2.2 Results of Irrigation Management Turnover in Two Irrigation Districts in Colombia

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SYNOPSIS

In 1975, farmers in the Coello and Saldaña irrigation districts in 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 paying water fees to the government and were dissatisfied with the cost and quality of management. 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 chapter assesses the extent to which turnover of management to farmers in these two irrigation districts has had an impact on:

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

Sustainability of irrigation is assessed relative to both financial viability of the districts and physical condition of irrigation infrastructure 19 years after the turnover. Quality of water distribution is assessed relative to efficiency, equity of distribution and productivity of water.[1]

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 operations and maintenance. The "delegation of authority", however, did not result in full turnover of authority to the farmers associations. The agency continued to exercise partial influence over budgets and staffing. Nevertheless, after turnover the districts began a gradual process of reducing staff, while continuing virtually the same level of management intensity as before turnover. 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% 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 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. After turnover the districts were able to expand irrigated area and sustain high levels of agricultural production while decreasing the annual average volume of water delivered.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.

4. Nineteen years after the transfer only 2% of total canal length in Coello, and 8% in Saldaña, was dysfunctional (mostly in tertiary canals). Of all water control and measurement structures only 15% in Coello and 12% 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 ill-effected by turnover. The intensive and costly maintenance investment the districts have been able to support, relative to the serious siltation problem, has been impressive.

5. However, since 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 are being well maintained until the present, this may lead to some deferred maintenance in the future.

6. 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. Coello district was able to substantially expand its area irrigated through steadily delivering less water per hectare and diversifying cropping. Saldaña, which had heavier soils, continued to irrigate only for rice, though it staggered planting dates in order to spread out irrigation demand over the year.

7. 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 remained stable after transfer.

8. Perhaps the most important finding of the study was 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 only partially be 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 ha. 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 rises in the cost of irrigation to farmers.

Irrigated Agriculture in Colombia

Colombia is a mountainous country in South America with an area of 1.1 million sq km and a population of 31.8 million people (Annex Figure 1). The country has 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 per year. A marked bi-modal distribution in April/May and October/November makes the need for irrigation primarily supplemental (Annex Figure 2).

Coello and Saldaña irrigation districts are located in the Tolima valley in central Colombia. The valley is at an elevation of 380 meters and is surrounded by the Andes mountains. It sits between the central and west mountain ranges of the country with the large Magdalena river running through the middle of the valley. The valley has a mostly flat topography with undulating terrain towards both mountain ranges and has primarily alluvial soils, fans, terraces and narrow valleys with minor rivers. Main soil characteristics are sandy and loam in Coello and clay and loam in Saldaña. Soil erosion is evident as one moves up 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 between 1000 and 1500 mm. The median temperature is 27.90C. Average relative humidity is 74% and the yearly average tank evaporation is 1800 mm (Annex Figure 2).

Agricultural and Socio-economic Context

In the 1930s, land reform in the Tolima Valley replaced the old hacienda system of peasant cultivation with land ownership for farmers. The introduction of irrigation to the area in the 1950s transformed the agriculture of the valley. Cotton became an important crop during the 1950s and 1960s. It was eventually replaced by rice which became the main irrigated crop by the 1970s and remains so today. Maize, sorghum, fruit and vegetables are also now irrigated in the valley.

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

DEVELOPMENT OF COELLO AND SALDAÑA DISTRICTS

Construction of the Coello-Saldaña Irrigation District began in 1945 and was completed in 1953, when the district became operational. The total capital cost for the district was US $5,500 per hectare (in 1993 dollars). Coello and Saldaña were initially constructed and managed as a single district. They were separated in 1976 only after management was turned over from the government agency to the water users associations.

Coello Irrigation District is a river diversion system which has a lateral intake with a design capacity of 28 cubic meters per second (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 both sediment intake and water depth control (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 km 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.

The district serves an irrigated area of approximately 25,600 ha, making it one of the largest schemes in the country. The district was not designed with a parallel drainage system, which has resulted in waterlogging and salinity problems on as much as 7,000 ha. It has 1,347 water users with 1,826 holdings. Average farm size is 14 ha. 26.6% of farms are five ha. or less in size; 14.4% exceed 50 ha in size (see Annex Tables 1 and 2).

The Saldaña District is also a river diversion scheme, located south of Coello District. 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 channels. As in Coello, each branch canal leads to unlined secondary and tertiary canals. Field turnouts are sliding gates (HIMAT, 1991b).

Saldaña District irrigates an area of approximately 14,000 ha. The lack of a complementary drainage system has resulted in waterlogging of up to 1,600 ha. Its 1,500 water users have 1,850 holdings. The average farm size is 7.5 ha. 56.4% of the farms in Saldaña are five ha. or less in size; only 5.1% exceed 50 ha. in size (Annex Table 1).

The schemes have composite under flow and over flow cross regulators along the main canals which consist of gates and side weirs. This design protects against over cropping and facilities desilting. It also enables a onger interval between gate adjustments than conventional designs. Hence, the design facilitated turnover by simplifying O&M requirements.

Rehabilitation of both irrigation canals and natural drains was done in Coello and Saldaña well before turnover. In Coello between 1968 and 1973, about US$ 8.69 million (in 1988 dollars) was spent on rehabilitation. In Saldaña between 1969 and 1972, about US $2.28 million (in 1988 dollars) was spent on irrigation and drainage works[2]. By 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 farmers. Rehabilitation was not done in connection with turnover.

However, the issue of who should be responsible to finance rehabilitation was always a matter of dispute. The users argued that since the government had not turned over ownership of the infrastructure, it was the responsibility of the government to maintain the infrastructure, which belonged to the nation. Despite pressure from the government, farmers 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. (This is still under construction, today).

TURNOVER PROCESS

In the early 1960s the Government of Colombia entrusted the operation and maintenance 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% of the farmers paid the water fee, but this percentage declined over time due to farmer dissatisfaction with the quality of management. Declining fee collections further hindered the ability of the agency to provide effective irrigation service. Inefficient operation and maintenance of the system further motivated farmers to take over management of the district.

As a result, the farmers, who had already formed an association, decided in 1975 to make a formal request to the government that management responsibility for the system be transferred to the association of water users. The association argued that the scheme should legally become their property since they had already re-paid the government their share for the costs of construction (Vermillion & Garces-Restrepo, 1994).

Negotiations for management transfer were completed within a year, between 1975 and 1976. The associations hired their own 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[3] 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. 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 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 HIMAT continued to give its advice and consent for annual budgets, O&M workplans, setting water fee levels, and personnel changes. The farmer association obtained direct control over the operation and maintenance of the entire system, including the intakes..

As part of a policy to improve the performance of irrigation districts, in 1976 the government created HIMAT. 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 case of 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 "Delegation of Administration," by which a public good (in this case, an irrigation district) could be turned over to a private-sector corporate entity (a water users association) for administration on behalf of the state. The users were then empowered to recruit staff and organize and manage operation and maintenance of 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 previously hired by the government. In 1993, a new Land Development Law was enacted, intended to grant full control over irrigation district management to farmers associations. (Min. of Ag, 1993). [4]

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 "delegation of authority" would not give farmer associations complete control over their budgets and O&M plans. Although farmers had wanted HIMAT to play an advisory role, the government continued to influence budget 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 (which is based on farm area irrigated) and a volumetric charge (based on basic water requirements by crop type). Revenues from the area charge, are used to guarantee coverage of fixed costs such as personnel. 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. Since 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 volume delivered or in the fee assesment. This system did not change with turnover.

Since the associations did not receive ownership of system assets, and since they had not paid for previous rehabilitation costs, the farmers expected that the government would pay for any future costs of 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 a total of 300 employees. By 1993, the total staff for both districts was 189, which was a 37% reduction since transfer (Annex Table 3). Accounting for changes in area irrigated, in 1975 there were 62.3 ha of service area per district staff. By 1993 this had risen to 147 ha per staff. Most reductions were made in maintenance and technical support staff. Reductions were gradual and occurred mostly through attrition and non-replacement. Labor laws made it difficult for district managers to release unneeded government employees. Nevertheless, district board members and agency officials reported that paper work was diminished and administration became more efficient after transfer, especially in irrigation scheduling, fee processing and communications between users and district management.

Operations and Maintenance Water is allocated to farmers on the basis of area and crop type. In theory, all users who plant the same crop type receive a basic allotment and are charged area and volumetric charges based on assumed deliveries relative to per ha. targets by crop type. Before turnover, irrigation was scheduled on the basis of pre-season crop plans, modified during the season by water requests submitted by registered farmers. 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 to go 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 ditchtender made an inspection of the farm to make sure that the canals, turnout and measuring device (if any) were in working condition. The ditchtender was responsible to deliver water to farm turnouts according to the agreed schedule and to record the total water delivered for the season. This system continued after turnover and was implemented mainly by the same staff as before, only thereafter they were under the hire of the farmer associations.

The districts estimate water requirements for each crop type, which becomes the "base allocation." The districts measure discharge at the intake and along the main canal at offtakes into secondary canals. Water is distibuted according to the base allocation, sometimes reduced when water is scarce.

Prior to turnover the agency prepared annual plans for maintenance and repairs. Such plans were prepared by the head of the maintenance unit, based on field inspections and sometimes 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.

District management have administrative and operational manuals detailing roles and responsibilities of staff and users. The districts have kept data on daily rainfall, temperature and relative humidity since project inception. Data on river flows and main and branch canal discharges are also recorded daily. Records of seasonal crop and irrigation plans, fee collection levels, register 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 enable continued expansion of irrigated area. Attention was given to reducing staff where possible and revising cropping patterns 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 8.64 mm per day versus 15.5 mm per day in Saldaña. In Coello, annual water demand was 1,097 mm, 948 mm of which was supplied by irrigation. In Saldaña, annual water demand was 1,318 mm, which was exceeded by an annual irrigation water supply of 1,517 mm. During the same year, 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 1.75 in Saldaña (Annex Tables 4 and 5). Coello has a relatively scarcer water supply in 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 ha of rice to be planted every month, year round. This improved water distribution and, according to farmers, it also improved profit margins somewhat by spreading rice marketing throughout the year.

Organization After turnover, the general assemblies of the farmer associations for Coello and Saldaña Districts elected boards of directors to supervise their districts. Each board had, and still has, seven members with fixed quotas for two categories of farmers--four members having farm sizes less than 20 ha[5] and three with farm sizes of more than 20 ha. Each is elected in a general assembly every two years. The board recruits and selects the general manager and participates with the general manager in the selection and releasing of other district staff.

After transfer each board recruited general managers who were engineers. The districts then became responsible for day-to-day operation and maintenance of the systems. The reduction in personnel allowed 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 Annex Figure 3).

MANAGEMENT PERFORMANCE AFTER TURNOVER

Through management turnover, farmers hoped to enhance the cost efficiency and quality of operations and maintenance, without sacrificing the agricultural productivity and financial and physical sustainability of the districts. 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 agricultural 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 per hectare at the time of turnover. However, it continues to fully finance rehabilitation. If farmers defer maintenance costs 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. Data on Coello indicates that the farmer districts were fiscally responsible in the sense that expenditures never exceeded revenues after transfer occurred. Figure 1 shows the changing patterns of revenue and expenditures before and after turnover. During the initial stages of scheme development, expenditures exceeded revenues, partially because of external subsidies and development assistance. The early drop in revenue and expenditures was due to the transition from scheme development to scheme management.

