4

Research Report

Results of Management Turnover in Two Irrigation Districts in Colombia

Douglas L. Vermillion
and
Carlos Garcés-Restrepo

International Irrigation Management Institute

Research Reports

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The authors wish to acknowledge, in memorium, the excellent work of Juan G. Fernandez, the principal field investigator, who died of cancer in 1995. They also thank David Seckler, Chris Perry, R. Sakthivadivel, Harald Fredericksen, and Gil Levine for their valuable comments on earlier drafts of this paper.

IIMI is grateful to the Colombian Institute for Land Development (INAT) for its support for this study. IIMI gratefully acknowledges the financial and technical support for this research from the Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ) and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) of Germany and the Ford Foundation.

Vermillion, D. L., and C. Garcés-Restrepo. 1996. *Results of management turnover in two irrigation districts in Colombia.* Research Report 4. Colombo, Sri Lanka: International Irrigation Management Institute (IIMI).

/ irrigation management / irrigated farming / privatization / farmer participation / farmers' associations / farmer-agency interactions / farmer-managed irrigation systems / social aspects / economic aspects / operation / maintenance / agricultural production / sustainability / water distribution / Colombia / Coello / Saldaña /

ISBN: 92-9090-329-5
ISSN: 1026-0862

Editor: Kingsley Kurukulasuriya; *Consultant Editor:* Steven Breth; *Artist:* D.C. Karunaratne; *Typesetter:* Kithsiri Jayakody; *Editorial/Production Manager:* Nimal A. Fernando.

Contents

Summary

In 1975, farmers in the Coello and Saldaña irrigation districts in the Tolima Valley, Colombia, petitioned the government for the right to take over management of the districts. They based their argument on the fact that, over the previous 20 years, they had already repaid their agreed 90 percent share of the cost of construction. They were also paying water fees to the government and were dissatisfied with the cost and quality of management that the government was providing. They argued that they could manage the systems more cost-effectively than the government. In 1976, the government agreed to the farmers' demands, expecting that turnover would save money for the government.

This paper assesses the extent to which turnover of irrigation management to farmers in the Coello and Saldaña irrigation districts in Colombia has had an impact on the cost of irrigation to farmers and the government, the sustainability of irrigation, and the quality of water distribution.

The sustainability of irrigation is assessed relative to both the financial viability of the districts and the physical condition of irrigation infrastructure 19 years after turnover. The quality of water distribution is assessed relative to efficiency and equity of distribution and to productivity of water.

The study found that turnover did achieve the government's main objective of discontinuing government financing for operations and maintenance. However, since the government retained partial control over the irrigation districts after turnover, staff levels declined slowly and the cost of irrigation to farmers changed little. A detailed inventory of irrigation infrastructure found that the vast majority of structures and canal lengths were in good functional condition.

The districts were able to continue to expand the irrigated area modestly and sustain high levels of production after turnover, partly due to a policy to limit rice production and deliver lower volumes of water per hectare. Perhaps the finding that would be of most concern to farmers was that while the cost of irrigation did not increase after turnover, the gross economic value of production per hectare and per unit of water grew dramatically. After turnover, irrigation constituted a relatively small and declining proportion of the total cost and value of agricultural production.

Results of Management Turnover in Two Irrigation Districts in Colombia

Douglas Vermillion and Carlos Garcés-Restrepo

Introduction

In 1975, farmers in two irrigation districts in the Tolima Valley, Colombia, petitioned the government for the right to take over management of the districts. They based their argument on the fact that, over the previous 20 years, they had already repaid their agreed 90 percent share of the cost of construction. In addition, they were dissatisfied with the cost and quality of irrigation management for which they paid water fees to the government. They claimed that they could manage the systems more cost-effectively. In 1976, the government agreed to the farmers' demands, expecting that turning over management of the irrigation districts would save it money.

This paper assesses the extent to which turnover of irrigation management to farmers in the Coello and Saldaña irrigation districts in Colombia has had an impact on:

- the cost of irrigation to farmers and the government
- the sustainability of irrigation
- the quality of water distribution

The sustainability of irrigation is assessed relative to both the financial viability of the districts and the physical condition of irrigation infrastructure 19 years after the turnover. The quality of water distribution is assessed relative to the efficiency and equity of distribution and to the productivity of water.

This study was conducted from 1993 to 1995. It involved analysis of data from the records of the two irrigation districts and from group and individual interviews with farmers, district management staff, board members, and agency staff. The study sampled 93 randomly selected farmers, 44 in Coello and 49 in Saldaña (Garces-Restrepo and Vermillion 1994).

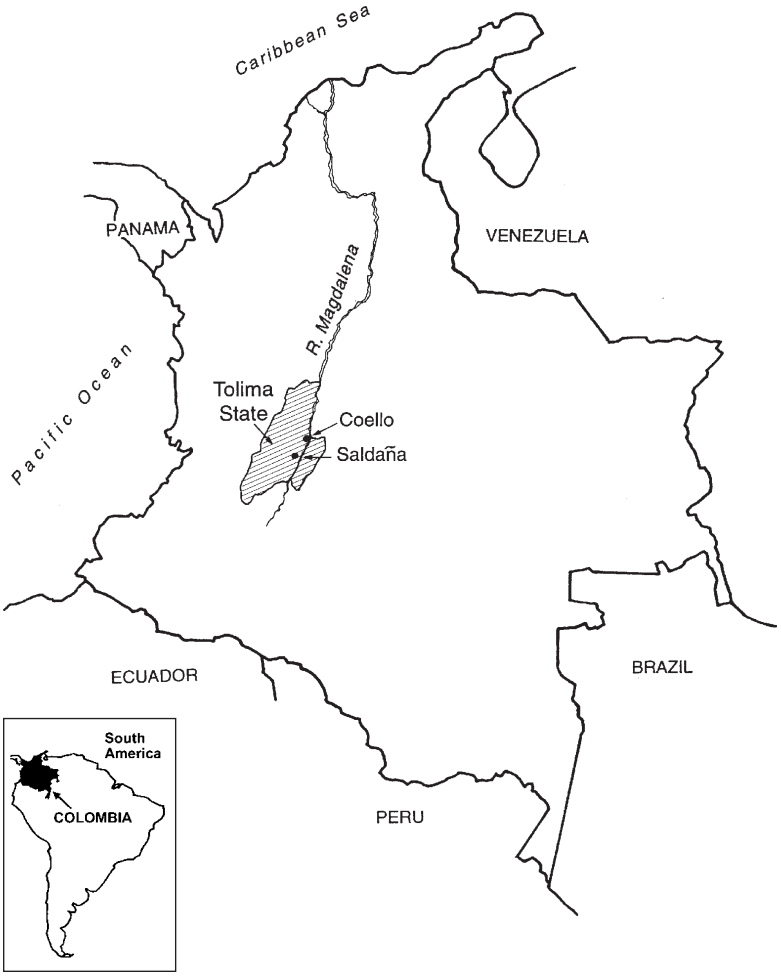
The central finding was that after turnover the gross value of output per hectare and per unit of water increased dramatically while the cost of irrigation to farmers held steady. New policies imposed by the water users' associations after turnover played a leading role in the improvements in economic performance. In particular, policies that restricted rice production in sandy areas and that reduced the average volume of water delivered per hectare supported crop diversification and raised the value of irrigated output. This study lends support to the hypothesis that management turnover programs worldwide will introduce incentives for improvement of management efficiency and productivity of irrigated agriculture (Vermillion 1992).

Irrigated Agriculture in the Tolima Valley

Colombia is a mountainous country (figure 1) with relatively abundant water resources, including more than 1,000 perennial rivers. It has both tropical and temperate climates and an average rainfall of 1,500 mm/year.

Coello and Saldaña irrigation districts are located in the Tolima Valley in central Colombia at an elevation of 380 meters. The valley sits between the central and west mountain ranges of the country, and the large Magdalena River runs through it. The valley has mostly a flat topography with undulating terrain toward both mountain ranges and has primarily alluvial soils, fans, terraces, and narrow valleys with minor rivers. The main soil characteristics are sandy and loam in Coello and clay and loam in Saldaña. Soil erosion is evident on the hillsides but is not yet a problem in the valley floor, except that it creates a high silt load in rivers and irrigation canals. Yearly precipitation in the valley is 1,000 to 1,500 millimeters. A marked bimodal distribution in April/May and October/November makes the need for irrigation primarily supplemental. The median temperature is 27.9°C. The average relative humidity is 74 percent, and the yearly average tank evaporation is 1,800 millimeters (figure 2).

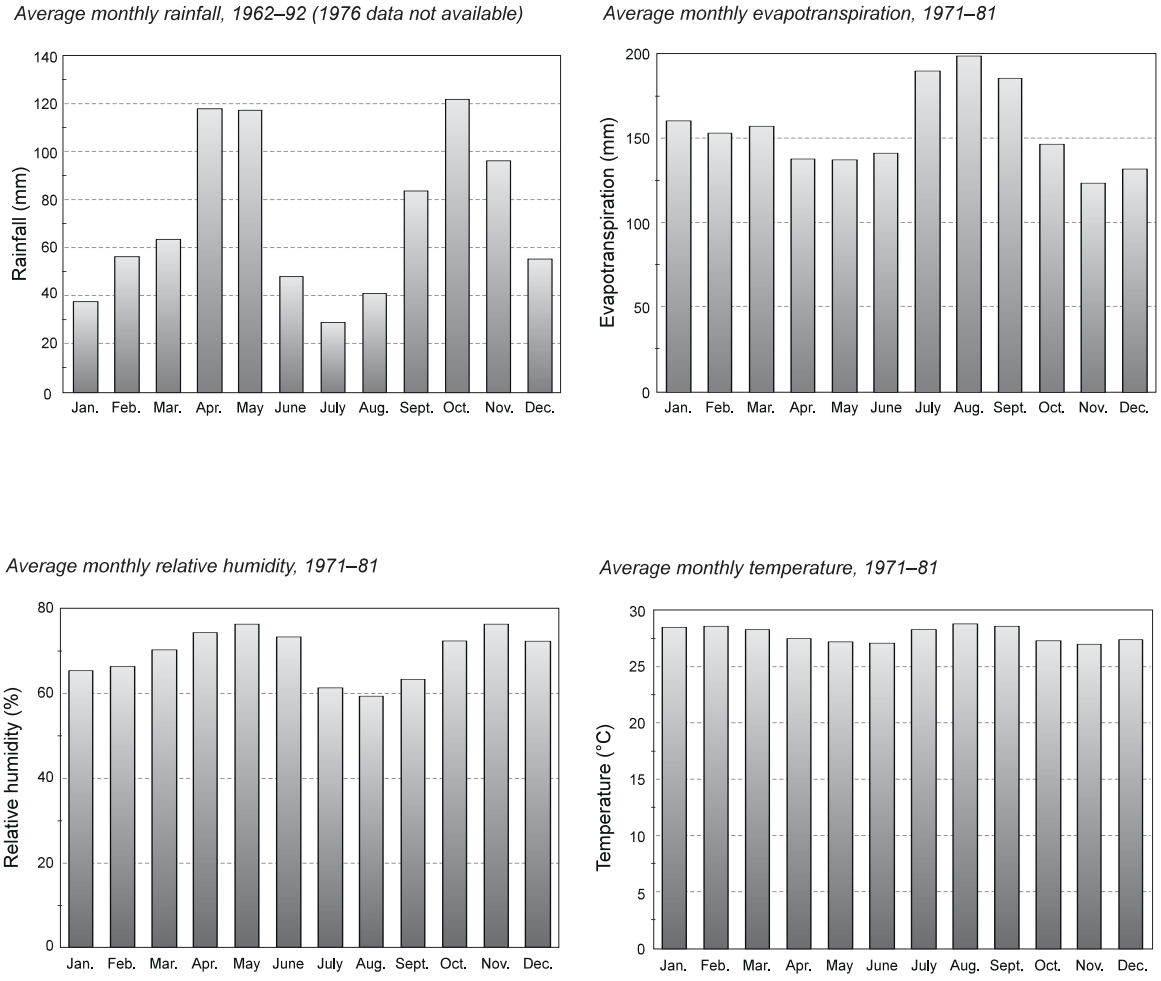
FIGURE 1.
Map of Colombia, with Coello and Saldaña irrigation districts.



