Policy, Planning, and Research

WORKING PAPERS

Agriculture Production and Services

Agriculture and Rural Development
Department
The World Bank
September 1989
WPS 264

Two Irrigation Systems in Colombia

Their Performance and Transfer of Management to Users' Associations

Herve Plusquellec

Two Colombian projects show how local farmers can manage an irrigation system in a developing country if the management and personnel are well-trained and motivated and if the infrastructure is in good condition at the time management is turned over to the farmers.

Policy, Planning, and Research

WORKING PAPERS

Agriculture Production and Services

Two Colombian irrigation projects are studied in this report, the Coello and RUT projects. Management of the RUT project is going to be transfered soon from public managers to farmers. The Coello project has been farmer-managed for about 13 years.

The keys to its success have been:

- The dynamism of the private farming sector and support services in Colombia.
- The high level of farmer training.
- Patterns of land tenure — with farms an average size of 15 hectares.
- Regular maintenance.
- The continuity of medium- and low-level staff, many of whom have been employed 10 to 15 years by the district.
- The availability of communication and transportation facilities.
- Some use of hydraulic engineering in the design of irrigation facilities, to simplify operations and reduce maintenance costs.

This study is part of a series of case studies on the interaction between design and performance of irrigation systems in selected countries. This series of studies is carried out in collaboration with the Bank Operations Evaluation Department and the International Irrigation Management Institute (IIMI), Kandy, Sri Lanka.

This paper is a product of the Agriculture Production and Services Division, Agriculture and Rural Development Department. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Herve Plusquellec, room N-8067, extension 30348 (75 pages with tables).

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table of Contents

CURRENCY EQUIVALENTS

US$1	=	300 Col$ (1988)
Colombian peso (COl$)	=	0.0033 US$

WEIGHTS AND MEASURES

1 acre (ac) = 0.405 hectares (ha)
1 mile (mi) = 1.609 kilometers (km)

GLOSSARY OF ABBREVIATIONS

CHO	-	constant-head orifice
ha	-	hectare
HIMAT	-	Instituto Colombiana de Hidrologia, Meterologia y Adecuacion de Tierras (Colombian Institute of Hydrology, Meteorology and Land Improvement)
IIMI	-	International Irrigation Management Institute
INCORA	-	Instituto Colombiano de la Reforma Agraria (Colombian Institute for Agrarian Reform)
Mm3	-	Million cubic meters
m^3/sec	-	Cubic meter per second
RUT	-	Roldanillo-Union-Toro
WUA	-	Water User Association

FOREWORD

This report is part of a series of case studies of irrigation systems in different countries. These studies focus on:

- the extent to which the design of the irrigation system fosters effective water management and provides equitable, reliable, timely water distribution to farms (analyzes water efficiencies, the effectiveness of maintenance, and cost recovery), and
- the extent to which the farmers' organization have taken responsibility for operating and maintaining the system and helping to recover costs.

Case studies are being prepared by the Bank's Operations Evaluation Department in cooperation with the Agriculture and Rural Development Department (AGR) in two semi-arid countries, Mexico and Morocco, and two tropical countries, Thailand and the Philippines. Other case studies in South East Asia will be prepared by the International Irrigation Management Institute (IIMI). The report on the case study of the Gezira Irrigation Scheme in Sudan is under preparation by AGR.

This working paper describes the design and management of two irrigation districts in Colombia: the Roldanillo-Union-Toro (RUT) district (9,700 ha) in the Cauca Valley and the Coello district (27,180 ha) in the Magdalena Valley.

The Coello project is one of the two publicly built projects in Colombia for which management responsibility was transferred to the Water User Association when HIMAT1/ was created in 1976. There are few such examples in developing countries.

In the RUT project, the system of water conveyance is first through open canals to individual farms where it is then pumped into pressure systems for delivery to sprinkler. HIMAT plans to transfer management responsibility for this project to the Water User Association in June 1989. It will be interesting to see whether the RUT is as successful in this transfer as the Coello district has been.

On account of the short time available for data collection and field visits, this report in no way presents the level of details and analysis found in reports of the Operations Evaluation Department. It should however, provide some useful information on irrigation projects in a humid tropical country where the farmers' involvement in management of irrigation schemes is institutionalized, and on two specific projects where water has been distributed to the satisfaction of the farmers and irrigated agriculture has been sustained for more than 20 years without major rehabilitation programs.

1/ HIMAT: Instituto Colombiano de Hidrologia, Meteorologia y Adecuacion de Tierras. (Colombian Institute of Hydrology, Meteorology and Land Improvement).

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

SUMMARY AND CONCLUSIONS

The two Colombian districts selected for this study -- Coello and RUT -- are suitable for year-round cultivation because they enjoy a humid tropical climate with two rainy seasons. The average farm in RUT (5 ha) is a third the size of the average farm in Coello (15 ha), but is still large compared to farms in irrigated areas in most developing countries. Coello district benefits from certain physical advantages: The compact shape of the irrigable area and natural drainage. The flat lands of the RUT are difficult to drain and suffer from a high water table.

Water is delivered and applied by gravity methods in Coello. In RUT, water is first lifted from the Cauca River and then distributed through open-channel distribution systems to the farmers who use their diesel pumps for pressurized application. Both systems are operated manually, although at Coello a number of simple control structures and desilting devices were designed to simplify operation and reduce the cost of maintenance.

In both districts, water is distributed under a pre-arranged demand system. Water distribution is equitable, timely, and reliable although there are only few measuring devices and the systems are generally operated and water delivered based on the experience and instincts of district staff. Although irrigation service is satisfactory to water users, overall efficiency in the Coello district, estimated at 30 percent,

is relatively low. The main problem, common to all rice districts in Colombia, is that rice is grown not on leveled lands (as in all other major rice producing countries) but on sloping fields with low contour bunds -- which wastes water and uses the abundant rainfall inefficiently. The higher overall efficiency in RUT, estimated at about 40%, is attributable to the water-saving pressurized method of application. Rice is the predominant crop in Coello, followed by cotton and sorghum, so average water consumption there is much higher than in RUT, where rice cultivation is not authorized and the cropping pattern is more diversified. Crop yields -- especially rice (6 ton/ha) and cotton (3 ton/ha) -- are high by both national and international standards.

The irrigation system in Coello district (and to a lesser extent in RUT) has been well maintained since its construction 35 years ago, so the requirements for rehabilitation are modest and largely confined to the replacement of maintenance plant and equipment.

As in other Colombian districts, operation and maintenance (O&M) costs are recovered through two direct water charges, by application of a fixed and volumetric rate. The fixed rate, payable before each growing season, covers approximately 50% of the O&M costs. The average O&M cost per ha in RUT is equivalent to US$55 in 1988 dollars. It is much higher than in Coello (US$35), reflecting the costs in RUT of energy for primary pumping, the cost of maintenance of pumping facilities, and the greater development of main and distribution canal systems, the drainage system, and the network of access roads. Collection rates on water charges are excellent (100%) in both districts, but only 75% of annual budget expenses are recovered in RUT; HIMAT contributes the rest. The Coello district gets no help in financing its annual O&M expenses.

The annual O&M cost per hectare in Coello is probably typical, and a good basis for estimating the costs of managing, maintaining and operating a medium size project in a humid tropical environment under sustainable conditions.

Coello district has been well managed by its Water User Association, USOCOELLO, since HIMAT2/ was created in 1976.

The farmer-managed Coello district has succeeded for several reasons: Chief among them the dynamism of the private farming sector and supporting service activities in Colombia, the high level of farmer training and the relatively large size of farm holdings. Other factors relevant to this comparative study have also played a role in this success:

- o the continuity of medium - and low - level staff (most of the operations personnel in both RUT and Coello districts have been employed at least 10 years and some more than 15 years);
- o regular maintenance, and the availability of communication and transportation facilities; and
- o some use of hydraulic engineering in the design of irrigation facilities, to simplify operations and reduce maintenance costs.

These two Colombian projects have shown that a conventional design project in a developing country can perform reasonably well if certain conditions are present: highly motivated and trained personnel, good management, and adequate transportation and communication facilities.

2/ HIMAT: Instituto Colombiano de Hidrologia, Meteorologia y Adecuacion de Tierras. (Colombian Institute of Hydrology, Meteorology and Land Improvement).

Coello represents an interesting case of successfully turning management of a publicly administered large irrigation scheme over to farmers. It is the Colombian government's objective to progressively turn the management of all irrigation districts over to water user associations. The question is whether the successful experience in Coello can be repeated in other districts. Transfer of management responsibilities to the RUT water association, scheduled for 1989, should be instructive. The RUT district presents more physical and managerial disadvantages than Coello:

- o higher O&M costs, to which the costs of individual pumping for pressurized application should be added;
- o smaller average farm size; and
- o unfavorable drainage conditions and the risk of flooding from the hill streams and the Cauca River.

Will the small farm holders in RUT be able to pay their share of O&M costs? Will the Water User Association be able to sustain maintenance of the irrigation facilities well enough to prevent deterioration of the facilities?

In a wider context, the question arises whether the same approach to irrigation design and management would work with the very small holdings found in most developing countries. This question will be examined in similar studies of irrigation projects in Asia and Africa.

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

I. IRRIGATION IN COLOMBIA

1. Of the 810,000 ha under irrigation in Colombia, 347,000 ha are irrigated in public projects managed by HIMAT and 463,000 ha are irrigated by the private sector.

2. Little information is available on private irrigation because there is no agency concerned with its promotion and coordination. About half of the private irrigation systems are located in the fertile soils of the Cauca River valley. Most of these systems were developed by private individuals with financial assistance from the state in the form of development loans. Conservation of these systems is the farmers' responsibility. By and large, private irrigation is well equipped and effectively managed -- vertically integrated to processing facilities for sugar cane, cotton, and feed grains. Private irrigated agriculture mainly uses sophisticated technology. Water is pumped from river or tubewells and applied to the land by sprinklers or efficient surface methods. The water is carefully controlled and irrigation highly efficient. Yields are relatively high: an average 80-120 tons/ha for sugar cane, 2.6 tons/ha for soybean, and 2.6 tons/ha for cotton). Cropping patterns are determined by the farmers according to price incentives and the relative profitability of various crops.

3. The public irrigation/drainage subsector in Colombia comprises 24 districts, of which 16 are essentially for irrigation. The remaining eight

are classified as drainage schemes. The total physical area for the 24 districts (which average 14,000 ha each) is 343,000 ha -- of which 120,000 ha have irrigation and drainage infrastructure and 113,800 ha have only drainage infrastructure.

4. Designed during the 1960s, most of the public districts are based on simple designs. Two have storage dams, eight are supplied from direct river diversions, and seven from river pumping stations.

Institutional Framework and Farmer Management Structure

HIMAT was established in 1976 as an autonomous public entity attached to the Ministry of Agriculture. It took over public sector irrigation and drainage investments from another organization, INCORA, which previously had established them in conjunction with land reform. The Colombian Institute for Agrarian Reform, INCORA, established in 1961 to reform the agrarian social structure of Colombia, initially concentrated on land reform. In later years, INCORA diversified its operations considerably, and undertook land and water development projects. The transfer of technical responsibility from INCORA to HIMAT in 1976 reflects the decline of agrarian reform as a national priority.

HIMAT is governed by a board of directors from several public institutions, and presided over by the Ministry of Agriculture. Thirteen regional directors are responsible for managing HIMAT's activities. HIMAT has a total staff of nearly 2,000, of which half are in the irrigation and drainage Sub-directorate (1,950 in the regional offices, and 50 at the central office).

A Water Users' Association (WUA) was established for each of the 24 irrigation and drainage districts. The government attaches great

importance to the need to strengthen the Water Users Associations so that management of irrigation and drainage facilities can eventually be transferred to them. A program to rehabilitate and complete the existing districts begun in 1981, is being implemented with the help of the World Bank. Once a reliable irrigation service has been established, the recovery of O&M costs is expected to gradually improve eliminating the need for further budget allocations. Once O&M costs are fully recoverable the district management is to be transferred to Water Users Associations. Management of two districts, Coello (27,187 ha) and Saldana (13,985 ha) in the Magdalena Valley, was transferred to their Water Users Associations when HIMAT was created in 1976. Plans are to transfer management of the RUT district to the Water User Association in June 1989.

Regulations were established in 1977 to provide guidelines for the running of districts where management had been handed over from HIMAT to Users' Associations (see Appendix 2: Translation of Acuerdo No. 41 dated November 16, 1977).

The main points of interest in this document deal with:

- Responsibilities of the Office of the District Chief,
- The Definition of water users,
- Rights and obligations of water users,
- Constitution and elections of the Board of Directors,
- Powers of the Board of Directors,
- Preparation of irrigation plans,
- Water distribution,
- Eligibility requirements for water use entitlement,
- Individual farm turnouts,
- Water charges, fixed and volumetric rate, and
- Offences and fines.

The board of each association is composed of seven members, four representing minor farm holdings (of less than 20 hectares) and three representing major holdings. The board members are elected for two years, but can be re-appointed indefinitely.

The seasonal cultivation and irrigation program is submitted for approval to a consultative committee composed of representatives of the large and small farm holdings, regional directors of HIMAT and representatives of other agricultural institutions (credit, extension services) at the discretion of the water users'associations.

Acuerdo No.41 also defines the book-keeping responsibilities of the district management as including:

- Master list of users,
- Record and file of works and procurement contracts,
- Updated inventory of the District's works and equipment,
- Hydrological and meteorological records,
- Records of rainfed and irrigated crops,
- Record of irrigation distribution orders,
- Record of volumetric consumption,
- Books of inventories, materials, equipment control, unit costs, yields, etc.
- Accounting and cash books,
- Correspondence files,
- Files of channel and on-farm water measurement records and topographical records,
- Personnel records,
- Book of minutes of the meetings of the Coordination Commitee, meetings with users, Users' Associations, etc.,

- Any other information needed to ensure the District's smooth operation.

