Guidelines for an

IIMI Program in Latin America

Guidelines

for an

IIMI Program in Latin America

Consultancy Report

Armando Bertranou

Ernst Schulze

January 1993

INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

Bertranou, A and E. Schulze. 1993. Guidelines for an IIMI Program in Latin America: Consultancy Report. Colombo, Sri Lanka: IIMI. xvi + 70 pp.

/ irrigation management / economic aspects / agricultural production / food production / peasants / water users' associations / performance / privatization / private ownership / policy / Latin America / Mexico / Brazil / Argentina / Chile / Peru / Cuba / Ecuador / Colombia /

The views expressed in this publication are those of the authors and do not necessarily represent the consensus of IIMI or its partners. Please direct inquiries and comments to:

International Irrigation Management Institute
P. O. Box 2075
Colombo
Sri Lanka.

Contents

Acronyms

ADB	-	Asian Development Bank
BID	-	Banco Interamericano de Desarollo
BM	-	Banco Mundial
CCC	-	Confederacion de Canalistas de Chile
CELA	-	Centro de Economia Legislación y Administración del Agua
CGIAR	-	Consultative Group on International Agricultural Research
CIAT	-	Centro Internacional de Agricultura Tropical
CIDIAT	-	Centro Interamericano de Desarrollo Integral de Aguas y Tierras
CIMMYT	-	Centro Interncional de Mejoramiento de Maiz y Trigo
CIP	-	Centro Internacional de la Papa
CNA	-	Comision Nacional del Agua
CNPAI	-	Centro Nacional de Pesquisa de Agricultura Irrigade in Paranaiba (Piaui)
CNR	-	Comision Nacional de Riego
CODEVASF	-	Compantia de Desenvolvimento de Vale do Sáo Francisco
CPATSA	-	Centro de Pesquisa Agropecuária do Trópico Semi-Arido
CRA	-	Centro Regional Andino
DGA	-	Direccion General de Aguas
DNOCS	-	Departemanto Nacional de Obras Contra as Secas
DR	-	Direccion de Riego
EAP	-	Economically Active Population
ECLAC	-	Economic Commission for Latin America and the Caribbean
EMBRAPA	-	Empresa Brasileira de Pesquisa Agropecuaria

FAO	-	Food and Agriculture Organization of the United Nations
FEDARROZ	-	Federacion Nacional de Arroceros
GDP	-	Gross Domestic Product
HIMAT	-	Instituto Colombiano de Hidrologia Meteorologia y Adecuacion de Tierras
ICA	-	Instituto Colombiano Agropecuaria
ICID	-	International Commission in Irrigation and Drainage
IDB	-	Inter-American Development Bank
IESR	-	Instituto de Economia y Sociologia Rural
IFAD	-	International Fund for Agricultural Development
IFPRI	-	International Food Policy Research Institute
IICA	-	Instituto Interamericano de Cooperaçào para la Agricultura
IIMI	-	International Irrigation Management Institute
IMTA	-	Instituto Mexicano de Tecnologia del Agua
INCDRA	-	Instituto National Colombiano de Reforma Agraria
INCYTH	-	Instituto Nacional de Ciencias y Tecnicas Hidricas
INERHI	-	Instituto Ecuatoriano de Recursos Hidraulicos
INIFAP	-	Instituto Nacional de Investigaciones Forestales y Agropecuarias
IRD	-	Integrated Rural Development
ISNAR	-	International Service for National Agricultural Research
NGO	-	Nongovernmental Organization
O&M	-	Operation and Maintenance
OAS	-	Organization of American States
ODI	-	Overseas Development Institute
ORSTOM	-	Institut Francais Recherche Scientifique pour le Developpement en Cooperacion
PHO	-	Pan-American Health Organization
RDP	-	Rural Development Program

SARH	-	Secretaria de Agricultura y Recursos Hidriculicos
SENIR	-	Secretaria Nacional de Irrigaçao
UNDP	-	United Nations Development Program
WB	-	World Bank

Executive Summary

A. IRRIGATION IN LATIN AMERICA

The area under irrigated agriculture in Latin America is about 16 million hectares (ha), which is about 8-10 percent of the total irrigated area in developing countries and which is nearly equal to the irrigated area of Pakistan. The countries in the region with large irrigated agricultural areas (according to FAO, 1989 statistics), are given below.

	Irrigated area	
	In hectares	As % of the total cropped area
Mexico	5,150,000	20.8
Brazil	2,700,000	3.4
Argentina	1,760,000	4.9
Chile	1,265,000	28.0
Peru	1,250,000	33.5
Cuba	896,000	26.9
Ecuador	550,000	20.7
Colombia	515,000	9.6

These countries account for almost 90 percent of the total irrigated area of the region.

Though the irrigation environment in Latin America has similarities to those in Asia and Africa, where IIMI's program has been concentrated so far, there are major differences in the social, economic and political factors important to irrigation. These include:

* A much more pertinent role of the private sector in the development and management of irrigation systems, particularly in countries like Brazil and Colombia.

* An increasing role of water users' associations in various forms and settings in managing irrigation systems, in particular, in countries like Chile, Brazil (organized into cooperatives), Mexico and Colombia (where associations are taking over the management at an accelerating pace), Ecuador, and parts of Argentina.

* An (export) market orientation of irrigated agriculture in several countries, with profitability as an important performance indicator.

* A high level of irrigation technology usage, though highly variable, including central pivot systems, canal regulations, information systems, etc.

The principal limitations that Latin American irrigation systems face, and which they share with irrigation systems worldwide, are: under-utilization of existing infrastructure; deficiencies in productivity and profitability; a marked engineering bias toward investments; and low emphasis on operation, maintenance and management issues.

Numerous experiences of failure have provoked a reconsideration of the concept that linked irrigation solely to water works. The result is the greater importance now being assigned to economic, human, social, environmental, and fundamental management aspects.

The management of water in general, and of irrigations systems in particular, has been converted into one of the inputs of the second generation needed to maintain increase in productivity.

The management of irrigation in Latin America shows considerable variations between countries, ranging from systems managed for public agencies through diverse types of shared management between the state and the users' associations, to the systems managed by private enterprises. Most striking, however, is the fact that in over 50-60 percent of the irrigated area in Latin America, the physical irrigation infrastructure is under private (nonpublic) ownership.

Current Developments

The irrigated agricultural sector is an integral part of the national economy and therefore is greatly affected by general socioeconomic policy decisions.

After what is called "the lost decade of the '80s," Latin America is now going through a process of rapid changes in socioeconomic policies which will have an impact on the irrigated agricultural sector. Three important policy developments are:

1. *Economic stabilization*

With some countries experiencing annual inflation rates of more than 1,000 percent, all countries of the region have acknowledged the need for stabilization in order to achieve economic growth.

During the last few years, a large number of countries introduced enormous fiscal adjustments. These adjustments are the result of considerable reductions in current expenditure and investments.

As it is not unusual that the irrigated agricultural sector benefits from many hidden subsidies (in investments as well as in operation and maintenance), the measures taken will undoubtedly have repercussions for the development and sustainability of the sector.

2. *Liberalization and deregulation of the economy*

The main aim of these measures is to make the economy more competitive and expand foreign trade.

Recently, the USA, Canada and Mexico signed a free trade agreement. Some countries of the region have been working hard at regional integration. For example, the establishment of a common market (MERCOSUR) for the countries of the Southern Cone is on its way.

These policy changes will have important consequences for the irrigated agricultural sector. It will force the sector to produce in a competitive climate, reduce production costs and increase profitability through crop diversification and specialization in commodities in which it has a comparative advantage (for example, no rice in dry areas anymore).

There is legitimate concern as to how small-holder irrigated agriculture, in particular, would face these challenges.

3. *Privatization and decentralization*

The disequilibrium in public financing, the dissatisfaction with public management and the overall inefficiencies of the region's economies, require decentralization of decision making to mobilize resources, overcome management deficiencies and, in particular, improve the possibilities of adapting to change and innovation.

In line with these overall policies, most of the more important irrigation countries of the region are engaged in a process of transfer of responsibilities for operation and maintenance from public agencies to water users (Mexico, Colombia, and Argentina, among others).

An IIMI program in Latin America should focus its efforts on issues that are closely linked to the consequences of these policies for the irrigated agricultural sector, and their impact on the efficiency and sustainability of the development and use of the water resources of the region.

B. TOWARDS AN IIMI PROGRAM IN LATIN AMERICA

Rationale

The rationale for an IIMI program in Latin America is based on the opportunities available in the region for addressing generic irrigation management issues in an environment that is different from those usually encountered in Asia and Africa. These differences stem from levels of technology used as well as from a more prominent role of the nonpublic sector in the development and management of irrigation systems.

Research Areas

Four areas of research have been identified:

1. *The management of water deliveries*

The overall objective of this research effort will be to develop a methodology and analytical framework for defining the most appropriate management system for a given irrigation environment. This will include analysis of the external as well as the internal environment of the different institutions in charge of water deliveries.

2. *The management of transfer of responsibilities*

The principal objective of this activity will be to develop a better understanding of the processes and conditions that govern management transfer processes and to develop a methodology for the assessment of factors effecting these processes.

3. *Methodologies for performance assessment*

In line with IIMI's performance program, the main objective of this activity will be to develop appropriate performance indicators, determine relevant performance determinants and develop appropriate and cost-effective methods for performance assessment, monitoring and evaluation.

Two levels are proposed: the irrigated agricultural sector as a whole and institutions in charge of water deliveries.

4. *The role of policy instruments*

Here, the main thrust will be to compare different policy instruments used to create an enabling environment in which the responsibility for the development and use of water resources has been largely shifted from the public to the private sector, while at the same time the sustainability of its use for the collective good is guaranteed.

Professional Development

A close linkage with ongoing activities and recent initiatives taken by the Economic Commission for Latin America and the Caribbean (ECLAC) in the field of training is proposed.

This holds in particular for ECLAC's initiative to promote a series of workshops for high-level policymakers and decision makers concerned with water resources development.

Fellowships are considered an important instrument in fostering regional inter-institutional linkages.

Information Exchange

The publishing of an irrigation management newsletter in Spanish and the translation of relevant (parts of) IIMI publications into Spanish are suggested.

Mode of Operation

The main feature of the mode of operation of an IIMI program in Latin America should be the establishment of a regional office in one of the countries of the region. The office will be headed by a "Jefe de Operaciones en Americo Latino" who will be responsible to the Director for International Cooperation.

The program will be regional in nature, guided by a regional Consultative Committee. The formation of specific working groups by topic or subregion should be considered in accordance with arising needs. A minimum critical mass of high-level multidisciplinary expertise should be established at IIMI's regional office, combined with "outposted" junior research associate staff working on collaborative research programs with national (research) institutions.

Level of Effort

The consultative mission which prepared this report is of the opinion that a minimum or threshold level of effort is required to justify an IIMI program in the region that can be expected to contribute in a cost-effective way to the fulfillment of the overall mission of the Institute. If such a threshold level cannot be achieved, IIMI should renounce any activity in the area that could be labelled as an IIMI Latin American Program.

Such a level of effort should permit the posting of at least four internationally recruited staff at IIMI's regional office at a cost of around one million US dollars per annum.

This amount would cover the establishment and operational requirements of the office, recruitment of limited but necessary local staff, field logistical support and hiring of international staff, as already mentioned.

This level of funding would be comparable to those of IIMI's on-going efforts in West Africa and Pakistan.

Location of the Regional Office

As IIMI's program in Latin America is of a regional nature, the following criteria should be considered in selecting a regional office location through a process of consultation with the countries in Latin America:

* Geographical location vis-a-vis irrigated agriculture of the region.

* Importance of the irrigated agricultural sector of the country; less emphasis to be given to this criterion because of the regional approach intended for the program.

* Good communication facilities, both internal and external.

* Interest of the government concerned in hosting an IIMI office.

1. Introduction

In 1984, the International Irrigation Management Institute (IIMI) was established to strengthen national capacities to manage irrigation systems and to conduct research in irrigation management. IIMI's creation grew out of explorations in the early 1970s within the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR).

Based in Sri Lanka, IIMI became a full member of the CGIAR in late 1990. Its research program aims at generating a set of strategies that will facilitate the development of better ways to manage irrigation systems. However, unlike many other kinds of agricultural research, nothing of significance in irrigation management can be studied in the laboratory. IIMI must therefore put its staff into direct contact with diverse irrigation management situations in the field.

IIMI's approach involves two principal methodologies -- collaborative field and action research, and thematic research. Collaborative field and action research is undertaken in specific collaborative projects with national irrigation agencies or other suitable organizations. In its thematic research program, the findings that emerge from the former are evaluated against similar research undertaken in other countries. Thematic research and collaborative field and action research together form an integrated, coherent program approach aimed at establishing a body of overview knowledge from which conclusions of direct and practical relevance to various aspects of irrigation management may be drawn.

IIMI complements its research programs with a set of research-related training and information activities that aim at fulfilling its goal of strengthening national irrigation management organizations by upgrading the skills of IIMI's partners -- senior and top-level managers, policymakers and individual researchers. IIMI's information activities are principally aimed at the dissemination of management innovations and research outputs to its partners and promoting the exchange of information among practitioners and researchers in developing countries.

Special emphasis is placed on disseminating results that are relevant and useful to those in positions to influence management and policy changes.

IIMI's initial efforts were devoted to establishing programs that relate to irrigation management issues in South and Southeast Asia.