In the 1930s, land reform in the Tolima Valley replaced the old hacienda system of peasant cultivation with landownership for farmers. Irrigation introduced in the 1950s transformed the valley's agriculture. Cotton became an important crop during the 1950s and 1960s. It was eventually replaced by rice, which has been the main irrigated crop since the 1970s. Maize, sorghum, fruit, and vegetables are also irrigated in the valley now.

Today, the Tolima Valley is a relatively prosperous farming area, located at a major transportation crossroads. It has numerous towns where agriculture and agro-business are the mainstream of the local economy. A large number of both public and private organizations that provide technical assistance and agricultural support services to farmer-managed irrigation systems are present in the area.

FIGURE 2.
Climatic data for Tolima Valley, Colombia.



Development of the Coello and Saldaña Districts

The Coello-Saldaña irrigation district became operational in 1953 when 8 years of construction were completed. The total capital cost for the district was US$5,500 per hectare (in 1993 dollars). Initially Coello and Saldaña were constructed and managed as a single district. They were separated in 1976 after management was turned over to the water users' associations.

Coello irrigation district is a river diversion system. It has a lateral intake with a design capacity of 28 m^3/s. The intake consists of an approach channel formed by an earthen levee, which facilitates flow intake during low river levels in the dry season. The intake has two radial gates with provision for controlling both sediment intake and water depth (HIMAT 1991a). The intake channel leads to the main conveyance canal (Gualanday), which has a capacity of 25 m^3/s and extends for 5.7 kilometers before reaching the command area. The

main canal divides into four branch canals, each of which leads to unlined secondary and tertiary canals. Field turnouts are sliding gates.

Coello district served an irrigated area of 25,600 hectares in 1993 (table 1), making it one of the largest schemes in the country. Because the district was not designed with a parallel drainage system, waterlogging and salinity are problems on as many as 7,000 hectares. In 1993, about 38 percent of the farms were 5 hectares or less in size and only 6.4 percent exceeded 50 hectares. Compared to 1968, we see a trend toward fragmentation of holdings and less inequity in farm size among farmers (table 2).

Saldaña district, located south of the Coello district, is also a river diversion scheme. It diverts water from the Saldaña River through a direct intake without an approach levee. The intake also has radial gates and water head controls. It has a design capacity of 30 m^3/s into the main conveyance canal. This canal conveys water to three partially lined branch canals. As in Coello, each branch canal leads to unlined secondary and tertiary canals. Field turnouts are sliding gates (HIMAT 1991b).

In 1993, Saldaña district irrigated 13,975 hectares (table 1). Because it lacks a complementary drainage system, waterlogging affects up to 1,600 hectares. Its 1,500 water users have 1,850 farmholdings. In 1993, 63.9 percent of the farms were 5 hectares or less in size and only 1.0 percent exceeded 50 hectares. As with Coello, the trend between 1968 and 1993 was toward fragmentation of holdings and less inequity in farm size among farmers (table 2).

Along the main canals, both schemes have composite underflow and overflow cross regulators, which consist of gates and side weirs. This design protects against overcropping and facilitates desilting. It also allows gate adjustments to be made at longer intervals than conventional designs do. Hence, the design facilitated turnover by simplifying O&M requirements.

TABLE 1.
Basic information, Coello and Saldaña districts.

Item	Coello	Saldaña
State	Tolima	Tolima
Period built	1949–53	1949–53
Transferred	Sept. 1976	Sept. 1976
Design area (ha)	44,100	16,428
Gross irrigated area, 1993 (ha)[a]	25,628	13,975
Net irrigated area[b] (000 ha)	15.3	12.5
Water users' association	Usocoello	Ususaldana
Main soil type	Sandy, loam	Clay, loam
Main crops	Rice, soybean, cotton	Rice
Water source	River Coello	River Saldaña
System type	Run-of-the river	Run-of-the river
Intake structure	Radial gates	Radial gates
Irrigation structures	1,666	756
Lowest water measurement point	Secondary canal	Secondary canal
Water delivery efficiency (%)	69	69
Length of main canal (km)	69	61
Length of canal network (km)	250	162
Area served per km canal (ha)	102	86
Turnout type	Sliding gates	Sliding gates

[a]Total of the areas irrigated for all crops grown in a year.
[b]Area irrigated for at least one crop a year.

TABLE 2
Number of farms by size, Coello and Saldaña districts, 1968 and 1993.

Farm size (ha)	1968				1993			
	Coello		Saldaña		Coello		Saldaña	
	no.	%	no.	%	no.	%	no.	%
0-5	264	26.6	589	56.4	703	38.5	1,255	63.9
5.1–10	200	20.1	146	14.0	386	21.1	279	14.2
10.1–20	207	20.8	141	13.5	300	16.4	231	11.7
20.1–50	180	18.1	115	11.0	322	17.6	181	9.2
> 50	143	14.4	54	5.1	115	6.4	19	1.0
Total	994	100	1,045	100	1,826	100	1,965	100

The rehabilitation of both irrigation canals and natural drains was done in Coello and Saldaña well before turnover. In Coello, US$8.69 million (in 1988 dollars) was spent on rehabilitation between 1968 and 1973. In Saldaña, US$2.28 million (in 1988 dollars) was spent on irrigation and drainage works between 1969 and 1972.[1] At the time of management turnover in 1976, the systems were in good physical condition, and rehabilitation was not an issue in negotiations between the government and the farmers. Rehabilitation was not done in connection with turnover.

However, the issue of who should be responsible for financing rehabilitation was always a matter of dispute. The users argued that because the government had not turned over ownership of the infrastructure, it belonged to the nation and was the government's responsibility to maintain. Despite pressure from the government, farmers have refused to repay the cost of rehabilitation in either system, except for an agreement with farmers in Coello to repay the cost of building a feeder canal to supplement their water supply (which is still under construction, today).

Turnover Process

In the early 1960s, the Government of Colombia entrusted the O&M of its irrigation districts to INCORA, the government land reform agency. The performance of the agency in irrigation management was not satisfactory. Water users of the Coello-Saldaña district were not only unhappy with the poor O&M service provided but were also concerned about the high management costs. In the early stages of development in the 1950s, more than 90 percent of the farmers paid the water fee, but the percentage of payers declined over time due to farmer dissatisfaction with the quality of system management. Declining fee collections further limited the ability of the government agency to provide an effective irrigation service. Inefficient system O&M further motivated farmers to seek to take over management of the district.

In 1975, the farmers, who had already formed associations, decided to formally request that the government transfer management responsibility for the system to the associations of water users. The associations argued that the scheme should legally become their property because farmers had already repaid the government their share of the costs of construction (Vermillion and Garces-Restrepo 1994).

[1]Drainage systems in both schemes are natural drains. No drainage system was ever constructed. The rehabilitation and maintenance of drains refer to the desiltation of small streams, the redirection of natural outlets, etc.

Negotiations for management transfer were completed within a year, between 1975 and 1976. The associations hired a lawyer to represent them in negotiating the terms of the transfer. Issues to be resolved included the disposition of district staff, ownership status of scheme assets, and the future degree of involvement of HIMAT[2] in the districts. It was finally agreed that most of the existing staff would be retained by the districts and others would be transferred out. The ownership of irrigation structures would remain with the government, although some equipment and facilities were transferred to the farmers' associations. The government concluded that under existing laws it could not relinquish the ownership of scheme assets. HIMAT would retain a role of oversight for district management to ensure that the systems were properly maintained. In practice, this meant that HIMAT continued to give its advice and consent for annual budgets, O&M work plans, setting water fee levels, and personnel changes. The farmers' associations obtained direct control over the O&M of the entire system, including the intakes.

As part of a policy to improve the performance of irrigation districts, the government created HIMAT in 1976. Its initial task was to turn over management of the Coello-Saldaña district to the two farmers' associations. The district was divided into two separate districts, Coello and Saldaña. This was the first irrigation management turnover in Colombia (Plusquellec 1989). It set a precedent for later transfers.

The transfer process employed a legal rule in the country's constitution referred to as the "delegation of administration" (Delegación de Adminis-tración), by which a public good (in this case, an irrigation district) could be turned over to a private corporate entity (a water users' association) for administration on behalf of the state. The users were then empowered to recruit staff and organize and take charge of O&M for the two systems with the proviso that it would be financially self-reliant and government subsidies for O&M would be discontinued. The delegation of administration created a continuing labor relations conflict between the districts and the government, which resulted in numerous legal debates and proceedings until the 1990s. Labor laws prohibited the firing of existing staff hired previously by the government. In 1993, Colombia enacted a new land development law, which was intended to grant full control over irrigation district management to farmers' associations (Ministerio de Agricultura 1993).[3]

[2]HIMAT, or the Institute for Hydrology, Meteorology and Land Development, was created in order to implement the turnover program and provide government oversight and support to irrigation districts afterwards. Negotiations about turnover included the issue of HIMAT's mandate after turnover. In 1994, this acronym was changed to INAT, when meteorology was removed from the institute's mandate.

[3]However, this law is currently being challenged in the courts regarding the issue of releasing staff who were originally hired by the government.

Changes in Management

Financial management

Farmers expected that through turnover they would not only improve management but would also contain or reduce the cost of irrigation. However, it soon became apparent that the delegation of administration would not give farmers' associations complete control over their budgets and O&M plans. Although the farmers had wanted HIMAT to play an advisory role, the government continued to influence budgeting and staff decisions. After turnover, the districts were unable to reduce staff and costs as much as they wanted, due to resistance from HIMAT.

Two kinds of water charges are assessed: a flat area charge (based on farm area irrigated) and a volumetric charge (based on basic water requirements by crop type). The revenues from the area charge are used to guarantee the coverage of fixed costs such as personnel. The volumetric fees are used more for variable costs such as operations.

Before and after turnover, farmers paid the area-based water fee prior to the season for which water was ordered. The volumetric fee was paid after the season and had to be paid entirely before any irrigation orders could be approved for the next cropping period. Farmers are charged volumetric fees according to the type of crop planted and its respective "base" or target allocation. Because water is only measured routinely down to the heads of secondary canals, volumetric charging is based on theoretical, as opposed to measured, water deliveries. Farmers may complain if they believe that their actual deliveries are less than adequate or less than the assessed amount, in which case district staff may make special measurements at tertiary offtakes with small flumes. This can result in either an adjustment in the volume delivered or in the fee assessment. This system did not change with turnover.

Because the associations did not receive ownership of system assets and because they had not paid for previous rehabilitation costs, the farmers expected the government to pay for any future rehabilitation or structural replacement. Hence, after turnover, farmers did not raise a capital-replacement fund (although they did raise an equipment-replacement fund).

Personnel

One of the more noticeable outcomes of turnover was the significant reduction of personnel. Before transfer, in 1975, the two districts combined had 300 employees. By 1993, the total staff for both districts was 189, a 37 percent reduction since transfer (table 3). Accounting for changes in area irrigated, in 1975 there were 62 hectares of service area per district staff member. By 1993 the ratio had risen to 147 hectares per staff member (table 3). Most reductions were made in maintenance and technical support staff and occurred gradually, mostly through attrition and nonreplacement. Labor laws made it difficult for district managers to release dispensable government employees. Nevertheless, district board members and agency officials reported that paperwork was diminished and administration became more efficient after transfer, especially in irrigation scheduling, fee processing, and communications between users and district management.

Operation and maintenance

In the Coello and Saldaña districts, water is allocated to farmers on the basis of area and crop type. In theory, all users who plant the

TABLE 3.
Staff levels before transfer (1975) and after transfer (1993), Coello and Saldaña districts.

