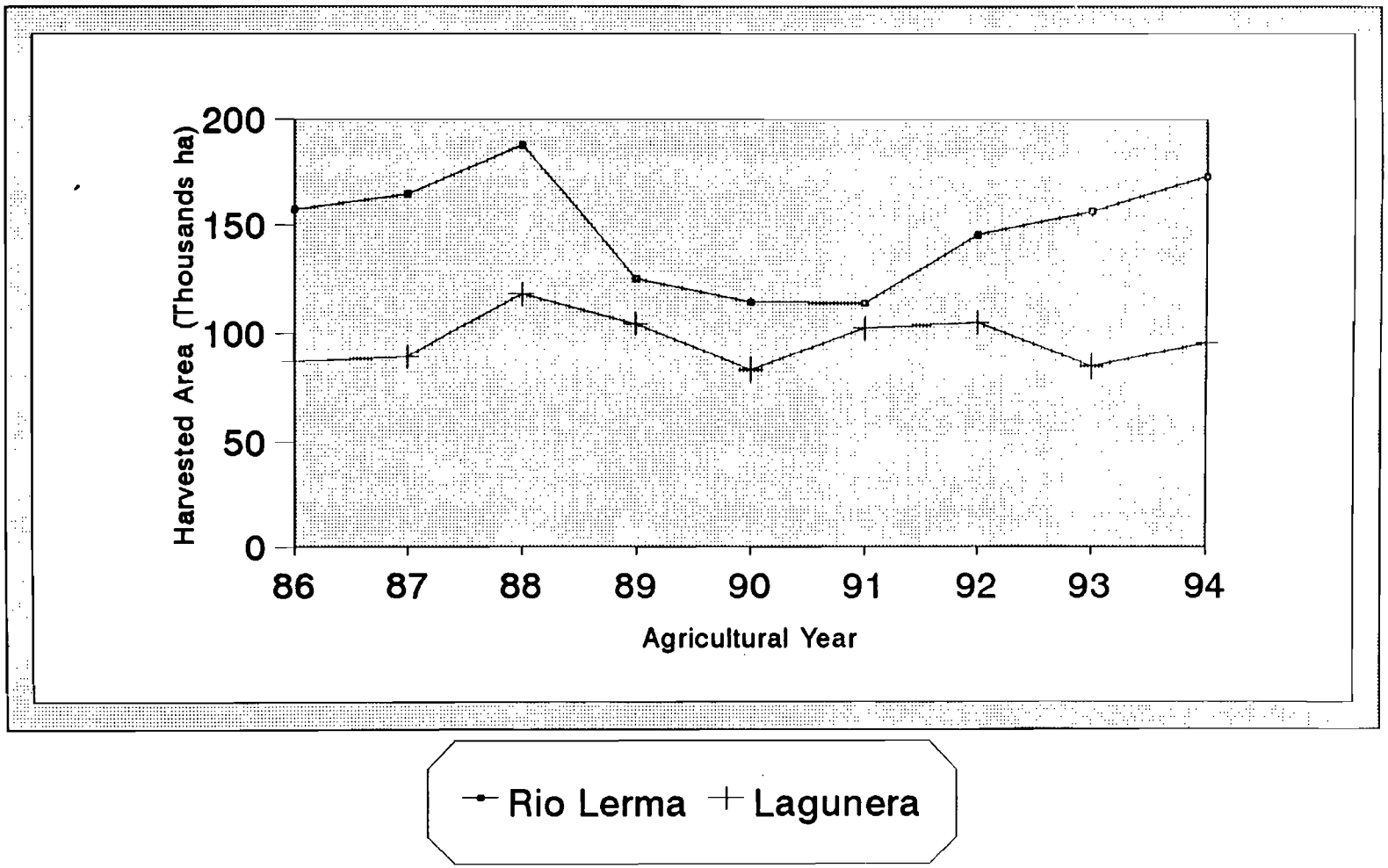
Map 1 Irrigated and Rainfed Areas in México

Figure 1 Changes in Profitability (1984-1994) Wheat, Maize and Sorghum in Alto Rio Lerma