In the rice-based humid tropics of Southeast Asia, the focus has been on the development of alternative operational strategies that will result in more equitable and efficient distribution of water supplies, and the techniques for system operation to support moves towards crop diversification away from rice to high-value crops, in the dry season.

In the arid and semiarid areas of the larger river basins in South Asia, IIMI has been involved in identifying causes of inequitable water deliveries, the management of conjunctive use of surface water and groundwater and managing irrigation systems to minimize water logging and salinity hazards.

In mid-1988, IIMI opened a regional office in Ougadougou, Burkino Faso to address the irrigation management issues of the Sahelian region of West Africa. IIMI's work in West Africa focuses on the development of manageable operational and maintenance strategies that accommodate the unique combination of land tenure, physical environment and agriculture.

As its Asian and African operations consolidate, IIMI wants to consider expansion of its activities to Latin America. IIMI's activities in Latin America have been limited to the organization of a special session on irrigation management in Latin America held in Rio de Janeiro on May 4, 1990 on the occasion of the 14th Congress of the International Commission for Irrigation and Drainage (ICID), and

to the organization of an international workshop on the performance of farmer-managed irrigation systems, in Mendoza, Argentina during November 12-15, 1991.

In considering expanding its activities to Latin America, IIMI fielded a two-man consultative mission to develop a workplan for the region.

During the months of November and December, 1991, the mission visited six Latin American countries (Argentina, Brazil, Chile, Colombia, Ecuador and Mexico) and had discussions with many members of national irrigation departments and other government departments, research institutions, water users' associations and regional organizations.

This report is the result of this mission.

2. Overview of Agricultural Sector and Irrigation in Latin America

2.1 RECENT EVOLUTION AND CURRENT SITUATION OF LATIN AMERICAN ECONOMIES

For three decades -- 1950 to 1980 -- developing countries in general reached growth rates of over five percent, ambitious public health and education goals were met and, in some cases, there was a fivefold increase in average income levels. In the 1980s, however, the gap between the standards of living in developing countries and the industrialized world increasingly widened. The per capita income of the richest country was 220 times the per capita income of the poorest country.

The great paradox is that, despite the fantastic opportunities brought about by the technological revolutions of the 20th Century, over one billion people -- a fifth of the world's total population -- live on a daily income of less than one US dollar. This was the standard of living in Western Europe and in the United States two hundred years ago (World Bank 1991).

The 1980s was a decade of crisis, with worldwide recession and loss of opportunities for many developing countries. During this decade, known as "the lost decade" (ECLAC 1990a), the economies of most developing countries in Latin America moved backwards. In fact, in 1989, the average gross domestic product per inhabitant in the region was 8 percent lower than that in 1980. Therefore, as regards the standard of material wellbeing of the Latin American population, it can be stated that the 1980s represented a period of marked recession. (For some characteristics of "the lost decade" in Latin America, see Appendix 1.)

Thus, these countries entered the 1990s with the burden of the recession of the 1980s, an enormous foreign debt, limited accessibility of their products to international markets, and a series of unsatisfied civil requirements. But this decade also witnessed important political improvements which have advanced the democratic process in several of the countries in Latin America.

Current Economic Situation

In 1991, Latin America experienced a slow economic recovery, in most cases, at a modest pace and on uncertain grounds.

Despite the still fragile stabilization processes, the major countries in the region (Mexico, Chile, Argentina, Brazil and Colombia) are operating on new bases: expansion of the export market, liberalization of trade, fiscal austerity, a more prudent management of monetary policies, and greater resistance to the state's regulating economic activities. Unfortunately, this recovery of macroeconomic variables has been accompanied by greater inequities and concentration of wealth, less job stability, and less fiscal resources for social expenditures (ECLAC 1991a).

The most important features of the current economic situation are economic stabilization and state reforms.

Economic stabilization policies have contributed to reduce inflation, especially in countries with high inflation rates (e.g., Argentina, Peru, Uruguay).

Despite great differences in growth, all economies tend to stabilize. After having reached annual inflation rates of more than 1000 percent, all countries in the region acknowledge the need for stabilization in order to achieve economic growth.

Therefore, it can be said that in 1991, most countries have managed to achieve or are on the way to achieving macroeconomic stabilization.

During the last few years, a large number of countries have introduced enormous fiscal adjustments. These adjustments mainly stem from a considerable reduction of public expenditures, consumption and investments. On the other hand, the interests accrued by the public foreign debt continue to burden fiscal budgets to the point that most countries in the region fail to meet their debt service obligations despite their willingness to comply with the payments.

This situation suggests the need for rapid state reforms and for the transformation of management structures together with decentralization of economic and institutional activities.

Although there are local variations, the common reasons for this situation include:

1. The disequilibrium in public financing, aggravated by recent restrictions and the continuous increase of costs and demands.

2. The dissatisfaction with public management, negatively affected by the vested interests of corporate groups and by the rigidity of central bureaucracies, which prevents them from responding to fast changes.

3. The evident overall inefficiencies in the region's economies and the need to improve their competitiveness and make their operation more rational (Martin 1988).

These circumstances require decentralization of decision making to mobilize resources, to overcome management deficiencies, and to improve the possibilities of adapting to change and innovation.

In Latin American countries, decentralization is gradually gaining political ground although the gap between policy and reality is still wide. In their respective constitutions, Peru (1979), Chile (1980), Guatemala (1985) and Mexico (1991) have introduced reforms favoring decentralization, while Brazil's new constitution (1988) goes even further from the point of view of fiscal policy.

In general, the economies of the region are operating with better, balanced public sectors and clear processes of turnover to the private sector.

On the eve of the third millennium, Latin America is confronted with a great economic and social challenge: sustainable and participatory development which calls for decentralization processes to help strengthen management activities and the local use of the region's resources.

This challenge also demands basic changes. Political democracy, economic liberalization and stabilization, and revision of the state's role to allow greater participation of the civil society, should lead to the economic recovery of the region and lay the foundation for growing equity.

2.2 THE AGRICULTURAL SECTOR IN LATIN AMERICA

2.2.1 Trends and Perspectives

Latin America faces serious problems of food scarcity, rural poverty and malnutrition (FAO 1989), usually attributed to high population growth rates and low agricultural productivity.

In past decades, agriculture constituted (although varying from country to country) a significant component of the Latin American economies. While the industrialization process did not favor

agricultural development, agriculture did contribute to the promotion of industrial dynamism through the transfer of resources, generation of foreign revenue, food supply, and a cheap labor force (Ortega 1986).

Despite an intensive modernization process started in the 1960s, agriculture in Latin America has evolved somewhat different from that in other countries. It is only loosely connected with national industries and services (with the exception of the main countries of the Southern Cone), and it concentrates on a limited number of agricultural commodities, geographical areas and certain types of producers.

The crisis of the 1980s has also increased the numbers of a seasonal migrant labor force with no other alternatives for rural employment (ECLAC 1990).

Over the last quarter of the century, the contribution of agriculture to the GDP of Latin American countries dropped, in general, from 15 percent to 11 percent (see Table 2.1), while rural employment dropped from 58 percent to less than 30 percent. It should be borne in mind, however, that contrary to what happened during the structural transformation processes of developed countries, in which the loss of relative weight of agriculture was a phenomenon that accompanied economic growth, in Latin America, a considerable part of that relative loss of importance is due to the labor force switching from agriculture to other activities of little economic relevance (ECLAC 1988a).

Table 2.1. Agricultural sector: Value added by agriculture, by country, 1960-87 (percentages).

Country	Percentage of GDP							
	Average			Annual				
	1960-69	1970-79	1980-87	1984	1985	1986	1987	1988
Argentina	12.9	11.8	13.1	13.7	14.1	12.9	13.1	13.9
Bahamas	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Barbados	20.2	10.1	8.7	9.3	9.2	9.1	7.9	7.2
Bolivia	20.5	18.0	21.1	22.2	24.3	23.8	23.3	22.7
Brazil	17.5	11.3	10.8	11.3	11.4	9.8	10.8	10.8
Colombia	27.2	23.6	22.0	22.2	21.9	21.3	21.5	21.3
Costa Rica	24.5	20.9	19.3	20.5	19.2	19.1	18.8	19.1
Chile	9.4	8.6	9.2	9.3	9.6	9.9	9.6	9.4
Ecuador	27.0	18.0	15.2	14.0	14.7	15.7	17.8	17.1
El Salvador	28.0	24.2	24.9	25.6	24.8	23.9	23.7	22.7
Guatemala	28.8	27.1	25.4	25.5	25.9	25.6	25.7	25.6
Guayana	24.7	19.7	22.3	23.7	23.5	24.3	23.0	21.6
Haiti	44.6	39.0	32.2	32.0	32.1	32.5	32.7	32.5
Honduras	33.3	27.9	25.3	25.2	25.2	25.0	25.6	25.3
Jamaica	10.0	7.7	8.3	8.8	8.9	8.6	8.4	7.6
Mexico	13.3	9.7	8.3	8.4	8.5	8.6	8.6	8.4
Nicaragua	25.2	24.4	23.8	24.3	24.1	22.2	21.7	23.8
Panama	16.9	12.9	10.1	10.1	10.2	9.8	10.1	11.2
Paraguay	34.2	29.0	26.1	26.7	26.9	25.2	25.9	27.2
Peru	16.1	12.9	11.7	12.2	12.4	11.8	11.5	13.3
Dominican Republic	26.7	18.7	16.5	17.1	16.9	18.3	15.5	15.1
Surinam	8.6	6.8	8.0	8.0	8.1	7.9	9.0	7.8
Trinidad & Tobago	5.3	4.0	2.9	2.8	3.1	3.3	3.7	4.3
Uruguay	11.6	10.6	10.5	10.6	11.1	10.8	10.4	10.4
Venezuela	5.3	4.8	5.3	5.3	5.6	5.7	5.8	5.8
LATIN AMERICA	15.10	11.70	11.20	11.50	11.60	10.9	11.30	11.40

Note: n.d. = no data available.
Source: BID Progress Económica Social en América Latina. Informe 1988.

2.2.2 Foreign Agricultural Trade

In many countries of the region (Brazil, Argentina, Colombia and, more recently, Chile), agricultural exports make up an important part of the agricultural GDP. In these countries, the growth of the agriculture sector depends on the dynamics of foreign demand for its products. However, the contribution of agricultural products to the region's total exports shows a substantial reduction from 51 percent in 1960 to less than 30 percent by the end of the past decade.

Agricultural exports consist of a limited number of products directed towards a small number of import markets with defined seasonal requirements mainly for fruits and vegetables.

There is a sharp contrast between developed countries and Latin American countries as regards their terms of entry into the world agricultural trade system. The evident agricultural protectionism of developed countries (for example, in regard to sugar, meat, flowers and, lately, bananas) has resulted in price and income instability in producer countries.

Except for Bolivia and the oil exporting countries, agricultural imports in the region show a tendency to decrease. For the region as a whole, during the last twenty five years, there has been a positive and increasing net contribution from agricultural foreign trade (measured as the difference between agricultural exports and agricultural imports). But, at country level, it is possible to distinguish four groups (ECLAC 1988a):

* Countries whose positive net balance turned negative in the 1980s (Peru, Mexico).

* Countries which maintained a positive net balance (Argentina, Brazil, Colombia).

* Countries which changed from deficit conditions in agricultural trade to surplus conditions (only Chile).

* Countries which remained net agricultural importers (Bolivia, Venezuela, Trinidad and Tobago).

These conditions carry implications for food security in Latin America. This aspect is dealt with below.

It has been suggested that the asymmetry in agricultural import-export dynamics between developed and developing countries is due, on the one hand, to the strongly protectionist policies and state support given to farmers in developed countries and, on the other, to the lack of sufficient support to farmers in Latin American countries (ECLAC 1989a). There are many reports (IDB, World Bank) which point to the need for diversifying production and markets, and for entering into global and regional agreements to remove the trade barriers between developed countries and the countries in the region.

Finally, it should be pointed out that the Latin American agro-export sector, characterized by its marked concentration and dynamism, differs from a large low-productivity sector oriented towards the domestic market and the production of foodstuffs.

The agro-export sector includes large national or transnational agricultural enterprises equipped with modern production, manufacturing and marketing facilities and having high productivity and profit levels, as well as enterprises with few modern production facilities and with competitiveness levels dependent on the intensive use of natural resources or a cheap labor force.

The expected agricultural protectionism in developed countries coupled with the loss of comparative advantages of exports based on natural resources and a cheap labor force, have affected agricultural policies which made foreign-market oriented production units the sole recipient of support and the source of agricultural development, while neglecting other basic equity aspects such as self-sufficiency in food.

2.2.3 Food Security

Food security is ever more frequently included as a major objective of food policies in Latin American countries. At FAO's 12th World Conference, it was stated that: "The ultimate goal of food security is to ensure that everybody, at all times, has physical and economic access to staple food sources."

Food self-sufficiency has been the central policy not only in developed countries but also in recently industrialized countries of Southeast Asia as well which are considered as paradigms of outward growth. In Latin America, food availability and accessibility problems have increased. Between 1950 and 1980, annual regional food production per capita grew by 1 percent, while apparent annual food consumption per capita grew by 1.1 percent. This gap between production and consumption was bridged by imports.

A quick review of the situation in different subregions shows that Central America has the worst calorie deficit while the Caribbean is strongly dependent on imported food (Figure 2.1). As regards the Andean subregion, there is a great heterogeneity in levels of food consumption and calorie adequacy. Bolivia and Peru have a great dependence on cereals. The Southern Cone countries show homogeneous levels of nutrition and better calorie adequacy. Mexico and Brazil show high calorie adequacy averages which hide deep inequities among their regions.