Except for 1984, between 1983 and 1992 in Coello, revenues always exceeded expenditures (Figures 1 and Annex Figure 4). However, its margin of surplus declined during the period, an evidence of improving management efficiency, in a context of continuing expansion of service area while water supply remained relatively static.. Expenditures rose in real terms by 51% while revenues rose by only 44% during the period

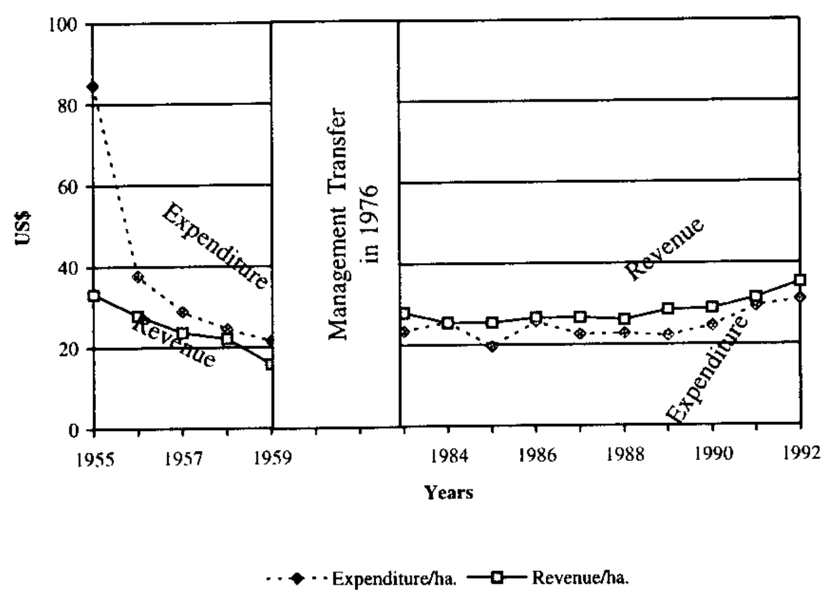
(Annex Table 5). "Sideline" revenue sources--such as rental of farm equipment and district property, technical services, fines against members, sale of materials and charges for transporting equipment and materials--increased from about 10% to 20% of revenue between 1983 and 1992 (Annex Figure 5). Before turnover revenue were taken to the government to at least regional levels. Part of the reason farmers wanted to take over management was because of their perception that they were financing overhead costs of government outside the system. After turnover, revenues which 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 public relations events and assemblies. Sideline revenues also help to limit the level of water fees.

Maintenance costs (including relevant staff costs) account for betwee 55% and 60% of total expenditures in Coello District. This is followed by costs of administration and operations. The proportion of each to total costs remained roughly the same after transfer (Annex Figure 6).

Saldaña District was in a weaker financial position than Coello after turnover, with expenditures exceeding revenues for six out of the ten years between 1983 and 1992 (Figures 1 and 2). However, the district gradually strengthened its position over time. The level of revenue per ha in Saldaña fluctuated widely, but between 1983 and 1992 real growth in revenues was 29%, compared with 20% growth in expenditures (Annex Table 6).

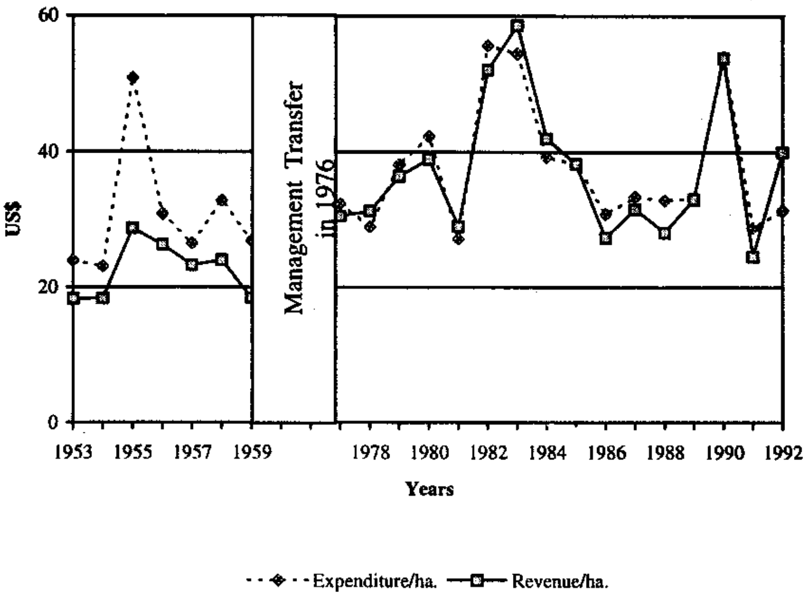
Both districts improved their financial positions after turnover, although from opposite directions. Coello reduced its surplus and enhanced efficiency; Saldaña diminished its pattern of deficits.

Figure 1. *Revenue and expenditure per hectare, Coello District, 1955-1993 **



* *In constant 1988 US Dollars. 1 US$ was 333 Colombian Pesos.*
In April 1994, exchange rate was 820 Colombian Pesos per US Dollar.

*Figure 2. Revenue and expenditure per hectare, Saldaña District, 1953-1992**



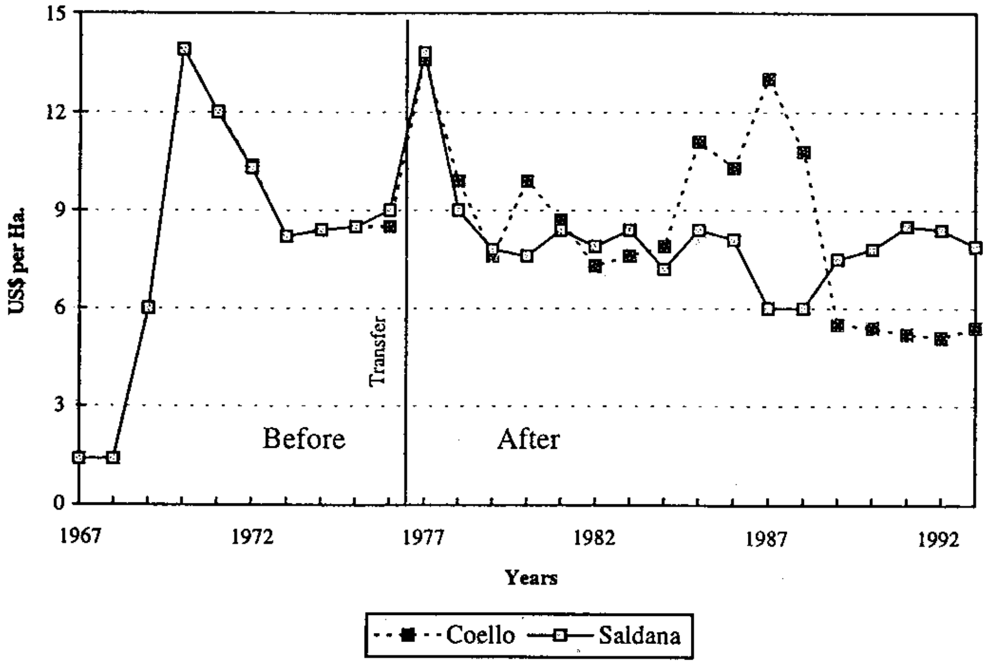
** In constant 1988 US Dollars. 1988 exchange rate was 333 Colombian Pesos per US Dollar. In April 1994, exchange rate was 820 Colombian Pesos per US Dollar.*

Coello and Saldaña both have a fixed area-based water fee and a volumetric water fee. These vary slightly by type of crop and by whether the farmer is a small holder or large holder (e.g. ≥ 20 ha.) The emphasis of farmers on containing the cost of management resulted in a decline in the area fee after turnover. However, the volumetric water fee rose after transfer in real terms (1988 pesos). In Coello the area fee for rice has dropped in real terms from about US$ 9.00 per ha in 1976 (at transfer) to US$ 5.55 per ha in 1993 (Figure 3), while the volumetric fee for rice rose slightly from about 13 cents (US) per 100 cubic meters (m^3) in 1976 to 16 cents (US) per 100 m^3 in 1992 (see Figure 4).[6]

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$ 9.00 per ha at transfer to US$ 7.96 per ha in 1993 (Figure 3). The volumetric fee rose from 13 cents (US) at transfer to 18 cents (US) per 100 m^3 in 1993 (Figure 4). The difference in the cost of water between Coello and Saldaña may be due to the fact that Saldaña has a serious problem of siltation in the intake canal and continuously employs costly floating drag lines on boats to desilt the canal year round. The most significant finding from Figures 3 and 4 is that 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 policy to discourage rice production and encourage crop diversification, reduce allocation of water per ha and encourage expansion of irrigated area.[7]

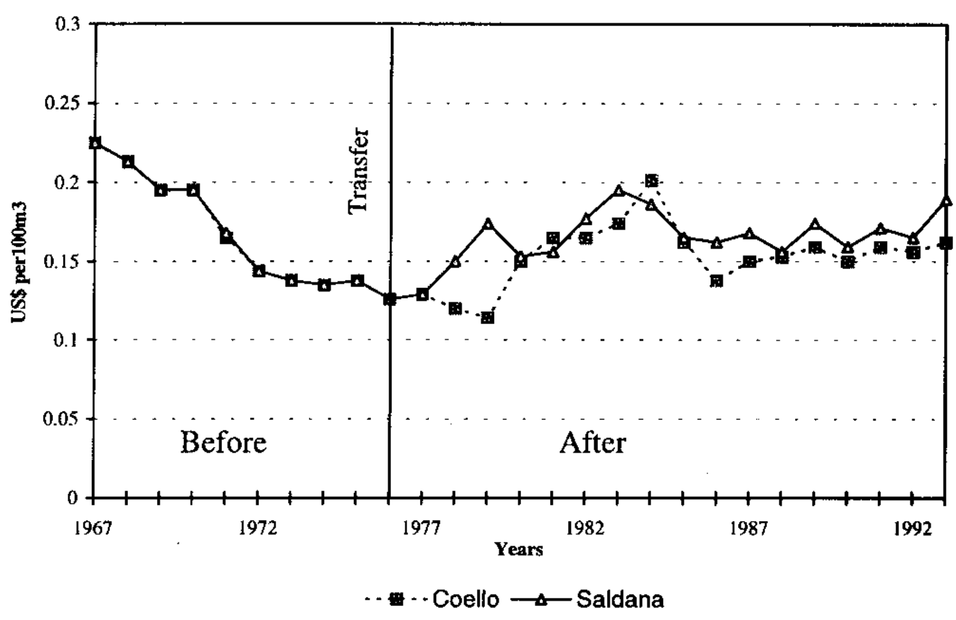
The rising area fee reversed to a long term decline, while the volumetric fee reversed from a decline to a long term rise after transfer. Farmer boards in both districts preferred to charge farmers more on the basis of volume of water used than by the flat area rate.

*Figure 3. Area water fee for rice, Coello and Saldaña Districts, 1967-1993**



** 1982 exchange rate was 333 Colombian Pesos per 1 US$. April 1994 rate was 820 Colombian Pesos per1 US$*

*Figure 4. Volumetric water fee for rice, Coello and Saldaña Districts, 1967-1993**



** 1988 exchange rate was 333 Colombian Pesos per 1US$.*

The total amount of area and volumetric fees collected in Coello District between 1983 and 1992 (for all crops) was $ 75,990 in 1983 and $ 92,041 in 1992 (in 1988 US$). Taking into account changes in annual net area irrigated, this means the actual cost of irrigation to farmers declined 13% from $ 6.63 per ha. in 1983 to $ 5.74 in 1992 (1988 US$; Annex Table 7).

Physical Sustainability

In both districts between 55% and 60% of all district income goes towards maintenance of the irrigation network. This percentage did not change significantly after turnover, since O&M budgets continued to be based on previous years and continued to be reviewed and approved by the agency. However, district managers reported concern that the strong farmer emphasis on cost reduction was compromising the physical sustainability of the systems.

To answer this question complete surveys of all canals and structures were conducted in 1994 in each district[8]. The survey classified canal sections as either fully functional, partially functional, or dysfunctional. Criteria are distinguished primarily according to the extent to which original hydraulic design conditions are supported. Partially functional canal sections still have at least 70% design capacity; dysfunctional sections have less than 70% design capacity.