	1975	1993		
Program	Both districts	Coello	Saldaña	Both
Administration	36	18	18	36
Maintenance	161	60	50	110
Operation	51	19	24	43
Technical[a]	52	0	0	0
Total	300	97	92	189
Net irrigated area[b] (000 ha)	18.7	15.3	12.5	27.8
Area/staff member (ha)	62	158	136	147

[a]Several "technical staff" members were retained after turnover but were shifted to other programs, including staff for hydrologic measurement, design, and accounting.

[b]Area irrigated for at least one crop a year.

same crop type receive a basic allotment, and they pay area and volumetric charges based on assumed deliveries relative to per-hectare targets by crop type. Before turnover, irrigation was scheduled on the basis of preseason crop plans, modified during the season through water requests submitted by registered farmers. The district management prepared irrigation schedules based on orders received from farmers. Irrigation requests were approved to the extent that predicted water availability met the aggregate demand. The user was responsible for going to the district office before the season to sign an agreement with the seasonal irrigation plan. The user was informed of the day and time of his or her irrigations, and the ditch tender made an inspection of the farm to be sure that the canals, turnout, and measuring devices (if any) were in working condition. The ditch tender was responsible for delivering water to farm turnouts according to the agreed schedule and recording the total water delivered for the season. This system continued after turnover and was implemented mainly by the same staff as before, but they were employees of the farmers' associations.

The districts estimate water requirements for each crop type, and these estimates become the base allocation. The districts measure discharge at the intake and along the main canal at offtakes into secondary canals. Water is distributed according to the base allocation, but sometimes is reduced when water is scarce.

Prior to turnover, the government agency compiled annual plans for maintenance and repairs. Such plans were prepared by the head of the maintenance unit, based on field inspections and sometimes on complaints from farmers. The most common maintenance works were desilting and cleaning of canals, road maintenance, and structural repairs. Targets were established in advance, but deviations were common due to funding constraints for repair or operation of heavy equipment.

The district management has administrative and operational manuals detailing roles and responsibilities of staff and users. The districts have maintained data on daily rainfall, temperature, and relative humidity since the inception of the project. Data on river flows and main and branch canal discharges are also recorded daily. Records of seasonal crop and irrigation plans, fee collection levels, registration of farmers, inventory of equipment and supplies, accounting, and yearly budgets have been kept regularly, before and after turnover.

After turnover, the new district administrations introduced practices to improve irrigation efficiency and allow continued expansion of irrigated area. Attention was paid to reducing staff where possible and revising cropping patterns to be consistent with the relative scarcity of water in the two systems. Water is more scarce in Coello. In 1993, the average target discharge or duty in Coello was 8.6 mm per day versus 15.5 mm per day in Saldaña. In Coello, the annual water demand was 1,097 millimeters, 948 millimeters of which was supplied by irrigation (table 4). In Saldaña, the annual water demand was 1,318 millimeters, which was exceeded by an annual irrigation water supply of 1,517 millimeters. During the same year, the relative water supply (i.e., ratio of total supply, including effective rainfall, to demand, calculated at the secondary-canal level) was 1.4 in Coello and 1.8 in Saldaña (table 5). Water is relatively more scarce in Coello during other years as well.

In Coello, where water supplies were insufficient for planting rice over the entire system, the association introduced a rice rotation and zoning plan to enable all farmers to plant rice at least once per year. In Saldaña, where water was more abundant, the association introduced a continuous, staggered planting arrangement for rice, which allowed 2,000 hectares of rice to be planted every month, year-round. This improved water distribution and, according

TABLE 4.
Basic system parameters, Coello and Saldaña districts, 1993.

Data set		Coello	Saldaña
A.	Irrigation water supply (mm)	948	1,517
B.	Effective rainfall (mm)	554	793
C.	Pumped water supply	0	0
D.	Irrigation duty (mm/day)	8.6	15.5
E.	Maximum irrigation demand (mm/day)	9	8.5
F.	Annual demand (mm)	1,097	1,318
G.	Seasonal maximum irrigation intensity (%)	54.4	93.7
H.	Annual irrigation intensity (%)	101	161
I.	Production (rice) (t/ha)	7	7
J.	Gross margin per year ($/ha)	1,146	1,593
K.	Gross irrigated area (ha)	25,628	13,975
L.	Regulation area (ha)	10	10
M.	Farmer management area (ha)	50	50
N.	Farm size (ha)	14	7.5
O.	Capital cost ($/ha)	5,500	5,500

TABLE 5.
Basic performance indicators, Coello and Saldaña districts, 1993.

Indicator	Formula[a]	Coello	Saldaña
Return to land ($/ha)	J	1,146	1,593
Return to irrigation ($/100 m^3)	J/(A+C)/10	12.00	10.50
Return to water ($/100 m^3)	J/(A+B+C)/10	7.60	6.90
Return to economy (%)	J/O	21	29
Fee/cost ratio (%)	P/Q	102	109
Water use efficiency (WUE) (%)	F/(A+B+C)	73	57
Relative water supply (ratio)	1/WUE	1.4	1.8
Delivery efficiency (%)	F/(D+D_1)	104	55
O&M area per staff member (ha/person)		324	189

[a]P = irrigation fee, Q = cost of irrigation, D_1 = duty for wells. See table 4 for other definitions.

to farmers, it also improved profit margins somewhat by spreading rice marketing throughout the year.

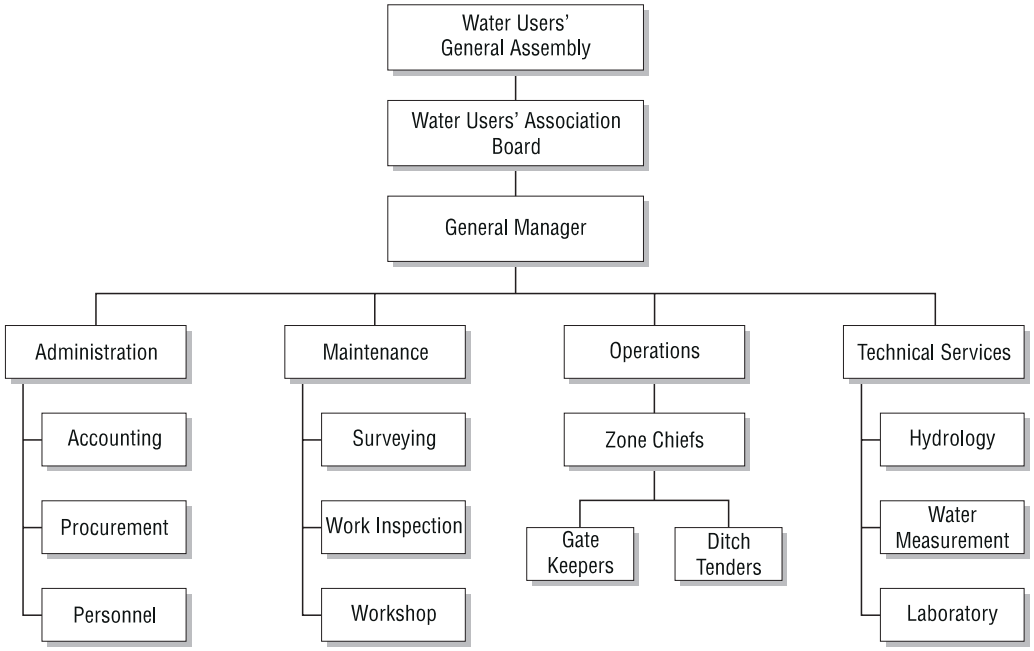
Organization

After turnover, the general assemblies of the farmers' associations for Coello and Saldaña districts elected boards of directors to supervise their districts. It was a requirement that each board had seven members with fixed quotas for two categories of farmers—four members with small farms the total area of which is less than 20 hectares[4] and three members with large farms, each with an area of more than 20 hectares. Directors were elected in a general assembly every 2 years. The board recruits and selects the general manager and participates with the general manager in the selection or release of other district staff.

After transfer, each board recruited a general manager who was an engineer. The districts then became responsible for day-to-day O&M of the systems. The reduction in personnel allowed the management to streamline the organizational structure by combining sections and integrating functions. In both districts, the general manager supervises an administrative unit and three technical units—operations, maintenance, and technical services (see figure 3).

[4]The required quotas for representation of large and small farm owners was officially dropped in 1994 but the same proportional constitution of board members continued up to the writing of this report, in 1996.

FIGURE 3.
Organizational structure, Coello district.



Management Performance after Turnover

In taking over management of the irrigation districts, farmers hoped to enhance the cost efficiency and quality of O&M, without sacrificing the agricultural productivity and financial and physical sustainability of the districts. The performance of the districts is assessed according to these criteria. The government's main interest was to reduce its own recurrent costs of irrigation without sacrificing the productivity of irrigated agriculture.

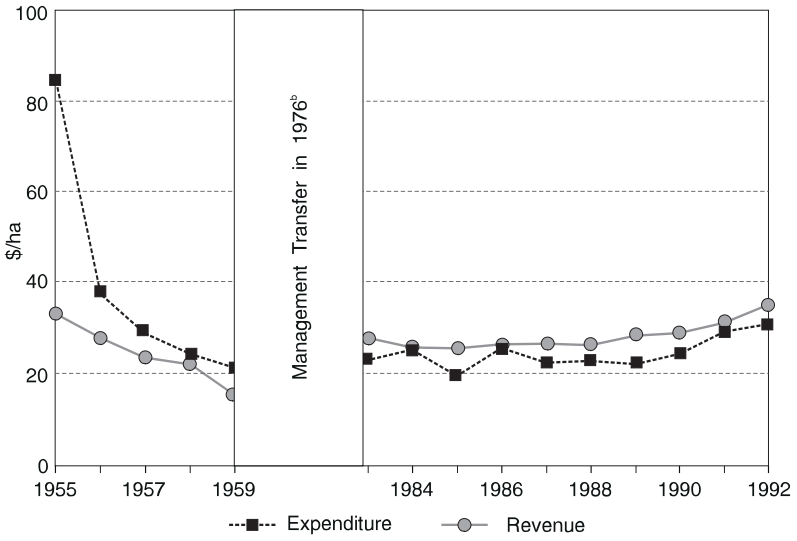
Impacts on government

The government's interest in the transfer was initially to accede to political pressures and later to reduce government subsidies to the irrigation sector through a national policy of management transfer. In Coello and Saldaña, the government was successful in discontinuing its subsidies for O&M, which were costing it about US$9/ha at the time of turnover. However, it continues to fully finance rehabilitation. If farmers defer maintenance, expecting that the government will finance future rehabilitations, the government may not conserve as much money in the irrigation sector as it would like.

Financial viability

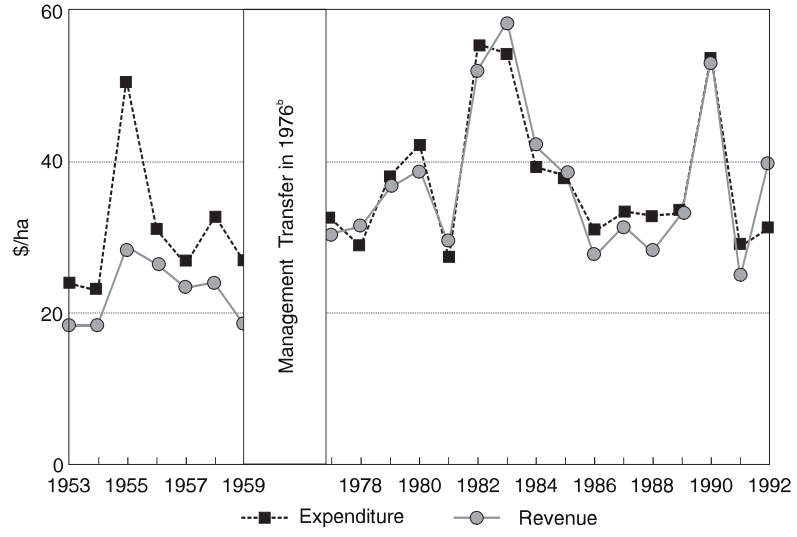
After transfer, the farmers' irrigation policy was essentially to balance the budget, contain the cost of management, and achieve a more responsive irrigation service. This was only partially successful. Figures 4 and 5 show the changing patterns of revenue and expenditure in Coello and Saldaña before and after turnover. In Coello, during the initial stages of scheme development, expenditures exceeded revenues, partially be-

FIGURE 4.
Revenue and expenditure per hectare, Coello district, 1955–92.[a]



[a]In constant 1988 U.S. dollars (US$1 = Col$333).
[b]Data for years 1960 to 1982 are not available.