Water Charges

Under Colombian law all beneficiaries of public works must pay a land appreciation surcharge proportionate to the value of the government's investment. Beneficiaries of land improvement districts are also liable for the cost of operations and maintenance (O&M). Operations and maintenance costs are recovered through (i) a fixed water charge (per hectare, per year) and (ii) a variable water charge based on the volume of water delivered for irrigation. The law does not state what proportion of these two charges are to meet O&M costs. Water rates are fixed once a year by HIMAT's Board of Directors before the first planting season starts, at the time of budget preparation.

In setting the fixed and volumetric water rates, HIMAT determines the users'contribution to O&M costs, the government pays the difference. Fixed charges are paid in advance, regardless of land use. Their payment is a pre-requisite for receiving the irrigation service. The volumetric water charges are paid at the end of each season. The collection rate is generally high.

Volumetric payments depend on how much water is actually delivered to the farmers. Rainfall varies markedly, which affects demand for supplementary irrigation water. Total water charges covered only 34.9% O&M costs in 1980 and 28.5% in 1987. Only a few districts, including RUT, approach self-sufficiency for operations and maintenance.

II. COELLO IRRIGATION DISTRICT

The Coello irrigation district is located about 150 kilometers from the capital, Bogota on the left bank of the Magdalena River in the Department of Tolima, at an elevation of between 200 and 300 meters. The project covers part of a large alluvial fan with a regular but relatively steep slope (a few meters per kilometer). The Magdalena River, which borders the project area on its east side, cuts deeply into the alluvial valley soils. The river and a number of deep gullies that dissect the project area ensuring the lower part of the project of adequate natural drainage. The Bogota-Cali highway crosses the project area. District headquarters are located in the town of Espinal, at the center of the area. The gross area of the Coello district is about 44,100 ha, of which only 27,187 ha are currently registered. The rest are not yet developed or completed. The climate is tropical with an average monthly temperature ranging between 25°C and 30°C. Mean annual precipitation is about 1350 mm equally distributed between the two rainy seasons, from March to May and September to December (see table 1).

In the project area, the alluvial soils, of volcanic origin, are medium texture, suitable for both paddy and nonpaddy crops.

The only source of water for the project is the Rio Coello, a tributary of the Magdalena River, that drains the east side of the central Andean ridge. The flow of the Rio Coello is not regulated and floods are common at the headworks of the project after heavy rainfall in the upper catchment. Average annual inflow volume is about 450 Mm^3. Average monthly discharges vary from 10.4 m^3/s in March to 18.3 m^3/s in November. Suspended load and bed load are particularly high.

About 99% of the lands of the Coello project belong to private owners and only 1% (270 ha) to beneficiaries of agrarian reform. About 56% of the farms in the district are smaller than 10 ha, occupying a total of only 14% of the land area. Another 26% of the farms occupy more than 20 ha each or a total of 71% of the land. The average size of the 1,681 farms is 16.2 ha (Table 2).

The Irrigation System

The Coello irrigation system was built between 1950 and 1953 with the assistance of a consulting firm from the U.S.A. This system consists of:

(i) an intake on the bank of the Rio Coello with no permanent structure across the river,

(ii) an 8km-long unlined conveyance canal of 25 m^3/sec capacity,

(iii) a small hydropower plant, "La Ventana," that takes advantage of a 20 meter drop,

(iv) a network of unlined main canals (83 km) and secondary and tertiary canals (160 km) delivering water to the farms through 990 farm outlets.

Most of the drainage system consists of natural channels deeply cut in alluvial soils. Diversion weirs have been built on some of these channels to capture the water drained from the upper part of the district and to reuse it through irrigation systems supplying the lower areas of the district.

The land slopes too much to avoid scouring in unlined channels of same slope, so the main canals have been designed with non-erosive, gentle slopes and deep-cut sections. Vortex-type drop structures built at the end

of each section effectively dissipate the energy and create minimal erosion downstream.

The headworks consist of a diversion bund made of boulders that direct the water through a short channel to the main canal intake. One interesting feature is that the flow into the main canal is controlled by stoplogs instead of through undershot gates. The head on the stoplogs is controlled by adjusting the desilting gate. By skimming the water from the diversion channel, the volume of silt introduced into the distribution system is minimized. Along the conveyance canal four desilting structures (consisting of two wing weirs) trap the silt upstream. The silt is drained back into the Rio Coello at appropriate times through radial gates associated with the wing weirs.

Control Structures

The major cross-regulators on the main canals are the composite type -- a long crest section with gates -- which allow them to maintain a nearly constant level upstream for reasonable periods without readjusting the gates. All other structures are simply sliding gates. A number of "Phallophet" flow measuring devices (which operate on the principle of the Parshall flume) have been installed recently to measure flows to individual farms.

Design Efficiencies

The values of on-farm efficiencies adopted in the feasibility study for the extension of Coello District were as follows:

paddy:	land preparation by puddling	:	55%
	sloping fields	:	45%
non-paddy crops:	furrow irrigation	:	62%
	sprinkler	:	70%

Agricultural Production

Rice, cotton and sorghum are the three main crops in the Coello district. Table 3 shows the cropping pattern, yields, and production in 1987. During the two growing seasons, 22,300 ha and 19,000 ha were cultivated on the 27,187 registered hectares - of this total of 41,300 ha under cultivation. Only 34,000 ha were irrigated, so cropping intensity was 152% and irrigation cropping intensity was 125%. Yields of rice paddy (6 tons/ha) and seed cotton (3 tons/ha) are high by international standards. Rice farmers are authorized to grow rice during only one of the two growing seasons and have to stay with the season they select in the early years of the project.

Farmers use advanced farming technology, including planes to apply some farm inputs.

USOCOELLO Water Users' Associations

The management of the Coello district was transferred to the Water Users' Association (known as USOCOELLO) when HIMAT was created in 1976. The general conditions of transfer were defined in an agreement between HIMAT and USOCOELLO.

USOCOELLO's regulations defining the rights and obligations of the association members, and the functions of the General Assembly, Board, and General Manager are set out in a document issued on October 31, 1986

(Estatutas De La Asociacion de Usuarios de Aguas del Districto de Riego del Rio Coello). Any owner, farmer or tenant farmer in the area can be a member of USOCOELLO and submit a request for registration. The district is well-managed and members of the Association participate actively in the annual meetings.

III. THE ROLDANILLO-UNION-TORO (RUT) IRRIGATION DISTRICT

The RUT project is located at about 1,000 meters elevation in the northern part of the province of Valle on the left bank of the Cauca River about halfway between the main cities of Cali and Medellin. The project area is connected by paved roads with the main North-South highway that follows the Cauca valley north to the seaport of Carthagena. The gross area of the RUT district is about 10,750 ha, of which 9,742 ha are "registered" lands.

As in Coello, the climate is tropical and farms benefit from two rainy seasons. The mean annual rainfall (1,123 mm) is slightly lower than in Coello and the second rainy season is less intense (see table 1).

The RUT project area has a relatively narrow configuration, bounded by low hills on the west and the Cauca River on the east. The lowlands in between were swampy before the project was implemented. The soils are suitable to all crops but in some areas contain harmful salts that affect the lower lands, which are difficult to drain.

The main source of water for the RUT district is the Cauca River, one of the two main rivers draining Colombia inter-Andean valleys. At the project level, the Cauca drains a catchment of 16,500 km^2 and its flow, averaging 320 m^3/sec by far exceeds project needs. The Cauca water is pumped to supply the project distribution system. A secondary source of water comes from the hill flows intercepted by one of the main canals running along the foot of the eastern hills. At times, when the Cauca River is high, the drained water is pumped back into the main irrigation system. Silt content of the Cauca water is high.

About 95% of the lands in the RUT district belong to private owners and 5% to beneficiaries of agrarian reform. The size of the average farm (5.6 ha) is about one-third of that in the Coello district. However, 75% of the farms have an average area of 1.37 ha (see table 2).

HIMAT is in the process of transferring the management of RUT district to the Water Users' Association. Apparently the large and small holders have different views on the advantages and disadvantages of this transfer, the former ones being in favor of the transfer.

The Irrigation System

Construction of the RUT irrigation system was undertaken by the Autonomous Corporation of Cauca Valley in 1958. First irrigation started in 1967 after the completion of the pumping station Tierrablanca. This system consists of two subsystems. One is supplied by the 31 km-long unlined "Interceptor" canal that runs along the eastern hills and the other is supplied by the 41km-long "Marginal" canal running along the left bank of the Cauca River. These two systems are supplied by the common pumping station Tierrablanca with a capacity of 6.8 m^3/sec. The Interceptor canal has been designed to collect the torrents flowing from the hills. Its transit capacity (100 m^3/sec) far exceeds irrigation needs. Located half-way along the Marginal canal is a second pumping station, to supplement the main station, and to pump drained water back into the Cauca River or the Marginal canal. A network of 75 km of secondary canals -- about half of them lined with concrete -- supply water through 350 farm turnouts. The drainage system consists of the 26km-long main collector draining into the Cauca River and 75 km of secondary drains. A flood protection dike was built between the Cauca River and the Marginal canal. The project was

originally designed for gravity application but most of the farmers have adopted pressurized application, mostly sprinklers, and use mobile motor pumps. This may be the consequence of the government's decision in the 1960s to leave the on-farm works, including land leveling, to the individual farmers. Most farmers use individual diesel pumps although a few farmers have recently converted to surface irrigation to reduce production costs. At present, only 10% of the area is gravity irrigated.

Control Structures

The two main Interceptor and Marginal canals are equipped with cross-regulators -- two radial gates -- every 10 km. An automatic constant upstream level gate was installed on the first section of the interceptor canal, but is now used as a conventional radial gate adjusted manually.3/ The offtake structures for the secondary canals are equipped with constant-head orifice (CHO) gates. (As happens in virtually all projects in developing countries, the operations staff do not use the CHO gates for water measurements because of the relative complexity of operation of these devices.). Farm turnouts are single-gate structures. A new type of structure has been built in the areas recently rehabilitated: The secondary canals are equipped with composite regulators -- long-crested

---

3/ The failure to use this gate as an upstream constant level gate demonstrates the risk of installing isolated automatic devices in an conventionally designed irrigation system for the purpose of testing this equipment. In this particular case, a modern approach would have been to design the entire Marginal canal for operation under downstream control by installing a series of automatic downstream constant level gates associated with constant-flow distributors.

weir and a small sliding gate. The secondary system has a few measuring devices of Parshall-type but there is no measurement of water delivered to the farms. The delivered volume is calculated based on the capacity of the individual pumping stations.

Agricultural Production

Cultivation in the RUT district is more diversified than in Coello. Cotton, sorghum, and soybeans are the three main crops. Grapes and passion fruit trees cover together cover nearly 1,000 ha. The cultivation of rice is not authorized (see table 4).

About 12% of the area is rainfed pasture. Overall cropping intensity is about 175% (excluding pasture) and the annual irrigation cropping intensity is about 120%. Crop yields are high even under rainfed conditions, as shown below (for growing season I):

Crop	Yields		Increase
	Rainfed	Irrigated	
	----- Ton/ha-----		(%)
Cotton	2.4	2.8	17
Maize	3.5	4.8	37
Sorghum	3.6	4.3	19
Soybeans	1.8	2.2	22

Yield increases due to irrigation ranging from 17% for cotton to 37% for maize are relatively modest, reflecting the good distribution of rainfall.

IV. PERFORMANCE AND MANAGEMENT

System of Water Allocation and Distribution

Water in both districts is distributed by pre-arranged demand. Individual farmers order water one day in advance in Coello district and two to three days in RUT. Standard order forms are submitted to the "ditchriders" ("Canaleros") of the Coello district during daily motorcycle tours they make at fixed schedules known by the farmers. The procedure for ordering water is established at informal meetings with farmers in the RUT district. Before the growing season, each farmer must submit a cultivation and irrigation plan to the districts for approval. To get irrigation service, farmers must have paid arrears on their water charges and their farm distribution systems must be in adequate condition. Water is released day and night. In the RUT district, there is no strict method for calculating the flows to be pumped or for taking losses into account. The two water masters have long experience in the hydraulic behavior of the two main canals and operate the entire system intuitively on the basis of dynamic controlled volume, and not on the basis of controlled flows. They trust to experience, taking virtually no measurements except the number of hours the main and individual pumping stations run. Table 5 shows the total volume of water diverted and delivered at farm turnouts in both districts for five growing seasons between 1985 and 1987. The average annual volumes used per district and per hectare and the conveyance/ distribution efficiency are summarized below:

	COELLO	RUT
Average annual volume diverted (Mm^3)	432	37.5
Average annual volume delivered (Mm^3)	282	25.3
Average Annual volume delivered (m^3/ha)	10,360	2,600
Conveyance/distribution Efficiency (%)	65.1	67.6

The reason for the high water use in Coello is that about 17,000 ha of rice per year are cultivated.

The conveyance/distribution efficiencies of 65% and 67% calculated by the districts are relatively high for unlined systems and, given the lack of systematic water measurement, may be questionable. However, they seem acceptable as estimates since some drained water is re-used in both districts and water collected by the interceptor canal in RUT district is not counted in the supply estimate.

Sprinkler application in the RUT district is affected by strong winds during the dry months. Field application efficiency is estimated at only 60-70%. Field efficiency of gravity irrigation, estimated at 40-50%, is also relatively low. Overall efficiency would be in the order of 43%.

Important amounts of water are lost in the paddy fields of the Coello district. As in other Colombian districts, rice paddy lands are not leveled and few farmers use the method of preparation by puddling commonly used in rice-growing Asian countries. However, water consumption in Coello is lower than in other districts. Water use per hectare per crop for example, reaches about 25,000 cubic meters in the nearby Rio Recio district. Taking into account seepage, evapotranspiration, and effective rainfall, field efficiency is roughly 45%, so overall project efficiency is about 30%. To introduce puddling techniques would certainly reduce water consumption but would also make it more difficult to rotate between paddy and nonpaddy crops.

Water use per hectare for nonpaddy crops is low. In RUT where annual water use per hectare is 2,600 cubic meters, many farmers seldom irrigate sorghum and cotton crops and in some seasons there is enough

rainfall to produce high yields without irrigation. In Coello, the historic annual volume of water delivered at farm turnouts in two seasons is 22 million cubic meters for a total cultivated area of 24,000 ha of nonpaddy crops (cotton, sorghum) in two seasons. This low water use illustrates the supplemental nature of irrigation for dry-foot crops in this district.