Results from the Coello survey show that 68% of the total canal length was fully functional (Annex Table 8). This constituted 250.2 kms of main, secondary, and tertiary canals. Partially functional canal sections were distributed relatively evenly between main, secondary, and tertiary canals. Eighty one per cent of the total channel length judged dysfunctional was in tertiary canals, the rest was along secondaries. Of 1,666 total structures examined in Coello, 71% were considered fully functional; 15% were dysfunctional (Annex Table 9). Of the 15% of structures which were dysfunctional, 66% of them were small flumes used for measuring water at field turnouts (Annex Figure 7). These were installed in the rehabilitation during the late 1970s and early 1980s. They had not been requested by the farmers association and are rarely used by the new management. 15% of dysfunctional structures were culverts.

In Saldaña, 48% of all canal sections were fully functional (Annex Table 8). 79% of the main canal was fully functional, whereas only 33% of secondaries and 28% of tertiaries were judged fully functional. 44% of the total canal length was partially functional, mainly in secondaries and tertiaries. Dysfunctional sections were located only in tertiary canals. 19% of the total tertiary length was judged dysfunctional. In Saldaña, 69% of the 756 structures observed were judged to be fully functional; 12% were dysfunctional (Annex Table 9). 65% of dysfunctional structures were small measurement flumes at turnouts, 11% are control structures, and 10% are larger flumes upstream from turnouts (Annex Figure 7).

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% of the total canal length was fully or partially functional; in Saldaña, 92% of canal length was fully or partially functional. This is a remarkable record, given that construction was completed in 1953, only limited rehabilitation had been done in both districts in the late 1960s and early 1970s, and management was transferred to the farmer 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 repair. Drainage improvement was needed in Saldaña and a supplemental feeder canal was planned for Coello. Farmers in Coello agreed to pay 90% of the cost of the feeder canal while farmers in Saldaña refused to pay any of the cost of the rehabilitation. Construction is underway in Coello but not in Saldaña[9].

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 main canal offtakes. In Coello average annual discharge at the intake varied from 14 cubic meters per second (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 (Annex Figure 8). Average annual water supply has not declined over time, but has shown a slight rise. Historical data on discharge at the intake was not available for Saldaña.

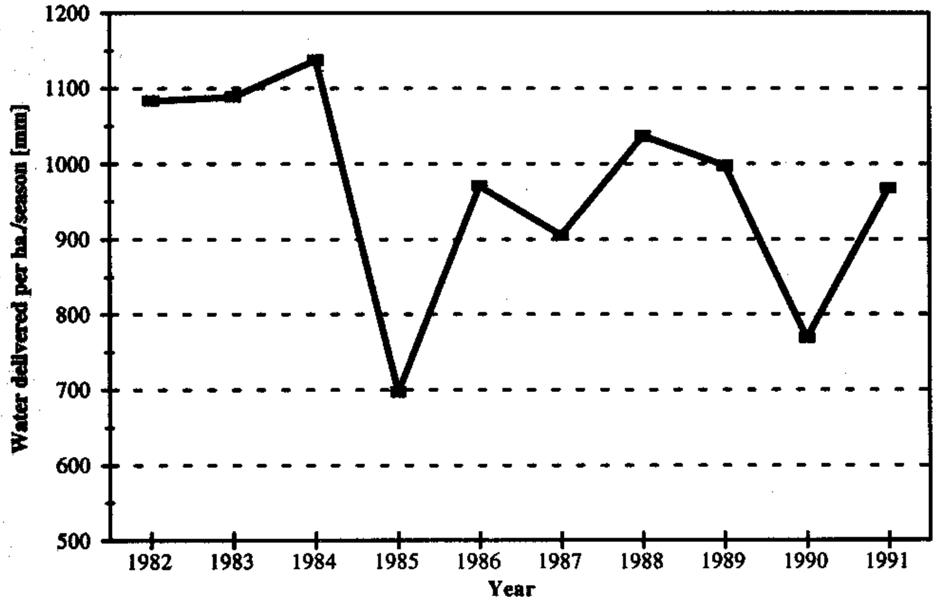
Comparison of data from 1982 to 1993 of the annual volume of water diverted at the headworks with the aggregate amount of water delivered to all tertiary canals, provides a measure of what is termed herein, "total conveyance efficiency" (Annex Figure 9). Annual average measures of total conveyance efficiency for this period were 60% in Saldaña and 69% in Coello. Part of the reason for relatively low efficiencies may be due to 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 and no doubt inhibits conveyance efficiency in both systems.

As a simple effort to assess equity of water distribution along tertiary canals, a field check was made on July 15, 1993 comparing actual and target discharges into farm outlets along a tertiary canal located at the Florencia Secondary Canal in Saldaña District. The ratio between actual and target discharges is termed the Delivery Performance Ratio, or DPR. From the first outlet at the headend to the 18th outlet at the tail, the DPR exhibited a clear downward trend from head to tail, ranging from 260% at the head to 75% at the tail (Annex Figure 10). One such test can not verify a pattern but it does suggest a distribution problem may exist in Saldaña at the tertiary level[10]. 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. Annex Figure 11 shows that the annual water supply delivered for the rice crop rose 25% from about 2,000 mm/ha in 1977 to about 2,500 mm/ha in 1991. However, Figure 5 shows a decline in the overall average annual volume of water delivered per hectare of 12%, from approximately 1,100 mm per season in 1982 to 970 mm in 1991. This was influenced by two basic changes in irrigated agriculture in Coello.

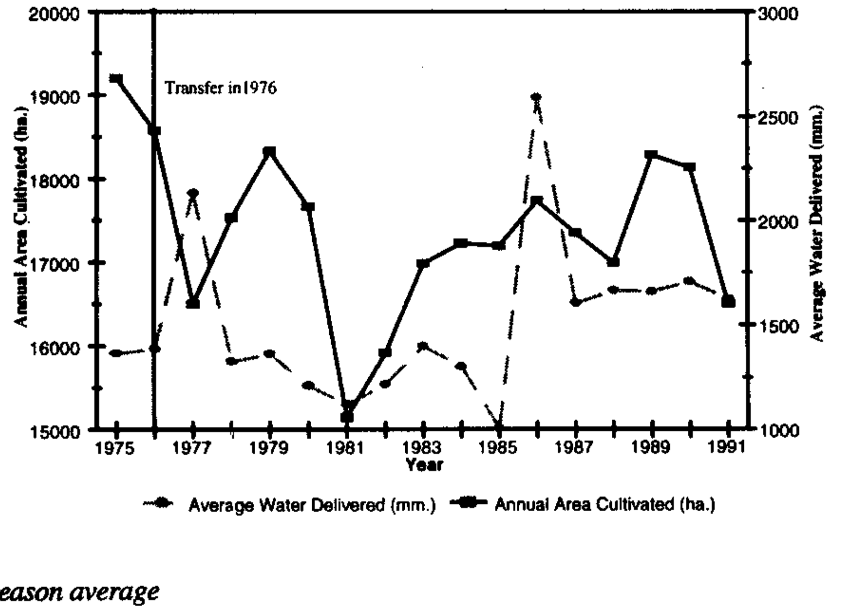
The first is the increase in gross annual irrigated area (total for two seasons) from approximately 21,000 ha in 1977 to between 27,000 and 37,000 ha in the latter 1980s and early 1990s (Annex Figure 12). The second was the shift away from rice monocropping to crop rotation as administered by the district. After transfer the districts excluded sandy area from rice production[11]. This permitted rice to be grown only once per year and led to an expansion of area planted in cotton, sorghum, soybean and other non-rice crops. The area planted in rice was about 19,200 ha in 1975, the year before turnover. It dropped to about 16,450 ha by 1991, a drop of 14% in area (Figure 6).

*Figure 5. Water delivered per hectare, Coello District, 1975-1991**



** Per season average*

*Figure 6. Area cultivated and water delivered per hectare for rice, Coello District**



** Per season average*

Contrastingly, Annex Figures 13 and 14 show the rise during this period in area cultivated in cotton and sorghum, the main non-rice crops in Coello. Average water deliveries for these non-rice crops varied widely, with no apparent increasing or decreasing trend. In Coello the decrease in the area fee and rise in the volumetric fee may have encouraged the expansion of irrigated area and a reduction in the volume of water 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 increase 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 level than in 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

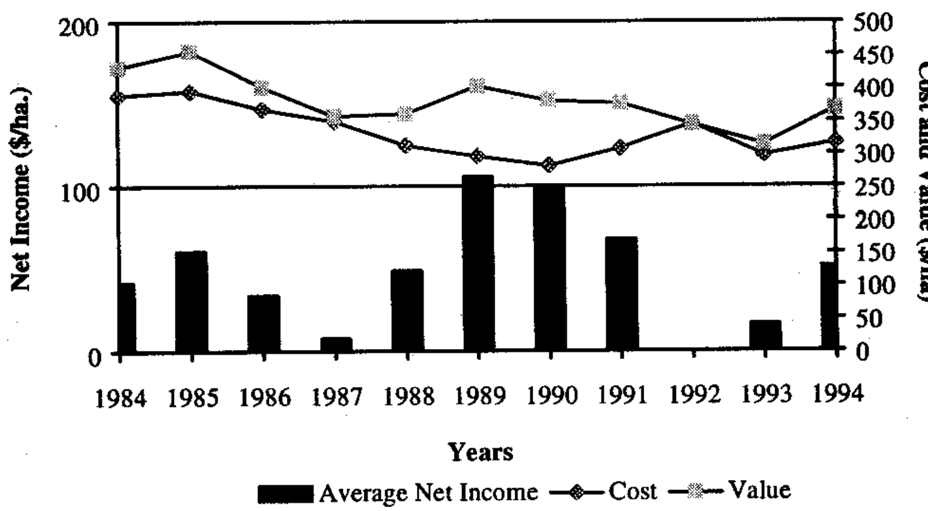
The gradual expansion of irrigated area after construction halted for about four years at the time of turnover, perhaps because of uncertainties and inefficiencies temporarily created by the change in management. But the expansion resumed after this apparent learning period and only began leveling off in the early 1990s (Annex Figure 12). The rate of expansion has been higher in Coello, where crop diversification has occurred, than Saldaña, where it has not.

Area expansion continued over several years, primarily as a result of two factors. First, the tertiary network was extended and improved over time. Secondly, as farmers gained more experience with irrigation and their livelihoods improved, they increased the area irrigated within their farms. Most of the expansion occured during the boom of the green revolution.

Largely as a result of the introduction of green revolution varieties in the 1960s and 1970s, average rice yields increased dramatically from approximately 2,500 kgs in the mid 1950s to approximately 6,000 kgs in 1976, at the time of transfer (Annex Figure 15). By the 1990s average rice yields were between 6,500 and 7,000 kgs per 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 eleven-year period from 1984 to 1994. The cost declined from about US $380/ha in 1984 to about $320/ha in 1994 (in constant 1988 dollars; Figure 7). Average net income for rice production varied widely from zero to about $105/ per ha. during the period, peaking in 1989 and falling to about $45 per ha in 1994.

*Figure 7. Cost and value of rice production, Coello and Saldaña Districts, 1984-1994**



* *Based on total production data for both systems. US dollar equivalents of 1988 Colombian Pesos.*

The total cost of water relative to the cost of rice production dropped from approximately 4.4% during the 1950s, before turnover, to between 3.1% (in Saldaña) and 3.3% (in Coello), largely due to increase in the cost of production. However, during the post-transfer period it has been rising, from 2% in 1984 to 3.3% in 1993 (in Coello).