FIGURE 5.
Revenue and expenditure per hectare, Saldaña district, 1953-92.[a]

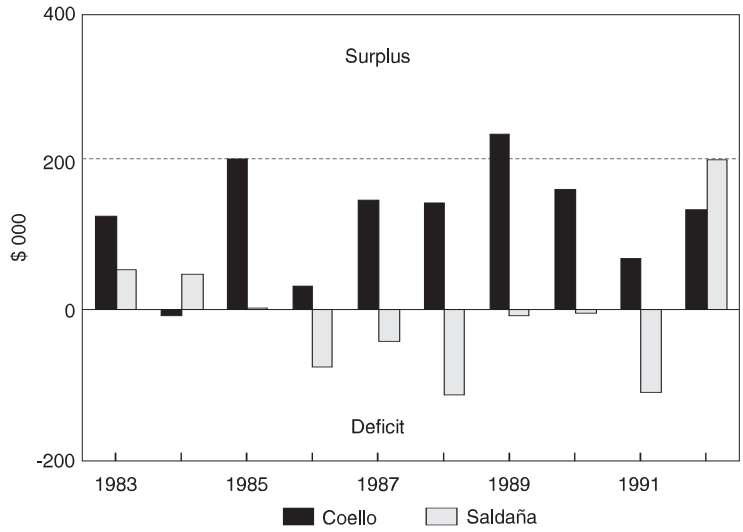


[a]In constant 1988 U.S. dollars (US$1 = Col$333).
[b]Data for years 1960 to 1976 are not available.

cause of external subsidies and development assistance. The early drop in revenue and expenditure was due to the transition from scheme development to scheme management.

Between 1983 and 1992 in Coello, revenues always exceeded expenditures, except for 1984 (figures 4 and 6). Expenditures rose in real terms by 51 percent, while revenues grew by only 44 percent during the

FIGURE 6.
Budget balances in Coello and Saldaña districts, 1983–92.[a]



[a]In constant 1988 U.S. dollars (US$1 = Col$333).

period (table 6). Sideline revenue sources—such as rental of farm equipment and district property, technical services, fines against members, sale of materials, and charges for transporting equipment and materials—expanded from about 10 percent of revenues to 20 percent between 1983 and 1992 (figure 7). Before turnover, revenue was taken to at least regional levels of the government. Part of the reason farmers wanted to take over management was their perception that they were financing overhead costs of the government outside the system. After turnover, revenues that are in excess of annual budget costs go into an equipment-replacement fund, are allocated to the next year's budget (to help limit the rise of fees), and are used by the water users' association for events and assemblies connected to public relations. Sideline revenues also help limit the level of water fees.

Maintenance costs (including relevant staff costs) accounted for 55 to 60 percent of total expenditures in the Coello district. This was followed by costs of administration and operation. The proportion of each to total costs has remained roughly the same since the early 1980s (figure 8).

Saldaña district was in a weaker financial position than Coello after turnover, with expenditures exceeding revenues for 6 of the 10 years between 1983 and 1992 (figures 5 and 6). However, the district gradually strengthened its position. The level of revenue per hectare in Saldaña fluctuated widely, but between 1983 and 1992 real growth in revenues was 29 percent, compared with the 20 percent growth in expenditures (table 6).

Both districts improved their financial positions after turnover, although from opposite directions. Coello reduced its surplus and enhanced efficiency; Saldaña diminished its pattern of deficits.

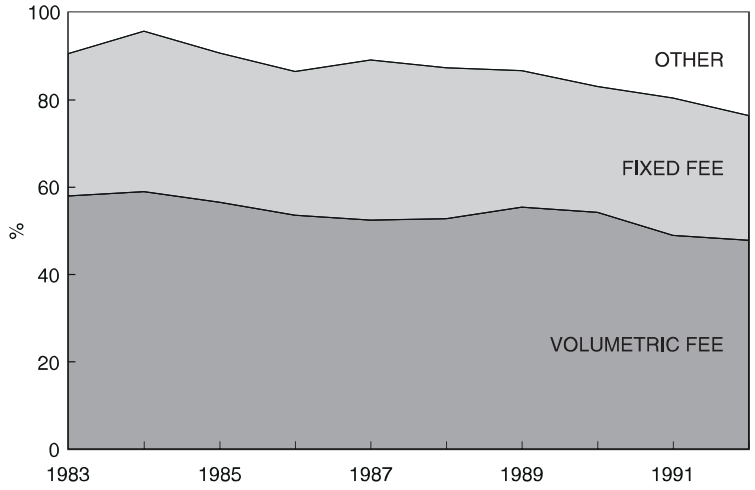
Coello and Saldaña both have a fixed area-based water fee and a volumetric water fee. These fees vary slightly, depending on type of crop and whether the farmer is a smallholder or a large operator (i.e., > 20 ha). The emphasis of the farmers on containing the cost of management resulted in a decline in the area fee after turnover. How-

TABLE 6.
Total revenue and expenditure, Coello and Saldaña districts, 1983-92 (In 1988 U.S. dollars).[a]

	Coello		Saldaña	
Year	Revenue	Expenditure	Revenue	Expenditure
1983	756,760	633,930	715,920	664,560
1984	705,710	711,410	700,900	655,560
1985	860,060	660,660	842,940	842,940
1986	855,260	825,530	578,380	652,550
1987	936,640	791,890	657,360	695,800
1988	936,040	795,200	647,150	757,360
1989	1,054,650	822,220	733,930	737,540
1990	1,063,060	904,200	711,410	713,210
1991	1,014,950	948,050	624,320	730,930
1992	1,086,790	955,260	923,420	725,230
Change 1983–92 (%)	+44	+51	+29	+20

[a]US$1 = Col$333. Only post-turnover data, which were available for both systems, are included, to indicate financial viability after removal of subsidies.

FIGURE 7.
Revenue sources, Coello district, 1983–92.



ever, the volumetric water fee rose after transfer in real terms. In Coello, the area fee for rice (in 1988 US dollars) dropped from about US$9/ha in 1976 (at transfer) to US$5.55/ha in 1993 (see figure 9), while the volumetric fee for rice rose from about US$0.13/100 m^3 (Col$42) in 1976 to US$0.16/100 m^3 in 1992 (see figure 10).[5]

In Saldaña both area and volumetric fees for rice are higher than in Coello. In Saldaña the area-based fee dropped only slightly after transfer, from US$9/ha to US$7.96/ha in 1993 (figure 9). In 1993, the volumetric fee rose from US$0.13/100 m^3 at transfer to US$0.19/100 m^3 (figure 10). The difference in the cost of water between the two districts may be due to the fact that Saldaña has a serious problem of siltation in the intake canal and employs boats equipped with costly floating draglines to desilt the canal year-round. The most significant finding from figures 9 and 10 is that

[5]These fee levels are for rice for smallholder farmers.

FIGURE 8.
Types of expenditure, and proportion (%) of each to total cost, Coello district, 1983–92.

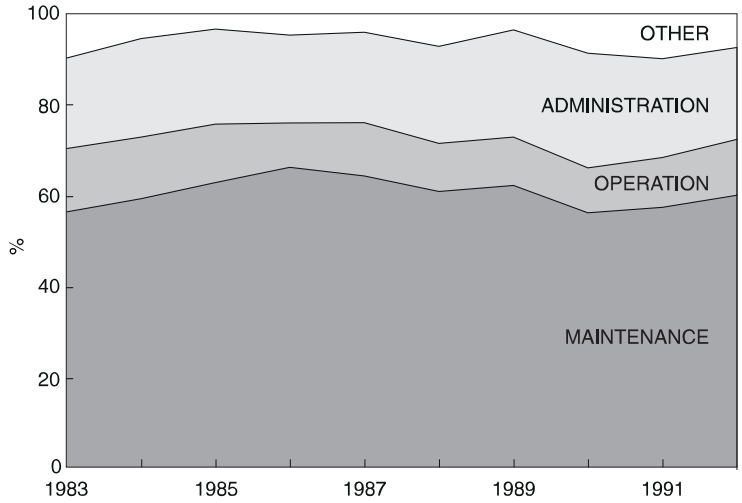
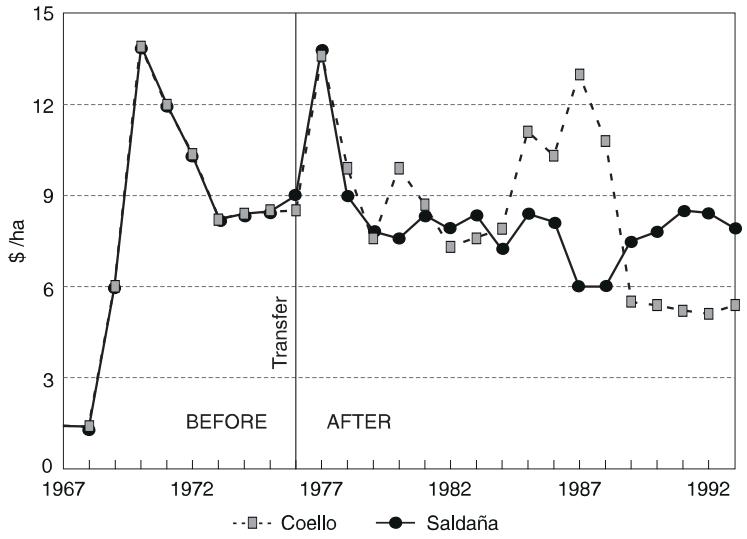


FIGURE 9.
Area water fee for rice, Coello and Saldaña districts, 1967–93.[a]



[a]In constant 1988 U.S. dollars (US$1 = Col$333).

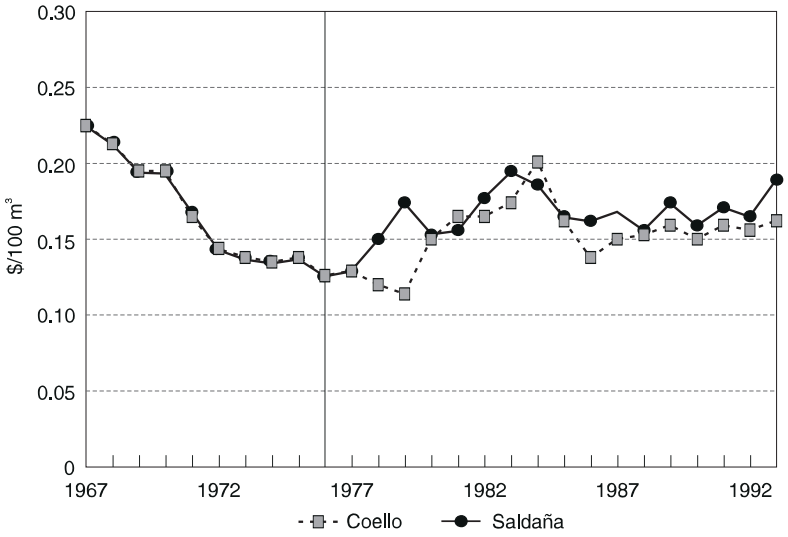
trends in both fees reversed directions at the time of transfer. Volumetric fees rose for two reasons: (1) the need for revenue to be linked to rising operating costs and (2) board policies of discouraging rice production and encouraging crop diversification, reducing allocation of water per hectare, and encouraging expansion of irrigated area.[6]

The rising area-based fee reversed a long-term decline, while the volumetric fee reversed from a decline to a long-term rise after transfer. Farmer boards in both districts preferred to charge farmers more in relation to volume of water used than to the area planted.