Water distribution in both Coello and RUT is timely, reliable and equitable. The pre-arranged demand system is not as flexible or convenient as pressurized systems under pure demand, but it meets the farmers' needs for the crops grown in those districts.

Groundwater tables have gradually risen in Coello district from over 20 meters before irrigation started in the 1950s to a few meters now. In some areas, the groundwater level is now less than one meter from the surface. The highest levels are observed during the rainy months of April and May, and in September and October. Rice cultivation in the Coello area, where the semi-pervious soils are suitable for both paddy and non-paddy crops, has contributed to the present situation. However, the sloping topography and the natural drainage conditions have contributed to maintain the groundwater table at a level not detrimental to most crops with the exception of some areas located too far from a natural drain.

The swampy lowlands of the RUT district occupying the central part of the project have been drained and reclaimed as part of the project, but because of the flat topography and salts present in the groundwater, there is a risk of waterlogging and salinization of the lowest areas. The district has been able to control water tables in the high risk areas through pumping, however.

Operations and Maintenance

Staffing

As in other districts, operation and maintenance (O&M) activities in Coello and RUT districts are the responsibilities of two district departments, one for operation and one for maintenance. In addition, there is a small staff for the administration and overall management of the district. The management structure is much the same for both public or farmer-managed system. The total staff of each district is distributed as follows:

	Coello	RUT
(No.)	(No.)	
Administration	18	10
Operation	19	20
Maintenance	60	54
	97	84

Table 6 gives a breakdown on the Coello staff.

Although the registered area in Coello district is nearly three times that in the RUT district, its total staff is only 15% larger and the operations staff in the two districts is about the same size.
For purposes of comparison, the following ratios including irrigation projects in other countries, may be of interest:

		Colombia Coello	RUT	Morocco Doukkala	Mexico Sinaloa
Irrigable area	(ha)	27,187	9,742	18,645	90,050
Net area per O&M employee	(ha)	345	131	148	660
Net area per ditchrider	(ha)	4,531	1,623	478	2751
Number of farms per ditchrider	(no)	280	309	195	218

The sharp differences in the area each ditchrider is responsible for reflects the average size of farms (2.6 ha in Morocco versus 16.2 in Coello and 5.7 ha in RUT).

The reason for the small difference between the number of maintenance staff in Coello and RUT districts is probably related to the length of irrigation canals, drains, and service roads that need maintaining (see below) and to the effects of scale.

Length of	Coello		RUT	
	(km)	(m/ha)	(km)	(m/ha)
Irrigation canals	250	9.2	127	13.0
Drains	21.5	0.8	144	14.8
Service roads	177	6.5	350	35.9

Equipment

Maintenance equipment available in Coello and RUT is listed below:

	COELLO	RUT
Excavators/Dragliners	5	7
Tractors	4	2
Motorgraders	2	2
Loaders	1	4
Dump Trucks	8	7
Various	1	7
TOTAL	21	29

Again, RUT district's relatively greater need for equipment reflects the greater length canals, drains, and roads to be maintained.

Condition of Facilities

The Coello district's irrigation and drainage facilities are generally in good condition. Mechanical equipment at the control gates is well maintained. Most of the farm gates have been replaced in recent years at the farmers' expense. The main canals are cleaned regularly despite the difficulties created by their deep-cut design. Access roads are in excellent condition, as are farm ditches and drains, which the farmers maintained. A bulldozer stand permanently near the headworks to rebuild the boulder bund immediately after each flood.

Conditions are not as good in the RUT district. Some sections of the Interceptor canal are infested with hyacinths, and the water is polluted by human waste. Several unlined secondary canals are infested with weeds and weeds are growing even in the recently lined sections. Protection works have been built in the sections of the Cauca River where erosion is a risk for the project land and facilities.

Annual Costs

Of the total budget for the Coello district for 1987 (US$844,000), 20.2% was allocated to administration, 13.2% to operations and 66.6% to maintenance (see table 7). Personnel expenses -- including salaries, fringe benefits, and personnel overhead (social security, etc.) -- represent about 50% of total expenses. The annual budget expressed in Colombian pesos was increased 37% for the year 1988 (see table 8). The annual O&M cost per hectare increased from Col$7,765 in 1987 (US$31.06) to Col$10,693 (US$35.64) in 1988. Considering how well maintained the Coello district facilities are, US$35 per hectare can be considered a good estimate for O&M costs for a medium-size irrigation project supplied by gravity in a humid tropical environment.

Table 9 shows actual expenses for the RUT project, based on information provided by the District. It does not include administrative expenses of the regional office that are charged to the district. Operating expenses represent 37% and maintenance 63% of the total budget of US$531,000. The average cost per hectare (Col$13,635, or US$54.5) is 75% higher than in the Coello district because of:

- the cost of energy for pumping (US$7.1 per ha),
- the relative higher maintenance costs (because of the more intensive system of canals, drains, and access roads in the RUT district),
- the O&M costs of three pumping stations, and
- possibly greater staff efficiency in the privately managed Coello district.

Cost Recovery

The fixed and volumetric water charges for Coello and RUT are determined every year before the first growing season. For Coello these rates are calculated to cover nearly 85% of expenses. Other income (for equipment rentals, bank interest, and extraordinary charges) provide the other 13-15% revenues (table 10). For RUT, these rates have been progressively increased with the objective of attaining full cost recovery by the time responsibility is transferred to the Water Users' Association.

For the year 1988, fixed and volumetric charges were set as follows:

		COELLO	RUT
Fixed Rate	(Col$/ha)	2,300-2,500a/	10,000
	(US$/ha)	7.7-8.3	33.3
Volumetric Rate	(Col$/$m^3$)	0.52	1.68
	(US$/1000$m^3$)	1.73	5.6
Average fixed rate/O&M costs (%) (1988)		42	55

The higher rates in RUT (about four times the Coello district's fixed rate and three times the volumetric rate) reflect the higher O&M costs and lower water consumption in RUT district. The fixed rate charges represent about 42% and 55% of the annual average expenses in Coello and RUT respectively. All of the charges are fully collected in both districts.

a/ Different fixed rates are applied in Coello district, depending on the size of the holdings and the nature of the crops. For the year 1988 the rates per season were as follows:

	Paddy	Nonpaddy
	Col$/ha	
Farms of 20 ha or less	2,300	2,500
Farms above 20 ha	2,500	2,500

Rehabilitation and Modernization

RUT district was included in the first irrigation rehabilitation project started in 1981, and Coello in the second project, started in 1986. Six irrigation districts were included in each of these two projects. The objectives of these two projects are to: i) halt deterioration of existing irrigation infrastructures through rehabilitation, and ii) construct new infrastructures to modernize use of available water and land resources. An important part of the work carried out in the RUT district and planned for Coello is to complete the existing facilities or expand the irrigated area. Rehabilitation will be limited. Work completed in the RUT district includes:

- o strengthening and raising the protection dike along the Cauca River, and
- o rehabilitation of existing infrastructure on about 1200 ha -- lining of secondary canals and construction of new control structures.

Most of the RUT maintenance equipment was also replaced. The planned construction of infrastructure to serve an additional 600 hectares on the left bank of the interceptor canal through a 30 metres lift was not executed.

Work to be undertaken at Coello includes:

(i) a fusable intake on the Rio Cucuana, a tributary of the Magdalena River south of the rio Coello,

(ii) A 1.8 km-long tunnel and a 30 km main canal,

(iii) a distribution system to serve an additional 12,000 ha,

(iv) tele-information system on water levels,

(v) replacement of maintenance equipment, vehicles, and motorcycles, and

(vi) minor work on existing control structures.

Although the RUT and Coello projects are 20 to 35 years old respectively, the irrigation and drainage facilities have been reasonably well maintained and there is no need for major rehabilitation. Replacement of the original obsolete maintenance equipment is the most important item on the rehabilitation agenda.

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 1: Average Monthly Rainfall in Coello and RUT Irrigation Districts (Millimeters)

	COELLO	RUT
January	60	46
February	79	61
March	118	102
April	188	142
May	216	141
June	63	90
July	30	61
August	60	72
September	121	111
October	208	146
November	114	92
December	93	59
Annual	1350	1123

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 2: Land Tenure in the Coello and RUT Irrigation Districts

Farm Size (ha)	RUT Farms No.	RUT Farms (%)	RUT Area ha	RUT Area (%)	COELLO Farms No.	COELLO Farms (%)	COELLO Area ha	COELLO Area (%)
0 - 5	1,380	75	1,892	19	587	35	1,445	5
5 - 10	194	10	1,317	13	350	21	2,448	9
10 - 20	133	7	1,816	18	300	18	4,204	15
20 - 50	131	7	3,888	38	321	19	10,213	38
50 - 100	19	1	1,197	12	110	6	7,110	26
Above 100	-		-		13	1	1,767	7
	1,857		10,110		1,681		27,187	
Private farms	1,606		9,236		1,656		26,917	
Agrarian reform	106		506		25		270	
farms	1,712		9,732		1,681		27,187	
Average farm size:			5.7 ha				16.2 ha	

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 3: Cropping Pattern, Irrigation, and Yields in the Coello District (1987) a/

	Areas Cultivated	Areas Irrigated (ha)	Production (tons)	Yield (tons/ha)
Season I				
Rice	7,638	7,638	48,043	6.29
Cotton	10,758	7,297	32,274	3.0
Sorghum	3,915	1,805	12,920	3.3
	22,311[a]/	16,740		
Season II				
Rice	9,708	9,708	57,714	5.95
Sorghum	9,307	7,513	26,060	2.8
	19,015[b]/	17,221		
Total	41,326	33,961		
Cropping intensity (over 27,187 ha)	1.52			
Irrigation intensity	1.25			

a/ Major crops only.
b/ Of the 27,187 ha that are registered.

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 4: Cropping Pattern, Irrigation, and Yields in the RUT Irrigation District (1987)

Crop	Areas of		Production		Yields		Water Use
	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated	
	ha		tons		ton/ha		m^3/ha
Campaign 1987/I:							
Cotton	1719	199	4813	477	2.8	2.4	3500
Maize	335	264	1608	924	4.8	3.5	2100
Sorghum	973	1514	4135	5450	4.3	3.6	1700
Soya	1904	467	4188	840	2.2	1.8	1800
Tomatoes	11	6	275	132	25	22	3100
Passion Fruit	460	166	6900	2158	15	13	3000
Pastures	51	1205	117	1052	2.3	0.9	1500
Grapes	352	-	6582	-	18.7	-	3700
Various	116	-	290	-	2.5	-	2400
	5921	3821					
Campaign 1987/II:							
Maize	14	103	391	204	3.8	3.0	2100
Sorghum	2062	1859	8886	7064	4.3	3.8	1700
Soya	2653	865	7428	1816	2.8	2.1	1800
Tomatoes	8	-	300	-	37.5	-	3100
Passion Fruit	626	-	9390	-	15	-	3000
Pasture	16	1115	-	-	-	-	1500
Grapes	352	-	5984	-	17	-	3800
	5745	3942					

Water Consumption Campaign I: 14,836,000 m^3

Campaign II: 11,757,100 m^3

26,593,700 m^3

Average Consumption (m^3/ha): 2730

(a) Of the 9742 ha that are registered.

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 5: Efficiency of Conveyance and Distribution in Coello and RUT Irrigation Districts

	COELLO (Mm^3)	Efficiency (%)	RUT (Mm^3)	Efficiency (%)
1985				
Semester I				
Total volume diverted	231.9		21.6	
Total volume delivered	157.9		15.0	
Efficiency		18.1		69.3
Semester II				
Total volume diverted	249.0		20.0	
Total volume delivered	157.8		12.9	
Efficiency		63.4		64.3
1986				
Semester I				
Total volume diverted	210.8		16.4	
Total volume delivered	127.5		11.3	
Efficiency		60.5		68.9
Semester II				
Total volume diverted	182.7		16.0	
Total volume delivered	108.7		9.9	
Efficiency		59.5		62.3
1987				
Semeter I				
Total volume diverted	206.7		19.6	
Total volume delivered	152.3		14.2	
Efficiency		73.7		72.3
Average Efficiency		65.1		67.6

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 6: A Breakdown of the Coello Irrigation District Staff

(Category)	(No. of Personnel)
ADMINISTRATION	
General Manager	1
Chief of personnel	1
Accountants	3
Cashier	1
Procurement chief	1
Internal auditor	1
Clerks	3
Secretaries	2
Typists	2
Messenger, cleaners	4
	19
OPERATIONS	
Department	1
Assistant chief	1
Secretary	1
Registry clerk	1
Water master	2
Ditchriders	6
Water measurement staff	4
Headworks staff	3
	19
MAINTENANCE	
Chief of department	1
Assistant chief	1
Cost estimator	1
Secretary	1
Inspector	1
Topographers	2
Laborers	10
Mechanics	5
Workshop personnel	5
Foremen, masons	2
Guards	10
Drivers	11
Heavy equipment operators	11
	61

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 7: Budget for Coello Irrigation District (1987)

	Administration	Operations	Maintenance	Total	
	--------(thousands of Columbian pesos)--------				(%)
Salaries and other benefits	23,647	19,792	64,970	108,409	51.0
Insurance	2,608			2,608	
Consultant fees	866			866	
Travel	125	113	100	338	
Materials & supplies	2,609	822	17,706	21,137	10.0
Maintenance and spare parts	708	1,030	22,050	23,788	11.3
Rent (houses, cars)	2,400	1,001	1,920	5,321	
Public services	640			640	
Advertising	550			550	
Administrative charges	4,688			4,688	
Maintenance of civil works			26,870	26,870	12.7
Contingencies	1,151	753	7,070	8,973	4.2
Guards	1,317			1,317	
Investments	1,300	700		2,000	
Miscellaneous	—	3,600	—	3,600	
Total	42,610	27,811	140,687	211,108	
(%)	20.2	13.2	66.6	100	

Average O&M cost/ha: Col$7,765/ha (US$31.06/ha).