In Coello, under post-transfer management during the 1980s, the total cost of irrigation remained essentially constant in real terms from $ 50.57 in 1983 to $ 50.63 per hectare in 1991 (in 1988 US dollars; Annex Table 9)[12] . However, the total gross value of output per hectare for all irrigated crops rose over four-fold (Figure 8) during the same period, from $ 944 to $ 4,300 per ha. The cost of irrigation as a percentage of the gross value of output was relatively small and dropped still further, from 5.4% to only 1.2% by 1991 (Figure 9).

Coello District also achieved impressive gains in gross value of output per unit of water, which increased 298%, from $ 2.35 per 100m^3 in 1983 to $ 9.35 per 100m^3 in 1991 (Figure 8 and Annex Table 10).[13] This reflects the gain in output relative to water resulting from crop diversification and this intensification brought on by the "green revolution."

Figure 8. *Gross value of output (GVO) for Coello District, 1983-1991 (1988 US$)*

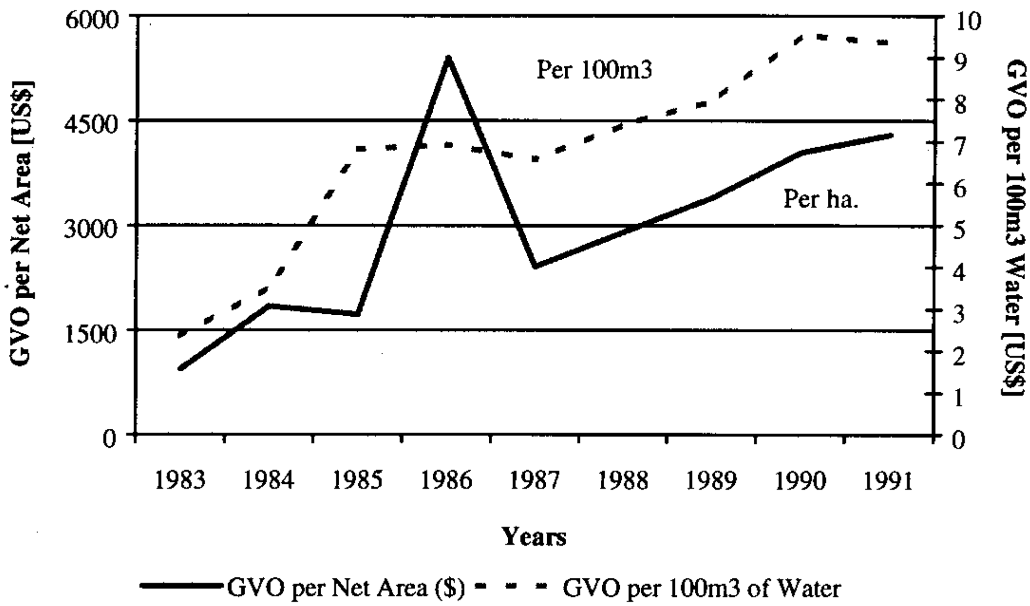
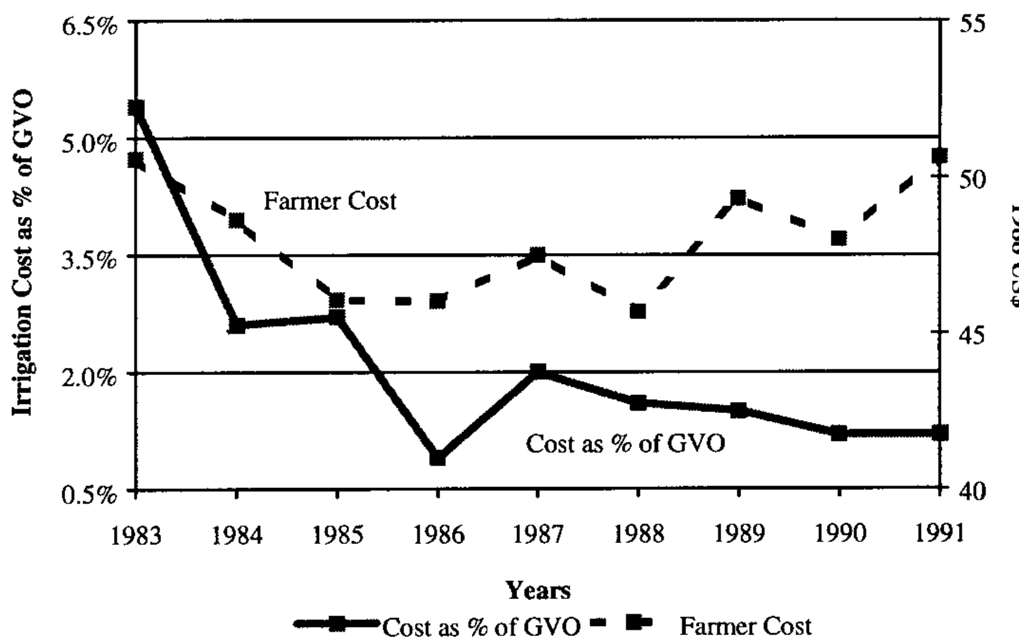


Figure 9. *Cost of irrigation per ha. to farmers and irrigation cost as a percentage of gross value of output (GVO), Coello District, 1983-1991 (1988 US$)*



PERSPECTIVES OF STAKEHOLDERS

Farmers

<u>Interest in turnover</u> The initiative for turnover came from the water users rather than 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.

<u>Role of government</u> In 1976, farmers agreed that HIMAT should continue to provide oversight and advice to the farmers associations about management of the 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 only partial and not 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 and half from the lower third area in each system. It was found that in Coello, only 29% of farmers sampled wanted the government to withdraw completely from working with the district; 48% wanted the government to continue to be partially involved in assisting the irrigation district, while 21% stated that the government should takeover management again (Annex Figure 16). In Saldaña, only 14% favored complete government withdrawal, 68% favored continuing partial government involvement, and 16% favored government takeover.

The most commonly mentioned roles which 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.

<u>Ownership</u> Sample farmers were also asked about who they think should own the irrigation infrastructure. In Coello, 76% thought the farmers association should own it; in Saldaña 80% thought the farmers should own it (Annex Figure 17). Only 19% in Coello and 18% in Saldaña thought that the government should own the structures.

<u>Outcomes of turnover</u> Sample farmers were asked the question, "Has the 1976 transfer of management for the irrigation district from the government to the farmers organization improved, worsened, or not changed much the management of the irrigation district?" In Coello, 53% responded that it had not changed much, 40% said it had improved, and only 7% said it had gotten worse. In Saldaña, 39% said management had improved after turnover, 36% said it had not changed much, and 25% said it had gotten worse. 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 farmers in both systems thought management had improved were in: 1) communication between district staff and farmers, 2) responsiveness of district staff to farmers, and 3) water distribution. About 70% of sample farmers in Coello and 91% in Saldaña stated that they had attended a district association meeting within the last year.

<u>Impacts on maintenance</u> Sample farmers were asked, "Has the functional condition of the secondary canal which delivers water to your field improved, worsened, or stayed about the same over the past ten years?" In Coello,

81% said it had stayed about the same, 17% said it had improved, and only 2% said it had worsened (Annex Figure 18). In Saldaña, 73% said it had stayed in about the same condition, 15% said it had worsened, and 13% said it had improved (with no significant difference between head and tail enders).

Impacts on operations Sample farmers were asked the question, "Over the last two 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% said it was always enough and 32% said it was enough most of the time. Only 20% said it was not enough most of the time and 2% said it was never enough. In Saldaña, 59% said water was always enough and 31% said it was enough most of the time. Only 4% said it was not enough most of the time and 2% said it was never enough. In Coello, a surprising 96% said water was delivered to their field on time all or most of the time. In Saldaña, 90% 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 a widespread satisfaction exists among farmers about water distribution after turnover.

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

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

District Staff

District managers expressed concern that the strong farmer disposition toward cost reduction was resulting in some decline in service and that this would eventually result in visible deterioration of the system. Experienced senior personnel had been replaced by younger, inexperienced staff; key technical positions have been eliminated or merged and little or no expenditure is 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, HIMAT staff at the district and higher levels were generally 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 elsewhere 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 law suits between the farmers and the agency, mainly over the issue of releasing staff. After the new Land Development Law of 1993, the government granted full authority over district staff and budgets to farmer associations.

CONCLUSION

Perception

Most farmers see turnover as having produced a more responsive and cost efficient management. Most, however, favor a continuing limited role for the agency, primarily in providing technical advice and in helping with dispute resolution. The majority believe that the association should own the irrigation infrastructure. However, most farmers appear satisfied with the performance of operations and maintenance. 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. 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 operations and maintenance. 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 operations and maintenance. The "delegation of authority", however, did not result in full turnover of authority to the farmers associations. The agency continued to exercise partial influence over budgets and staffing. Nevertheless, after turnover the districts began a gradual process of reducing staff, while continuing virtually the same level of management intensity as before turnover. 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% 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 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. After turnover the districts were able to expand irrigated area and sustain high levels of agricultural production while decreasing the annual average volume of water delivered. 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.

4. Nineteen years after the transfer only 2% of total canal length in Coello, and 8% in Saldaña, was dysfunctional (mostly in tertiary canals). Of all water control and measurement structures only 15% in Coello and 12% 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 ill-effected by turnover. The intensive and costly maintenance investment the districts have been able to support, relative to the serious siltation problem, has been impressive.

5. However, since 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 are being well maintained until the present, this may lead to some deferred maintenance in the future.

6. 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. Coello district was able to substantially expand its area irrigated through steadily delivering less water per hectare and diversifying cropping. Saldaña, which had heavier soils, continued to irrigate only for rice, though it staggered planting dates in order to spread out irrigation demand over the year.

7. 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 remained stable after transfer.

8. Perhaps the most important finding of the study was 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 only partially be 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 ha. 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 rises in the cost of irrigation to farmers.

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END NOTES

[1] This study was conducted during 1993-1995. It involved analysis of data from .the records of the two irrigation districts, 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. IIMI is grateful to INAT for its support for this study. IIMI gratefully acknowledges the financial support for this research from the Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ) of the Government of Germany.and the Ford Foundation.

[2] Drainage systems in both schemes are natural drains. No drainage system was ever constructed. Rehabilitation and maintenance of drains refers to de-siltation of small streams, re-directing natural outlets, etc.

[3] HIMAT is the acronym for the Institute for Hydrology, Meteorology and Land Development. In 1994 its acronym changed to INAT, when meteorology was removed from its mandate.

[4] However, this Law is currently being challenged in the courts regarding the issue of releasing staff who were originally hired by the Government..

[5] The previously required quotas for board member positions with farm holdings less and greater than 20 ha. have recently been dropped.

[6] These fee levels are for rice for small holder farmers.

[7] 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. 76% of all farmers are "small holders" in Coello; 90% are "smallholders" in Saldaña.

[8] This was a comprehensive inventory and examination of all structures and canal lengths in both systems. However, due to the timing of the study it was not possible to do an examination before turnover.

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

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

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

[12] Cost of irrigation to farmers is the total revenues from all water charges collected by net irrigated area, per year.

[13] Unfortunately, similar data was not available for Saldaña.