The area and volumetric fees collected in the Coello district (for all crops) totaled

[6]It should be noted that fee structure differs by crop and by whether farmers are classified as "small" (< 20 ha) or "large." The rate is higher for larger farms. The fee for rice for small farmers is used herein as this has been an important crop in both systems. In 1993, 76 percent of all farmers were "smallholders" in Coello and 90 percent were "smallholders" in Saldaña.

FIGURE 10.
Volumetric water fee for rice, Coello and Saldaña districts, 1967–93.[a]



[a]In constant 1988 U.S. dollars (US$1 = Col$333).

TABLE 7.
Annual cost of irrigation to farmers, Coello district, 1983–92.[a]

Year	Charges paid ($)			Net irrigated area (ha)	Cost to farmers ($/ha)
	Fixed	Volumetric	Total		
1983	246,246	439,039	685,285	13,550	50.57
1984	259,459	414,830	675,375	13,890	48.62
1985	292,793	486,786	779,579	16,925	46.06
1986	281,081	458,258	739,339	16,070	46.01
1987	342,643	491,591	834,234	17,565	47.49
1988	342,642	494,294	817,417	17,900	45.67
1989	330,330	584,384	914,714	18,550	49.31
1990	306,306	577,177	883,483	18,410	47.99
1991	319,219	496,996	816,216	16,120	50.63
1992	309,909	520,120	830,030	15,410	53.86

[a]In 1988 U.S. dollars (US$1 = Col$333).

US$75,990 in 1983 and US$92,041 in 1992 (in 1988 dollars). Taking into account changes in annual net area irrigated, this means the actual cost of irrigation to farmers rose slightly from US$50.57/ha in 1983 to US$53.86/ha in 1992 (table 7).

Physical sustainability

In both districts, 55 to 60 percent of total district income goes toward maintenance of the irrigation network. This percentage did not change significantly after turnover,

TABLE 8.
Results of canal maintenance survey, Coello and Saldaña districts, 1994.

Condition[a]	Main canal		Secondaries		Tertiaries		Total network	
	km	%	km	%	km	%	km	%
				Coello				
Functional	46.8	68	54.6	76	68.5	63	169.9	68
Partially functional	22.3	32	17.3	24	35.7	33	75.3	30
Dysfunctional	0	0	0	0	5.0	4	5.0	2
Total	69.1	100	71.9	100	109.2	100	250.2	100
				Saldaña				
Functional	47.8	79	14.6	33	15.2	28	77.6	48
Partially functional	13.0	21	27.6	62	30.8	53	71.4	44
Dysfunctional	0	0	2.4	5	10.6	19	13.0	8
Total	60.8	100	44.6	100	56.6	100	162.0	100

[a] *Fully functional:* Original hydraulic design conditions are intact, including canal capacity, bed slope, slide slopes, and freeboard. Any canal erosion, breaches, cave-ins, siltation, or weeds are not significant enough to noticeably interfere with operational objectives. *Partially functional:* Original design conditions are compromised by some deterioration in bed slopes, side slopes, freeboard, etc., although operational capacity is still at least 70% of original design. *Dysfunctional:* Operational capacity is below 70% of design capacity, and major rehabilitation is needed.

because O&M budgets continued to be based on the previous year's budget and continued to be reviewed and approved by the government. However, district managers in HIMAT expressed concern that the farmers' strong emphasis on cost reduction was compromising the physical sustainability of the systems.

To address this issue, a comprehensive inventory and examination of all structures and canal lengths in both systems were conducted in 1994. The survey classified canal sections as fully functional, partially functional, or dysfunctional. The criteria were primarily the extent to which original hydraulic design conditions were supported. Canal sections that were less than fully functional but that still operate at 70 percent of design capacity or higher were classified as partially functional; sections that operate at less than 70 percent of design capacity were classified as dysfunctional.

The Coello survey shows that 68 percent of the total canal length was fully functional (table 8). This constituted 250 kilometers of main, secondary, and tertiary canals. Partially functional canal sections were distributed relatively evenly between main, secondary, and tertiary canals. Dysfunctional canal lengths were only found at the tertiary level, and at this level only 4 percent of the sample lengths were found to be dysfunctional. Of the 1,666 total structures examined in Coello, 71 percent were considered fully functional; 15 percent were dysfunctional (table 9). Of the dysfunctional structures, two-thirds were small flumes used for measuring water at field turnouts (figure 11). These were installed in the rehabilitation period during the late 1970s and early 1980s. They had not been requested by the farmers' association and are rarely used by the new management. Fifteen percent of dysfunctional structures were culverts.

In Saldaña, 48 percent of the total network was fully functional (table 8). Seventy-nine percent of the main canal was fully functional, whereas only 33 percent of secondaries and 28 percent of tertiaries were judged fully functional. Forty-four percent of the total canal length was partially functional, mainly in secondaries and tertiaries. Dysfunctional sections were located only in tertiary and secondary canals with 19 percent of observed tertiary lengths and 5 percent of secondary lengths being found dys-

TABLE 9.
Results of structure maintenance survey,[a] Coello and Saldaña districts, 1994.

Structure	Coello (no.)				Saldaña (no.)			
	Functional	Partially functional	Dysfunctional	Total	Functional	Partially functional	Dysfunctional	Total
Headgates[b]	30	16	4	50	0	0	0	0
Control-drops[c]	40	7	18	65	0	0	0	0
Control	53	24	2	79	100	17	10	127
Drops	121	14	0	135	0	0	0	0
Distribution box	15	1	1	17	0	0	0	0
Culverts	102	20	38	160	16	3	2	21
Siphon	25	6	0	31	40	5	0	45
Aqueducts	10	0	0	10	0	0	0	0
Radial gates	0	0	0	0	36	3	2	41
Box culverts	0	0	0	0	0	0	2	2
Flumes	0	0	0	0	0	0	9	9
Gates	496	32	9	537	0	0	0	0
Bridges	91	11	0	102	120	20	7	147
Regulation dam[d]	7	0	0	7	0	0	0	0
Canaletas[e]	186	88	166	440	210	98	56	364
Measuring	2	17	14	33	0	0	0	0
Total	1,178	236	252	1,666	522	146	88	756
Proportion (%)	71	14	15	100	69	19	12	100

[a]*Fully functional:* Keeps design conditions; no elements missing; no modifications apparent or needed. *Partially functional:* Some deterioration is evident; minor components missing; requires minor maintenance (painting, grease); still functions with 15% of design requirement. *Dysfunctional:* Heavy deterioration; broken, damaged, or missing components; is not functional at all.

[b]Include radial gate structures; all others are sliding gates.

[c]Include four types: vortex (14), box (23), vertical (23), and chute (5) .

[d]Small dams that capture drainage, which is reutilized in the system.

[e]Flume-type measuring structure.

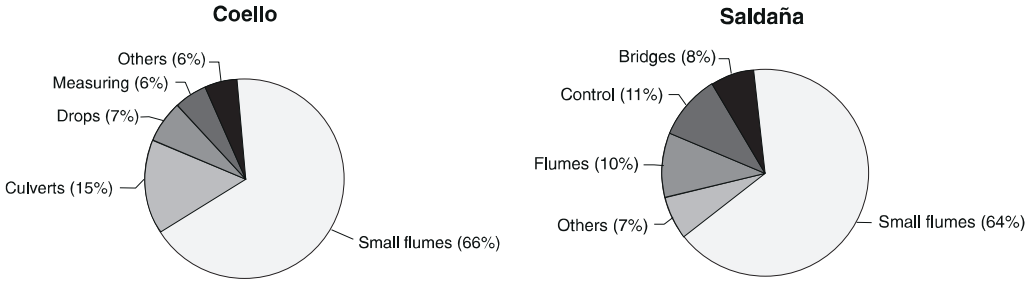
functional. Nineteen percent of the total tertiary length was judged dysfunctional. In Saldaña, 69 percent of the 756 structures observed were judged to be fully functional; 12 percent were dysfunctional (table 9). Of the dysfunctional structures, 64 percent were small measurement flumes at turnouts, 11 percent were control structures, and 10 percent were larger flumes upstream of turnouts (figure 11).

It is not surprising that the more water-abundant system has a lower rating in maintenance. But the large majority of structures in both districts is still fully functional. In Coello, 98 percent of the total canal length was fully or partially functional; in Saldaña, 92 percent of the canal length was fully or partially functional. This is a remarkable record, given that construction was completed in 1953, that only limited rehabilitation had been done in both districts in the late 1960s and early 1970s, and that management was transferred to the farmers' associations in 1976.

In 1984, HIMAT, in agreement with the users, conducted feasibility studies on modest rehabilitation and system expansion in both Coello and Saldaña. Some portions of the canal and road networks had deteriorated and were in need of repairs. Drainage improvement was needed in Saldaña and a supplemental feeder canal was planned for Coello. Farmers in Coello agreed to pay 90 percent of the cost of the feeder canal, but farmers in Saldaña refused to pay any of the cost of the rehabilitation. Construction is underway in Coello but not in Saldaña.[7]

[7]The government recently dropped its insistence that farmers must pay for rehabilitation after turnover. However, it has a new policy to gradually phase out existing subsidies.

FIGURE 11.
Composition of dysfunctional structures.



Irrigation operations

There is no indication that the operational performance of the Coello or Saldaña systems changed significantly as a result of turnover. Water continues to be delivered without being measured below the main canal offtakes. In Coello, the average annual discharge at the intake varied from 14 m^3/s in 1977 to 16 m^3/s in 1993, with an average fluctuation between minimum and maximum discharge levels of 4 m^3/s (figure 12). The average annual water supply, rather than declining over time, has shown a slight rise. Historical data on discharge at the intake were not available for Saldaña.

The comparison of the annual volume of water diverted at the headworks with the aggregate amount of water delivered to all tertiary canals, provides a measure of what is termed, herein, total conveyance efficiency (figure 13). The annual average total conveyance efficiency for 1982 to 1993 was 60 percent in Saldaña and 69 percent in Coello. Part of the reason for relatively low efficiencies may be the reportedly high sediment loads in main canals. This is the most serious management problem in Saldaña and is a major problem in Coello as well.

As a simple effort to assess equity of water distribution along tertiary canals, a field check was made on 15 July 1993 comparing actual and target discharges into farm outlets along a tertiary canal located at the Florencia secondary canal in the Saldaña district. The ratio between actual and target discharges is termed the delivery performance ratio, or DPR. From the first outlet at the head end to the eighteenth outlet at the tail, the DPR exhibited a clear downward trend, ranging from 260 percent at the head to 75 percent at the tail (figure 14). One such test cannot verify a pattern, but it does suggest that a distribution problem may exist in Saldaña at the tertiary level.[8] The distribution arrangement at the time of inspection was continuous flow.

We have noted above the stable or slightly rising trend in annual average discharge at the intake in Coello between 1977 and 1993. Figure 15 shows that the annual water supply delivered for the rice crop rose by 25 percent from about 2,000 mm/ha in 1977 to about 2,500 mm/ha in 1991. However, figure 16 shows a 12 percent decline in the overall average annual volume of water delivered per season, from approximately 1,100 mm/ha in 1982 to 970 mm/ha in 1991. This trend was influenced by two basic changes in irrigated agriculture in Coello.