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 8: Budget for Coello Irrigation District (1988)

	Administration	Operation	Maintenance	Total	
	--------(Thousands of Columbian pesos)----------				(%)
Salaries and other Benefits	30,007	23,234	93,302	146,544	50.0
Insurance	3,228	-	-	3,228	
Consultant fees	3,761	-	-	3,761	
Travel	190	113	165	468	
Materials & supplies	3,149	1,054	25,628	29,831	10.0
Maintenance and spare parts	1,001	1,230	33,450	35,681	12.0
Renting	3,000	1,232	2,760	6,992	
Public services	800	-	-	800	
Advertising	660	-	-	660	
Admin. charges	5,625	-	-	5,625	
Repairs & maintenance	-	-	28,500	28,500	9.8
Contingencies	4,017	2,180	14,706	20,904	7.1
Surveillance guards	1,647	-	-	1,647	
Investments	1,800	1,290	-	3,090	
Miscellaneous	-	3,000	-	3,000	
Total	58,887	33,334	198,511	290,733	
(%)	20.3	11.4	68.3	100	

Average O&M cost/ha: Col$10,693/ha (US$35.64)

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 9: Actual Expenses for RUT Irrigation Districts (1987)

	Operations	Maintenance	Total	(%)
	--(thousands of Columbian pesos)--			
Salaries and other payroll costs including social security)	19,847	38,230	58,077	43.7
General costs, repairs, travel, spare parts, and materials	12,112	39,806	51,918	39.1
Maintenance contracts	-	5,584	5,584	4.2
Pumping energy[a/]	17,255	-	17,255	13.0
Total	49,214	83,630	132,834	
(%)	(37%)	(63%)		
Total (US$ thousands)	196.8	334.5	531.3	
Total O&M cost per ha (US$/ha)	20.2	34.3	54.5	

a/ Energy cost US$7.1 per hectare

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Table 10: Projected Revenues from Water Charges in the Coello Irrigation District (1988)

I. **Fixed Rate**

Semester A	No. of ha	Rate/ha (Col pesos)	Revenues (Col$000)
Rice			
farms of 20 ha or less	2,252	2,300	5,179
Farms above 20 ha	5,331	2,500	13,327
Other crops	17,782	2,500	44,455
			62,962
Semester B			
Rice			
Rice farms of 20 ha or smaller	4,186	2,300	9,627
Farms above 20 ha	5,086	2,500	12,715
Other crops	16,093	2,500	40,232
			62,575

II. **Volumetric rate**

	Mm^3	Rate/m^3 (Col. pesos)	
Rice (16,855 ha x 14,000 m^3)	235	0.48	113,265
Other crops	22	0.48	10,560
Total			249,362
Other income (for equipment rentals bank interest, and extraordinary charges)			41,370
			290,733

APPENDIX 1

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

Chief Characteristics of Coello and RUT Irrigation Districts

	COELLO	RUT
A. GENERAL		
Climate		
- Classification	Humid tropic	Humid Tropic
- Average annual rainfall	1,350 mm	1,123 mm
- Average annual temperature	27.6 c	28.5 c
Water Supply		
- Source	Rio Coello	Cauca River
- Flow	unregulated	unregulated
- Average annual flow	452 Mm^3	10,110 Mm^3
- Groundwater quality	C2S1-C3S1	C3S1
Registered Irrigation Area	27,187 ha	9,742 ha
Irrigated Soils	Colluvial	Alluvial
Main Crops	Rice, cotton, sorghum	Cotton, soya, sorghum, pasture
Land Tenure		
- Number of farms	1,681	1,857
- Average farm size	16.2 ha	5.7 ha
- Total area of farms smaller than 5 ha (as % of total)	5%	19%
- Total area of farms smaller than 20 ha (as % of total)	29%	50%
- Areas affected by agrarian reform (as % of total)	5%	1%
No. of Water Users' Associations	1	1
District management	USOCOELLO	HIMAT

	COELLO	RUT
B. SYSTEM DESCRIPTION		
Type Diversion Structure	gravity side-intake	pumping station 4 x 1.7 m^3/sec
Irrigation System		
Main canals	91.3 km	75.5 km
Secondary canals	78.8 km	51.3 km
Tertiary canals	80.0 km	-
Total	250 km	126.8 km
No. of measuring devices	81	16
Transit capacity of main system	25 m^3/sec	13.8 m^3/sec
Farm outlets	990	350
Capacity of Drainage System		
Main drains	21.5 km	26 km
Secondary drains	-	76.7 km
Tertiary drains	-	41.6 km
Total	21.5 km	144.3 km
Pumping station	-	2
Access Roads	177 km	350 km
Present Condition of Components		
Diversion structure	Fair	-
Pumping stations	-	Medium
Main canals	Fair	Fair to poor
Distribution system	Fair	Fair to poor
Drainage system	Fair	Medium
Access roads	Good	Good
Hydromechanical equipment	Good	Fair

C. ACTUAL PROJECT PERFORMANCE	COELLO	RUT
- System of water allocation and distribution	prearranged demand	prearranged demand
- Advance notice needed for water delivery	1 day	2 to 3 days
- Conveyance and distribution efficiency	65.1%	67.6%
- Field application efficiency	(45%)[b]	(65%)
- Overall efficiency	(30%)[b]	(43%)
- Average annual water diverted	15,900m^3	3,830m^3
- Average annual water delivered	10,360m^3	2,600m^3
- Water delivered for rice per season	14,000m^3	-
- Flexibility of water distribution	Satisfactory	Satisfactory
- Reliability of water distribution	Satisfactory	Questionable
- Method of water measurement	(visual estimate)	(visual estimate)
- Environmental Impact		
o Waterlogging	No	500 ha affected
o Salinization	No	500 ha affected
o Silt	Medium [a]	

---

[a] High silt content but effective desilting devices.
[b] Author's estimate.

D. OPERATION AND MAINTENANCE	COELLO	RUT
Number of District employees		
- Operations	19	20
- Maintenance	60	54
- Administration	18	10
Total	97	84
Net registered area per O&M employee	280 ha	115 ha
Number of ditchriders	6	6
Net irrigated area per ditchrider	4,531 ha	1,623 ha
No. of farms per ditchrider	280	309
Farm turnouts per ditchrider	165	58
Operations activities	Good	Satisfactory
Maintenance activities	Good	Medium
O&M estimated costs (1987) (Col$ thousands)	211,107	132,840
(000'US$)	844.4	531.4
Actual costs of water distribution (Col$/ha)	7,764	13,635
(US$/ha)	31.05	54.5
Average cost of water delivered at farm turnouts (US$1,000m^3)	3	21
Water charges (1988)		
o fixed rate (Col$/ha)	2300 - 2500	10,000
(US$ ha)	7.7 - 8.3	33.3
o volumetric rate (Col$/m^3)	0.52	1.68
(US$1,000m^3)	1.73	5.6
Collection rate for water fees	100% (1987)	106% (1986)
Cost recovery (1987)	86.9% b/	76.5%

b/ The 13.1% difference is covered by other district revenues.

APPENDIX 2

CASE STUDIES OF TWO IRRIGATION SYSTEMS IN COLOMBIA

Their Performance and Transfer of Management to Users' Associations

AGREEMENT NO. 41

(November 16, 1977)

Approving the General Regulations for the Land Development Districts managed by delegation of the Colombian Institute of Hydrology, Meteorology and Land Development (Instituto Colombiano de Hidrología, Meteorología y Adecuación de Tierras--HIMAT)

In exercise of the powers conferred by law and especially Decrees No. 182 of 1968 and Nos. 132 and 2259 of 1976,

THE BOARD OF DIRECTORS OF HIMAT

DOES HEREBY AGREE AS FOLLOWS:

Article One

The General Regulations that provide the basic guidelines governing the running of the Districts whose management has been delegated to the Users' Associations are hereby approved as follows:

CHAPTER I
LAND DEVELOPMENT DISTRICTS

Article 1. Purpose

These Regulations define the basic guidelines for the running of the Land Development Districts which are managed by the Users' Associations, following delegation by HIMAT.

Article 2. Definition

For the purposes of these Regulations, a Land Development District shall be understood to be an agricultural unit that has the necessary irrigation and drainage works for the conservation of the land it comprises and for the appropriate agricultural, commercial and industrial development of that land.

Article 3. Authority of the Districts

In their capacity as technical and administrative entities, the Districts shall have all the necessary authority to operate.

Article 4. Responsibilities of the Office of the District Chief

The Office of the District Chief shall be responsible for:

1. Operating water structures, canal systems and other irrigation and drainage works in the District;

2. Distributing irrigation water and delivering to users the volumes to which they are entitled, in accordance with the irrigation plan in effect within the District and the District's distribution status;

3. Monitoring and overseeing the correct use of the water for the purposes and according to the priorities established in these Regulations, with respect to both irrigation and drainage water;

4. Maintaining and improving all the works and natural channels that make up the District's flood control, irrigation and drainage system, and maintaining the District's machinery and equipment;

5. Preparing and analyzing agricultural, hydrological, meteorological and land tenure statistics, the List of Users, etc., on an ongoing basis;

6. Planning and monitoring studies and projects to ensure better use of the District's water and soil with a view to their long-term use, improvement and expansion;

7. Resolving, to the exclusion of any other authority, specific matters that arise within the District with reference to these Regulations;

8. Punishing, with the issuance of a reasoned resolution, any violations of these Regulations and other provisions in effect by the users, imposing the appropriate penalties, in accordance herewith;

9. Ensuring that the various tasks assigned to the users and third parties in connection with the works of the District are in strict compliance with the authorizations in question and taking steps to order their suspension in the event of noncompliance;

10. Setting, in accordance with the volumes of water available in the District, the limits to be observed in the distribution status referred to in Chapter V of these Regulations, establishing the practices to be followed to ensure better distribution of water for each status, with strict observance of the rights of each user and the irrigation plans being developed;

11. Determining the District's distribution status, notifying the users at least 24 hours in advance;

12. Approving the crop and irrigation plan for each crop season, taking into account the recommendations of the District's Advisory Committee and authorizing any changes to the irrigation plan that might prove necessary;

13. Overseeing the completeness and order of the documentation held by the District and ensuring the optimum use and maintenance of its equipment;

14. Programming the use of the District's machinery (shovels, bulldozers, motorized graders, dump trucks, pumps, etc.) for conservation works and keeping statistical data on operating and maintenance costs;

15. Approving the designs for land improvements, protective works and intake structures submitted by the users in accordance with the plans previously drawn up by the Office of the District Chief;

16. Ordering the relocation of farm intakes which it considers are detrimental to the District's operations;

17. Submitting programs and specifications for the repair of collection structures and equipment and distribution systems, the periodic cleaning and upgrading of irrigation, outlet and drainage channels, the repair and upgrading of patrol roads, the administrative center, communication networks, etc.;

18. Submitting studies, plans and budgets for the construction of new works such as dividers, protective works, water measurement and meteorological stations, spillways, irrigation and drainage channels, patrol roads, etc., together with proposals for their financing;

19. Formulating the draft budgets for current operating expenditures, annual maintenance and the special budgets described in the relevant chapters of these Regulations;

20. Regulating the collection of charges for services rendered by the District, as established by Resolution of the Office of HIMAT's General Manager;

21. Deciding on user status in respect of outstanding obligations, after consulting the Office of HIMAT's Assistant Manager for Land Development;

22. Maintaining better relations with District users and responding to user suggestions and questions that it receives direct or that it receives through the bodies representing users;

23. Performing its financial responsibilities and duties, as specified in the relevant chapter of these Regulations;

24. Promoting, coordinating and supervising any programs which HIMAT or public or private officials involved in the District's development might suggest with respect to irrigation or drainage engineering, crops, experiments, plant health, storage or marketing;

25. Ensuring that the programs established in the course of the activities referred to in (24) above are adopted and implemented by the District users;

26. Submitting monthly reports and an annual report on the District's activities and progress;

27. Forming the District Coordination Committee, convening meetings at least twice a month and drafting the pertinent minutes;

28. Keeping and updating the following books and records on the printed forms and of the types prescribed by HIMAT:

a. Master list of users;

b. Record and file of works and procurement contracts;

c. Updated inventory of the District's works and equipment;

d. Hydrological and meteorological records;

e. Records of rainfed and irrigated crops;

f. Record of irrigation distribution orders;

g. Record of volumetric consumption;

h. Books of inventories, materials, equipment control, unit costs, yields, etc.

i. In and out logbook of water regulation files.

j. Accounting and cash books;

k. Correspondence files;

l. Files of channel and on-farm water measurement records and topographical records;

m. Personnel records;

n. Books of minutes of the meetings of the Coordination Committee, meetings with users, Users' Associations, etc.;

ñ. Any other information needed to ensure the District's smooth operation;

29. Authorizing changes in any of the data contained in the master list of users. Changes that entail amendments to the total amount of debt for the land shall call for the prior approval of the Office of HIMAT's Assistant Manager for Land Development.

30. Enforcing all the conditions imposed by HIMAT in the agreement delegating administration of District operations.

Article 5. Internal organization

The Office of the District Chief shall perform the responsibilities assigned to it, as described in the foregoing Article, acting through the departments established by the respective Association in each case.

Proviso. An Advisory Committee shall be established in each of the Districts in accordance with the provisions of Article 39 of these Regulations.

Article 6. In order to ensure the proper running of each District and for purely administrative purposes, the Districts may be divided territorially as specified in the special regulations for each of them.

CHAPTER II
USERS AND THEIR REPRESENTATION

Article 7. Definition of users

For all purposes of implementing these Regulations the term "user" shall apply to any individual or body corporate who, as owner, user, usufructuary or who in any other capacity, farms land within the District and is entitled to the benefits deriving from the water works, a further absolute requirement being inclusion in the respective master list of users.

Proviso. Persons occupying or using land belonging to HIMAT, whose tenure has not been previously legalized by INCORA, may not be District users.

Article 8. Master list of users

The master list of users is an updated record of all District users, accredited as such on the basis of cadastral surveys, documents and maps as may be required to prove land tenure.