Given the trends observed in the evolution of food security, macroeconomic equilibria and a free market do not guarantee that those who lack purchasing power will have access to nutritional essentials. It will be necessary to make use of resources which are being wasted to improve food availability and accessibility. Indeed, a large part of the labor force -- both urban and rural -- is unemployed or underemployed; large tracts of arable land are left abandoned; the irrigation infrastructure (particularly, of large irrigation works) is operating at 50 percent to 60 percent below capacity due to poor maintenance or lack of repair; average cereal yields are well below those attained in some Asian countries; and an important part of the agro-industrial sector remains idle (IICA 1991).

Thus, it can be concluded that the region will have to maximize the potential use of its national, regional and local resources in order to produce the basic components of staple diets and increase the levels of self-sufficiency. Some other characteristics of rural agricultural development in Latin America are given in Appendix 2.

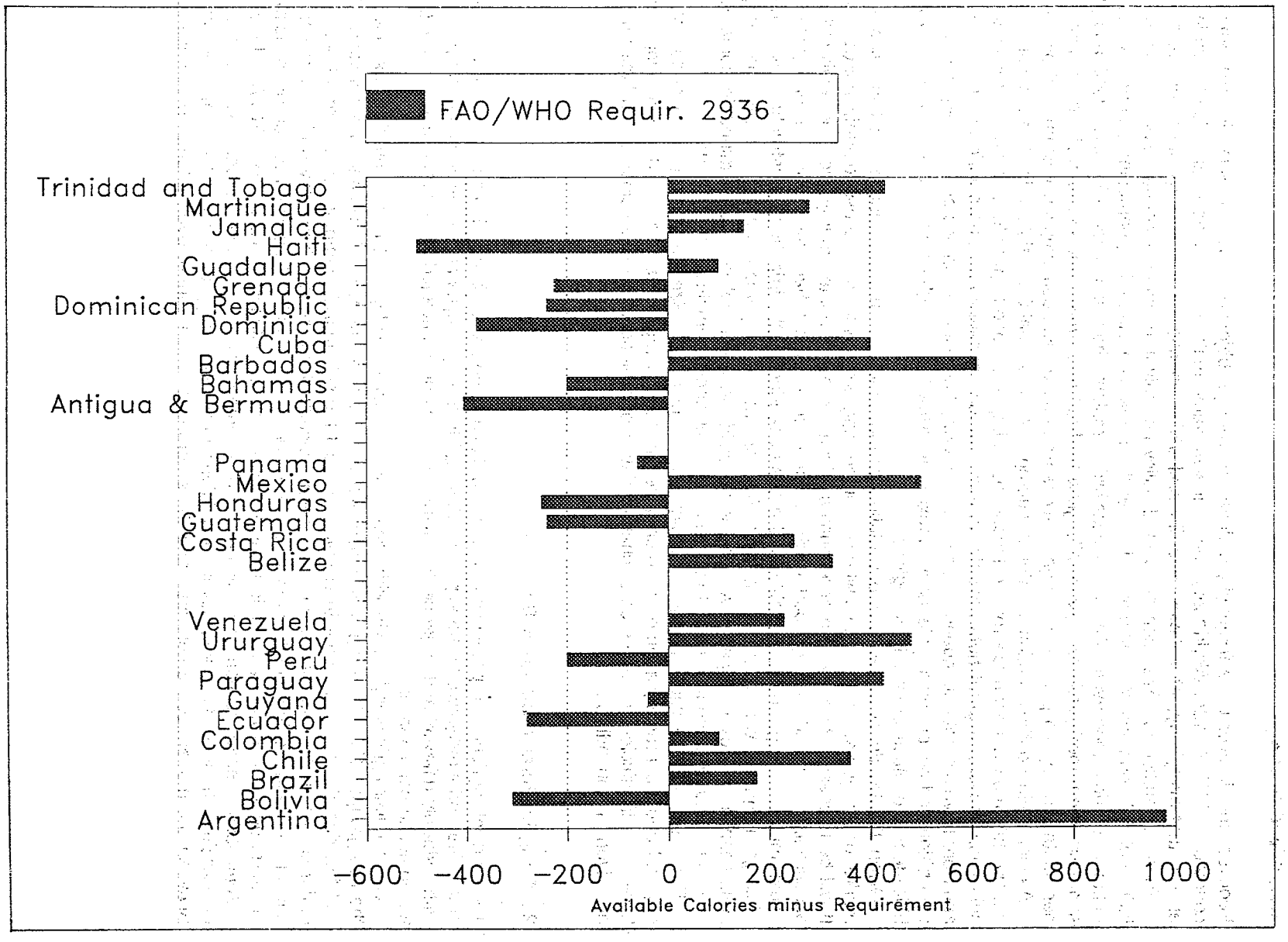
2.2.4 Agricultural Production Systems

The current agricultural production system in Latin America is bimodal with a sector of modern enterprises oriented towards the export market and to the most dynamic domestic markets that coexist with a sharply different and larger sector of small peasant units engaged in the production of basic goods for domestic consumption.

The peculiar agricultural growth with scarce rural or social development has widened the gap between the two groups. Experts in regional agricultural economics point out that the main characteristic of the last few decades was not agricultural stagnation but the substantial economic expansion of only a part of the sector. In this way, a nucleus of modern agricultural activity has been developing, with land and capital concentrated in a small number of enterprises which benefitted directly from public investments in infrastructure and from economic incentives and state assistance services (FAO/ECLAC 1986).

Agricultural modernization in a Bimodal and heterogeneous rural environment has deepened the inequalities, the inequities, and poverty conditions of the peasantry as it has widened the income gap between the modernized enterprises and the enterprises which cannot even attempt modernization.

Figure 2.1. Calorie deficiency in Latin America: the difference from the FAO/WHO recommended requirement, 1979-81.



Source: Regional Overview of Food Security in Latin America and the Caribbean with a focus on Agricultural Research, Technology Transfer and Application, IICA, January 1991.

While total Latin American agricultural production grew 1.96 percent between 1980 and 1986, the agricultural export sector grew by 3.1 percent. However, the 65 million poor in Latin America have not benefitted from this growth. On the contrary, it has brought about more poverty and social atomization of the peasantry compelling them to act as environmental deterioration agents who cause serious erosion and deforestation problems (IIAC 1988), or to sell their labor in order to supplement their incomes.

2.2.5 Peasant Agriculture

Peasant agriculture is based on family labor and production is organized according to the little land available, with restricted use and management of technological inputs. A peasant unit consumes what it produces and its aim is the survival of its family group -- quite different from an entrepreneurial unit which has the goal of maximizing returns.

From the point of view of land tenure, peasant agriculture comprises a varied group of people: small landowners, tenant farmers, sharecroppers, precarious owners without title deeds, etc.

The Latin American peasantry of about 65 million people is almost two-thirds of the total rural Latin American population and almost a fifth of the total population of the region (FAO/ECLAC 1986). In some subregions, like the Andean region, the relative importance of the population associated with peasant agriculture is even greater, while in Argentina, Uruguay and Southern Brazil labor-intensive and productive peasant units oriented towards the market and agro-industry are confined to limited areas.

FAO's updated estimates show that the number of peasant units tends to increase (at present there are some 16 million) and there is also an increase in the population directly engaged in peasant agriculture (75 million). About 60 percent of the peasantry is made up of farmers who are either landless or have precarious possession of the land. Lack of access to land and low productivity account for the sector's poverty (de Janvry 1989).

Peasant agriculture comprises 159 million hectares, a fifth of the land incorporated into regional agriculture. This area includes arable land as well as forest areas and land not suitable for agriculture. But, if only the cultivated area is considered, then almost 40 percent (i.e., 60.5 million ha) is in the hands of peasants.

As for unit size, in the early 1980s, 40 percent of the units (about 5 million units) had less than 2 ha. Persistent land and water scarcity as well as the trend toward *minifundios* are typical characteristics of Latin American peasantry mainly engaged in food production. Statistics reveal the important share of peasant agriculture in the food supply of the region. In the early 1980s, small-scale farmers accounted for 41 percent of the agricultural production destined for consumption and for 32 percent of agricultural production directed towards foreign markets (ECLAC 1986).

Some examples show that in Mexico peasant agriculture produces more than 45 percent of staple food products while in Brazil, most agricultural production is carried out in small units (Graciano da Silva 1986).

In Chile, there has been a reduction in the share of peasant agriculture in the food supply due to the loss of peasant lands resulting from the sale of Agrarian Reform plots. Not only was this loss considerable (over 200,000 ha under irrigation), but it also entailed the loss of the more productive irrigated lands (Echenique and Rolando 1989). However, family agriculture in Chile still comprises about 30 percent of both agricultural and irrigated lands.

The abundant empirical data available show that governmental support to peasantry has been, and still is, insufficient. Agricultural policies have been biased towards the medium- and large-scale producers with a view to attaining capital, technology and market control levels in keeping with the modernization strategy. ECLAC (1989b) states that "the operational instruments the State has used (investments, subsidies, loans, etc.) have only benefitted 25% of the production units, while the peasantry has kept on producing over 50% of the agricultural final consumption goods with very limited governmental support."

The above underscores the economic and social significance of the peasantry. To eradicate rural poverty, it is necessary to take up the challenge of making peasant agriculture a part of economic and social development through the provision of productive, permanent, and environment-friendly jobs.

The peasant sector possesses a production and organization capacity which must be enhanced in order to achieve a more participatory, equitable and self-generated rural development.

2.3 IRRIGATED AGRICULTURE IN LATIN AMERICA

2.3.1 Regional Distribution

Water resources and their use

Although Latin America and the Caribbean have much of the world's water resources, they also have some of the most arid areas. The uneven distribution of water gives rise to different situations at both national and regional levels.

The average annual rainfall in the region is about 1,500 mm; 50 percent more than the world's average. Nevertheless, there are serious water supply problems due to the population distribution pattern and the vast agricultural areas located in semiarid or high-mountain regions.

The main geographic system of the region -- the Los Andes range and its prolongation into the massifs of Central America and Mexico -- gives rise to three types of water systems in: the watershed of the Atlantic Ocean and Caribbean Sea (84% of the total area of the region); the Pacific basin (11% of the total area); and the area which lacks direct access to the sea (5% of the total area). ECLAC's Division of Natural Resources has carried out a Basin Inventory (1990) which describes the characteristics of the water system in each of these three areas (Appendix 3).

Although information on groundwater availability and on the amount annually withdrawn is lacking, the importance of groundwater use in Latin America cannot be underestimated. The City of Havana (Cuba) depends almost exclusively on groundwater; in Mexico, 330,000 ha of the Central and Northern Pacific are irrigated with groundwater; and the vast arid and semiarid regions of Argentina, Brazil, Chile and Peru use groundwater to make up for surface water deficits. It should be borne in mind that in many rural communities in the Andean valleys of Bolivia, Peru, Chile, Ecuador, Colombia and Venezuela mountain springs are the only source of drinking water and irrigation water for small farm units. (For information on water demand, see Appendix 4.)

Irrigation in Latin America

Over the last 40 years, the world's irrigated land area increased from 95 million ha in 1950 to 220 million ha in 1990, increasing its share of the world's total cultivated area to 15 percent. Although not evenly distributed, 72 percent of the world's irrigated land is located in developing countries.

From the point of view of production, the importance of irrigated agriculture is even greater: it has been estimated that the value of crops produced in irrigated areas is 37 percent of the value of the world's total crop.

The relative importance of irrigation, measured as a percentage of the irrigated area to the cultivated area, is given in Table 2.2 for selected countries in Asia, Africa an Latin America (FAO Production Yearbook 1990).

Latin America, with 15.8 million ha (or 9% of its cultivated area) under irrigation has less than 7 percent of the world's total irrigated land area. Three fourths of this area are located in northwestern Mexico, central and northern Brazil, the Peruvian coast, the central valleys of Chile and in Argentina's Andean region (Table 2.3).

Table 2.2. Ratio (percentage) of irrigated area to the cultivated area of selected countries in Latin America, Asia and Africa.

Country	Irrigated area ('000 ha)		% of growth	Cultivated area ('000 ha)		% of growth	% of irrigated area/ cultivated area	
	1974	1989		1974	1989		1974	1989
Latin America								
Mexico	4,293	5,150	19,96%	23,690	24,710	4,28%	19,34%	22,25%
Brazil	1,200	2,700	125,00%	59,100	78,650	33,08%	2,03%	3,43%
Argentina	1,410	1,760	24,82%	34,400	37,740	9,71%	4,10%	4,66%
Peru	1,120	1,250	11,61%	3,185	3,730	17,11%	35,16%	33,51%
Chile	1,240	1,265	2,02%	4,098	4,525	10,42%	30,26%	27,96%
Venezuela	211	264	25,12%	3,567	3,895	9,20%	5,92%	6,78%
Costa Rica	31	118	280,65%	490	528	7,76%	6,33%	22,35%
Ecuador	506	550	8,70%	2,609	2,653	1,69%	19,39%	20,73%
Colombia	290	515	77,59%	5,102	5,380	5,45%	5,68%	9,57%
Asia								
China	41,755	45,349	8,61%	102,017	96,115	-5,79%	40,93%	47,18%
Pakistan	13,343	1,622	21,56%	19,553	20,730	6,02%	68,24%	78,24%
Indonesia	4,840	7,550	55,99%	19,390	21,260	9,64%	24,96%	35,51%
Philippines	990	1,620	63,64%	7,318	7,970	8,91%	13,53%	20,33%
Sri Lanka	77	560	17,40%	1,918	1,901	-0,89%	24,87%	29,46%
Iran	6,000	5,750	-4,17%	1,690	14,830	777,51%	355,03%	38,77%
Iraq	1,550	2,550	64,52%	5,280	5,450	3,22%	29,36%	46,79%
Bangladesh	1,299	2,738	110,78%	9,133	9,292	1,74%	14,22%	29,47%
Nepal	175	943	438,86%	2,326	2,641	13,54%	7,52%	35,71%
Africa								
Tanzania	50	153	206,00%	4,990	5,250	5,21%	1,00%	2,91%
Morocco	1,032	1,265	22,58%	7,630	9,291	21,77%	13,53%	13,62%
Chad	6	10	66,67%	2,920	3,205	9,76%	0,21%	0,31%
Sudan	1,685	1,890	12,17%	12,060	12,510	3,73%	13,97%	15,11%
Senegal	150	180	20,00%	4,980	5,226	4,94%	3,01%	3,44%
Nigeria	810	865	6,79%	29,900	34,335	14,83%	2,71%	2,52%
Egypt	2,843	2,585	-9,07%	2,843	2,585	-9,07%	100,00%	100,00%
Madagascar	426	900	111,27%	2,475	3,092	24,93%	17,21%	29,11%

Source: FAO 1990.