ANNEXES

Annex Table 1. Number of farms by size category, Coello and Saldaña Districts, 1968 and 1993

Farm Size Category	1968				1993			
	Coello		Saldaña		Coello		Saldaña	
	No. of Farms	% of Total	No. of Farms	% of Total	No. of Farms	% of Total	No. of Farms	% of Total
0-5 ha.	264	26.6	589	56.4	703	38.5	1,255	63.9
5.1 - 10 ha.	200	20.1	146	14	386	21.1	279	14.2
10.1 - 20 ha.	207	20.8	141	13.5	300	16.4	231	11.7
20.1 - 50 ha.	180	18.1	115	11	322	17.6	181	9.2
> 50 ha.	143	14.4	54	5.1	115	6.4	19	1
Total	**994**	**100**	**1045**	**100**	**1,826**	**100**	**1,965**	**100**

Annex Table 2. Basic information, Coello and Saldaña Districts

District	Coello	Saldaña
Item		
State	Tolima	Tolima
Period Built	1949-1953	1949-1953
Transferred	September 1976	Setpember 1976
Design Area (ha.)	44,100	16,428
Irrigated Area (ha.) [1993]	25,628	13,975
Water Users' Association	Usocoello	Usosaldana
Main Soil Type	Sandy, Loam	Clay, Loam
Main Crop(s)	Rice, Soybean, Cotton	Rice
Water Source	River Coello	River Saldaña
System Type	Run-of River	Run-of River
Intake Structure	Radial Gates	Radial Gates
Irrigation Structures	1,666	756
Lowest Water Measurement Point	Secondary Canal	Secondary Canal
Water Delivery Efficiency (%)	69.2%	69%
Length of Main Canal (km.)	69.1	60.8
Total Length of Canal Network (km.)	250.2	162
Ha. Served/Km. Canal	102.4	86.3
Turnout Type	Sliding Gates	Sliding Gates

Annex Table 3. Staff levels before and after transfer, Coello and Saldaña Districts, 1975 and 1993

Program	Before Turnover (1975): Coello and Saldaña Combined	After Turnover (1993)		
		Coello District	Saldaña District	Both
Administration	36	18	18	36
Maintenance	161	60	50	110
Operation	51	19	24	43
Technical	52	0*	0*	0
Total staff members	300	97	92	189
Irrigated area (ha.)	18,700	15,300	12,500	27,800
Area/staff member (ha.)	62	158	136	147

** Several "technical staff" members were retained but shifted to other departments. These include staff for hydrologic measurement, design and financial matters.*

Annex Table 4. Basic system parameters, Coello and Saldaña Districts, 1993

Data Set	Value	
	Coello	Saldaña
A Irrigation water supply	948 mm	1517 mm
B Effective rain	554 mm	793 mm
D Irrigation duty	8.64 mm/day	15.5 mm/day
F Maximum irrigation demand	9 mm/day	8.5 mm/day
G Annual demand	1097 mm	1318 mm
H Seasonal maximum irrigation intensity	54.4%	93.7%
I Annual irrigation intensity	101%	161%
J Production (Rice)	$ 7 t/ha.	$ 7 t/ha.
K Gross margin	$ 1,146.45 ha./yr.	$ 1,593 ha./yr.
L Total area	25,628 ha.	13,975 ha.
L Regulation area	10 ha.	10 ha.
M Farmer management area	50 ha.	50 ha.
N Farm size	14 ha.	7.5 ha.
O Capital cost	$ 5,500/ha.	$ 5,500/ha.

Annex Table 5. Basic performance indicators, Coello and Saldaña Districts, 1993

No.	Name	Formula*	Units	Coello	Saldaña
1	Return to land	K	$/ha	1,146.45	1,593
2	Return to irrigation	K/(A+C)/10	$/m3	0.12	0.105
3	Return to water	K/(A+B+C)/10	$/m3	0.076	0.069
4	Return to economy	K/O	%	20.84	28.96
5	Fee/cost ratio	Q/P	%	101.9	108.9
6	Water use efficiency	G/(A+B+C)	%	73.00	57.00
6 (1)	Relative water supply	1/WUE	Ratio	1.37	1.75
7.	Delivery efficiency	F/(D+E)	%	104.0	54.8
9	O&M area/staff		Ha./staff	324	189

* *Letters refer to those in Annex Table 4. C refers to pumped supply; E refers to wells. Neither occur in either system*

Annex Table 6. Total revenue and expenditures, Coello and Saldaña Districts, 1983-1992 [In 1988 US$]*

Year	Coello District		Saldaña District	
	Total Revenue	**Total Expenditure**	**Total Revenue**	**Total 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	695,8,00
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	**+44%**	**+51%**	**+29%**	**+20%**

* *In 1988, US$ 1.00 = 333 Colombian Pesos*

Annex Table 7. Annual cost of irrigation to farmers, Coello District, 1983-1992

Year	Fixed Charge Paid	Volumetric Charge Paid	Total Water Charge Paid	Total Water Charge Paid (1988 US$)	Net Irrigated Area (ha.)	Cost to farmers per ha. (1988 US$)
	In million 1988 US $					
1983	246,246	439,039	685,285	685,285	13,550	50.57
1984	259,459	414,830	675,375	675,375	13,890	48.62
1985	292,793	486,786	779,579	779,580	16,925	46.06
1986	281,081	458,258	739,339	739,339	16.070	46.01
1987	342,643	491,591	834,234	834,234	17,565	47.49
1988	342,642	494,294	817,417	817,417	17,900	45.67
1989	330,330	584,384	914,714	914,715	18,550	49.31
1990	306,306	577,177	883,483	883,483	18,410	47.99
1991	319,219	496,996	816,216	816,216	16,120	50.63
1992	309,909	520,120	830,030	830,030	15,410	53.86

***** *In 1988, US$ 1.00 = 333 Colombian Pesos***

Annex Table 8. Results of canal maintenance survey, Coello and Saldaña Districts, 1994

Description		Coello				Saldana			
		Maintenance Conditions*				Maintenance Conditions*			
		Length	**Functional**	**Partially Functional**	**Dysfunctional**	**Length**	**Functional**	**Partially Functional**	**Dysfunctional**
Main Canal	KM Sub-Total	69.1	46.8	22.3	0	60.8	47.8	13	0
	Percentage (%)	100	68	32	0	100	79	21	0
Secondaries	KM Sub-Total	71.9	54.6	17.3	0	44.6	14.6	27.6	2.4
	Percentage (%)	100	76	24	0	100	33	62	5
Tertiaries	KM Sub-Total	109.2	68.5	35.7	5	56.6	15.2	30.8	10.6
	Percentage (%)	100	63	33	4	100	28	53	19
Total Network		**250.2**	**169.9**	**75.3**	**5**	**162**	**77.6**	**71.4**	**13**
Percentage (%)		**100**	**68**	**30**	**2**	**100**	**48**	**44**	**8**

Maintenance condition:

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, Major rehabilitation is needed.*

Annex Table 9. Results of structure maintenance survey, Coello and Saldaña Districts, 1994

	Coello District				**Saldaña District**			
	Maintenace Condition				*Maintenance Condition*			
	Functional	**Partially Functional**	**Dysfunctional**	**Total Number**	**Functional**	**Partially Functional**	**Dysfunctional**	**Total Number**
Headgates**	30	16	4	50				
Control-drop***	40	7	18	65				
Control	53	24	2	79	100	17	10	127
Drops	121	14	0	135				
Distribution Box	15	1	1	17				
Culverts	102	20	38	160	16	3	2	21
Siphon	25	6	0	31	40	5	0	45
Aqueducts	10	0	0	10				
Radial Gates					36	3	2	41
Box Culverts					0	0	2	2
Fumes					0	0	9	9
Gates	496	32	9	537				
Bridges	91	11	0	102	120	20	7	147
Regul. Dam***	7	0	0	7				
Canaletas****	186	88	166	440	210	98	56	364
Measuring	2	17	14	33				
Total	**1178**	**236**	**252**	**1666**	**522**	**146**	**88**	**756**
Percentage (%)	71	14	15	100	69	19	12	100

* Headgates for main canals include radial gate structures; all others are sliding gates.

** The 65 control-drop structures combination include 4 types of drops: i) vortices [14]; ii) box [23]; and iii) vertical [23] and shute [5] units.

*** Regulation dams are small dams that capture drainage, which is re-utilized in the system.

**** Flume-type measuring structure.

Maintenance condition:

Fully functional: Keeps design conditions; no elements missing; no modifications apparent or needed.

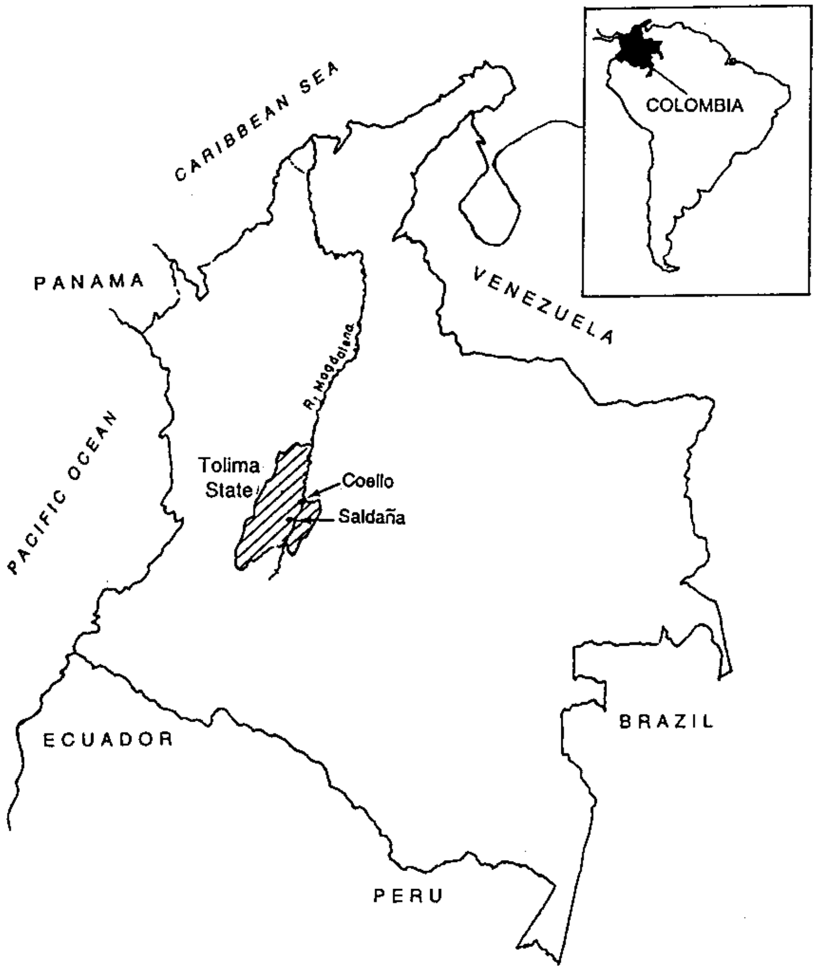
Partially functional: Some deterioration is evident; minor components missing; requires minor maintenance [painting, grease]; still functions with 15% of design requirement.