Article 9. Data in the master list of users

The following data must appear in the master list of users:

a. List registration number;

b. Name and identification of the user;

c. Capacity in which the user farms the land;

d. Name of farm;

e. Name and identification of owner;

f. Area of farm that is irrigated;

g. Total area of farm;

h. Name of the channel or channels feeding the farm intakes;

i. Number of farm intakes;

j. Capacity of farm intakes and their location [?abscisas];

k. Name of collector drains or natural channels through which the drainage water flows.

Article 10. Joint liability of nonusing owner

When the user is not both owner and user, the user shall be required, in the contract signed with the owner and by virtue of which he is permitted to farm the land, to accept joint liability with the owner, thereby guaranteeing all acts, measures and bills outstanding upon termination of the user's relationship with the District, for whatever reason.

Proviso 1. The District shall maintain an updated list of nonowning users, who have left the owner with unpaid bills with respect to the matters referred to in this Article.

In order for such nonowning users to be reaccepted as users, an authenticated certificate of full settlement of bills issued by the owner shall be required.

Proviso 2. When the ownership of a farm changes, the new owner or those with whom the new owner signs contracts for the farming of the land in question may not be included in the master list of users until any outstanding bills payable to the District with respect to that farm have been settled.

Article 11. Transfer of user status

If any user, in accordance with the provisions in effect, transfers his rights to another, the latter shall provide the Office of the District Chief with the deed to the land and all other information required for his inclusion in the master list of users, without which he shall not be entitled to any user rights.

Article 12. Rights of users

Users shall have the following basic rights:

1. To receive at their outlets the water to which they are entitled in accordance herewith;

2. To exercise the right to elect and be elected to the Association Board, providing this does not conflict with these Regulations;

3. To ask to have these Regulations explained to them for the sake of promoting their implementation and compliance with them;

4. To make whatever claims they deem necessary concerning District-related matters, either direct or through the Association Board;

5. To submit to the District Chief, either directly or through the Association Board, any suggestions for increasing service efficiency, with regard to water distribution and the conservation, upgrading and construction of works as well as improving farming activities and the overall organization of the system;

6. To ask the District Chief for technical advice concerning the design and construction of their irrigation or drainage channels and the corresponding structures for the optimal use of irrigation water, erosion control methods, grading work and the construction of farm buildings, as well as for the installation of pumps and use of underground water based on studies, for which service they shall pay the tariffs to be established;

7. To ask the District Chief to intervene in securing the assistance of public, parapublic, union or private entities capable of providing advisory services in areas such as: soil analysis, fertilizer use, improved seed, herbicides, insecticides or pesticides, use of farm machinery, plant and animal health, agricultural experimentation and extension.

Article 13. Basic obligations of users

Users shall have the following basic obligations:

1. To submit whatever documentation they are asked to show in evidence of their user status;

2. To facilitate any works relating to the operations conservation or upgrading of the structures on their farms;

3. To build on their farms the minimum works needed for the correct use of the irrigation water and for its control, without prejudice to the payment for damage and losses resulting from poor management;

4. To ensure that the irrigation and drainage works that serve their farms and any other works for which they are made responsible by special regulations are kept clean and in good working condition;

5. To pay in a timely fashion whatever obligations they have with the District for any of the services rendered;

6. To comply with the stipulations of the District's irrigation plans and those concerning sowing dates, payments and tasks pertaining to the District's operation and conservation;

7. To permit, in accordance with Articles 67 and 68 of Decree-Law 2811 of 1974, the passage of irrigation and drainage channels that serve adjoining and neighboring farms, with a view to upgrading the District's operations;

8. To comply with all the District's regulations and provisions.

Article 14. Users' Association

All District users shall be represented by the Users' Association established in accordance with Decree No. 755 of 1967, the pertinent provisions of Decree No. 2259 of 1976 and these Regulations.

Article 15. Membership of the Users' Board of Directors Association

The Association shall be managed and administered by a Board of Directors composed of seven members with their respective alternates, four of whom shall be representatives of the small users, the remaining three being representatives of the large ones.

Proviso 1. For the purposes of this Article, "small users" shall be understood to be those who farm up to 20 ha of irrigable land and "large users" shall be understood to be those who farm more than 20 ha.

Proviso 2. Any user who operates more than one farm in any capacity may elect or be elected solely on the basis of the sum total of his respective area in the District.

Article 16. Election of the Association's Board of Directors

The election of the representatives of small and large users to serve on the Board of Directors shall be based on the votes of the members of the respective group, separately, each user having one vote, at a meeting to be held in July of every even-numbered year on a date previously agreed upon between the Association's Board of Directors and the Manager of HIMAT, so that the newly elected Board shall assume office as from August of the same year.

The meeting shall also elect one Auditor, with two personal alternates, who shall assume the responsibilities conferred on him by the Association's Bylaws and who must be a public accountant.

Proviso 1. The Chairman of the outgoing Board shall notify Association members of the date of the meeting for the election of the Board of Directors at least 30 days before it is to be held. If 10 days elapse without this being done, HIMAT shall take steps to do so. Announcement of the meeting shall be publicized as widely as possible in order to ensure that it is attended by a majority of the users.

In order to be able to open the meeting at the time and on the date agreed upon, there shall be at least half the number of duly registered users in attendance plus one, all of whom shall have fully met their obligations in order to take part, the presence of one HIMAT representative also being required.

Proviso 2. When the first Board of Directors of the Association is to be elected, the respective District Chief shall convene the meeting.

Proviso 3. In the absence of the necessary quorum, a margin of one more hour shall be allowed, after which time the meeting shall proceed with the election of the Board, regardless of the number of users present.

Proviso 4. The proceedings of the meetings referred to in this Article shall be recorded in the pertinent minute book.

Proviso 5. The meetings referred to in this Article shall be chaired by the Chairman of the outgoing Board of Directors or by the person who convenes the meeting, until the meeting elects the user who will chair it from among those present.

Proviso 6. The Office of the District Chief shall prepare a list of eligible users pursuant to these Regulations at least 10 working days prior to the date scheduled for the meeting.

Proviso 7. In those Districts where there are duly organized Users' Associations that are recognized by HIMAT and whose Boards of Directors have been elected by a general meeting of users, such Boards shall be ratified as such until the date of the new election, as stipulated in Article 16 above.

Article 17.

Users shall vote in person, no proxies being permitted for this purpose.

Article 18.

In order to be entitled to elect and be elected to the Board of Directors, as referred to in the foregoing Article, users must be included in the master list of users and have fully met their obligations to the District in all respects.

Article 19.

The following procedure shall be followed for the election of members of the Board of Directors:

1. The slate of candidates shall be opened, a principal and alternate being listed for each slot;

2. Voting will then take place, those candidates receiving the majority of votes from eligible members being elected, and care being taken to ensure that all administrative divisions that make up the District are represented.

Article 20.

Membership on the Board of Directors shall not carry with it any advantages with respect to the compliance of obligations vis-à-vis the District.

Article 21. Board of Directors' term of office

The Board of Directors shall be renewed every two years, its members being eligible for re-election indefinitely.

Proviso. In the event that a member of the Board of Directors loses his user status during the term for which he was elected, he shall automatically cease to be a member of the Board and shall be replaced by his alternate. If both he and his alternate have lost their user status a special election shall be called to fill the vacancies, in accordance with the procedure described in Article 16.

Article 22. Powers of the Board of Directors

The Board of Directors are hereby empowered to:

1. Work with District officials in seeing that the users they represent fulfill their duties and obligations and particularly those relating to the maintenance of the irrigation and drainage systems;

2. Ask the District Chief, if the need should arise, to see that the rights of each of the users represented by the Board are respected and that there is compliance with the relevant provisions;

3. Notify the District Chief of any noncompliance or abuse committed in the District;

4. Propose measures and studies it considers worthwhile in order to make better use of the water and soil in its District;

5. Propose the study and construction of any special works of common interest that are deemed necessary, including their financing;

6. Approve, reject or amend, on appropriate grounds, the financing plans submitted by the District Chief for the studies and special works geared to the upgrading of the District or in connection with the procurement and replacement of equipment;

7. Oversee investments and the proper execution of studies, tasks and special works undertaken in the District;

8. Work with the District Chief in all matters relating to improving the operation of the irrigation and drainage systems;

9. Formulate its own bylaws, which shall require the approval of the Office of HIMAT's General Manager in order to be valid.

Proviso. In the event of any disagreement with the District Chief regarding the interpretation and application of the provisions of this Chapter, the Association shall take the matter to the Assistant Manager for Land Development in the first instance and to the General Manager of HIMAT in the second and final instance.

Article 23.

The Board of Directors shall meet in ordinary session once a month to decide on matters relating to the operation of the District and in extraordinary session when convened by the District Chief, its chairman or by

a number of users representing 50% or more of those registered. A representative of HIMAT must be present in order for the decisions taken at these meetings to be valid.

Proviso 1. In the event that no ordinary meetings are held for three consecutive months, HIMAT will convene a meeting of users in order to proceed with the election of a new Board for the rest of the period in question, in accordance with these Regulations.

Article 24. Operation of the Board of Directors

Each year the Board of Directors shall elect a chairman, deputy chairman and minutes secretary from among its members, who shall be eligible for re-election. Decisions of the Board shall be adopted by an absolute majority vote and shall be recorded in the minute book.

Proviso. The Board may agree to pay a fee to its members for attendance at its meetings, not to exceed the equivalent of a daily wage, based on the minimum wage set by the Government for the District's region, plus any travel costs involved.

Article 25. Expense of the Association

In order to absorb the expenses involved in running the Association, such as: rental of premises, payment of wages to personnel, office equipment, printed forms, etc., the Association is authorized, following discussion and approval of properly justified budgets, to prorate among the users of the respective District, quarterly, semiannual or special assessments in proportion to the areas classified as suitable for irrigation in the master list of users.

Proviso. The assessments referred to in this Article shall be entered under collections by the respective District office, payment being as obligatory for the users as that of amounts payable for services. The total amount collected for the ordinary operations of the Board may in no case exceed 3% of the District's ordinary budget.

Article 26. Limitations

The powers conferred on the Board of Directors in this Chapter may in no case limit the Institute's technical, administrative and fiscal autonomy.

CHAPTER III
WATER SUPPLY

Article 27. Water supply

The following shall be considered water of the District and subject to its administration and control:

1. Water that is collected or dammed by structures of any kind, in all the watercourses located within the District or found elsewhere, subject to the legal requirements in the latter case;

2. All water which for any reason springs or emerges spontaneously on land located within the District and which does not disappear on the same land and any water that is extracted from the subsoil by artificial means.

Article 28. Excess water

Any excess water that remains from any use allowed by the District shall, providing it remains within the required limits, again revert to the District's administration; its recycling shall be subject to any formalities and conditions established in these Regulations and the legal provisions in effect.

Article 29. Infiltration

The District shall consider water under its administration to include that in the subsoil or circulating through the subsoil within an area not less than 100 m to each side of the axis of any water pipe covered by these Regulations, by virtue of the direct infiltration of such pipes; its use is therefore prohibited without the prior authorization and formalities required by the District.

CHAPTER IV
WATER USE

Article 30. Order of priority

The District's water may be used for the specific purposes agreed upon, in the following order of priority:

(A) The communities of the District that need water for the household use of their residents;

(B) The household service of District residents;

(C) The watering of livestock;

(D) The irrigation of farms located within the District, in accordance with the pertinent plan;

(E) Electric energy;

(F) Industrial establishments which need it to operate their machinery;

(G) Other uses indicated by the National Government or HIMAT.

Article 31. Drinking water infrastructure

Infrastructure that already exists or is built for the supply of drinking water to communities located within the District and that use the District's water shall be subject to the pertinent legal provisions in effect.

Article 32. Water for household use

The District's water may be used for household purposes if this does not cause unauthorized diversions from the channels or deterioration to existing banks or structures and only when the property is equipped with the facilities necessary to guarantee compliance with Article 36 of this Agreement.

Proviso. The District shall take whatever measures are advisable in order to prevent any contamination of the waters flowing through its channels or flows of wastage.

Article 33. Possession of intake gate keys

No individual other than authorized District staff may have keys to the intake gates and structures or may alter their openings in any manner. It shall also be prohibited, without prior authorization, to place any parapets or obstacles of any nature in the irrigation or drainage channels or in the structure or to undertake any type of works on them or to install pumps or rams.

Article 34. Legalization of user status

In order to be entitled to use District water for irrigation purposes, all individuals or bodies corporate shall be required to have their user status legalized vis-à-vis the District, under the terms of these Regulations, accepting in their entirety all the legal and technical conditions already established or that might be established in the future.

Article 35. HIMAT approval

Entitlement to the benefits referred to in paragraphs (E) and (F) of Article 30 of these Regulations shall be subject to all the limits of legislation in effect and to approval by HIMAT.

Article 36. Prohibition against the discharge of waste water and harmful substances

Under no circumstances may any type of waste water, industrial waste, household waste, debris or substances that are harmful to human health, plant or animal life, agriculture or industries that are already established or that are to be established in the future be discharged into the irrigation channels or drainage channels or ditches.

Proviso. In special cases, authorizations in this respect may be granted by HIMAT, following consultation with the District Chief.

CHAPTER V
DISTRIBUTION AND USE OF IRRIGATION WATER

Article 37. Irrigation plans

Distribution of irrigation water in the District shall be based on semiannual or annual crop and irrigation plans.

Article 38. Preparation of irrigation plans

The District Chief shall prepare the irrigation plans, which shall be submitted to the District Advisory Committee for its consideration at least 45 days prior to the date scheduled for the start of sowing for the agricultural season in question.

Article 39. Membership of the Advisory Committee

The District Advisory Committee shall have the following members:

A. Two representatives of the small users, elected by the Board of Directors of the Association from among the latter's representatives;

B. Two representatives of the large users, elected in the same manner as described in (A) above;

C. The Regional Manager of INCORA;

D. The Regional Chief of HIMAT;

E. The Administrator of the Users' Association, who shall chair the Committee;

F. A representative of the branches of the *Caja Agraria* that serve the District;

G. A representative of INDERENA;

H. Representatives of other entities and associations, which in the opinion of the Users' Association should be represented on the Committee, shall be decided upon in the special regulations established for the individual Districts.

Proviso. The Committee shall meet at least once every calendar quarter or whenever it is asked to meet by the District Chief so that it can give its opinion and assistance with respect to programs and plans aimed at furthering the District's development.