Table 2.3. Irrigated area of selected countries for selected years from 1965 to 1989.

Country	Area ('000 ha)					
	1965	1970	1975	1980	1984	1989
Mexico	3,750	3,950	4,529	4,980	5,100	5,150
Brazil	610	796	1,300	1,800	2,200	2,700
Argentina	1,620	1,700	1,442	1,580	1,660	1,760
Chile	1,091	1,180	1,242	1,255	1,257	1,265
Peru	1,060	1,106	1,130	1,160	1,200	1,250
Cuba	493	520	593	762	834	896
Ecuador	450	470	509	520	537	550
Colombia	235	250	278	310	322	515
Venezuela	225	284	299	315	322	264
Dominican Republic	115	125	140	165	180	225
Bolivia	75	80	117	140	155	165
Guyana	109	115	121	125	127	130
El Salvador	20	20	32	110	110	120
Uruguay	35	52	57	79	92	110
Costa Rica	66	70	78	82	85	118
Honduras	26	26	36	61	84	90
Nicaragua	18	29	66	80	83	85
Guatemala	43	56	61	68	75	78
Haiti	40	60	70	70	70	75
Paraguay	40	53	60	62		67
Surinam	15	27	33	42	45	59
Puerto Rico	39	39	39	39	39	39
Jamaica	24	24	31	33	34	35
Panama	18	20	23	28	301	32
Trinidad	11	15	19	21	21	22
Total	10,218	11,054	12,298	14,085	14,920	15

Source: FAO 1990.

Latin America has diverse irrigation patterns on account of its different climatic, geomorphological, technological, economic and sociocultural conditions. By the end of the 1980s, there were 15.8 million ha under irrigation, which, when compared to its potential, is considerably low. Indeed, the irrigation potential of South America alone amounts to 160 million ha. Estimates show that the average annual potential irrigable land area does not exceed 80 percent of the total irrigated area due to runoff fluctuations and inadequate on-farm distribution and delivery (Merea Canelo 1990).

As regards irrigation methods, gravity irrigation is practiced, with low efficiency levels, in almost 95 percent of the irrigated areas in Latin America. Sprinkler irrigation is used in only 3 percent of the irrigated areas, Brazil being the country which uses it the most (60-65% of the agricultural area uses sprinkler irrigation). Drip irrigation is not used very much in the region.

The five countries of the region each of which irrigated more than one million hectares in 1989 are: Mexico (5.10 million ha), Brazil (2.70 million ha), Argentina (1.76 million ha), Chile (1.26 million ha) and Peru (1.25 million ha). They accounted for 77 percent of the irrigated area in Latin America. More information on irrigated areas are given in Tables 2.2 and 2.3. The following general observations can be made:

* There are countries in which the irrigated area is more than 20 percent of cultivated area and irrigated agriculture makes large contributions to the national gross domestic product through agricultural exports. In these countries (Peru, Ecuador, Chile), irrigated agriculture is essential for the national economy.

* In the case of Mexico, irrigated agriculture contributes half of the agricultural production, but the agricultural sector's contribution to the national gross domestic product is only 5 percent.

* Brazil has undergone fast irrigation growth. In 1970, only 800,000 ha were irrigated, and 20 years later, that area increased to 2.7 million ha. In less than five years (1975-80), the area with sprinkler irrigation more than tripled. Brazil has the highest irrigation potential (48 million ha) in the region.

* In some countries there are regions where irrigated agriculture represents a very high percentage of the cultivated area. The most outstanding example is that of Mendoza (Argentina), which has labor-intensive crops with a high aggregate value due to their connection with agro-industries. In the case of Chile, vegetables and fruits are grown in the central valley and the produce is either exported or sent to industrial markets; here, regional irrigated agriculture yields foreign revenue.

* The Andean countries (Peru, Bolivia, Colombia, Ecuador, and Venezuela) show a marked contrast between the mountainous region (usually known as "sierra") and the plains (intermountain valleys and the coast). They have ecological, productive, technological and sociocultural differences. In the sierra, crops are grown for domestic consumption in small peasant farm units. On the other hand, in the coast or valleys, crops are grown in large farm units for export purposes (banana, sugar cane, rice, soya, etc.). The marked difference between the coast or valleys and the sierra is that the former is characterized by its dynamism, expansion and high technological level, while the latter is characterized by a relatively stagnant traditional production.

On the coast, large investments have been made in irrigation and high yields have been obtained, while in the sierra, the lack of irrigation investments brought about food supply deficits (Ecuador, National Development Program of the Irrigation Sub-sector, FAO 1991).

In Peru, the situation is completely different because the coast competes with the sierra in food production. Different technological levels, together with the well-known problems that exist in the Peruvian sierra, bring about a reduction in its contribution to the national economy.

2.3.2. Irrigation Developments in Latin America

Irrigation in Pre-Columbian periods

When the Spaniards arrived in the New World, irrigated agriculture was already being practised by the Incas, Mayas and Aztecas. They had devised their own irrigation technology which was based on strict crop uniformity, water distribution and infrastructure maintenance standards.

The Incas, for example, carried out substantial irrigation development in the sierra. There was a marked difference between the coast and the sierra: due to lack of rains, agriculture in the coast was -- and still is-- dependent on irrigation, while in the sierra irrigation complements rain-fed agriculture. This situation called for different production techniques in both areas.

The Spanish conquest

After the Spanish conquest and colonization, many irrigation systems were abandoned and the centralized management systems of the Incas, Aztecas and other civilizations were replaced by Spanish systems. This situation prevailed until the end of the colonial period.

After the conquest, the inhabitants of the Andean areas and of the highlands of Central America and Mexico directed their efforts towards gold and silver mining. The staple food these communities consumed (manioc, maize, tomato, potato, etc.), and which were grown in irrigated areas, were unknown to the conquistadors.

The tropical and coastal areas of the subcontinent were full of plantations where African people worked as slaves. Cattle was raised in the pampas and in scarcely inhabited valleys of the south.

The primary export model

Towards the end of the 19th Century, a great expansion in world trade took place and a primary export model was introduced in the region based on the export of agricultural products (mainly meat and grains) and raw material from Latin America to industrialized countries.

The demand from industrialized countries contributed to the increase in the export of tropical products (coffee, sugar, bananas, cocoa) from Central America, the Caribbean countries and Brazil.

The growth of the primary export sector greatly affected the spatial or regional organization of the economic activity which was organized according to the commodities to be exported with comparative advantages to exogenous demand (North, D. 1960).

Agricultural growth is dependent on irrigation. Irrigation contributes to the production of food for domestic consumption in the Andean countries and in the regional economies of Chile and Argentina.

Nowadays,the Latin American countries remain largely exporters of primary goods or of goods closely related to primary products. The only exceptions are provided by Mexico and Brazil.

Water management and the State

The consolidation of independent States in Latin America towards the end of the 19th Century granted jurisdiction over water resources and laid the basis for water management. The different constitutions of the independent countries granted the State the right to intervene in water resources matters. However, most countries inherited the Spanish Law which does not leave irrigation exclusively to the State, although it does define water as a public good subject to private concession.

Through state centralization, water and irrigation acquired new political relevance: water distribution, maintenance and expansion works and water property.

This shows that Latin American countries considered irrigation to be an activity that belonged exclusively to the public sector and therefore their governments played a most important role in the provision of infrastructural services and job opportunities.

Agricultural modernization and irrigation

Up to the Second World War, the region kept on producing primary goods, but deterioration of real prices affected fiscal revenues which depended on the price of agricultural exports. Thus, an industrialization or import substitution process was set up in Latin America. As this industrialization process was subsidized by the agricultural sector, the gap between urban and rural areas widened.

The agricultural modernization, based on the Green Revolution, which started in Mexico in the early 1960s, granted farmers the opportunity to increase food production.

High crop yields were obtained only when chemical inputs were used and when the soil had a specific and timely humidity. That is to say, new technologies called for highly trained farmers, skilful in irrigation management. This explains why technological upgrading, including that of irrigation, did not develop massively. On the contrary, it increased the difference between a highly productive agricultural sector capable of incorporating new technologies and which benefitted from public investments in irrigation and technical assistance, and a large sector of small productive units devoted to food production and unable to absorb the technological package (Gerson, Gomez, ECLAC 1979).

Agricultural modernization has also led to the relating of investments to resources. Those countries which possess large natural resources and high agricultural capacity and a scarce labor force tend to invest in labor-saving technologies (e.g., rain-fed agriculture in Argentina). On the other hand, those countries where suitable agricultural land is scarce and where agricultural production is attained only through irrigation, priority is given to investments in irrigation and soil adequacy (Soil Adequacy Programme, National Planning Department, Colombia 1991).

In view of the relative scarcity of resources, agricultural modernization processes should aim at strengthening farmers' abilities to achieve the highest water use efficiency.

Investments in irrigation development

Since 1965, 250,000 ha were developed every year in Latin American countries and the average annual growth rate during 1975-80 was 3 percent.

It is difficult to determine exactly how much has been invested in irrigation works, but from the data provided by the World Bank, the International Development Association and the Inter-American Development Bank (IDB), an approximation can be reached.

During 1973 and 1985, the World Bank invested US$1,420 million in irrigation and drainage works. The IDB invested US$1,570 million during 1961 and 1983. Thus, between 1960 and 1985, almost US$5,500 million have been invested in irrigation at an average rate of US$200 million per year. The average cost of an irrigation project was US$68 million, while the average cost per hectare was US$2,100 and the cost per family was US$10,200 (Colmenares, Aguirre, IICA 1986).

Real irrigation investment figures may probably be higher because the contributions of local counterparts have not been included in these calculations.

But, in view of the current economic situation, it is highly unlikely that similar irrigation investments will be made in the near future.

With the exception of Chile and Brazil, the loss of dynamism of the economies of the region during the 1980s, the weakening of the State and the restrictions imposed on international cooperation and financing sources brought about a slow-down in irrigation development. Chile managed to maintain irrigation development because of the incentives given to the export of its irrigated agricultural goods. As for Brazil, it was due to the implementation of two irrigation programs, PROINE and PRONI, which aimed at producing basic foodstuffs for domestic consumption, that irrigation development was maintained. During the 1982-86 five-year period, a great expansion of the irrigated area was attained through the incorporation of more than 150,000 ha per year.

2.3.3. Current Situation and Irrigation Constraints

During the period of expansion of the irrigated areas (the 1960s and 1970s) some contradictions started to build up in relation to investments in irrigation. In spite of the heterogeneity of Latin American countries they all share similar problems in regard to the investment process:

Over-dimensioned water works

The installed capacity of irrigation and drainage is underutilized. The underutilization of the irrigated area, common to all Latin American countries, is due to an oversupply of irrigation and to a partial use of the irrigated area (Grassi, C 1990).

Overvaluation of irrigation benefits

Irrigation projects in Latin America have design and planning deficiencies: while their costs are underestimated, their benefits are overestimated. In view of the gap that exists between expected benefits and real benefits, financing institutions have increasingly overevaluated irrigation profitability (Carruthers 1989).

Irrigation projects are designed and built according to a series of technical assumptions. If one of them fails, so does the system's execution and operation. The comparison between irrigable and irrigated areas shows the effects of these limitations. In many instances, the irrigated land is half the assumed irrigable area.

The overvaluation of the expected production and of the water management capacity means that production does not suffice to defray the costs and that the rates of return turn out to be lower than expected. So, although irrigation may increase individual farmer income levels, the increased production of irrigation projects may not be high enough to cover the costs of diverting scarce resources from other sectors to irrigation-based production.

Deficiencies in productivity and profitability

As regards productivity and profitability of productive units and of irrigated crops, the proposed targets have not been met. The data provided by specific projects show that irrigation projects improved farmers' net income, but the results were 30-60 percent lower than those foreseen during the *ex ante* evaluations.

Profitability problems are caused by deficiencies of irrigation and drainage projects. New projects without a sound technical base entail higher costs which sometimes cannot be recovered and must be defrayed with local resources. There is also a tendency to consider that irrigation has certain attributes which are not strictly inherent to it. These attributes (redistribution, equity, regional development, etc.) are considered as targets to be met simultaneously with production improvements. In fact, irrigation is directly linked to production increases, and as such it constitutes an important tool in improving income levels of small-scale farmers.