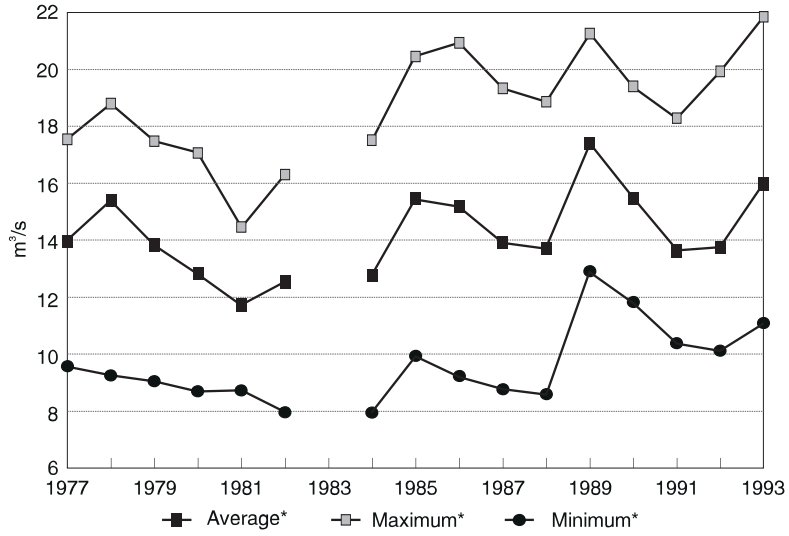
The first is the expansion in gross annual irrigated area (total for two seasons) in Coello from approximately 21,000 hectares in 1977 to between 27,000 and 37,000 hectares in the late 1980s and early 1990s (figure 17). The second is the shift away from rice monocropping to crop rotation as administered by the district.[9] After transfer, Coello district excluded the sandy area from rice production.[10] This partial restric-

[8]Distributional inequity may be partly the result of the siltation problem, but it would require additional research to bear this out.

[9]Coello district established a zoning system, which restricted continuous cultivation of rice in certain areas.

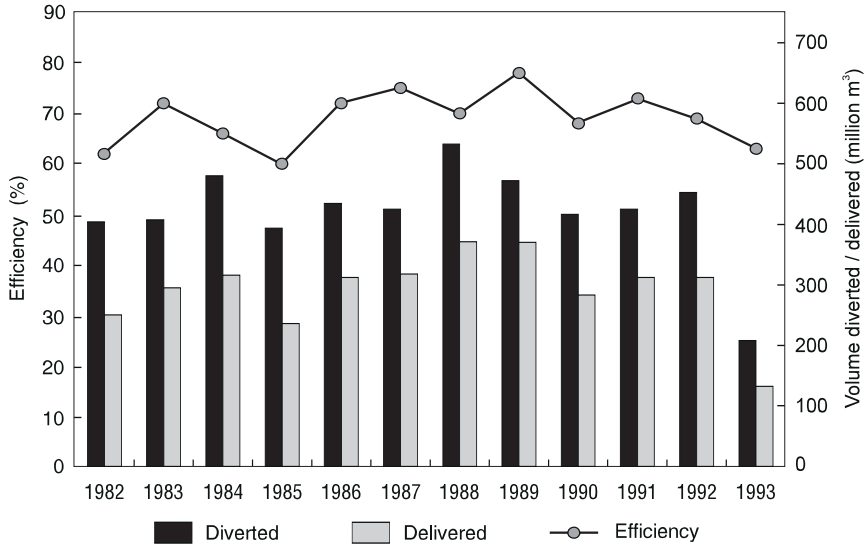
[10]Prior to transfer, some sandy areas were reportedly receiving as much as 30,000 m^3/ha of water supply annually for rice production. After transfer, that water was reallocated for area expansion and for heavy soil areas that had not been receiving enough water before transfer.

FIGURE 12.
Discharge at intake, Coello district, 1977–93.[a]



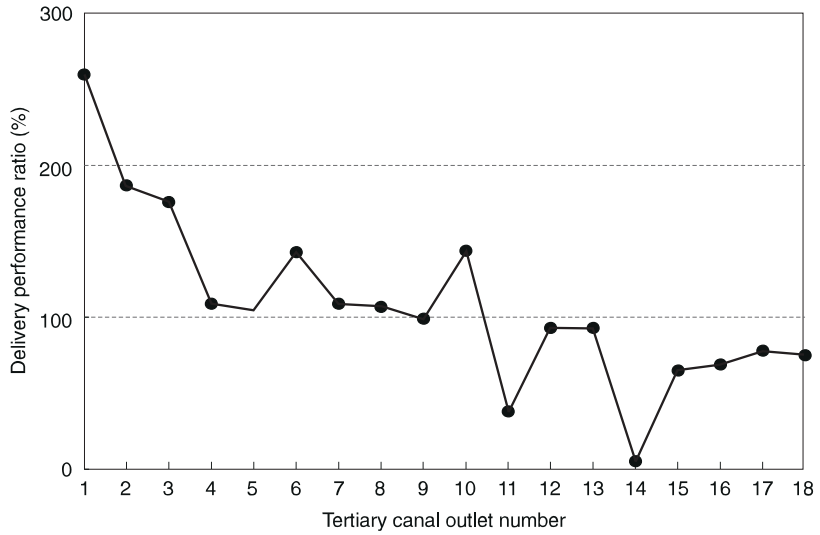
*Average of 12 months.
[a]1983 data not available.

FIGURE 13.
Main canal total conveyance efficiency (ratio of water delivered to water diverted), Coello district, 1982–93.



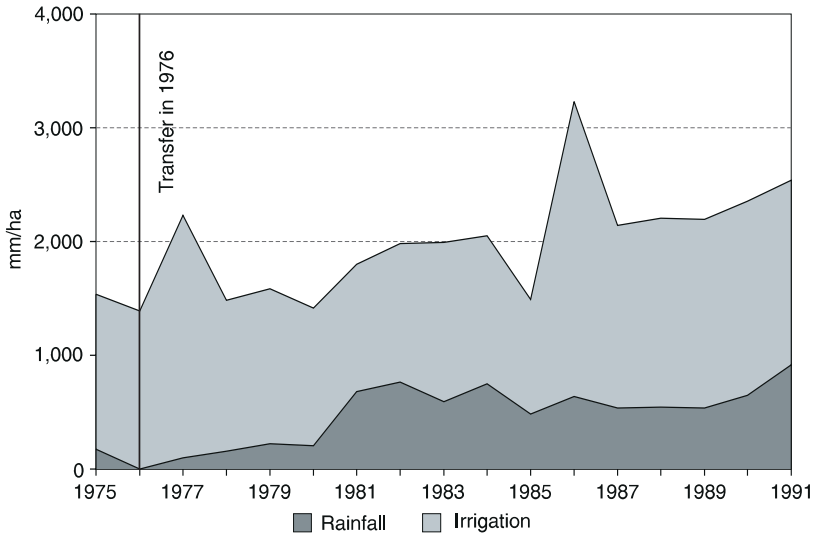
tion on cultivating rice encouraged crop diversification in the district, with an increase in the area planted to cotton, sorghum, soybean, and other nonrice crops. About 19,200 hectares was planted to rice in 1975, the year before turnover. The area dropped to about 16,450 hectares by 1991, a 14 percent decline (figure 18).

FIGURE 14.
Water delivery performance ratio along sample tertiary canal, Saldaña district, 15 July 1993.



Note: Distance from tertiary head increases as outlet number increases.

FIGURE 15.
Annual water supply for the rice crop, Coello district, 1975–91.[a]



[a]Main growing season: March, April, May, June, and July.

In contrast, figures 19 and 20 show the rise during this period in area cultivated to cotton and sorghum, the main crops other than rice in Coello. Average water deliveries for these crops varied widely, with no apparent increasing or decreasing trend. In Coello, the decrease in the area fee and the rise in the volumetric fee may have encouraged the expansion of irrigated area and a reduction in the volume of water

FIGURE 16.
Water delivered per hectare per season, average, Coello district, 1982–91.

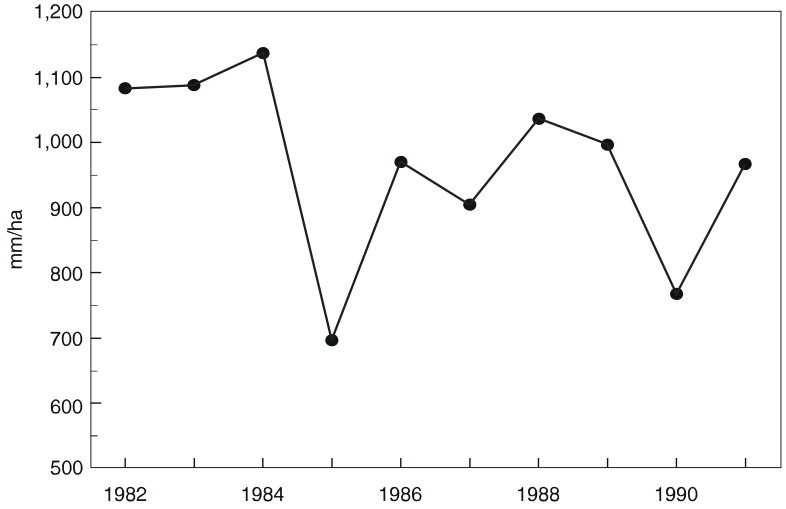
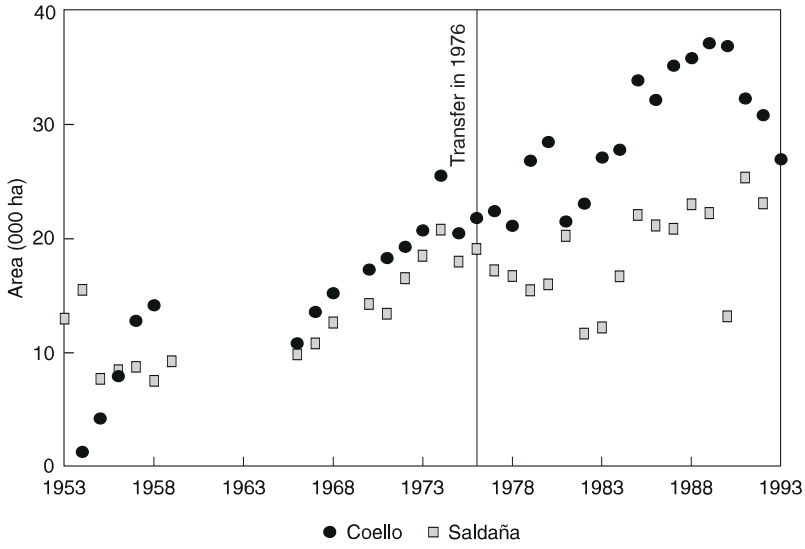


FIGURE 17.
Gross annual irrigated area[a] before and after transfer, Coello and Saldaña districts, 1953–93.[b]

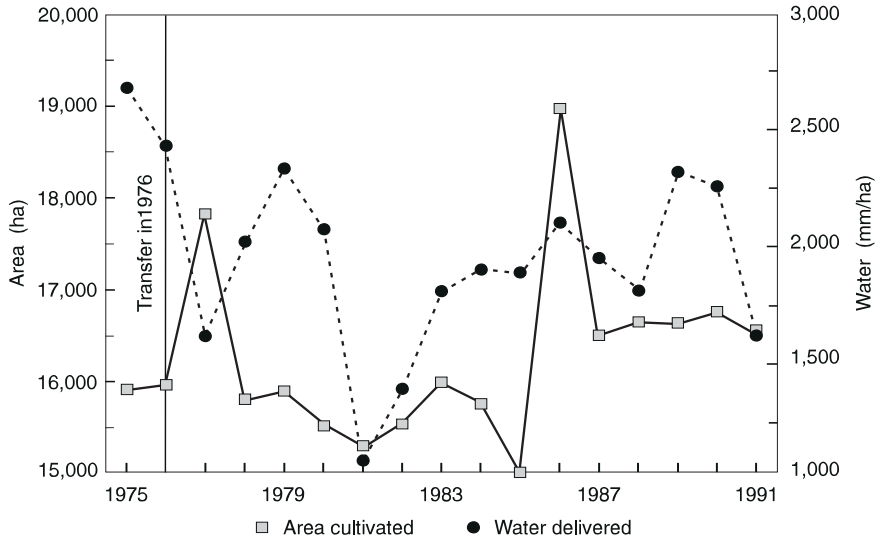


[a]Summation of irrigated area for both crop seasons.
[b]Data for 1960–64 missing.

delivered per hectare. The discipline imposed by the district to dramatically reduce the volume of water delivered per hectare encouraged crop diversification and a substantial growth in irrigated area. Rice monocropping was unsuitable for Coello's sandy soils.