The District Chief shall be responsible for calling meetings of the Advisory Committee and for its coordination and actual functioning.

Article 40. Factors to be reflected in the irrigation plans

The following factors must be reflected in the irrigation plans:

1. The date on which the growing cycles in the Districts begin and end, the crops planted and their watering needs.

2. The volumes of water estimated to be available to the District during the agricultural season covered by the irrigation plan, on a monthly basis.

3. The recommendations of the Colombian Government concerning the priorities that must be given to certain crops within the national or regional agricultural program;

4. Users' requests regarding the type of crop they are most interested in developing;

5. Credit facilities for each crop and the marketing prospects for the products in question;

6. Proper soil use in order to avoid salinity, dangerous fluctuations in the water table and erosion.

Proviso 1. The District Chief shall base his evaluation of the factors referred to in paragraphs 1 and 2 of this Article on the following data:

1. Meteorological data, to determine the approximate value, rate, quantity and volume of average monthly rainfall, temperature, evaporation, etc.;

2. Hydrological records, to determine the average monthly value of the volumes produced by usable sources;

3. Records of irrigated areas and volumes delivered to them, to determine gross demand for irrigation of the different crops grown;

4. Capacity and conveyance losses of the distribution systems;

5. Agrological characteristics of the crop land and the stage of development of the farm.

Proviso 2. Until the District Chief has the statistical records referred to in this Article and other background information to help prepare precisely tailored irrigation plans, distribution shall be based on provisional irrigation plans prepared after consideration of both users' desires and the hydrological potential of the supply sources and the capacity of the distribution network and the agrological suitability of District land, to the extent that such background information is based on previous experience and statistics.

Article 41. Distribution status categories

The following distribution status categories shall be applied in the District:

1. Unrestricted;

2. Rotation;

3. Emergency;

4. Drought.

"Unrestricted" status shall be understood to be when the various District sources of water have sufficient water to meet users' demands with ease;

"Rotation" status shall be understood to be when the water reserves in the District permit the rational distribution of water among the various channels deriving their water from these sources, in accordance with the requirements of the pertinent irrigation plans.

"Emergency" status shall be understood to be when the District's sources of supply do not have sufficient volumes of water to serve the entire irrigation network simultaneously, necessitating the concentration of available volumes in one or more channels and the proportional reduction of quotas previously approved.

"Drought" status occurs when, for reasons of *force majeure*, lack of water at the sources of supply or the need to undertake works in the District's channels or supply structures, distribution of irrigation water is impossible.

Article 42. Limits and priorities with respect to the distribution status categories

As soon as these Regulations enter into effect the District Chief shall, after consulting the Association, prepare draft rules for approval by HIMAT to set for the District the estimated volumes of its various water sources, the areas approved and the crops, which will determine the limits of each distribution status category.

Proviso. For the purposes of this Article, the following factors (*inter alia*) shall be taken into account:

A. The hydrological records and conveyance losses of the District's various supply sources;

B. Conveyance losses in the distribution channel systems;

C. The areas earmarked for irrigation for each of the channels and their agrological characteristics;

D. Location of the various channels and their distribution branches.

Article 43. Order of distribution

During rotation and emergency status, the volumes or quotas to which the various users along a single channel are entitled shall be delivered starting with the far end of the channel in question and finishing with the intake point, the District Chief reserving the right to change this order when the areas to be irrigated warrant such a change.

Article 44. Eligibility requirements for water use entitlement

Users shall meet the following requirements in order to be entitled to use the irrigation water:

1. They shall have documentary evidence of full payment of their obligations vis-à-vis the District with respect to the charges and installments referred to in Chapters II, VIII, IX and X of these Regulations, which shall be submitted when the special regulations of each District are set;

2. They shall see that the channels assigned to them by the special regulations and their own irrigation and drainage channels and the banks of their headwater, receiving and protective structures are kept clean and weed-free and their land is properly prepared and graded. Irrigation service shall not be provided to areas that have not complied herewith;

3. Within the deadline set by the District Chief, they shall have submitted the crop program accompanied by the corresponding irrigation request for the crop season in question and shall have been notified personally of the approval or rejection of said request;

4. They shall be present in person or be represented at the corresponding irrigation outlet at the time and on the day when they are scheduled to receive irrigation services and shall sign the respective voucher;

5. They shall monitor the use of the water assigned to them from the site at which it is received until it reaches their fields;

6. They shall obey the orders and comply with the requirements set by the District under of these Regulations.

Proviso. For the purposes referred to in paragraph 2 of this Article, the maintenance of the assigned channels, i.e. for both irrigation and drainage, shall be carried out jointly by the users involved, with the number of days' work contributed by individual users proportional to the areas classified as suitable for irrigation, in the quantity and at the times indicated by the Office of the District Chief. If any user fails to assist in maintenance, the District may impose a direct contribution by charging the user's account for the amount in question.

Article 45. General provisions governing irrigation services

Irrigation services shall be subject to the following provisions:

1. The Office of the District Chief shall issue the order for irrigation services in accordance with the plans adopted or the distribution status in effect, following verification that the user has complied with all the obligations established in the foregoing Article;

2. District irrigation requests shall be made at least 48 hours prior to use, via submission of the irrigation order referred to in the foregoing paragraph;

3. The District shall not be liable should it be unable to provide water or obliged to supply a smaller volume than scheduled in the irrigation plan for reasons of *force majeure* or an Act of God.

   During periods of scarcity or emergency, water shall be distributed in the most equitable manner possible, in accordance with the order of priority indicated in Article 30 above. Once the demand for water for communities and livestock have been met, if there is still water left to distribute, priority in its distribution shall be given to crops that are most important to the area;

4. Waste or excessive use of water shall not be permitted during irrigation;

5. Water service shall be continuous, day and night, except in cases of *force majeure*.

6. Users shall be responsible for any damage that the water assigned to them causes or might cause to any works belonging to the District or to any private property or community service, when such damage is caused by defects or deficiencies in the irrigation or drainage works for which they are responsible or because of their poor management of the irrigation water.

7. If, once it has begun, irrigation is interrupted because of negligence on the part of a user, the latter shall lose his turn for irrigation services and shall be required to pay for the amount of water used that was wasted because of his negligence.

8. Zone Chiefs and watermen shall not obey orders from the Office of the District Chief unless they are issued in writing on official printed forms. Any alterations or frauds committed by users with respect to these orders shall be subject to the penalties specified in these Regulations, without prejudice to any criminal liability that might apply.

9. Users may not use the irrigation water for any purpose other than that specified in the irrigation plan, nor may they transfer it in full or in part, for any reason whatsoever.

CHAPTER VI
DISTRICT WORKS

Article 46. Categories of works

To ensure the control and distribution of water within the District, the latter shall be responsible for the operation of the following works:

1. Headworks, diversion structures, sills, gates and ancillary mechanical and electrical equipment built or installed at the sources of supply referred to in Article 27 of these Regulations;

2. Headworks, diversion or dam works, with all their mechanical and electrical accessories and devices that may be built, purchased or installed in the future at the sources of supply referred to in the foregoing paragraph;

3. All the main channels, with their respective structures and civil engineering works, that connect with existing and future headworks;

4. All secondary and tertiary channel networks and distribution ditches, with all their structures and civil engineering works that connect with the channels;

5. The drainage channel system and related structures;

6. The network of local roads already built and to be built by the District, both inside and outside the irrigation zones, for general service and for the operation and maintenance of the works;

7. The telephone and radiotelephone facilities that serve the District;

8. Water structures at the sources of supply and along the District's irrigation and drainage channels, as well as the climatological and meteorological stations within the District's jurisdiction to observe hydroclimatological factors;

9. The buildings and other structures that the District uses for its operations;

10. All the works both within and outside the District's boundaries, that are used for the utilization and development of the water in the corresponding areas.

Article 47. Organization and control of roadways

The District shall be responsible for maintenance, upgrading, appropriate sign placement and traffic regulation throughout the network of shoulders running parallel to the irrigation and drainage channels and other roads belonging to it.

Article 48. Specifications and maintenance of channels and roadways

All main and secondary channels that are planned or built and any that are relocated shall be subject to the specifications of the original project, with respect to roads suitable for vehicles, shoulders, zones, parallel drainage, etc.

Tertiary channels and channels in general shall, if they are deemed by the District Chief to require service roads, be equipped with roads suitable for vehicles in accordance with the specifications indicated by said official and the cost of their construction shall be borne by the users to benefit.

Article 49. Suspension and regulation of traffic

Whenever it is necessary to repair any road the District Chief may suspend traffic on it after posting the customary signs.

He may also limit or prohibit the use of the roads by certain vehicles, tractors or machinery which, because of their nature, could damage the District's road system.

Article 50. Transit of livestock

With the exception of stretches connected by bridges designed for livestock, such animals shall not be allowed to wander or remain anywhere along the roads or in the channel and drainage areas owned by the District.

Farm owners who have livestock are required to fence in their properties in an appropriate manner with a view to preventing their animals from encroaching on the roads and causing damage.

Article 51. Prohibition of obstacles

District users and other individuals or entities are categorically prohibited from depositing on the roadways any excavated material, trash or material extracted in the process of maintaining the works and from placing obstacles of any kind that block or impede transit. The use of the areas bordering the channels and roadways for farm activities of any type that interfere with their specific purpose, as established by the District, shall also be prohibited.

Article 52. Repair of damage

Violators of the Articles in this Chapter shall be required to cover the costs incurred by the District in the repair of the damage and losses caused to the works and shall further be subject to the penalties referred to in these Regulations.

Article 53. Rights of way

If, in order to prevent serious damage to the District's works, it should prove necessary, on an emergency basis, to use any farm area or privately-owned roads for the transportation of workers, equipment or materials, the owner of the farm in question may not prevent such activity. In return, the owner shall be compensated fairly and justly, for any physical damage caused him. For this purpose, the District Chief shall authorize the transit and shall estimate any damage actually incurred; in the event of any disagreement the procedure shall be governed by current legislation with respect to this matter.

CHAPTER VII
USERS' INTAKE AND OTHER WORKS

Article 54. Users' intake structures

In order for the water to be supplied to and used by the users, they shall be required to build and maintain their intake structures on the appropriate bank of the channel, in accordance with the plans, location and other specifications approved by the District and further to install whatever spillways, intake ports or calibrated flumed structures the Office of the District Chief considers necessary for the regulation and metering of the irrigation water.

Article 55. Construction for intake structures

The users shall be given a set period, to be established in the special regulations for each individual District, following the effectiveness of these Regulations, for the permanent construction of the intake, diversion and flumed structures referred to in the foregoing Article, in accordance with specifications and plans approved by the District.

Article 56. Temporary intake structures

If an intake structure is destroyed as the result of *force majeure*, making it incapable of collecting water, the District Chief may authorize the construction of a temporary intake structure at the most suitable point. In the event that *de facto* occupation of private land proves necessary, the procedure shall be in accordance with current legislation.

Article 57. Level of intake structures

Special care shall be taken in the location of permanent intake structures to ensure that they are designed in such a way that the base of the structure is at a suitable level in relation to the supply channel so as to avoid any undesirable changes in the normal designed levels of the channels. Care shall also be taken so that the walls and bases of the intake structure have proper foundations in order to ensure its stability and that the head and tail walls are of the appropriate height to protect the channels and shoulders.

Article 58. Gates and devices

The intake structures shall be equipped with the necessary gates and devices to protect the supply channels and to facilitate regulation by District officials.

Article 59. Change in channel location

If any of the irrigation or drainage channels in the District were to constitute a permanent danger to public utility works or to private property, the District may order that they be relocated.

If it were necessary for the new channel to occupy privately-owned land or if the threat was to public utility works, the procedure to be used for the acquisition of the land shall be in accordance with current legislation.

Article 60. Channel capacity

The District's distribution channels and irrigation ditches can receive only the volume of water they can normally contain, without prejudice to public roadways, public utility works or private property. District officials shall limit this volume to the maximum that the channels' design capacity permits.

Article 61. Suspension of irrigation because of damage

In the event of a breakage in the channel or imminent danger of such a breakage or any other serious accident, the Office of the District Chief may suspend all water supply to the channel or reduce the supply to the amount that is strictly necessary so that users whose intake structures are located before the point of danger will have some water; the District will, in any case, take steps to have the necessary repairs done as quickly as possible, with the assistance of those involved.

Article 62. Prohibition against the building of protective structures

Within the area of the District it shall be prohibited to construct protective structures along irrigation ditches and irrigation or drainage channels without the prior authorization of the Office of the District Chief or to place docks, parapets, diversion dams or any obstacles along natural watercourses.

Proviso. Ownership of both banks of a watercourse does not imply any exemption from the foregoing provision.

Article 63. Authorization of protective structures

Authorization to build protective structures shall be requested in writing from the Office of the District Chief by those interested in such a project. The District shall conduct a visual inspection, which the interested parties shall be invited to attend, following which a report shall be written. Accurately placed stakes will be used to mark the location of the protective structures that are authorized and their type and main features shall be determined following the granting of authorization.

Article 64. Protective structures involving plantations

Interested parties may build protective structures involving plantations, providing they make a written application, giving their reasons, to the District, which is the regulating and decision-making body that shall decide on the area in which such plantations shall be located.

Article 65. Construction plan for protective structures

All protective structure works that users and other interested parties are authorized to build shall be consistent with a master plan, whose purpose is the gradual channelization of all watercourses involved.

Article 66. Halting of unauthorized work

All orders to halt work that do not comply with the stipulated requirements shall be obeyed immediately; otherwise the penalties referred to in these Regulations shall be imposed.

Article 67. Communal protective structures

When the District deems it advisable to build a protective structure that would benefit several users it shall order its construction after consulting the Users' Association and the resulting costs shall be shared among those benefiting from it both directly and indirectly in a manner proportionate to the areas classified as suitable for irrigation, in accordance with a special budget, as established in these Regulations.

Article 68. Reinforcement of protective structures

Whenever there are plans to reinforce or modify an old protective structure, authorization must first be obtained from the District Chief after the submission of the work schedule.