Marked engineering bias of irrigation projects

As can be seen from Table 2.4, large investments have been made in the construction of irrigation works and in on-farm development.

Table 2.4. Breakdown (percentages) of total irrigation cost by category of expenditure, Latin America, 1961-86.

Category	Estimated cost as % of total cost	Actual cost as % of total cost
Studies	3	6
Engineering and construction	62	75
On-farm development	28	15
Technical assistance	1	4
Management and miscellaneous	2	2
Other	1	1
Total	97	103

Source: Colmenares, Aguirre - CEPI-IICA, Costa Rica 1986.

During this period, large reservoirs and irrigation waterworks as well as water storage and distribution works were constructed. This physical infrastructure, which at that time had strong political and social relevance, did not include supporting services to agricultural production such as rural extension, technical assistance to farmers, applied agricultural research and trade promotion mechanisms.

Profitable and sustainable agricultural production does not depend only on physical infrastructure or on water conveyance efficiency but on extension and training services that will help farmers improve their performance and ensure higher profits. Thus, it is necessary to set up a system that will help farmers improve their performance and ensure higher profits. And it is necessary to set up a system that will contribute to strengthen farmers' management skills in irrigation, production and trade.

Neglect of O&M

Most irrigation projects in Latin America are poorly maintained (Grassi 1990). The lack of maintenance activities, the serious restrictions on the operating capacity of irrigation managers and the underutilization of irrigated areas contributed to an increase in maintenance and rehabilitation costs and to environmental degradation.

Deficient maintenance leads to poor operation; poor operation leads to deficient maintenance (Sagardoy 1986).

In view of the serious economic crisis that the region has been confronted with and of current budgetary restrictions, it is necessary to raise returns on irrigation investments through rehabilitation works and higher operation and maintenance efficiency.

During the 1980s, foreign financing was directed towards rehabilitation and maintenance works with a view to improving the performance of existing irrigation system in the region.

If the irrigable area is expanded through the construction of new irrigation works, the region will be confronted with serious equity problems which will jeopardize the overall performance of the system.

Theoretically, it is assumed that operation and maintenance costs include items which are not inherent to them and that a substantial increase in irrigation charges will automatically render better operations and maintenance services (Sagardoy 1986), but experience shows that this may not be so. Although an increase in irrigation charges may be required, O&M costs must be reduced first. The tariff structure must be accompanied by adequate institutional changes and improved management capacity.

In order to achieve an effective reduction in O&M costs (65% corresponds to personnel), users must assume management responsibilities.

But it should be pointed out that due to weak financial evaluation mechanisms, lack of budgetary diagnosis and lack of information on what taxes have been used for, users are reluctant to participate in the system's improvement activities.

Lack of adequate supporting and training services

The region suffers from an underutilization of the potential capacity of human resources. Irrigation water management did not improve due to the lack of adequate supporting and extension services to farmers.

Failure to meet the goals of irrigation projects, low irrigation water distribution and application efficiencies, failure to reach the potential of irrigated areas and increased production brought about higher costs for the national economies of the region (Colmenares, Aguirre 1986).

In view of the above, it will be necessary to increase the operating capacity so as to improve the efficiency and efficacy of the existing irrigation infrastructure. Latin America is directing its efforts towards improving the operation and maintenance of the existing infrastructure.

This means that current irrigation development must be based on MANAGEMENT and not on physical design, construction or expansion of irrigation.

Human resources training, technological upgrading and institutional development will make it possible to improve irrigation performance.

Through training, small-scale farmers will be able to achieve efficient and organized irrigation management, and irrigation managers will be able to improve their management skills.

Although these situations developed during 1965-80, no efforts were made to rectify them. They have persisted and contributed to the discredit of irrigation.

But investments in irrigation projects with uncertain rates of return continue, leading to situations described earlier (Bertranou 1990). Some of the possible reasons for this are:

* Projects are supposed to help small-scale and medium-scale farmers. This reason is often given to justify support for projects with low rates of return. Sociopolitical considerations can, in certain cases, have a high degree of rationality. But if these projects have no assurance of a corresponding subsidy, they become misleading aid for the weakest which is expropriated by the strongest.

* In several instances, vicious cycles have developed that are difficult to reverse, and bring negative feedback on irrigation investments. Through misleading signals (subsidized prices for inputs and/or products of agriculture) communicated to the market and to decision makers, unreasonably high expectations of the profitability of investments in irrigation have been maintained. In turn, these have generated greater output levels, which have a depressive effect on prices. But the political pressures generated to raise prices for agriculture (for reasons of income distribution or regional development) have reinforced the feedback loop of this vicious cycle.

* The unwieldiness of the multiple-purpose and gravity irrigation projects is one of the causes for the existence of an excess supply of irrigated land and the relatively underutilized capacity of water stored for irrigation purposes. It is not that this type of project with large economies of scale should be fundamentally justified by the energy it generates. But at the same time, they are not marginal projects when evaluated from the point of view of irrigation. The subject of the unwieldiness of gravity irrigation projects -- in contrast to the use of groundwater (wherever this exists) -- should be analyzed.

* In general, there is a bias among administrators and politicians in favor of large engineering projects. They display a lack of understanding in operations and maintenance of less impressive investments, and tend to underestimate their value. The appeal of a newly completed grandiose

public works project and the crowning bronze plaque which immortalizes it are weighty factors difficult to overcome.

* The pressures of the companies involved in the construction of large infrastructure works can also influence decisions. This is less true in periods of economic recession.

At the end of the 1970s international financing institutions began to question the benefits of irrigation investment projects due to the negative results that expert evaluations yielded, and concluded that infrastructure development did not run parallel to management and human resources development.

Action-oriented recommendations were proposed for irrigation management at the United Nations Conference on Water held at Mar del Plata, Argentina, in 1977. The recommendations stressed the need to improve existing irrigation systems and their administration, before undertaking new irrigation projects. Efforts in this direction should focus on: funds earmarked for operation and maintenance, participation of small groups of water users in experiments, better training and extension services, and political priority to irrigation (ODI 1976). These recommendations are still relevant today.

International organizations have recommended that priority be given to human resources training in irrigated agriculture. During the last twenty years, large investments were made in irrigation and drainage infrastructure but little attention was paid to the most important resource: the people in charge of operating, maintaining and using those systems (World Bank 1990).

2.4 IRRIGATION INSTITUTIONS IN LATIN AMERICA

2.4.1 Some General Characteristics

Forms of government and water management

Irrigation water systems in Latin American countries have different characteristics from the point of view of both their legal and managerial organization. Argentina, Brazil, Mexico and Venezuela have adopted federal constitutions, and the rest have opted for unitarian forms of government: this difference is critical for irrigation management systems. In unitarian countries, water management is exercised either by the central executive power or by national decentralized or autonomous agencies. In federal countries, while some still maintain centralized water management systems, others grant broader powers to the province making up the federation (López, J. 1976).

Legal principles

Latin American legal systems uphold a number of principles on water resources which constitute both the framework and the basis for water management. The two most important principles in irrigation water management in the region are:

* Waters are of public domain: This legal and political criterion may be considered the rule in the matter.

* Granting of special or exclusive rights: The state's discretionary power to grant exclusive water rights to certain persons -- whether public or private -- through administrative proceedings (concession, license, permit, authorization) is widespread in Latin American legislation (INCYTH.CELA 1976). This, however, does not mean that, in practice, there have been no private water appropriations. In this regard, it is worth mentioning that Brazil and Ecuador are confronting serious problems in attempting the legalization and inventorying of existing concessions and private uses.

Water management systems

Despite considerable differences among the countries of Latin America, three basic water management systems may be identified:

* Systems with numerous public (and, sometimes, private) agencies and little central coordination (e.g., Argentina, Bolivia, Colombia, Chile and Venezuela).

* Systems with centrally coordinated policies, but responsibilities dispersed among different institutions as regards specific water uses (e.g., Brazil, Costa Rica and Peru).

* Systems with a central water management agency and little, if any, dispersion of functions whether for specific or regional uses (e.g., Ecuador, Honduras and Mexico) (ECLAC 1989c).

Types of irrigation systems management

Table 2.5 is an attempt to illustrate, in an indicative way only, the different types of irrigation systems management encountered in the region. At first, distinction has been made according to the ownership of the physical infrastructure. The role of the private sector in irrigation development is much more important in Latin America than, for instance, in Africa or Asia. As can be seen from Table 2.5, approximately 40 percent of the irrigated area is equipped with public systems, while on the remaining 60 percent the infrastructure is owned by private enterprises or associations. There are however considerable differences between the countries of the region.

Table 2.5. Types of irrigation systems management in selected Latin American countries.

	Irrigated area ('000 ha)*	Public Systems		Private Systems	
		Public management[1] (%)	Joint management (state and users)[2] (%)	Users' association management[3] (%)	Enterprises management[4] (%)
Argentina	1,750	10	60		30
Brazil	2.700	5			95
Chile	1.260			80	20
Colombia	520	15	15		70
Ecuador	550	20		70	10
Mexico	5.150	55		30	15
Total	11.930	3.330	1.130	2.940	4.530
%	100	28	9	25	38

Notes:
[1]The irrigation infrastructure is owned by the state and managed by state agencies
[2]The irrigation infrastructure is owned by the state and managed (jointly) by state agencies and users' associations.
[3]The irrigation infrastructure is owned and managed by user' associations.
[4]The irrigation infrastructure is owned by the private sector and managed by enterprises or individuals.

Source: FAO 1990.

Ownership of infrastructure is an important attribute in the management of the system. In Colombia, for instance, the government, through HIMAT, has the right of veto over the budgets of the Water Users' Associations. The rationale is that the government is the owner of the infrastructure and wants a guarantee that the system is properly maintained. Such a right of veto is inconceivable if the infrastructure is private property.

A second distinction concerns the responsibility for operation and maintenance of the system. Here also there are large differences between the various countries.

Enterprise ownership and management dominate in Brazil and Colombia. In Brazil, the strong production cooperatives in the south of the country are included in the category of enterprise management.

Association ownership and management dominate in Chile and Ecuador, though the agricultural production systems differ considerably.

Joint management of public owned systems is widely encountered in Argentina.

In Mexico, over half of the irrigated area is under public systems, and also managed by public agencies. There is however a rapid transfer of responsibilities for operation and maintenance to users' organizations.

It should be stressed that Table 2.5 is only indicative in nature. In reality, things are usually more complicated than the four categories distinguished here suggest.

2.4.2 Water Users' Associations in Latin America

The main characteristics of users' associations in the region are set out below (Solanes 1979). Emphasis is placed on certain countries because of their representativeness.

Forms and modes of user participation

In Latin American countries, users may participate at different levels: in policymaking, in public management agencies, or in field activities carried out by agencies made up exclusively of users.

In Mendoza (Argentina), users participate directly in the Canal Inspections and Irrigators' Commissions. Through the General Irrigation Department, users are also involved in water policymaking and water management in general. In Chile, users may participate in users' associations, but not in the state agencies. The Mexican user is a member of an Irrigation District Board of Directors, where he interacts with public officials, but he has no direct involvement in the Central State Management Agency.

In the region as a whole, user participation at the policymaking level is formalized through the political processes. In a number of countries, the irrigators are a significant political pressure group.

Type of association

In Latin American countries, users may be members of associations with or without legal approval. Legalization is important in guaranteeing the sound management of such associations.

In Mendoza (Argentina), users' associations are of necessity created by law and governed by public law regulations. Users' associations in Chile, on the other hand, are private entities but the law grants legal capacity to the Canal Users' Associations. In Mexico, users participate in public law entities, most of them without legal capacity while in Peru users are members of legalized public law associations.

Creation and membership of users' associations

In Mendoza, being an irrigator implies membership of a Canal Inspection. In like manner, every irrigator in Chile becomes a member of an Irrigation Community just by holding a water right; but the creation of a Canal Users' Association follows formal procedures and has to be approved by the Executive Power. Irrigation Districts in Mexico are created by the States and users are bound by law to become members

of the users' associations. An irrigator in Colombia, on the other hand, is free to join or not join a users' association.

Management organization and decision-making power

The most frequent organizational pattern in the region provides for an executive management body and a deliberative body (Chile, Mexico); sometimes there is also a control organ (Mexico, Colombia). In Mendoza the different functions are performed by the Canal Inspector.

There is a tendency towards guaranteeing the rights of small-holder irrigators ("one user, one vote") regardless of the size of their holdings.

Objectives, functions and powers of the associations

Users' associations perform -- simultaneously or separately -- three basic functions: deliberative, conflict-solving, and executive or managerial functions.

Users' associations in Mendoza carry out the following activities: water distribution among members, control of water use, *de facto* settlement of conflicts, canal cleaning and maintenance, and preparation of the association's budget. In Mexico, users' associations are different in that they participate in the decision-making processes of the central management agency. This is evident in the Irrigation District Board of Directors, which helps to define irrigation and crop plans, promotion actions, budgets, etc.

Associations' relationship with the State

Users' associations still fall under the State's Water Administration and, therefore, are subject to its regulations. The State is responsible for budgetary (approves yearly budgets), administrative (approves number and type of personnel) and technical (approves major works) control. Furthermore, the State is empowered to appoint an intervenor when the associations fail to meet basic targets or they are not efficiently managed.

2.4.3 Training in Water Management

As already mentioned, funds for investment in irrigation systems are becoming more and more difficult to obtain. Latin America needs to increase or, at least, maintain crop yields and the benefits of the considerable investments made. And this implies operating and maintaining irrigation projects more efficiently (World Bank 1990).