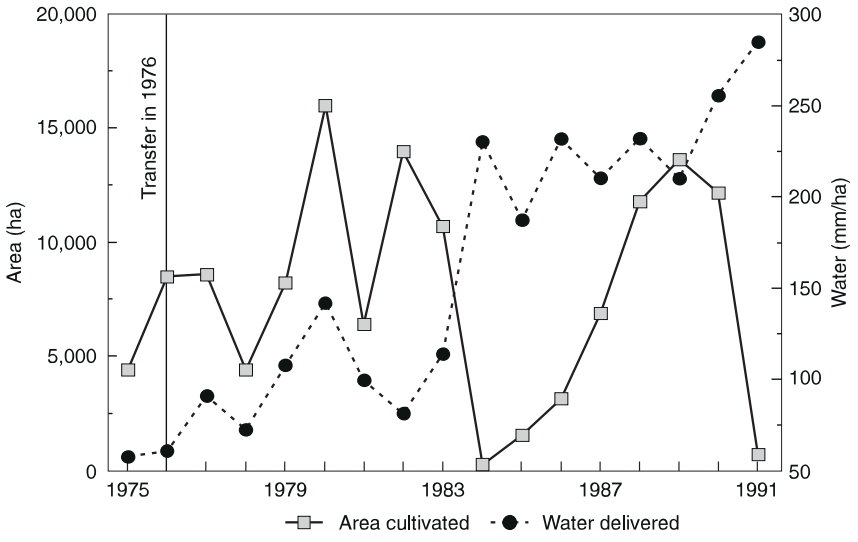
In short, operational and maintenance problems appear to be more prevalent at the tertiary and distributary levels than in

FIGURE 18.
Area cultivated to rice annually and water delivered per hectare,[a] Coello district, 1975–91.



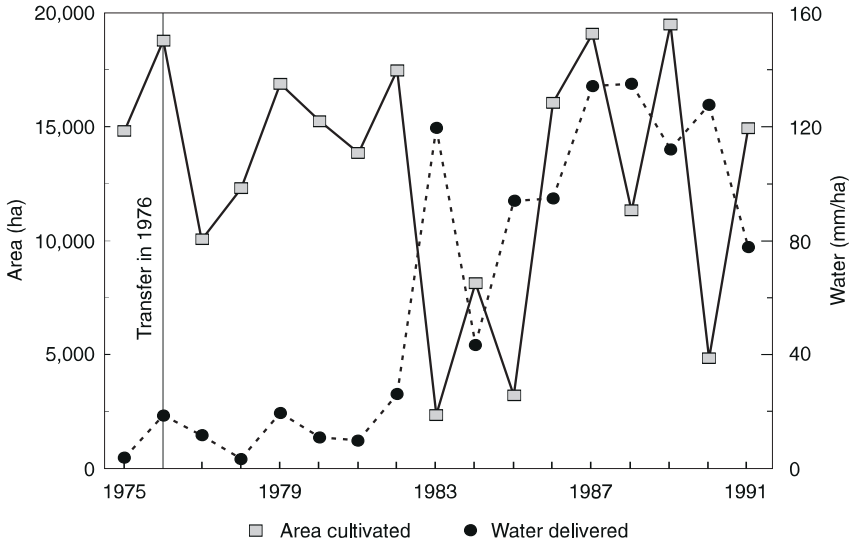
[a]Pre-season average.

FIGURE 19.
Area cultivated to cotton annually and water delivered per hectare,[a] Coello district, 1975–91.



[a]Pre-season average.

FIGURE 20.
Area cultivated to soybean annually and water delivered per hectare,[a] Coello district, 1975–91.



[a]Pre-season average.

the main system, as indicated by the maintenance survey, DPR analysis, and farmer perceptions. While the problems do not appear to be severe, there is clearly room for improvement.

Agricultural productivity

The gradual expansion of irrigated area halted for about 4 years at the time of turnover, perhaps because of uncertainties and inefficiencies temporarily created by the change in management. But the expansion resumed after this apparent learning period and only began leveling off early in the 1990s (figure 17). The rate of expansion has been higher in Coello, where crop diversification has occurred, than in Saldaña, where it has not.

Area expansion was primarily a result of two factors. First, the tertiary network was extended and improved over time. Second, as farmers gained more experience with irrigation and their livelihoods improved, they expanded the area irrigated within their farms. Most of the change occurred when modern, fertilizer-responsive varieties were introduced in the 1960s and 1970s. Average rice yields increased dramatically from approximately 2.5 t/ha in the mid-1950s to approximately 6 t/ha in 1976, at the time of transfer (figure 21). By the 1990s, average rice yields were between 6.5 t/ha and 7.0 t/ha. Most of the increase in yields occurred before transfer, but high yield levels were sustained afterwards through the early 1990s, with a slightly increasing trend. We conclude that the transfer did not have any noticeable detrimental impact on yields.

Both the cost and value of rice production declined moderately during the 11-year period from 1984 to 1994. The cost fell from about US$380/ha in 1984 to about US$320/ha in 1994 (figure 22). Average net income for rice production varied widely, from zero to about US$105/ha during the period, peaking in 1989 and falling to about US$45/ha in 1994.

The total cost of water relative to the cost of rice production dropped from approximately 4.4 percent during the 1950s, before turnover, to between 3.1 percent (in Saldaña) and 3.3 percent (in Coello), largely

FIGURE 21.
Average annual rice yields before and after transfer, Coello and Saldaña districts. 1953–93.

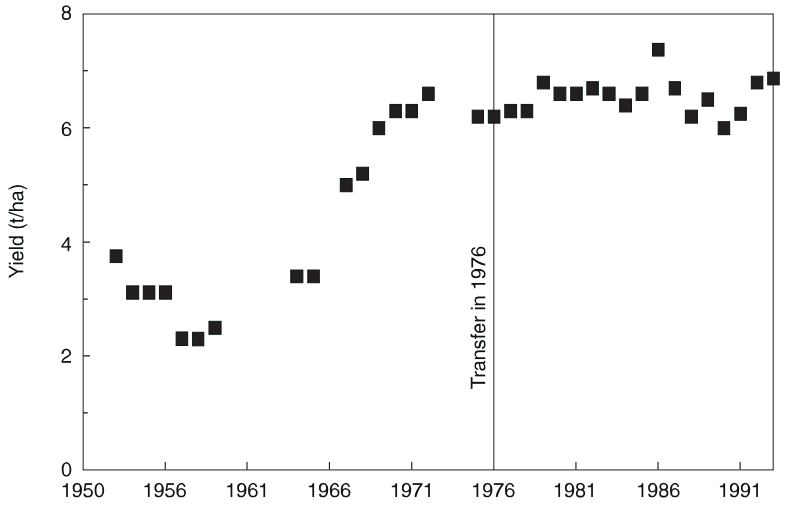
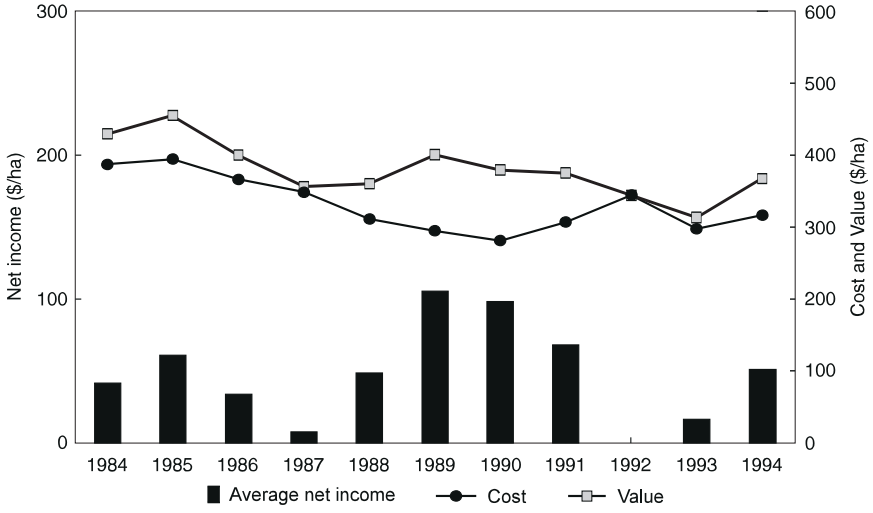
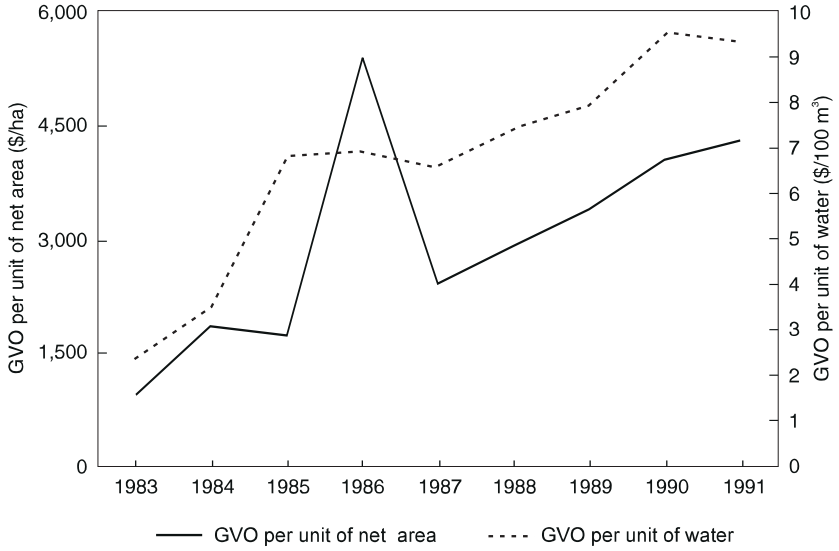


FIGURE 22.
Cost and value[a] of rice production, Coello and Saldaña districts, 1984–94.[b]



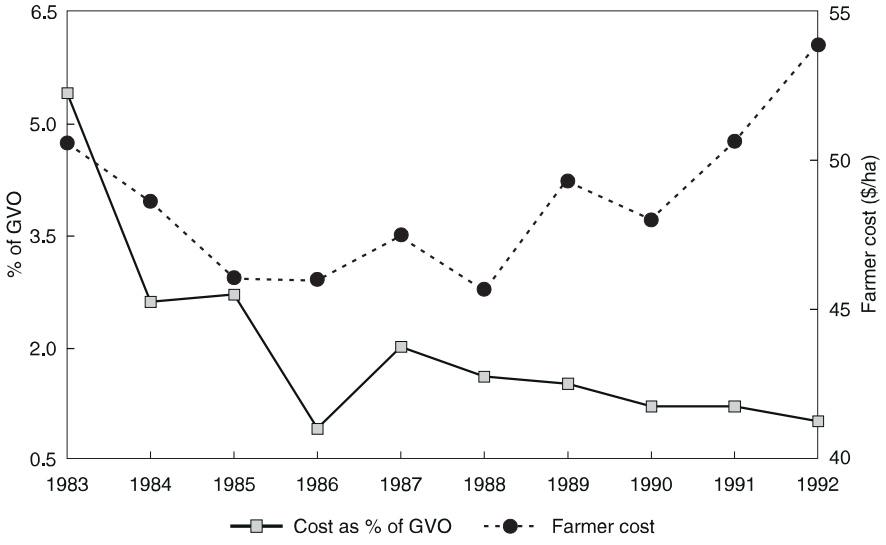
[a]In constant 1988 U.S. dollars (US$1 = Col$333).
[b]Based on total production data for both systems

FIGURE 23.
Gross value of output (GVO) in relation to net area and water use, Coello district, 1983–91.[a]



[a]In constant 1988 U.S. dollars (US$1 = Col333).

FIGURE 24.
Irrigation cost as a percentage of gross value of output (GVO) and cost of irrigation per hectare to farmers, Coello district, 1983–91.[a]



[a]In constant 1988 U.S. dollars (US$1 = Col333).

due to rising cost of production. However, during the post-transfer period it has been rising, from 2 percent in 1984 to 3.3 percent in 1993 (in Coello).