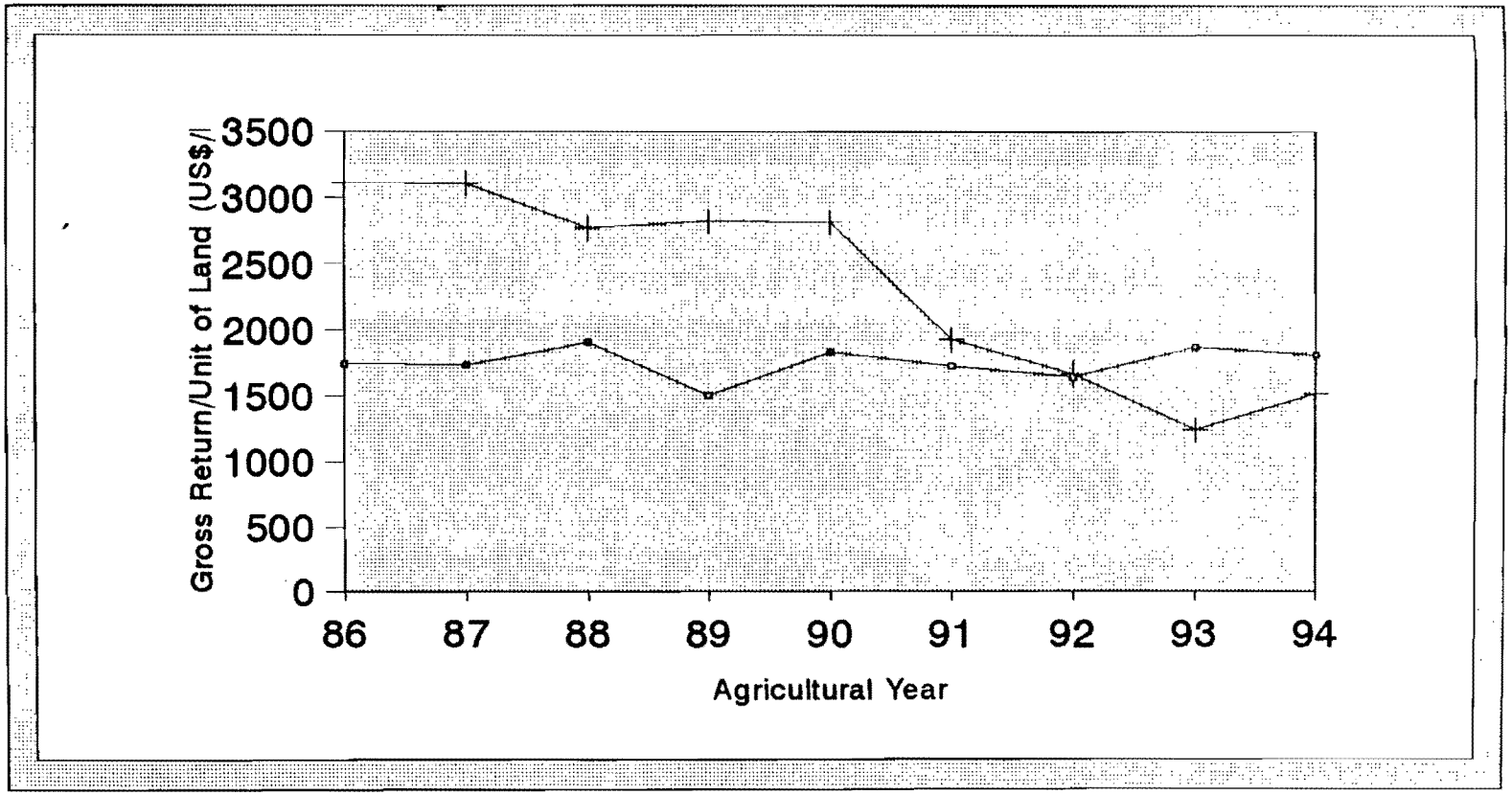
in constant 1982 US dollars
data provided by Dr. E. Palacios-Velez

Figure 2 Changes in Harvested Area (1986-1994) Alto Rio Lerma and Lagunera Districts



data from CNA

Figure 3 Gross Return per Unit of Land (US$/ha) Alto Rio Lerma and Lagunera Districts



Constant 1982 US dollars