Experiences in different countries show that the attainment of these objectives hinges on the irrigation agencies' capacity to adapt to changing circumstances (such as crop diversification and environmental problems) and ensure that their irrigation systems remain efficient.

One of the greatest challenges to both formal and informal irrigation institutions will be the efficient use of their technical and managerial resources. This capacity will be maximized only when training is explicitly included as the integrating function of all irrigation activities.

ECLAC has conducted numerous studies on the integrated management of water resources (including irrigation) together with several regional institutions (CIDIAT, INCYTH.CELA, etc.).

The conclusion that can be made is that there is a general deficiency in the administration of water management institutions. The evolution of water management institutions has failed to keep pace with the growth in water demand. It has now become mandatory to improve the quality of management, regardless of the administrative system (ECLAC 1989).

The objective of improved management, together with better cooperation among the water management agencies from different countries, will only be attained through deliberate actions at regional level to promote the training of all groups involved in water management.

The report of the "Expert Committee on Training in Management Projects and Water Resources Systems" contains an estimate of the demand for training in water management in the region. It also evaluates conditions in order to draw up and carry out a training program on water management in Latin America. (It should be noted, however, that the study was not directed at training at the user level.) The methodology adopted for the report consisted of a survey of water management training needs during the 1985-87 period in eight countries in the region: Argentina, Bolivia, Brazil, Costa Rica, Guatemala, Nicaragua, Peru and Venezuela.

Provision of training

The analysis identifies training activities conducted by sectoral institutions. And the main conclusion is that although there are both academic and nonacademic institutions involved in water management, the present situation is far from the ideal of integrated water management training. The following examples illustrate the point:

* During the period under consideration, only one institution in Central America carried out a training program on water management principles for its professional staff.

* Venezuela is the only country in the survey where water agencies have their respective training departments.

* Except in the case of the Center for Water Economy, Law and Management (CELA, INCYTH) and the Andean Regional Center (CELA, INCYTH) in Mendoza, Argentina, there are no institutions providing integrated water management training in any of the countries in the survey. (CIDIAT in Venezuela incorporated integrated management only in 1989.)

As none of these institutions is in a position to undertake training activities separately without serious restrictions, the report recommends setting up a Cooperative Network for a regional training system, which could take advantage of the existing infrastructure and institutions.

Demand for training

The study on the demand for water management training consisted of an analysis of training activities conducted in the 1985-87 period (explicit demand) and the identification of future training needs so as to estimate potential demand.

The present situation points to a true need for training in the integrated management of water resources among the different institutions. But this demand has a special characteristic in Latin America; it is in a latent state. This is so because it is not manifest in specific budget allocations.

Integrated water management is a new field for training in the region. Surveys predict a discrepancy between its existing training institutions and the potential demand for training. There is a need to pool efforts to define an integrated water management program and to marshall existing resources through the said Cooperative Network.

3. Main Issues Related to Irrigation Management

Within the context of the structural reform processes (discussed in the previous chapters) in which the agricultural and irrigation sectors participate, the focus should be on the following issues, which are the most important issues related to irrigation management.

3.1 THE TRANSFER OF IRRIGATION INSTITUTIONS TO USERS' ASSOCIATIONS

All the important countries with irrigated agriculture in Latin America are carrying out some sort of program for the transfer of irrigation responsibilities to users' associations.

Turnover processes are influenced by the characteristics of the respective countries.

Argentina

In Argentina, there are different types of water management organizations: private associations with their own infrastructure and entrepreneurial management, decentralized management bodies at provincial level and federal public systems with centralized management. It is in the last type that efforts are being made towards implementing a turnover process, but so far it lacks political decision making and a clear methodology.

The case of Mendoza (decentralization at provincial level) constitutes a clear example of a successful management system based on a horticultural/industrial model with great potential for improvement. The irrigation infrastructure belonging to the State is managed jointly by the State and the users through a complex system of representation in management councils, payment for services and distribution of responsibilities. At present, the challenge is to implement reforms to improve the integrated management of water (Chambouleyron 1989).

The case of Mendoza is an interesting one because of the variety of state-user relationships in different disciplines (economics, management, law, sociology, finance) (Llop. A., Bertranon A. 1989).

Brazil

In Brazil, there are large domestic variations in turnover processes. The efficient rice growers of Santa Catarina and Rio Grande do Sul -- organized in powerful associations -- and the competitive farmers of San Pablo (under Japanese influence), organized in the COTIA and expanding to other parts of the country, have little in common with the farmers of the northeast, who are faced with problems of land tenure, low technological level and poverty. The private irrigation boom in Brazil during the last decade was due to:

* An unsatisfactory domestic food demand.

* Credit availability for rural electrification and purchase of pressurized irrigation equipment.

* A growing economy with reasonable domestic agricultural prices.

The present economic crisis has slowed down this process but it has not eliminated the initial drive.

Within this context of private irrigation development, traditional public irrigation, carried out by CODEVASF, DNOCS and the former DNOCS, has lost importance and now comprises only 5 percent of the countries irrigated area, and it is found only in "difficult" areas such as the northeast.

In these areas, irrigation has to undergo the problems involved with Integrated Rural Development in which situation the turnover of irrigation institutions to users' associations is difficult to achieve.

Chile

In Chile, turnover processes started some ten years ago. The changes in water management policy are the result of a series of innovations. Among these innovations were:

* The reform of the Water Code.

* The creation of the General Water Department.

* The setting up of the National Irrigation Commission and the Irrigation Promotion Law.

As a result of these reforms, the State is no longer responsible for water management but for its supervision. The turnover process can be considered successful.

The most talked about reform concerns the establishment of a water rights market. Although water is still considered a public good, once the State grants a water right, it becomes a private good which can be freely sold. Nevertheless, since there has not been a substantial amount of water rights transfers, it is difficult to know the price of water on this "market."

What is most important from the point of view of irrigation water management is that the Water Law defines three types of users' organizations:

* *De facto* water communities, when there is more than one user in the system.

* Irrigation canal, drainage or water users' associations which may be formally set up and are managed by a board of directors elected by the users. This type of association must be authorized by the General Water Department.

* Water watch committees, the highest level of organization in a system. They are responsible for the management of a whole system which comprises different users' associations. These committees are also managed by a board of directors elected by the users.

The law sets out that users' associations are responsible for water management and water work maintenance within their jurisdiction. With the exception of the *La Paloma* Reservoir, the irrigation infrastructure belongs to the users.

Chile has the most advanced turnover process in the region. It has two important characteristics:

* The farmers know how to manage the water (Irrigation has existed in Chile since the colonial period).

* The irrigated agricultural sector has a high profitability.

Colombia

In Colombia, the turnover process has interesting peculiarities. Colombia has entered into an institutional agreement with the World Bank under which it has undertaken to carry out the turnover process through a loan granted by the Bank. The governmental agency in charge of promoting and constructing large-scale projects is HIMAT and regional corporations will undertake the construction of small-scale projects. This program, which contains a plan for rehabilitation and expansion of irrigated areas, has been in force since 1980.

In a recent (1991) document issued by the National Planning Department on a Land Adequacy Programme for the period 1991-2000, the government ratified its intention to promote agriculture in general and irrigation in particular. To this end, the government will provide the funds required to implement expansion projects, aiming at recovering all investment costs without subsidizing O&M costs. Rehabilitated projects, as well as new ones, should be turned over to the users under the following conditions:

* The association to which the system is transferred must bear O&M costs.
* Users must ensure that the equipment is in good working condition.
* The transfer can be achieved only if 60 percent of the users agree on it.

The World Bank and the government have agreed to invest US$450 million in 250,000 ha for a 6-8 year period.

Ecuador

Ecuador's turnover process lacks political and institutional definition. At present, 70 percent of the irrigated area belongs to private companies or users' associations. Historically, water was appropriated for agricultural use and no conflicts arose as long as water was abundant.

But, starting in the 1950s, the growing demand for water brought about problems of water use which were exacerbated by population growth and the subdivision of land with water rights. All this led to the promulgation of a new law, based on the principle that water is a public good, which has made it possible to start a new era of users' organizations.

It should be pointed out that in accordance with the Water Law, there are over 3,000 Water Boards.

INERHI is currently engaged in arranging irrigation concessions and in making a users' inventory with ORSTOM support.

In Ecuador, irrigation system management entails knowledge and organization and rehabilitation of irrigated systems; turnover is less important. (There are two excellent reports on irrigation water management: FAO/World Bank 1991; Whitaker, M. and Alzamora, J.)

Mexico

The case of Mexico is of great relevance because it has the largest irrigated area in the region. It has traditionally had a centralized water management agency which played a major role in irrigation management, and since the Mexican revolution, large tracts of cultivated land are publicly owned.

During the last decade, privatization processes brought about great changes in the Mexican economy. The amendment of Article 27 of the Constitution started the privatization of land, which allowed the land to be rented, sold or otherwise used. As a result of these changes, the amendment of the water law got under way and an irrigation district turnover policy is being implemented (Trava, J 1991; Palacios Velez, E. 1990).

In order to make up for food deficits, the Mexican government depends on irrigated agriculture. Agricultural production must be increased, and this increase can only be achieved through increasing the irrigated area. But to do so, water ownership restrictions must be removed. This objective constitutes quite a challenge because, traditionally, the operations of irrigation districts was subsidized by the state. The impact of the Article 27 amendment upon small-scale agriculture is not yet known.

Peru

Peru has contributed to the development of irrigated agriculture in Latin America. The turnover of water management responsibilities to users' associations dates back to 1989 when the water management was legally handed over to the Board of Users.

While in Chile the agricultural sector had great potential for expansion and in Colombia and Mexico turnover processes were carried out with international financial assistance, in Peru turnover took place in a rather abrupt form and at a moment of great economic upheaval.

The situation in Peru is as follows: in the sierra, irrigation has always been managed by the users because the state's participation was restricted; in the coast, large investments have been made but the users' have had little participation in management.

But there are regions in which alternative, outstanding systems have been developed. Such is the case with Jequetepeque district where the systems are operated by third parties. In this region, the irrigation charges have brought about a tenfold increase in the income levels of the associations.

Nongovernmental organizations are also participating in this process. In Lima, the GPER (Permanent Group on Irrigation Studies), together with the universities, other NGOs and some governmental departments, is working on the design of irrigation policies.

It is necessary to strengthen the abilities of users' associations in water management, increase their participation, improve communications with them and provide them with technical assistance.

The turnover of irrigation responsibilities to users' associations is something common to all irrigation systems in Latin America. The main aspects to be taken into account in the transfer process are: obstacles to the transfer process; impact of the transfer process and the need to devise a follow-up and evaluation system for this process.

Obstacles to the transfer process

* Administrations: the turnover process depends on the willingness of public departments to hand over responsibilities for water management and on the capacity of users' associations to assume these responsibilities. This aspect calls for an organizational analysis which should be dealt with separately.

* Profitability: this aspect is very important and is discussed in 3.2.

Impact of the transfer process

There are three types of impacts that should be analyzed:

* Impact on the system's efficiency.

* Impact on income distribution, specially, on small-scale irrigation systems.

* Impact on environmental sustainability

Monitoring and evaluation

The turnover process must be monitored, regulated and evaluated by the state so as to achieve the objectives sought. The state must also help those who are left out of the system.

3.2 PERFORMANCE OF IRRIGATION SYSTEMS

In Latin America, only a few techno-economic studies on irrigation performance measurement have been carried out.

The countries which have conducted this type of study are Mexico and Argentina. In Mexico the studies were conducted through the Secretariat of Agriculture and Water Resources, the National Institute of Forest and Agricultural Studies, the Mexican Institute of Water Technology and the Post-graduate School of Chapingo. In Argentina, studies were carried out through INCYTH (National Institute for Water Science and Technology), which has two regional centers located in Mendoza, the Regional Andean Center and the Center for Water Economics, Law and Management. The latter is the only agency in Latin America which has carried out sociological studies on water resources and the environment. Both centers are closely connected with the National University of Cuyo.

During the international workshop on performance measurement in farmer-managed irrigation systems, organized by IIMI and INCYTH, only one paper on application efficiency was submitted (Chambouleyron et al. 1991). This paper discusses physical variables, such as crop type, and mechanization, infrastructure and organizational variables. These studies are of the utmost importance to all irrigated areas of Latin America since they constitute the basis on which decisions are taken to improve irrigation performance.

This type of study should be promoted as its usefulness has been proved by the information generated in studies organized by these institutions and by IIMI. The conclusions of the workshop that was held in Mendoza constitute an excellent base on which a research program could be undertaken.

One of the most important tasks in improving the performance of irrigation systems is efficient operation and maintenance. This task, compared with the construction of new irrigation work, is held in low esteem, and this is the reason why O&M and the personnel devoted to it are assigned a low hierarchial level. In view of this low hierarchial level, the funds allotted to O&M are always insufficient. Although great efforts have been made to demonstrate the importance of O&M (World Bank, ICID 1989), they have proved relatively ineffective.

Though irrigation is a many-sided activity, it is mainly an economic activity which must yield positive economic results; that is, it must be profitable.

In the previous section it was pointed out that one of the main requirements for turnover is the system's profitability. If the system is not profitable, efficient management and successful turnover will not be achieved. Otherwise, what is turned over is poverty.

Special attention should be given to this indicator due to the many hidden subsidies that exist in this sector. These subsidies should be taken into account if a successful turnover is to be attained. Irrigation agencies should regularly carry out studies on economic policies in irrigated systems which should include an analysis of irrigation water costs (FAO 1986).