Dysfunctional: Heavy deterioration; broken, damaged or missing components; is not functional at all

Annex Table 10. Total cost of irrigation to farmers and gross value of output, 1983-1991 [1988 US Dollars]

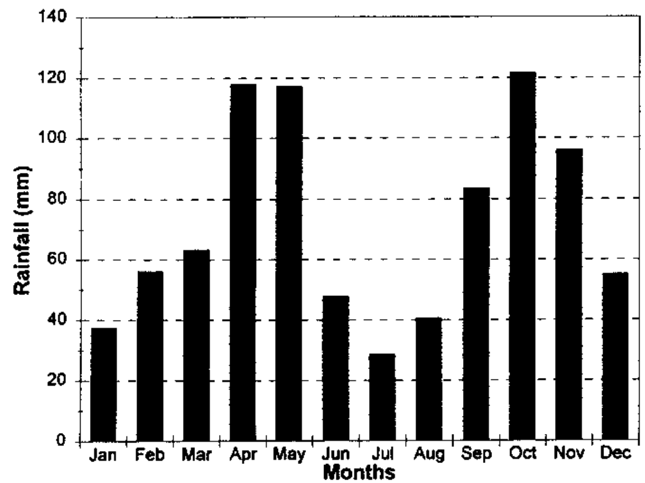
Year	Irrigation Cost per Ha. [US$]	GVO per Ha. [US$]	GVO per 100m³ Water	Irrigation Cost as % of GVO
1983	50.57	944	2.35	5.4%
1984	48.62	1,844	3.53	2.6%
1985	46.06	1,722	6.81	2.7%
1986	46.01	5,394	6.92	0.9%
1987	47.49	2,410	6.57	2.0%
1988	45.67	2,909	7.41	1.6%
1989	49.31	3,391	7.96	1.5%
1990	47.99	4,046	9.54	1.2%
1991	50.63	4,300	9.35	1.2%

Annex Figure 1. Map of Colombia, with Coello and Saldaña Irrigation Districts

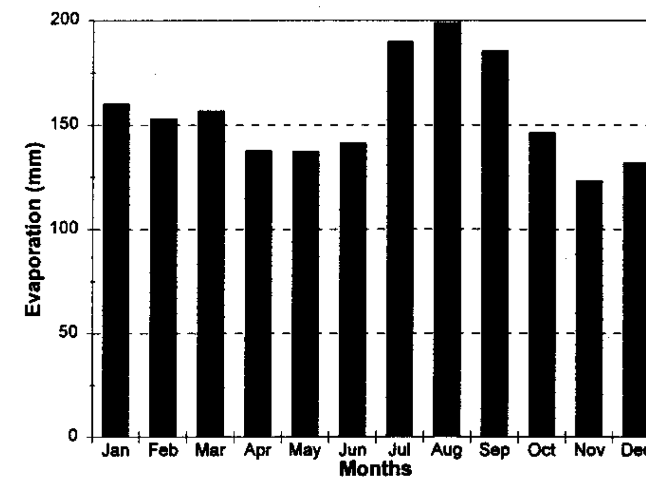


Annex Figure 2. *Climatic data for Tolima Valley, Colombia*

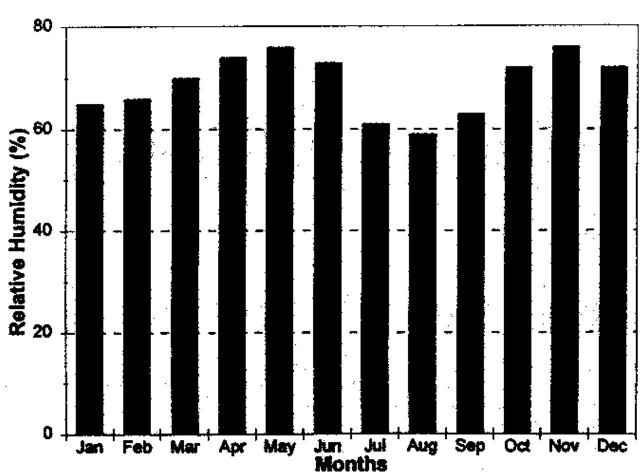
Average monthly rainfall - 1962-1992
(1976 data not available)



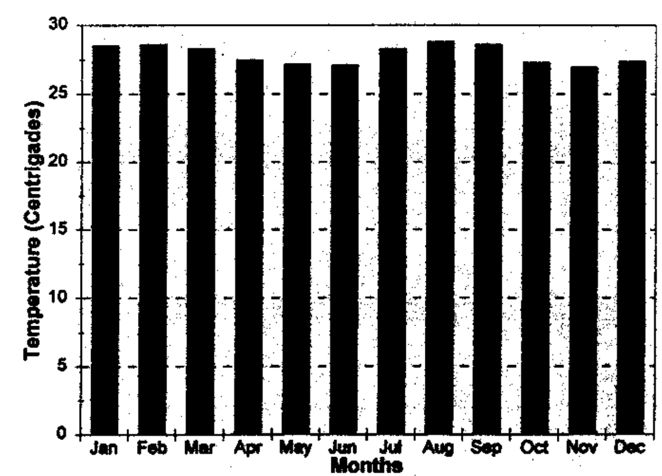
Average monthly evapotranspiration - 1971-1981



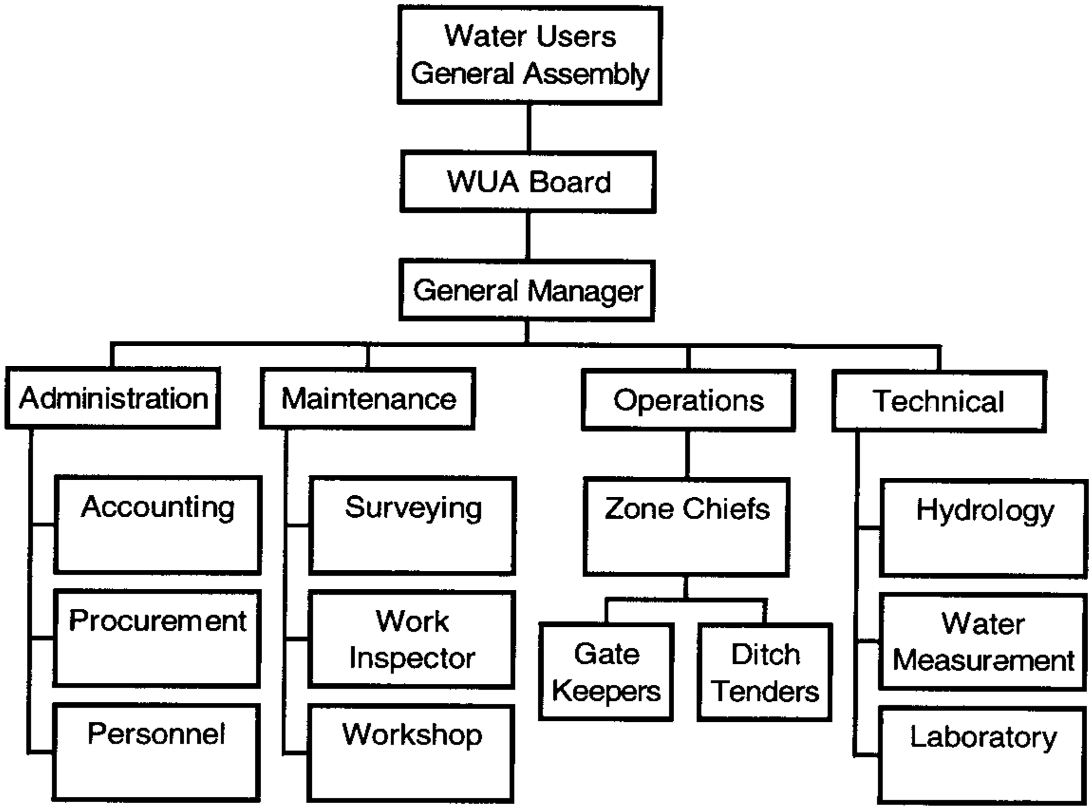
Average monthly relative humidity - 1971-1981



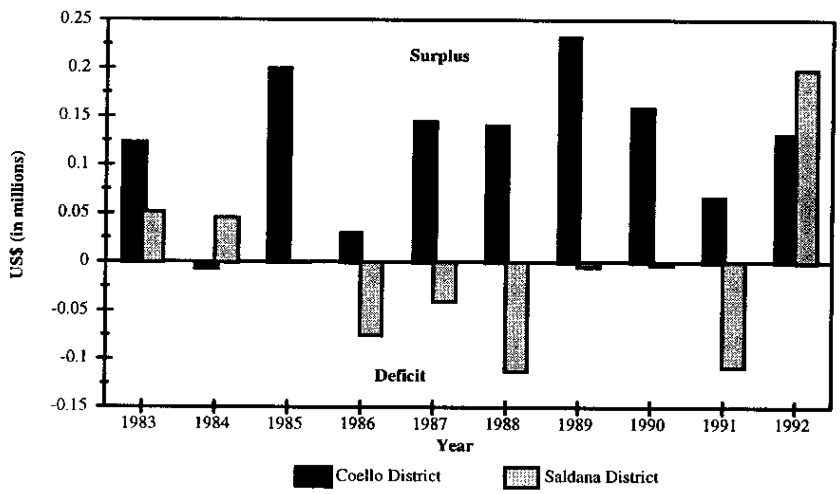
Average monthly temperature - 1971-1981



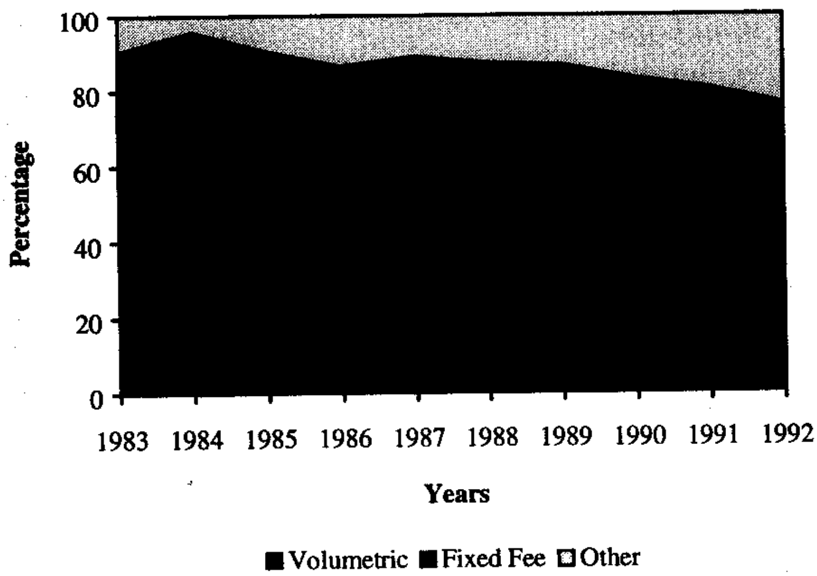
Annex Figure 3. *Organizational structure, Coello District*



Annex Figure 4 . *Budget balances in Coello and Saldaña Districts, 1983-1992*

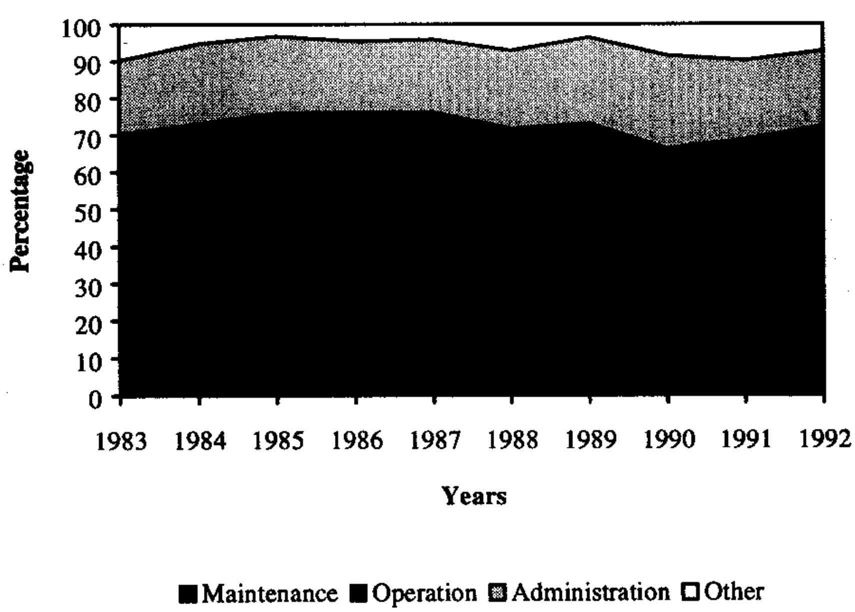


Annex Figure 5. *Revenue sources, Coello District**



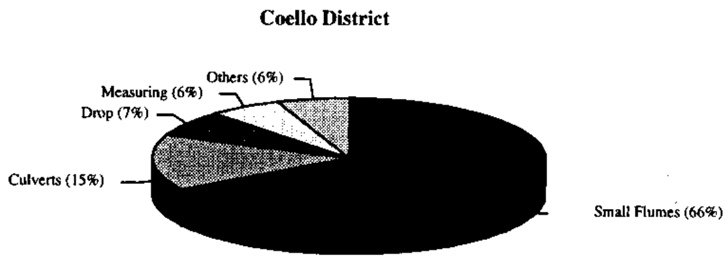
* *In constant 1988 Colombian Pesos, 1983-1992*