Article 69. Authorization for excavation of channels

All excavation in the channels for which the District is responsible shall, regardless of the purpose, require its prior authorization and the interested parties shall, for this purpose, submit their application, indicating the location, purpose and scope of the respective works. In granting authorization, the District Chief must ensure that the movement of materials does not vary the maximum slope of the channels and that the excavations do not affect any protective structures, bridges, intakes, etc.

Article 70. Works on land crossed by channels

Owners of land that is crossed by channels or watercourses may not make an opening in such channels or build any irrigation or drainage works without the authorization of the District Chief, who shall establish the distance that must exist between the watercourse or channel and the works that are planned, the depth of such works and other conditions that are essential in order to avoid any seepage or reduction in water supply to the owner of the farm served.

Article 71. Maintenance of ditches

With a view to enabling users to increase their benefits from the irrigation water to which they are entitled, the District may require them to maintain their irrigation ditches in a condition that permits sufficient capacity along their entire length so that they carry the entire volume assigned.

Article 72. Maintenance of drainage channels

Users are required to keep their drainage channels, wasteways and inlets clean and in good working condition at all times, complying with the conditions established by the District in order to prevent them from damaging public roads, communal channels, private channels or to the land of any user. With respect to the discharge outlets of these channels, the interested party or parties shall carry out, at his or their expense, whatever works the District Chief deems necessary in order to prevent erosion or other damage.

Proviso 1. If a drainage channel or ditch scheduled for cleaning is located on land belonging to third parties, the user of the farm receiving irrigation service shall carry out the cleaning to the satisfaction of the Office of the District Chief, which may require him to do any repairs that are needed to the bed, banks, roadways or adjoining land so as not to cause damage to the farm receiving irrigation service, authorizing him to occupy the area required for the appropriate disposal of materials removed.

Proviso 2. In the case of irrigation or drainage channels that cross several farms, the users of each of them shall be required to undertake the periodic cleaning of their stretches, in accordance with the relevant maintenance plan.

In the event of failure to perform this work, the District Chief shall authorize the maintenance of the works in question and charge for such maintenance accordingly, without prejudice to penal action in the event of any physical damage to other works attributable to such failure.

Article 73. Periods for work execution

Users shall be required to carry out the works referred to in this Chapter within the periods set for that purpose by the District. In the event of unjustified noncompliance, the District Chief may contract out the work at the expense of the interested party or parties, which shall be required to pay for them plus a 20% surcharge, without prejudice to the penalties referred to in these Regulations.

CHAPTER VIII
OPERATING BUDGET

Article 74. Period

The District's operating budget shall cover a period of one calendar year.

Article 75. Sources of budget funds

The District's ordinary operating budget shall be funded by the users on the basis of the charges set in the income budget.

Article 76. Definition

For the purposes of the foregoing Articles, the District's ordinary operating budget shall be prepared in accordance with the guidelines issued by HIMAT for that purpose and shall itemize operating costs and further establish a reserve fund for equipment replacement.

Article 77. Timetable for budget preparation

Each year the District Chief shall prepare the draft operating and income budgets for the District during the following year, after consulting the Users' Association, and shall submit them to the Office of HIMAT's General Manager no later than October 1, accompanied by a detailed supporting memorandum.

Article 78. User charges

The income budget, which will be equal to the District's operating budget, shall be prepared, with respect to irrigation service, on the basis of two types of charges:

1. Fixed charge;

2. Volume-based charge.

The first type of charge will apply in the case of drainage services only.

In the case of both irrigation and drainage services, the charges established for these two different services will be used.

Article 79. Fixed charge

The fixed charge shall be the amount payable by District users per hectare classified as suitable for irrigation or drainage in the master list of users, whether or not they use the irrigation and drainage services.

Article 80. Volume-based charge

The volume-based charge for irrigation services is the amount that District users pay per cubic meter supplied to their intake.

Article 81. Approval

By December 1 of each year HIMAT shall approve, reject or modify the draft budget submitted to it for consideration, taking the supporting memorandum into account, or shall process it directly in the event that it has not been submitted in time. HIMAT's decision shall be final.

Article 82. Notification

Once the approval referred to in the foregoing Article has been granted, the District Chief shall notify District users, by circular, and by December 25 of each year, of the approved charges that will come into effect on January 1 of the following year.

Article 83. Payment schedule

Fixed charges shall be paid in advance in semiannual installments from the first day of the month on which the half-year begins.

Payments in respect of the volume-based charge for permanent crops shall be paid semiannually. In the case of nonpermanent crops, payment shall be in accordance with the District's requirements. Such payments shall become due and payable within the periods established in the regulations issued by each District Chief.

Proviso. The District Chief shall announce, with appropriate advance warning and notification, the places or offices where the payments referred to in this Article shall be effected.

Article 84. Claims

Users required to pay the tariffs may submit a claim in writing to the District Chief within 15 days of the start of the collections referred to in the foregoing Article in connection with any purely arithmetical errors that might have been made at the time of payment. Such claims shall be dealt with by the District Chief before the specified deadline for payment, without this implying any extension of the deadline for the user.

Article 85. Advance payment

If any other payment should fall due while a claim is pending, the interested party must submit the receipt for the payment in question or not be permitted to proceed with the claim.

Article 86. Executive Collection by legal means

After accounts receivable with respect to tariffs have been drawn up and the deadline for payment has expired and a decision handed down on any legal remedies that have been sought, legal means of collection may be sought directly by HIMAT or by the Public Treasury official with jurisdiction, in accordance with the procedure indicated for cases decided by summary jurisdiction.

Proviso. In the event that the payments in question are in arrears, the District Chief shall, pursuant to Article 45 of Decree No. 1112 of 1952, be required to report this to the National Tax Authority so that this agency refrains from issuing the debtors in question certificates of full settlement of bills with respect to income, property and other taxes, until the pertinent payment has been made.

Article 87.

Late payment of bills with respect to both types of charges, i.e. fixed and volume-based, shall be subject to interest at the rate of 2% per month on the outstanding balance for every month or fraction thereof for which the payment is late.

Article 88. Accounting system

For the purposes of this Chapter the handling of funds, control of budgetary items, records, books and other procedures shall be consistent with HIMAT's bylaws concerning accounting.

Article 89. Equipment

The procurement of the equipment needed for the District's operations shall be effected out of the reserves established for equipment renewal, at the request of the District Chief. If there are no reserves established or if such reserves are insufficient, the procurement may be effected from extraordinary fees charged with the approval of the Association.

Article 90. Fiscal control

The Auditing Office of the Controllership of the Republic with responsibilities for HIMAT shall exercise fiscal control over the funds and property assigned to the District, in accordance with pertinent legislation.

CHAPTER IX
SPECIAL AND EMERGENCY WORKS

Article 91. Definition of special works

For the purposes of this Chapter special works shall be considered those which, despite not being included in the District's ordinary operating budget, prove necessary for a segment or all of the users in order to upgrade water collection, distribution and drainage, to prevent damage to channels, structures, roads or buildings or to facilitate the transit of equipment and farm products. The resulting cost shall be absorbed by the users who benefit.

Article 92. Need for special works

The need for special works may be identified by the users, their representative Board or by the District Chief, the latter being responsible for proposing the features, costs and financing plans.

Article 93. Approval of special works

The Association shall be responsible for approving the special works and for the financing plans to be submitted to the District Chief for subsequent approval by HIMAT.

Article 94. Definition of emergency works

Emergency works shall be understood to be those deemed vital in order to repair damage and defects in the District's works caused by unforeseen circumstances and *force majeure*, such as floods, heavy rains, landslides, etc.

Article 95. Financing of emergency works

The cost of the emergency works shall be borne by the users who will benefit from them, in proportion to the area classified as suitable for irrigation and in accordance with the financing plan submitted by the District Chief, approved by the Association and adopted by HIMAT.

Proviso. Works shall be considered "emergency" when, in the opinion of HIMAT's specialized bodies, they cannot be postponed without compromising the safety and proper operation of the District's works.

CHAPTER X
VIOLATIONS AND PENALTIES

Article 96. Serious violations

The following shall be considered serious violations in the Irrigation District:

A. Theft of irrigation water;

B. Serious offenses against District officials in word or deed;

C. Destruction of protective structures belonging to other users, impairment of intakes belonging to others and clandestine works that cause damage to third parties;

D. An interruption in the District's communication services;

E. Unwarranted closing or obstruction of the District's operating and maintenance roads;

F. Sale or transfer of irrigation water for the service or use of farmland belonging to others;

G. Damage to the structures, channels or equipment belonging to the District;

H. Building of plugs or structures that impede the free flow of water in the channels and irrigation ditches or that alter the design conditions required for their operation;

I. Payment for the District's services with checks backed by insufficient funds;

J. Failure to comply with the irrigation plan approved by the District.

Proviso 1. In the case of the theft of irrigation water, the District Chief shall, without prejudice to the pertinent penalties, estimate the volume of water stolen and take steps to collect payment for it.

Proviso 2. The penalities for the violations mentioned in section (B) of this Article shall be imposed without prejudice to any penal action that may be instituted.

Proviso 3. In the events referred to in sections (C), (D), (E) and (G) above, violators shall be required to repair the damage and shall be held liable for any damages claimed by the District or by those harmed. In the event referred to in section (H), violators shall be required to take down what they have built and shall be held liable for any damages claimed by the District or those harmed.

Article 97. Fines and penalties

The commission of any of the acts referred to in the foregoing Article and the violation of any of the provisions of these Regulations or other pertinent rules shall subject the violators to successive fines of up to Col$500 and the temporary or permanent suspension of the right to use the irrigation water.

Article 98. Damages for negligence

Any users who, through negligent use of the water, flood roads or cropland belonging to other users, damage public roads, drainage works, channels or generally cause damage to public or private property shall be subject to fines, without prejudice to any civil liability that may arise from such acts.

Article 99. Imposition of penalties

Fines and penalties shall be ordered or imposed by the Director of the Users' Association by a decision giving the grounds for the decision.

Article 100.

The interested party or his representative or proxy shall be notified in person of the decision to impose the penalty within five working days of the date on which it was issued.

Article 101.

If the interested party cannot be notified of the decision in the manner prescribed in the foregoing Article, appropriate proof of such notification being required, a notice on regular paper shall be affixed in a public area of the Association's administration office for a period of five working days. Said notice shall contain the actual wording of the decision.

Proviso. Notification of the decision, whether in person or by notice, shall include an indication of the legal remedies that can be taken against it.

Article 102.

Unless the requirements described above are met, notification of the decision shall not be deemed to have been made and it may not be enforced,

unless the interested party, claiming to be sufficiently informed, accepts the decision or seeks one of the legal remedies available to him, within the time allowed, to appeal the decision.

Article 103. Legal remedies

The following legal remedies shall be available against decisions to impose penalties:

1. A request for reversal to the Director of the Users' Association, asking that the decision to impose the fine or suspension be clarified, modified or revoked;

2. An appeal to the Users' Association's Board of Directors to the same effect.

Article 104.

These remedies shall be sought in writing within five working days of receipt of the notification in person or of removal of the posted notice. Once this period has elapsed without any remedy being sought, the decision shall be final.

Article 105.

The appeal may be presented *per se* or as ancillary to the request for reversal in the event the latter is unsuccessful, both being decided upon outright.

Article 106.

The act of requesting a reversal or appeal shall suspend the effects of the decision until the matter is settled.

CHAPTER XI
GENERAL AND TRANSITORY PROVISIONS

Article 107.

The specific regulations required by the Office of the General Manager for each District, in accordance with the authorization conferred by this Board on November 16, 1977, shall include an Article that reads as follows: "All the rules contained in Article 41 dated November 16, 1977, issued by the Board of Directors of the Colombian Institute for Hydrology, Meteorology and Land Development are hereby declared incorporated in these Regulations."

Article 108. Assistance from the police force

The District Chief may request assistance from the police force in enforcing compliance with these Regulations and as provided for by law.

Article 109. Plant and animal health

All District users shall be required to comply strictly with government requirements regarding the control of pests and diseases that attack crops and livestock and shall cooperate with government action in the manner required.

Article 110. Priority of rules

The distribution and use of water within the boundaries of the Irrigation District and the maintenance and upgrading of all the works within its borders shall be consistent with these Regulations, any other concordant provisions relating to water and, lastly, shall meet the technical criteria adopted by the Office of the District Chief.