This aspect was given emphasis because of the "economic adjustment" which the countries of the region have been forced to undergo.

3.3 IRRIGATION SYSTEMS MANAGEMENT

This area includes studies aimed at analyzing the complex relationships that exist, at water distribution and allocation levels, between water supply and demand for different uses and users.

These studies will provide the models required for an improved management of irrigated systems.

It should be pointed out that these studies have been carried out by research institutions and not by administration itself. Such studies will be profitable if and when a close relationship exists between the administration and the research institution. But very often, these studies are based on the objectives of the research institutions and its researchers rather than on the needs of the administration and managers. This results in models which are never used and it becomes necessary to analyze it to find the causes which prevent the use of the model. First of all, the demand for the study and its contribution to a minor irrigation system must be established.

It is the administration which has to define the objectives of the study. If it cannot do it and the objectives are fixed by other agencies, it is most likely that the models generated by the study will never be used within the administration. Thus, if an administration is unable to define its objectives and requirements, it means that it does not know itself. It is then imperative that the organization and its performance be analyzed prior to undertaking other studies. In this way, these studies will prove to be more useful.

The countries of the region have expressed interest in studies on reservoir management, conjunctive use of surface water and groundwater, depletion and salinization of aquifers, and macroeconomic models on water reallocation due to changes in crop patterns.

Finally, some models require a lot of data, but the critical economic situation of these countries has prevented them from collecting the required information. Therefore, the development of models with low information demand is strongly required.

3.4 INTEGRATED MANAGEMENT

In section 2.3.3, the characteristics of the current situation and irrigation constraints in Latin America have been described. It is difficult to describe a situation common to all countries of the region since the state's participation varies from country to country, although there is a tendency towards shifting its management role to a supervisory role.

However, most water management systems lack integration and focalization of activities. Integration is a process which aims at achieving higher coordination, avoiding duplication of efforts and controlling the unproductive competition between different organizations. Focalization refers to the direction which integration processes should take in order to reach the most vulnerable social groups.

Examples:

1. Lack of integration between economic and social policies: In section 2.1, reference is made to the difficulties faced in achieving growth with equity. If the social policy is defined as an equitable development process, the economic policy should contain the corresponding distributive components. The amendment of Article 27 of the Mexican Constitution is a clear example of the need to correlate economic policies with social policies.

2. Lack of coordination between administrative units: Water management in Latin America is very much dispersed within the state's bureaucratic system. It is common to find many ministries engaged in water resource matters. The most common case is that of the Ministry of Public Works and the Ministry of Agriculture, the former with a marked engineering bias and the latter with a production bias, but both sharing water management deficiencies.

3. Lack of coordination within a single sector: Many countries, such as Argentina, Brazil, Colombia and Ecuador, have federal, regional and state agencies engaged in the management of irrigated

areas. Since these agencies strive to survive under great economic restrictions, management deficiencies occur.

4. Lack of coordination between international agencies and NGOs: In many Latin American countries, NGOs have developed greatly. Although their contribution has, in most cases, been beneficial, it is necessary to coordinate efforts and focalize activities within a common strategy. Otherwise an administrative dispersion will take place and the state's supervisory role will be weakened.

This brief diagnosis is applicable to the public sector in general and to some irrigation associations in particular. Latin America is undergoing great changes in its public sectors and in this respect adequate irrigation system management is of the utmost importance.

Although irrigation managers are very much concerned about turnover processes, such processes cannot be made efficiently without an integrated management of irrigation systems.

The fact that irrigation associations have their own sociocultural features, use different technologies and operate under different regional conditions calls for the design of special irrigation water management techniques suitable to each particular situation.

3.5 INTERNAL MANAGEMENT OF IRRIGATION ORGANIZATIONS

With regard to the overall management of water resources (relationships between different organizations), Latin America is currently concerned with the internal management of irrigation organizations.

In addition to the turnover process which necessarily entails a physical reduction (less personnel), irrigation organizations must be strengthened through an efficient decision making system.

The components of irrigation organizations that affect decision making are:

* The organization operates as a rigid and static entity which has not been able to adapt itself to ever-changing conditions.

* Due to lack of incentives, users do not participate in the decision-making process.

* Information within the organization is scarce and the existing information is seldom used.

* The objectives of the organization are not clearly defined and, in some cases, members do not know what these objectives are about.

* The members of the organization are not well-acquainted with management techniques.

As regards this last item, it should be pointed out that since the budget is the instrument by which resources are allocated on the basis of certain political priorities, it constitutes a basic programming tool.

In this respect, there are many budgetary deficiencies (Braveli 1989):

* There are no institutional or organizational regulations to compel all members of the irrigation organization to participate in the preparation of the budget.

* In general, new budgetary reallocations cannot be done.

* There are no control mechanisms that permit the identification of activities, the people responsible for their execution, and the sector in which they are carried out. This is why it is so important to devise an information system.

* As the budget is an instrument which has not been legitimated by management politicians, it does not possess the power to limit the ever-increasing demands.

The performance of an organization cannot be improved without a budget because it expresses, in a rational way, a set of political priorities.

3.6 LEGAL ISSUES

Most Latin American countries which have large irrigated areas (Chile, Peru, Ecuador, Brazil and Mexico) have passed new water laws . Demands for technical assistance to analyze the impact that these legal norms exert and/or for reforms that should be undertaken to improve their use and fulfillment have been made.

Private irrigation development in Brazil and Ecuador has affected sustainability and has given rise to conflicts between uses and users. Colombia and Mexico are in the process of formulating new legal norms.

3.7 SMALL-HOLDER IRRIGATION

The case of Mexico, with 500,000 farmers producing 45 percent of the staple food, is often given as an example of the importance of small-holder irrigation.

Because of the impact import liberalization, decentralization and transfer policies will have on small-holder irrigation, studies should focus on its main weakness, i.e., its inability to get organized.

New organizational forms should be explored so that small-scale agriculture is incorporated into commercial markets. The problem is that since small-scale farmers cannot express their needs, it is they who will have to continue bearing the burden of economic-adjustment policies.

Among other issues in relation to small-holder irrigation are the lack of technology, the need to improve on-farm irrigation management, and land tenure. These problems could be overcome if farmers were trained to get organized into new organizational patterns.

4. Towards an IIMI Program in Latin America

4.1. RATIONALE

Until now, IIMI's activities in Latin America have been very limited.

The most important one was the organization of a special session on irrigation management in Latin America held in Rio de Janeiro on May 4, 1990 on the occasion of the 14th Congress of the International Commission on Irrigation and Drainage. The session was attended by a large number of irrigation specialists from Latin America. IIMI had invited seven speakers to give their views on the major irrigation management issues of the subcontinent. The seven papers presented at this session were published in Spanish, French and in English by IIMI.

A second activity concerned the organization of an international workshop on the Performance of Farmer-Managed Irrigation Systems in the context of IIMI's program and network on Farmer-Managed Irrigation Systems. The workshop, organized in collaboration with INCYTH, the Argentinean *Instituto Nacional de Ciencia y Tecnica Hidrico,* was attended by some seventy participants of which forty were from various Latin American countries.

In addition, there are a number of Latin American subscribers to IIMI publications, approximately 400 out of a total of 3,000 in the mailing list. IIMI's publications are, with very few exceptions, all in the English language, and this certainly constraints their accessibility to a large number of readers in Latin America.

The fact that IIMI so far has few activities in or directed towards Latin America is in itself not a reason for the development of an IIMI program in the region.

The main, if not the only reason, for such an expansion of IIMI's activities is the extent to which it contributes to the fulfillment of the overall mission of the Institute.

IIMI defines its mission as being:

> To foster the development, dissemination and adoption of lasting improvements in the performance of irrigated agriculture in developing countries.

By lasting improvements IIMI means those which are environmentally sound, economically viable and socially equitable. Performance improvements will be measured primarily in terms of productivity, equity and sustainability.

As articulated above, IIMI's mission is very broad. IIMI believes, however, that its own unique role or niche will be to help develop and apply improved irrigation management systems and policies, which, in turn, will lead to improvements in the performance of irrigated agriculture. This is done through international research and in partnership with national agencies and institutions.

Though the irrigation environment in Latin America has similarities to those in Asia and Africa, where IIMI's program has been concentrated so far, there are major differences in the social, economic and political factors important to irrigation. These include, in particular:

* A much more pertinent role of the private sector in the development and management of irrigation systems, in particular, in countries like Brazil and Colombia.

* A usually prominent role of water users' associations in various forms and settings in managing irrigation systems, particularly in countries like Argentina, Chile and Ecuador.

* Government policy in the major irrigation countries of the region is to withdraw from responsibilities of managing irrigation systems and to hand that responsibility over to users' associations, like in Mexico for instance.

* In many countries, the agricultural basis of irrigation is market oriented, with profitability as an important performance indicator. This automatically leads to an increased awareness of cost effectiveness of operation, maintenance and management of irrigation systems.

* Though highly variable, a high level irrigation technology (central pilot systems, canal regulations, information systems, etc.) is usually used.

These and other differences and developments provide special opportunities to gain a deeper understanding of underlying causes of generic irrigation management problems. In this respect, an IIMI program in Latin America would definitely contribute to the Institute's efforts in the "development of environmentally sound and lasting improvements in irrigation management."

With regard to the "dissemination and adoption" aspect of IIMI's mission statement, it has to be realized that the irrigated area in the whole of Latin America is around 16 million ha or about 8-10 percent of the total irrigated area in developing countries.

It should also be realized that the dependency on irrigation varies considerably from one country to another. Of the major irrigation countries of the area, most dependent on irrigation are Peru (with 34% of its cultivated area under irrigation) followed by Chile and Cuba (with approximately 28%), and Mexico and Ecuador (with 21%).

On the other end of the spectrum, there are countries like Argentina and Brazil with less than 5 percent of the cultivated area under irrigation. This does not mean that irrigation in those countries in not important in a regional context.

Together with the presence of certain well-developed institutions in irrigation and drainage research, these figures illustrate that the rationale for an IIMI program in Latin America lies, in particular, in the opportunities it offers in addressing generic irrigation management issues in an environment that is different to (and in a certain way more developed than) those usually encountered in Asia and Africa.

The product of this effort is expected to benefit not only Latin America but third world irrigation in general. It will definitely contribute to the development of the concept of irrigation management as a discipline in its own right and create an awareness of the needs and the potential benefits that can be obtained from the application of the principles and practices of modern management to the management of irrigation systems and the development of effective irrigation institutions.

4.2. RESEARCH AREAS

In Chapter 3, the major irrigation management issues emerging from current structural reform processes were briefly discussed. It would not be too difficult to generate a lengthy list of researchable subjects from these issues.

As resources will probably be limited, as well as because of the need to use whatever resources are available as cost-effectively as possible, there is a need to focus on a limited number of areas. Areas that should then be addressed are mainly in a basic or strategic research mode. (Basic research is

defined by the CGIAR as research designed to create new knowledge and understanding. Strategic research is to solve specific research problems or to develop techniques.)

Another area of focus could be the (basic and strategic) research efforts on issues that are closely linked to the new irrigation policies of the countries of the region. These new policies are structural reforms in irrigation management (turnover) and liberalization of the economy and they will have a considerable impact on the (performance of the) irrigated agricultural sector of the different countries of the region. With these considerations in mind, as well as IIMI's mandate, four major areas have been identified for inclusion in an IIMI program for Latin America. These areas are given below.

4.2.1. The Management of Water Deliveries

Background

Irrigation can be defined in many ways. In a restricted functional sense, a suitable definition is:

> Irrigation is the totality of means employed by people to augment and control the supply of water to the soil for the purpose of enhancing the productivity of crops.

This process of control and supply involves many actors. The role of the various actors and how they carry out their statutory tasks, from an operational management perspective, is the principle domain of irrigation management.

A management perspective requires a clear definition of key decisions which are made by an organization or individual in relation to its objectives. As the objective is the control and supply of water for enhancing the productivity of crops, the relevant key decisions for irrigation have to relate to water delivery.

A management perspective of water delivery addresses, in particular, issues of how different management conditions as human resources, their motivation and incentive, management information systems, organizational structure and other management control systems influence the quality of decision making processes, and ultimately the performance of the irrigation organization.

In very general terms, one may say that of the 16 million ha irrigated in Latin America roughly one third is managed by private persons or enterprises (including cooperatives), one third is managed by the public sector (public irrigation agencies) and one third by water users' associations, sometimes, like in Argentina, in association with public agencies.

The public sector is rapidly turning over its responsibility for operation and maintenance of irrigation systems to water users' associations. So, the importance of public irrigation management is declining in favor of management by water users' associations.

Large-scale irrigation districts (public and private) exist in Mexico, while at the other end of the spectrum one encounters the traditional small-scale farmer-managed irrigation systems, mainly in the sierra.

Latin America, therefore, offers interesting opportunities for analyzing water deliveries, from an operational management perspective, under a variety of different types of management.

Objectives

The overall objective of the research effort will be to develop a methodology and analytical framework that allows to define the most appropriate management system for a given irrigation environment. This will include analysis of the external as well as the internal environment of the different institutions in charge of water deliveries. Particular emphasis will be on the creation of appropriate internal management conditions (human resources, organizational structure, rules and procedures, and management information systems).

Approach

Use will be made of methods of management analysis developed by IIMI and other institutions. These methods will be tested and further developed in close collaboration with a number of institutions that operate in a variety of different irrigation environments.

4.2.2. The Management of Transfer of Responsibilities

Background

Certain countries in the region are engaged in an important process of transfer of responsibilities for operation and maintenance of irrigation systems to users' associations. There are, however, considerable differences in conditions and approach under which this process is implemented.