In Coello, under post-transfer management during the 1980s, the total cost of irrigation[11] remained essentially constant at about US$50/ha in real terms. However, the total gross value of output per hectare for all irrigated crops rose over fourfold during the same period, from US$944 to US$4,300 per ha (figure 23). The cost of irrigation as a percentage of the gross value of output was relatively small and dropped still further, from 5.4 percent to only 1.2 percent by 1991 (figure 24).

Coello district also achieved impressive gains in gross value of output per unit of water, which quadrupled from US$2.35/100m^3 in 1983 to US$9.35/100m^3 in 1991 (figure 23).[12] This primarily reflects rises in crop prices, enhanced value per unit of water due to crop diversification, and, to some extent, lower average water consumption per hectare.

Perspectives of Stakeholders

Farmers

Interest in turnover. The initiative for the turnover of management came from the water users rather than from the government. Farmers assessed the implications of turnover and gave their collective approval in the general assembly meetings in September 1976. By the time of turnover, farmers were already financing most of the cost of O&M and expected that they would be able to keep the irrigation fees from rising, or even reduce them.

Role of government. In 1976, farmers agreed that HIMAT should continue to provide oversight and advice to the farmers' associations about management of the irrigation districts. But it soon became apparent that HIMAT's role in the districts after turnover was more than just oversight. Many farmers saw HIMAT as restricting their ability to further reduce staff and budgets, as the associations had wanted. Therefore, farmers perceived the transfer as being less than enough to give them full control.

A stratified random sample of 93 farmers (44 in Coello and 49 in Saldaña) was drawn in 1994, taking half from the upper third area (head enders) and half from the lower third area (tail enders) in each system. It was found that in Coello, only 29 percent of the farmers sampled wanted the government to withdraw completely from working with the district; 48 percent wanted the government to continue to be partially involved in assisting the irrigation district; and 21 percent stated that the government should take over management again (figure 25). In Saldaña, only 14 percent favored complete government withdrawal; 68 percent favored continuing partial government involvement; and 16 percent favored government takeover.

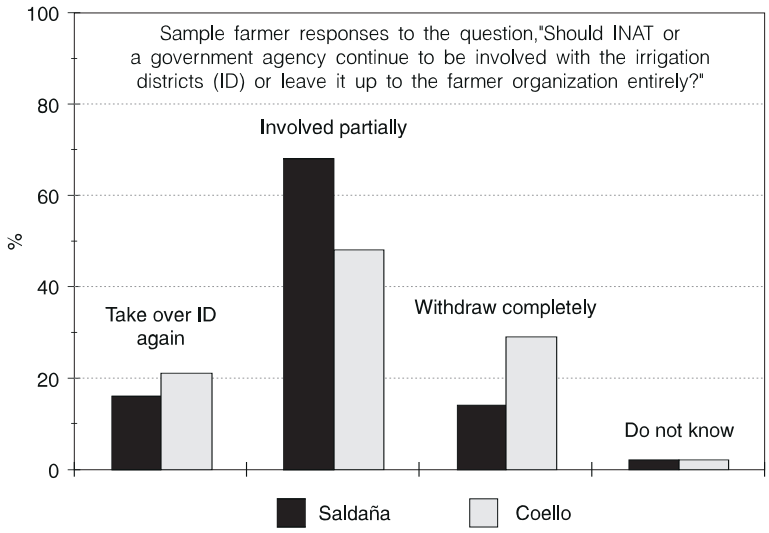
The most commonly mentioned roles that sample farmers said they would like the government to continue to play in the irrigation districts were to provide technical guidance, settle disputes among farmers, regulate water allocation in the river basin, manage the intake and main canal, and help rehabilitate the system.

Ownership. Sample farmers were also asked who should own the irrigation infrastructure. In Coello, 76 percent thought the farmers' association should own it; in Saldaña, 80 percent thought the farmers should own it. Only 19 percent in Coello and 18 percent in Saldaña thought that the government should own the structures.

[11]Total revenues from all water charges divided by net area irrigated per year.

[12]Unfortunately, comparable data were not available for Saldaña.

FIGURE 25.
Farmer perspective about withdrawal of the irrigation agency.



Note: N=44 in Coello and 48 in Saldaña.

Outcomes of turnover. Sample farmers were asked, "Has the 1976 transfer of management for the irrigation district from the government to the farmers' organization improved, worsened, or not changed much of the management of the irrigation district?" In Coello, 53 percent responded that it had not changed much, 40 percent said it had improved, and only 7 percent said it had worsened. In Saldaña, 39 percent said management had improved after turnover, 36 percent said it had not changed much, and 25 percent said it had worsened. In Saldaña, 7 of the 11 farmers who stated management had worsened were tail enders. In Coello, there was no significant difference between head and tail enders.

The most common ways in which management had improved, according to the farmers of both systems were (1) in communication between district staff and farmers, (2) in responsiveness of district staff to farmers, and (3) in water distribution. About 70 percent of the sample farmers in Coello and 91 percent in Saldaña stated that they had attended a district association meeting within the last year.

Impacts on maintenance. Sample farmers were asked, "Has the functional condition of the secondary canal that delivers water to your field improved, worsened, or stayed about the same over the past 10 years?" In Coello, 81 percent said it had stayed about the same, 17 percent said it had improved, and only 2 percent said it had worsened. In Saldaña, 73 percent said it had stayed in about the same condition, 15 percent said it had worsened, and 13 percent said it had improved (with no significant difference between head and tail enders).

Impacts on operations. Sample farmers were asked, "Over the last 2 years was the irrigation water delivered to your farm always enough for your crop water requirement, enough most of the time, not enough most of the time, or never enough?" In Coello, 45 percent said it was always enough and 32 percent said it was enough most of the time. Only 20 percent said it was not enough most of the time, and 2 percent said it was never enough. In Saldaña, 59 percent said water was always enough, and 31 percent said it was enough most of the time. Only 4

percent said it was not enough most of the time, and 2 percent said it was never enough. In Coello, a surprising 96 percent said water was delivered to their fields on time all or most of the time. In Saldaña, 90 percent said water was delivered on time all or most of the time. This question did not address the issue of change, but it did demonstrate that since turnover, widespread satisfaction exists among farmers about water distribution.

Regarding water theft or disputes over water, only six sample farmers (14%) in Coello stated that they were aware of incidents in the last 2 years. Of the sample farmers, 86 percent were not aware of any such cases. In Saldaña, only two sample farmers stated that they were aware of any theft or dispute over the last 2 years. Forty-seven sample farmers (96%) were not aware of any such occurrence.

Impacts on agricultural productivity and profitability. Farmers did not indicate that management turnover had had a significant impact on either the productivity or the profitability of agriculture.

District staff

District managers expressed concern that the strong farmer disposition toward cost reduction was causing some decline in service and that this would eventually result in the visible deterioration of the system. They said experienced senior personnel had been replaced by younger, inexperienced staff, key technical positions had been eliminated or merged, and little or no expenditure was being made in training or replacement of equipment or structures. Some noted occasional undue influence by large-scale farmers over field operations staff in the distribution of water.

Agency staff

At first, members of the HIMAT staff at the district and higher levels generally were resistant to the transfer. They perceived that jobs would be lost and the role and power of the agency would diminish as a result of management turnover, first in Coello and Saldaña, and eventually in other districts as well. For several years after turnover, the agency pressured the farmers' associations in Coello and Saldaña against releasing staff and reducing budgets. This resulted in lawsuits between the farmers and the agency, mainly over the issue of releasing staff. After the land development law of 1993 was enacted, the government granted full authority over district staff and budgets to farmers' associations.

Conclusion

Perception

Most farmers see turnover as having produced a more responsive and cost-efficient management. Most, however, favor continuing a limited role for the agency, primarily in providing technical advice and in helping with resolving disputes. The majority believe that the association should own the irrigation infrastructure. However, most farmers appear satisfied with the performance of O&M tasks. Many believe that management performance, especially cost efficiency, would have improved even more had the users been granted full control over staff and budgets after turnover. Association board members perceived that the partial turnover brought only partial benefits.

Professional staff in the districts are less sanguine about the results, expressing concern that cost-cutting measures are compromising the quality of O&M. The agency was

concerned about the implications of turnover on agency staff and budgets.

Main results

The following are the study's main conclusions about performance changes after turnover.

1. Management turnover achieved the government's objective of discontinuing subsidies and making the districts financially self-reliant for O&M. The delegation of administration, however, did not result in full turnover of authority to the farmers' associations. The government agency continued to exercise partial influence over budgets and staffing. Nevertheless, after turnover, the districts began to gradually reduce staff, while continuing virtually the same level of management intensity as before. Most sample farmers felt that communications with district staff and their responsiveness to farmers had improved after turnover.

2. The districts have been only partially successful in containing costs. Staff levels have been reduced 35 percent since transfer. However, the cost of irrigation remained relatively constant for a decade after turnover. Coello district has been financially solvent ever since turnover, with a decreasing margin of budget surplus over time. It has also diversified its revenue sources beyond water charges. Saldaña, however, has had continuing problems balancing its budget, but has made progress toward solvency with growth in revenues outpacing growth in expenditures over time. Both districts raised irrigation fees for rice over time and costs of irrigation to farmers rose in real terms—although as a percentage of the total cost of rice production, or gross value of output, the cost of irrigation dropped substantially. In Coello, financial viability has been achieved by spreading the cost of irrigation among more farmers through expansion of area, by increasing volumetric fees for rice, and by diversification of revenue sources.

3. Nineteen years after the transfer, only 2 percent of total canal length in Coello and 8 percent in Saldaña were dysfunctional (mostly in tertiary canals). Of all water control and measurement structures, only 15 percent in Coello and 12 percent in Saldaña were dysfunctional. The vast majority of dysfunctional structures were field outlet measurement structures (which were not normally used). We conclude that the districts have been able to sustain preventive maintenance so far. And owing to statements by sample farmers, we conclude that system maintenance has not yet been adversely affected by turnover. The intensive and costly maintenance investment the districts have been able to support, relative to the serious siltation problem, has been impressive.

4. However, because the government retained ownership of the scheme assets, farmers insist that the government should finance future rehabilitation and modernization. Neither association is raising a capital replacement fund. It is apparent that this arrangement is preventing the associations from achieving complete local financial sustainability. Although the systems have been well maintained until the present, this may lead to some deferred maintenance in the future.

5. After turnover, the farmers' associations soon established new crop rotation and irrigation scheduling arrangements designed to permit extension of irrigated area while decreasing the average amount of water delivered per

hectare. The Coello district was able to substantially expand its area irrigated by steadily delivering less water per hectare and diversifying cropping. Saldaña, which has heavier soils, continued to irrigate only for rice, though it staggered planting dates to spread irrigation demand over the year. However, the study indicates there is a moderate problem of inequitable water distribution to tail enders, which is due partly to siltation and some lack of control at the tertiary level.

6. It is apparent that the transfer did not inhibit long-term expansion of the area irrigated or the ability of irrigated agriculture to sustain high levels of rice yields. Despite rising costs of agricultural production and a decline in crop prices, yields and area irrigated rose slightly after transfer and then remained stable.

7. Perhaps the most important finding of the study is that increases in the gross value of output per hectare and per unit of water increased dramatically, while the cost of irrigation to farmers remained roughly the same after turnover. Irrigation constituted a relatively small and declining proportion of the total cost and value of production. Improvements in economic performance after turnover can be only partially attributed to broader factors such as cultivation improvements and crop prices. After turnover, new district policies to restrict rice production in sandy areas and reduce average volume of water delivered per hectare supported crop diversification and improved the value of irrigated output. Cost-containment policies such as reductions in staff and cessation of flow of funds outside the schemes undoubtedly helped prevent increases in the cost of irrigation to farmers.

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Internet Home Page http:/ /www.cgiar.org

ISBN: 92-9090-329-5

ISSN: 1026-0862