Article 111. Circumstances not covered

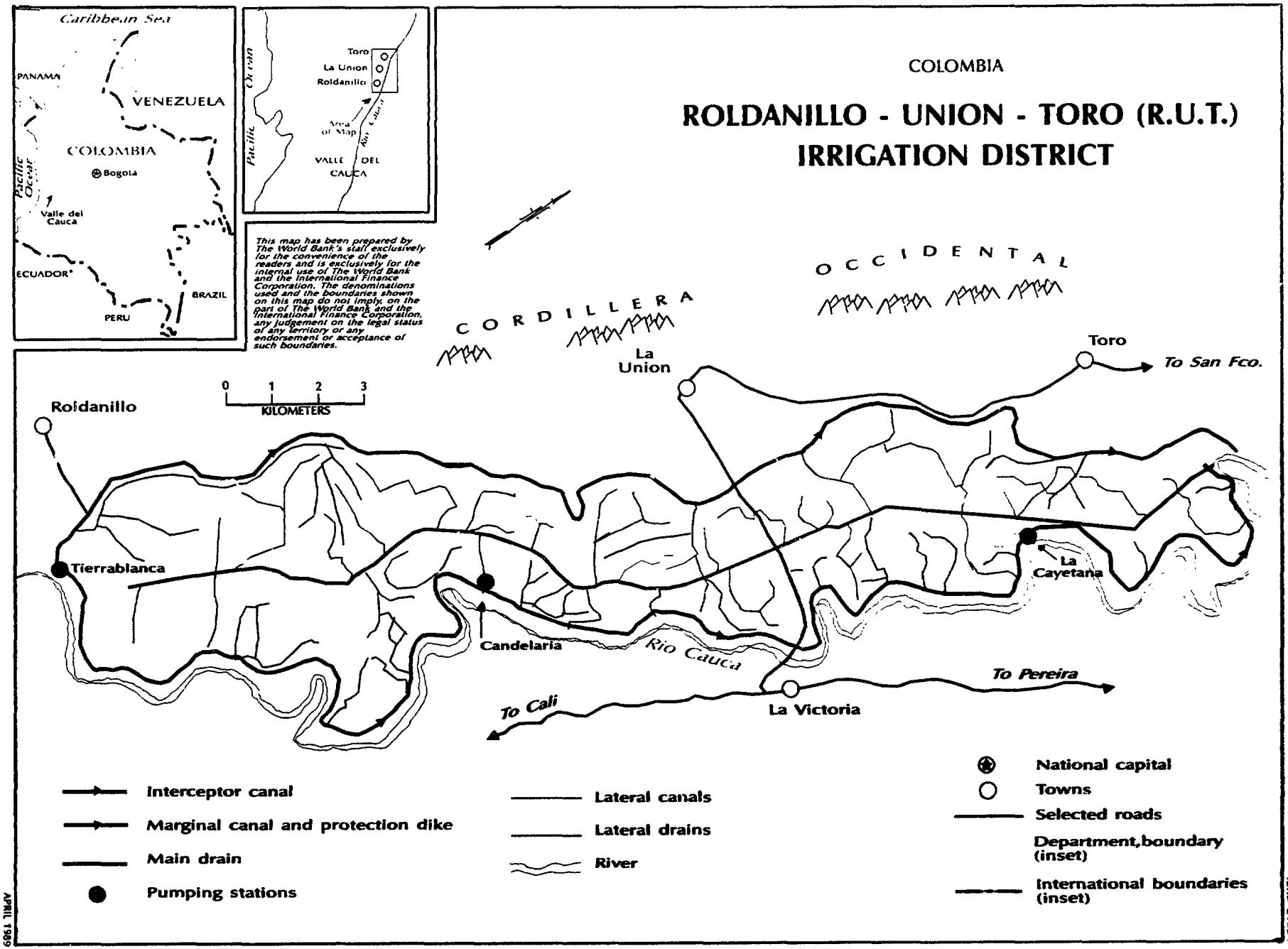
Any circumstances not covered by these Regulations shall be subject to the pertinent provisions in effect within HIMAT and legislation governing the matter in question.

Article Two

These Regulations shall enter into effect on the date on which they are issued and shall abrogate any conflicting provisions.

FOR COMMUNICATION AND IMPLEMENTATION.

Bogotá, November 16, 1977


COLOMBIA
ROLDANILLO - UNION - TORO (R.U.T.)
IRRIGATION DISTRICT
Caribbean Sea
PANAMA
VENEZUELA
COLOMBIA
Bogota
Pacific Ocean
Valle del Cauca
ECUADOR
BRAZIL
PERU
Toro
La Union
Roldanillo
Area of Map
Rio Cauca
VALLE DEL CAUCA
This map has been prepared by The World Bank's staff exclusively for the convenience of the readers and is exclusively for the internal use of The World Bank and the International Finance Corporation. The denominations used and the boundaries shown on this map do not imply, on the part of The World Bank and the International Finance Corporation, any judgement on the legal status of any territory or any endorsement or acceptance of such boundaries.
CORDILLERA OCCIDENTAL
0 1 2 3
KILOMETERS
Roldanillo
La Union
Toro
To San Fco.
Tierrablanca
La Cayetana
Candelaria
Rio Cauca
To Pereira
To Cali
La Victoria
Interceptor canal
Marginal canal and protection dike
Main drain
Pumping stations
Lateral canals
Lateral drains
River
National capital
Towns
Selected roads
Department,boundary (inset)
International boundaries (inset)
APRIL 1969
IBRD 21534

IBRD 21515

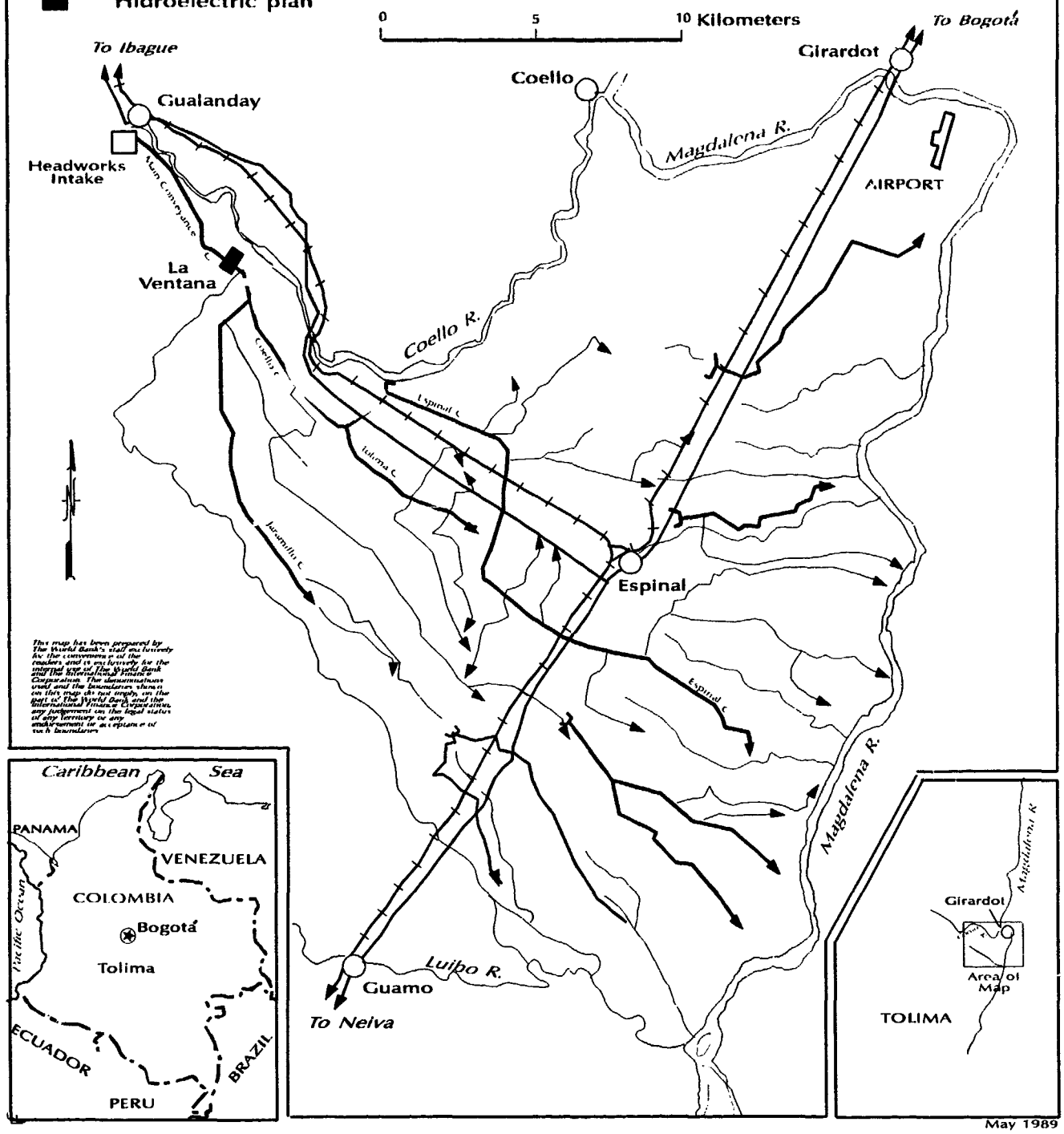
COLOMBIA

COELLO IRRIGATION DISTRICT

Project boundary
Main canal system fed by Coello river
Lateral canals
Irrigation system fed by runoff
Natural drainage system
Rivers
Hidroelectric plan

National capital
Towns
Selected roads
Railroads
Department boundary (inset)
International boundaries (inset)

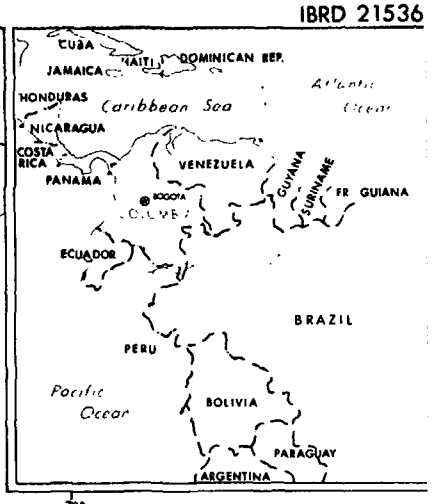
0 5 10 Kilometers



May 1989

IBRD 21536

COLOMBIA
IRRIGATION DISTRICTS



PANAMA
VENEZUELA
ECUADOR
PERU
BRAZIL

Riohacha
Santa Marta
Barranquilla
Repelon
St. Lucia
Manati
Cartagena
Prado
Sevilla
Valledupar
Monteria
La Doctrina
Sincelejo
Zulia
To Caracas
Abrego
Cucuta
Lebrija
Barrancabermeja
Bucaramanga
Medellin
Quibdo
Alto Chicamocha
Samaca
Sogamoso
Tunja
Manizales
Pereira
Armenia
Ibague
Rio Recio
BOGOTA
R.U.T.
COELLO
Girardot
Villavicencio
Tulua
Buga
Palmira
Cali
Buenaventura
Saldana
San Alfonso
El Junco
Naiva
Porvenir
Popayan
Pasto
Sibundoy
To Quito
GUAVIARE
VAUPES
AMAZONAS

Elevations (meters)
3000
1,000
0

MILES
0 50 100 150

KILOMETERS
0 50 100 150 200 250

Irrigation Districts Under Study:
- COELLO (For Detail See IBRD 21535)
- R.U.T. (For Detail See IBRD 21534)
- Irrigation Districts
- National Capital
- Cities and Towns with Population Over 40,000
- Main Highways
- Rivers
- Department, Intendencia, and Comisaria Boundaries
- International Boundaries

APRIL 1989

PPR Working Paper Series

	Title	Author	Date	Contact for paper
WPS243	Averting Financial Crisis - Kuwait	Fawzi H. Al-Sultan	July 1989	R. Simaan 72167
WPS244	Do Caribbean Exporters Pay Higher Freight Costs?	Alexander J. Yeats	July 1989	J. Epps 33710
WPS245	Developing a Partnership of Indigenous Peoples, Conservationists, and Land Use Planners in Latin America	Peter Poole	August 1989	S. Davis 38622
WPS246	Causes of Adult Deaths in Developing Countries: A Review of Data and Methods	Richard Hayes Thierry Mertens Geraldine Lockett Laura Rodrigues	July 1989	S. Ainsworth 31091
WPS247	Macroeconomic Policies for Structural Adjustment	Carlos A. Rodriguez	August 1989	R. Luz 61588
WPS248	Private Investment, Government Policy, and Foreign Capital in Zimbabwe	Mansoor Dailami Michael Walton	August 1989	M. Raggambi 61696
WPS249	The Determinants of Hospital An Analysis of Ethiopia	Ricardo B.-Dicowsky David W. Dunlop	August 1989	V. Israel 48121
WPS250	The Baker Plan: Progress, Shortcomings, and Future	William R. Cline	August 1989	S. King-Watson 33730
WPS251	Patents, Appropriate Technology and North-South Trade	Ishac Diwan Dani Rodrik	August 1989	S. King-Watson 33730
WPS252	Do the Secondary Markets Believe in Life After Debt	V. A. Hajivassiliou	August 1989	S. King-Watson 33730
WPS253	Public Debt, North and South	Helmut Reisen	August 1989	S. King-Watson 33730
WPS254	Future Financing Needs of the Highly Indebted Countries	Ishrat Husain Saumya Mitra	August 1989	S. King-Watson 33730
WPS255	The External Debt Difficulties of Low Income Africa	Charles Humphreys John Underwood	August 1989	S. King-Watson 33730
WPS256	Cash Debt Buybacks and the Insurance Value of Reserves	Sweder van Wijnbergen		
WPS257	Growth, External Debt , and the Real Exchange Rate in Mexico	Sweder van Wijnbergen	August 1989	M. Bailey 31854

PPR Working Paper Series

	Title	Author	Date	Contact for paper
WPS258	Understanding Voluntary Organizations: Guidelines for Donors	L. David Brown David C. Korten		Z. Kranzer 69485
WPS259	Dealing with Debt: The 1930s and the 1980s	Barry Eichengreen Richard Portes	August 1989	S. King-Watson 33730
WPS260	Growth, Debt, and Sovereign Risk in a Small, Open Economy	Jagdeep S. Bhandari Nadeem Ul Haque Stephen J. Turnovsky	August 1989	R. Luz 61588
WPS261	Inflation, External Debt and Financial Sector Reform: A Quantitative Approach to Consistent Fiscal Policy	Sweder van Wijnbergen Roberto Rocha Ritu Anand	August 1989	M. Bailey 31854
WPS262	Adjustment and External Shocks in Ireland	Dermot McAleese F. Desmond McCarthy	August 1989	M. Divino 33739
WPS263	How Has Instability in World Markets Affected Agricultural Export Producers in Developing Countries	Peter Hazell Mauricio Jaramillo Amy Williamson	August 1989	C. Spooner 30464
WPS264	Two Irrigation Systems in Colombia: Their Performance and Transfer of Management to Users' Associations	Herve Plusquellec	September 1989	H. Plusquellec 30348
WPS265	The Influence of Imperfect Competition in International Markets: Some Empirical Evidence	Alexander Yeats		
WPS266	Policy Changes that Encourage Private Business Investment in Colombia	Mansoor Dailami	August 1989	M. Raggambi 61696
WPS267	Issues in Income Tax Reform in Developing Countries	Cheryl W. Gray	August 1989	N. Campbell 33769
WPS268	Shortcomings in the Market for Developing Country Debt	John Wakeman-Linn	September 1989	S. King-Watson 33730
WPS269	Women in Development: Issues for Economic and Sector Analysis	Women in Development Division	August 1989	J. Lai 33753
WPS270	Fuelwood Stumpage: Financing Renewable Energy for the World's Other Half	Keith Openshaw Charles Feinstein	September 1989	J. Mullan 33250