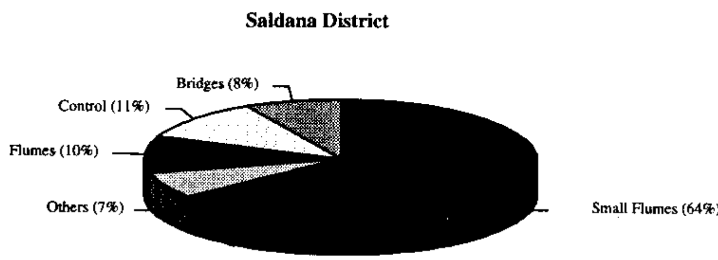
Annex Figure 6. *Types of expenditures, Coello District**



* *In constant 1988 Colombian Pesos, 1983-1992*

Annex Figure 7. *Composition of dysfunctional structures**

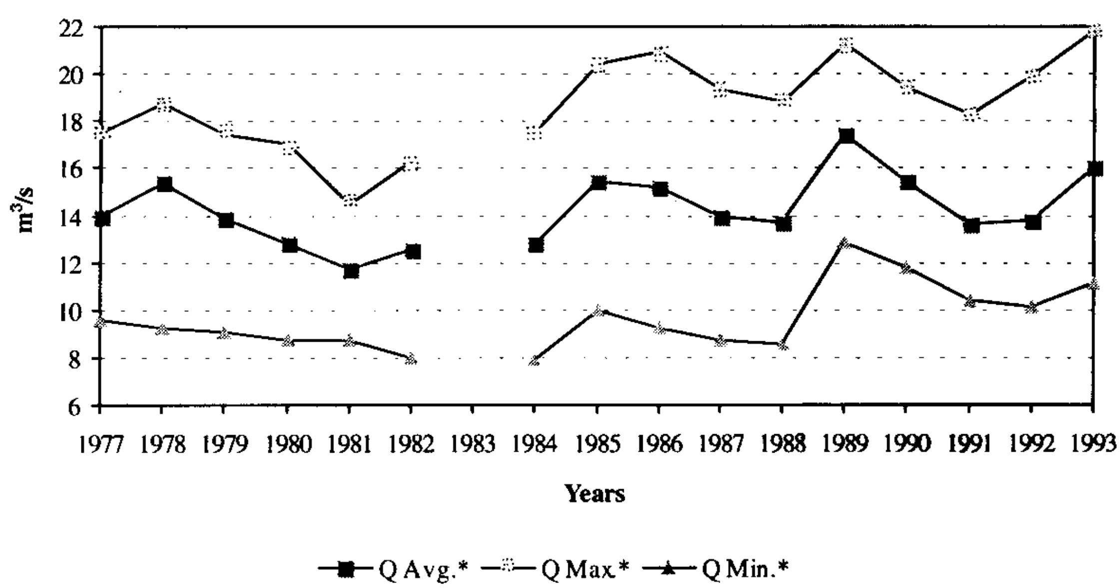




** 252 or 15% of all structures are "dysfunctional."*

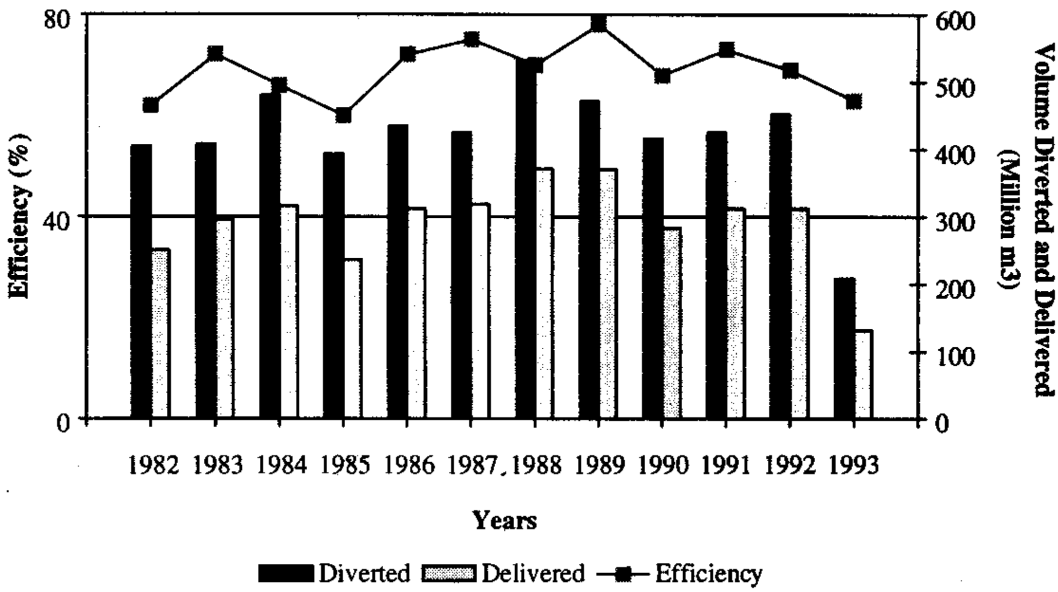
"Dysfunctional" is defined as: heavy deterioration; broken damaged or missing components; is not functional within 70% of design requirement.

Annex Figure 8. *Discharge at intake, Coello District, 1974-1993*



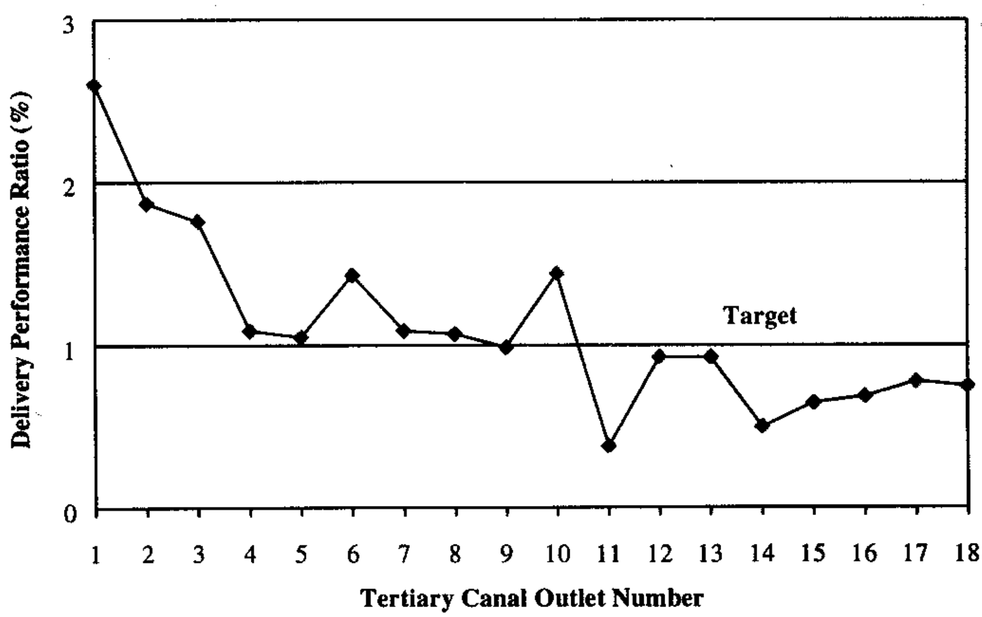
**Average 12 months. Data not available for 1983.*

Annex Figure 9. *Main canal total conveyance efficiency, Coello District*



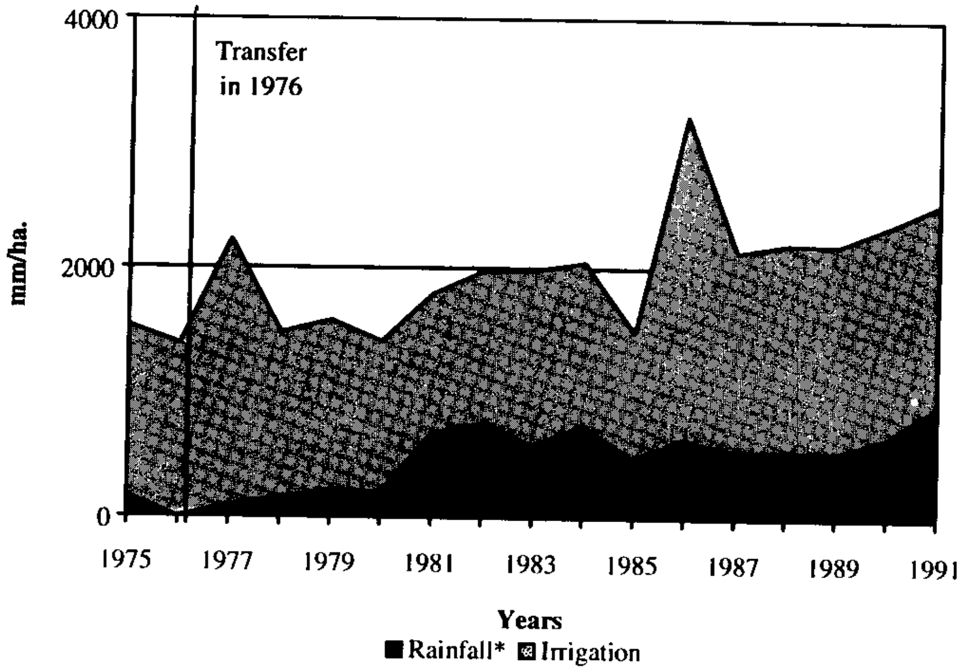
(Ratio of water delivered to diverted, 1982-1993)

Annex Figure 10. *Water delivery performance ratio along sample tertiary canal, Saldaña District*



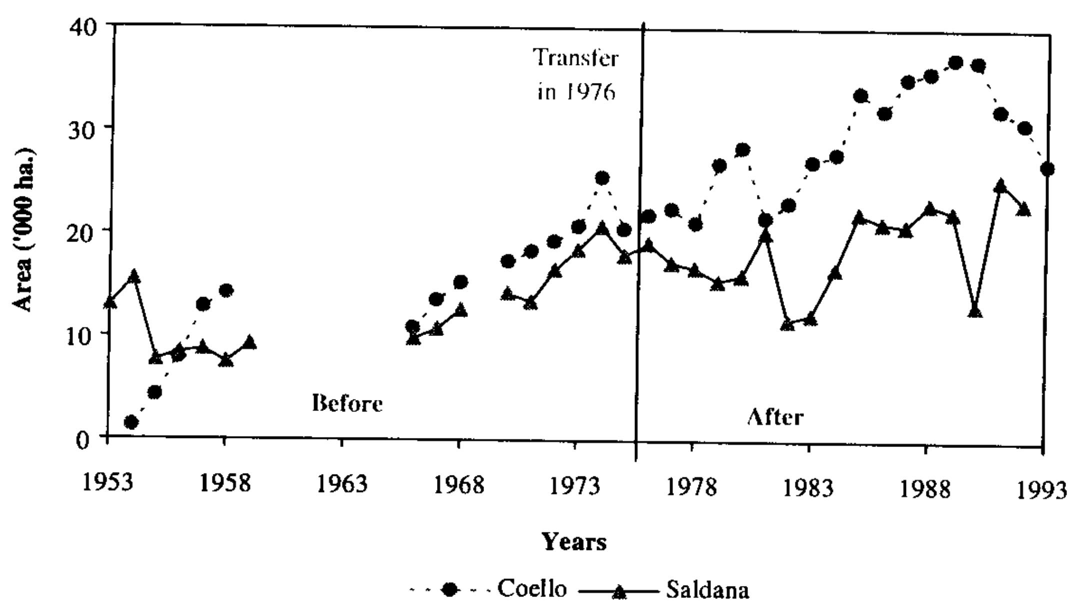
[Ratio of water delivered to targeted. Measured July 15, 1993. Distance from tertiary head increases as outlet number increases]

*Annex Figure 11. Annual water supply for rice crop, Coello District**



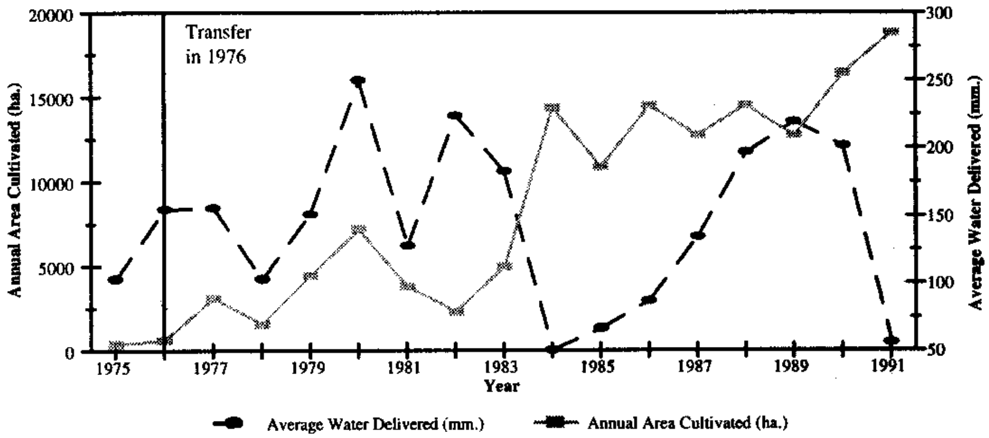
* *Main growing season - March, April, May, June and July. For years 1975-1991.*

Annex Figure 12. Gross annual irrigated area before and after transfer, Coello and Saldaña Districts*



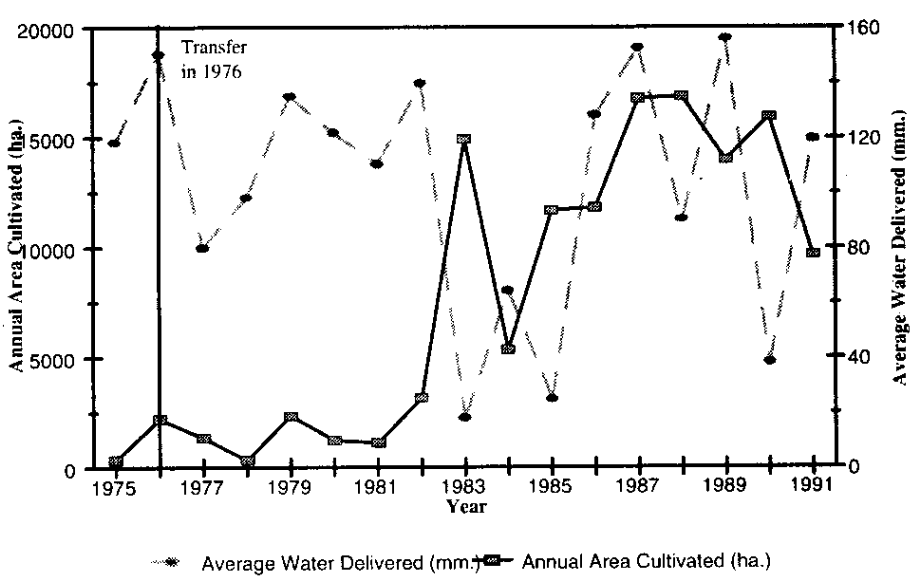
* *Summation of irrigated area for both crop seasons, 1953-1993. Data for 1960-1964 is missing.*

Annex Figure 13. *Area cultivated and water delivered per hectare for cotton, Coello District**



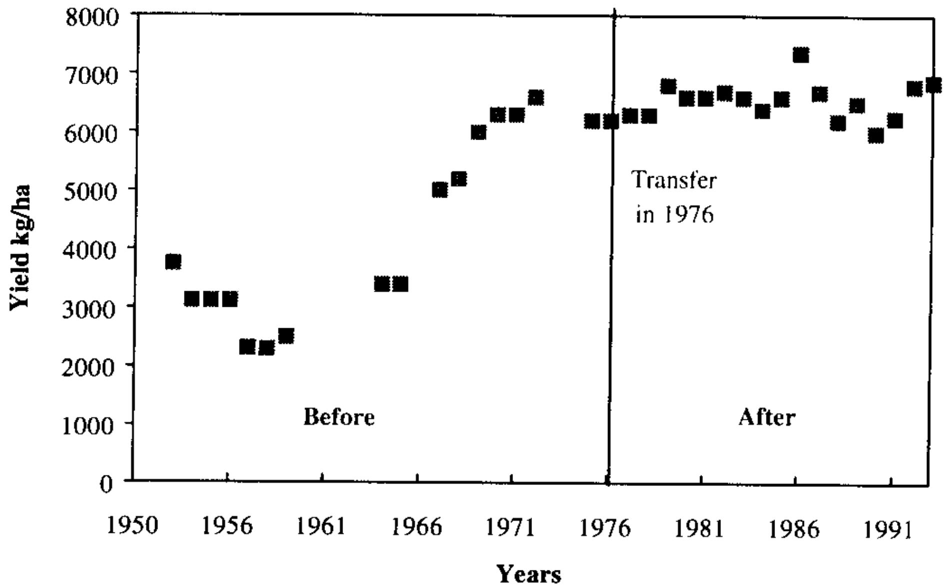
** Per season average*

Annex Figure 14. *Area cultivated and water delivered per hectare for Sorghum, Coello District**



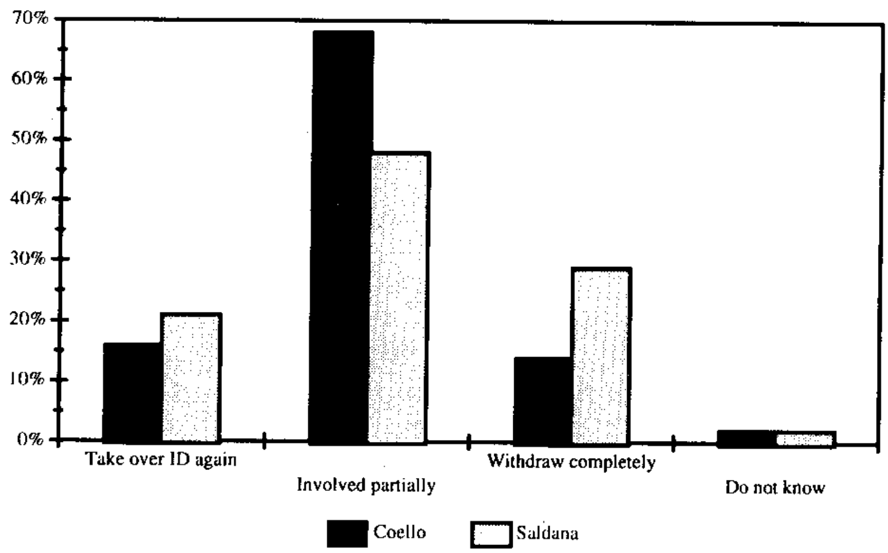
** Per season average*

Annex Figure 15 Average annual rice yields before and after transfer, Coello and Saldaña Districts



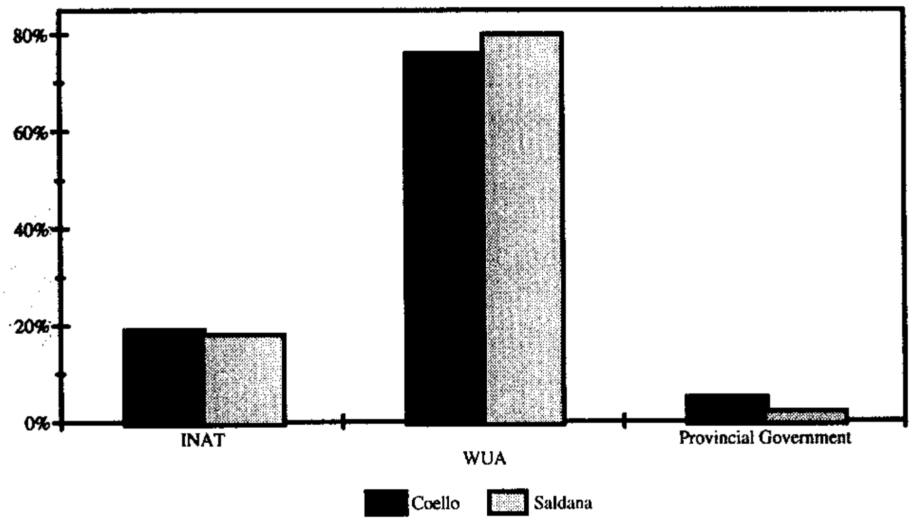
(For years 1963-1993)

*Annex Figure 16 Farmer perspectives about withdrawal of the irrigation agency**



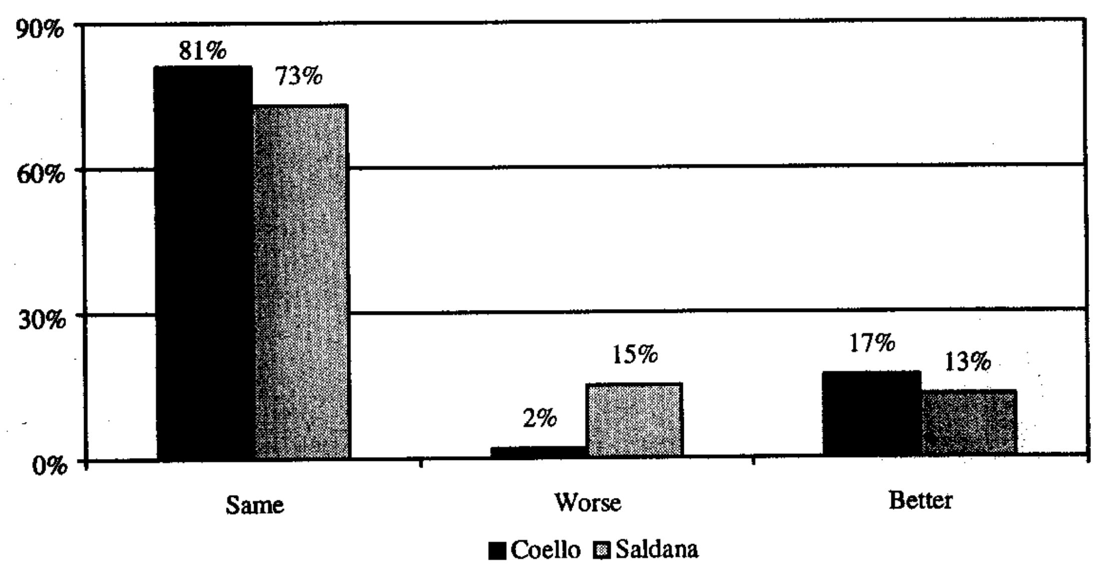
* *Sample farmer responses to question, "Should INAT or a government agency continue to be involved with the irrigation district or leave it up to the farmer organization entirely?" N = 44 in Coello and 48 in Saldaña.*

Annex Figure 17 *Farmer perspectives about ownership of irrigation structures**



** Sample farmer response to question, "Who should own irrigation district structures?" N = 42 in Coello and 49 in Saldaña.*

*Annex Figure 18 Farmer perceptions about secondary canal maintenance**



N = 42 in Coello and 48 in Saldaña