Chile is a typical example where the government's role in irrigation management is mainly limited to new projects and for a limited period of time only. Consequently, there exists strong water users' associations (*associacion des canalistas*) that even have their own confederation.

Argentina has recently gone (and, in a way, is still going) through an interesting process of increasing the size of the associations, mainly for reasons of administrative convenience, cost-effectiveness and economy of scale.

Colombia is another country with a consistent policy in transferring responsibility for operation and maintenance to water users' associations.

Most important in this respect is Mexico, who within its *Comision Nacional de Aguas* has created a special Division (*Sub-Gerencia*) in charge of transfer of operation and maintenance responsibilities to water users' associations. Out of the 3.5 million ha in 77 irrigation districts 150,000 ha have already been transferred and another 600,000 ha will follow soon.

In terms of transfer of management responsibilities to water users' associations, Latin America is most likely well ahead of many other countries of the world in which such transfer is discussed, considered or already implemented. As it may be expected that such development may spread more widely in the coming decades, Latin American experiences could be highly beneficial for these developments if properly analyzed and documented. An effort along these lines could be equally beneficial to adjust ongoing efforts.

An IIMI program on transfer of responsibilities is difficult to imagine without a Latin American component.

Processes of transfer of management responsibilities do not occur spontaneously; they require careful planning and management. An analysis of the management requirements, approaches and conditions would be the main thrust of this activity.

Objectives

The main objective of the program will be to develop a better understanding of the processes and conditions that govern management transfer processes and to develop a framework and methodology for the assessment of factors effecting these processes, and to make available experiences more accessible to decision makers and managers in charge in order to raise the prospects for successful results from the transfer of irrigation management responsibilities.

Approach

The approach would be the selection of a limited number of case studies of irrigation management transfer processes in different irrigation environments.

4.2.3. Methodologies for Performance Assessment

Background

In recent years, there has been a significant increase in the attention given to the subject of performance assessment. More and more policymakers and managers in developing countries are emphasizing the need for a performance-orientation. A significant number of irrigation agencies are developing performance-oriented attitudes, despite the conceptual and practical difficulties that stand in their way. Many irrigation managers are experimenting with mechanisms to improve the collection of data that can provide feedback to management. At the international level, several lending organizations, including ADB, IFAD, and the World Bank, have established guidelines for monitoring and assessing the performance of irrigation systems. The International Commission on Irrigation and Drainage (ICID) has reoriented one of its working groups to focus specifically on the subject of performance monitoring. And methodologies to enable irrigation managers to monitor the performance of irrigation systems are beginning to be investigated. Nevertheless, much remains to be done before irrigation agencies around the world routinely collect information on irrigation system performance, and before such data are accepted as essential for effective operation.

There are two levels where performance assessments is of particular importance: at the level of the irrigated agricultural sector as a whole and at the level of the organization(s) in charge of water deliveries.

Changes that are currently taking place in Latin America in terms of structural adjustments and liberalization of the economy will have important consequences for the irrigated agricultural sector as a whole. There is a need to know how these changes affect an efficient and sustainable use of the water resources and what could be the socioeconomic consequences. With such knowledge, it is possible not only to identify measures to correct occurring program externalities but also to develop a tool that would allow to predict the consequences of certain policy measures.

At the level of the organization(s) in charge of water deliveries, performance assessment is of particular importance as a tool for feedback and internal management control.

Objectives

In line with IIMI's performance program, the main objectives of the program would be to develop appropriate performance indicators, determine relevant performance determinants and develop an appropriate and cost-effective method for performance assessment, monitoring and evaluation.

Approach

The approach would be the selection of a number of irrigation systems with different characteristics in terms of the prevailing socioeconomic conditions, agricultural production systems and irrigation technology. These systems will constitute a national or regional irrigation performance analysis network.

4.2.4. The Role of Policy Instruments

Background

In countries like Chile, Brazil and Colombia, the private sector not only plays an important role in the management of irrigation systems, but also in their development.

A major part of the investments in the irrigated agricultural sector in these countries is made by the private sector, commonly facilitated by policy instruments as credit and loans from the government or international lending agencies.

It has become an accepted principle that the ultimate beneficiaries should not only bear the cost for operation and maintenance of the systems, but also pay back at least a major part of the investments in hydraulic infrastructure, when such investments are made by the government.

Current developments in Latin America tend to a further decentralization and privatization of responsibilities for development and management in the irrigated agricultural sector.

Abolition and decreasing of subsidies on agricultural products and inputs to the agricultural sector are in line with these policies and efforts to liberalize the economy.

In contrast to these tendencies and policies, there is however the need for a more integrated approach towards the use of water resources. Irrigated agriculture is by far the most important consumer of water. Industrialization and population increase, particularly in urban areas, will rapidly increase the demand for water for nonagricultural purposes. It will force the irrigated agricultural sector to use its resources more efficiently, particularly in water-short environments.

Besides the quantitative aspect of water use, there is also the need for appropriate measures to safeguard the water quality and the sustainability of land and water resources.

The role of the government in a process of devolution and privatization will therefore have to shift from a direct involvement in the implementation and management of public water resources development projects, towards a more indirect one of planning, performance monitoring and control, to ensure that optimal social benefits from water as a collective good can be obtained for society as a whole.

A key question in this respect is what policy instruments the government should develop to create an environment that on the one hand allows and encourages the nonpublic sector to assume more responsibilities in the development and use of water resources while on the other hand it should be able to control such developments in the interest of society as a whole.

The policy instruments or tools the government can use to create such an "enabling" environment cover a wide range of options like subsidies, credit, loan and tax instruments. In the area of legal and administrative mechanisms, they include laws, rules, regulations, etc.

The role of government policy instruments, however, exceeds the area of socioeconomic, legal and administrative matters as mentioned above. A more active role of the government concerned is capacity development.

If the government wants to privatize irrigation operations, it should take measures that allows the development of the human resources needed to achieve such an objective.

In liberalizing the economy, it remains a government responsibility to take the necessary steps to allow the agricultural sector to become more competitive, for instance, through agricultural research.

Objectives

The objectives of this study will be to compare the different policy instruments used to create an enabling environment in which the responsibility for the development and use of water resources has been largely shifted from the public to the private sector, while at the same time the sustainability of its use as a collective good is guaranteed.

Approach

The approach will be through a series of well-prepared workshops and seminars of short duration on well-defined issues for high-ranking policymakers and decision makers. It is expected that these workshops will, in turn, generate recommendations on issues to be addressed in a research mode for further discussion. A close linkage with ECLAC's initiatives concerning workshops for administrators is anticipated (see professional development below).

Interrelationships between program areas

The above four program areas have not been selected only because of their individual importance, but also because of their mutual inter-dependencies.

Irrigation aims to control the supply of water for purposes of enhancing the production of crops. This process requires the delivery of a certain amount of water at a certain place at a certain time. A proper understanding of the management requirements to carry out this task is a prerequisite for improvements in irrigation management.

Performance assessment is an essential part of these management requirements.

The same understanding is required for the transfer of responsibility for water delivery from one institution to another. Both activities of water delivery as well as of transfer of responsibility can only be implemented properly if the external environment permits. It is the role of policy instruments to create such an enabling external environment.

4.3 PROFESSIONAL DEVELOPMENT

The instruments of professional development that are of particular importance to an IIMI program in Latin America are workshops, short courses, training needs assessments and fellowships.

In respect to an IIMI professional development program for Latin America, the mission would like to make the following observations.

The first concerns the language problem. The working language for short courses, training needs assessments and workshops should be Spanish. Courses and other materials will all have to be developed and presented in Spanish.

Apart from pure professional arguments, as that on the need for mobilizing local expertise to the greatest extent possible, an IIMI program in professional development should always have the character of a joint effort with national or regional institutions in charge of professional development.

In this respect, mention should be made of two initiatives taken by ECLAC concerning:

* A program of workshops for administrators at a strategic-institutional level.

* A program of courses for administrators at technical-administrative level. The implementation of the course will be mainly in the hands of CELA (INCYTH-Argentina), CIDIAT (Merida-Venezuela) and the Fundaçao Getulio Vargas (Brazil).

Concerning IIMI's training needs assessment methodology and overall training cycle, it is proposed to investigate as to what extent this methodology differs or resembles the approaches already accepted by the ECLAC initiative. On the basis of such comparison, the rational for new initiatives should be assessed.

When there is scope for new initiatives in the area of training needs assessment, the mission proposes that they should be incorporated in the same consultative mechanism ECLAC has already developed for the professional development activities mentioned above.

In the area of fellowships, the mission is of the opinion that this should be considered an important instrument in the realization of a regional program. In particular, permitting fellows from one country to work in another in the context of a collaborative research program that addresses similar irrigation management issues in different countries could substantially contribute to the regional character of the program.

4.4 INFORMATION EXCHANGE

In its information exchange program, IIMI should expect to continue the same basic modes of operation currently in use; project reports, working papers, technical publications (monographs, management briefs, journal articles, newsletters, seminar proceedings, country papers). It should be envisaged that

all information intended for distribution in Latin America should be prepared in Spanish. The working language of the proposed regional office should also be Spanish.

The mission likes to emphasize, in particular, three areas of activity under an information exchange program:

* The publishing of an irrigation management newsletter in the Spanish language.

* The translation of selected publications and papers from English into Spanish. Such a program can best be organized through IIMI's proposed regional office in Latin America. Possibilities of involving local institutions and publishers in this process should be explored.

* The possibilities offered by IIMI's special awards program should be fully utilized. There are some unique experiences in Latin America that merit dissemination among a wider audience.

4.5. MODE OF OPERATION

IIMI's mode of operation is always one of close collaboration with national agencies and institutions in charge of operation and maintenance of irrigation systems, national research systems and universities as well as institutions in charge of irrigation policies. There is no reason to deviate from this general principle in the implementation of an IIMI program in Latin America. A close association with national systems should also be IIMI's basic operational concept for its operations in Latin America.

There are, however, different ways and systems through which such an association can be effectuated. A very pertinent question in this regard is whether effective linkages with national systems require the posting on a resident basis, or whether such linkages can also be established on a nonresident, or visiting staff basis.

The mission is of the opinion that an IIMI program in Latin America requires staff in residence in the area if it is to be effective. The main reasons are:

* The remoteness of the area from IIMI's headquarters. A nonresident mode of operation that would allow the establishment of close linkages with national agencies would require a disproportionate amount of staff travel time as well as travel costs.

* The principal language to be used for program implementation will have to be Spanish. Support services familiar with the Spanish language are far more easy to mobilize in the area itself.

The question of how the language "barrier" would affect the integration of the Latin American program into IIMI's total program will be dealt with later.

Once it is decided that an effective program in Latin America cannot do without staff in residence, another important question that emerges is whether one should opt for a (sub) regional or (multi) country approach? As this question is more difficult to answer than the previous one, distinction is first made between operational and programmatic aspects and requirements.

For reasons of administrative and operational efficiency, the mission strongly recommends that the establishment of one regional office with operational responsibilities for the entire region should be part of any option IIMI may wish to choose for its operation in Latin America. It should be so, also in the event that IIMI would post resident scientists in several countries of the region with a specific country mandate. Delegation of operational and administrative responsibilities should be in accordance with IIMI's overall practices in this respect.

The person in charge of IIMI's regional office should be called Head of Latin America Operations (*Jefe de Operaciones en America Latina*). The adjective "field" to "operations" has been left out on purpose

as it could suggest (in particular, when "field" would be translated to "*campo*" in Spanish) limitation to field research, which is not the case.

The Head of the Latin America Operations will be responsible to the Director for International Cooperation of IIMI.

Above, a distinction was made between a (sub) regional and (multi) country approach because the mission attaches great importance to the difference in modes of operation these two categories represent.

In a (multi) country approach, IIMI's operations are carried out in one or more countries, with their own mechanism of interaction with local agencies and institutions (like a Consultative Committee) but without any institutionalized mechanism for linking the activities in the various countries, except IIMI's own internal mechanisms.

The main feature of a (sub) regional approach is precisely the existence of some kind of consultative or coordinative mechanism that cuts across the borders of the individual countries and in which there is a clear role for the (agencies and institutions of the) participating countries. This could take the form of a (research) network for instance, but other mechanisms can also be considered.

As a (sub) regional approach is difficult to consider without the existence of a regional office, the choice on whether to operate on a (multi) country or (sub) regional basis can be made in the knowledge that there will be a regional office in any event for reasons of operational and administrative efficiency.

The mission likes to recommend that IIMI should opt in principle for a (sub) regional approach, mainly for the following reasons:

* A (sub) regional approach substantially enhances contacts between institutions of the various countries.

* A leading principle of IIMI's program in Latin America is that it will address generic irrigation management issues, in particular. A (sub) regional approach allows to focus on issues that are of importance to more than one country.

* It is expected that a substantial part of the research work will be done by national institutions. A mechanism for direct contact between these institutions promotes and facilitates coordination and the adoption of commonly agreed research methodologies.

It is therefore, proposed that an IIMI program in Latin America will be guided through the mechanism of a Consultative Committee that is regional in nature. The terms of reference of the Committee can be similar to those adopted for country operations.

The committee should comprise senior officials from leading irrigation countries of the region and, in particular, those in which IIMI has country operations. The mission does not think that IIMI should establish sub-regional consultative committees. One consultative committee for the whole of the region would be more desirable and can better serve the purpose of program consistency.

At the same time, however, the mission recognizes that in view of the regional character of the approach, the need could arise for the establishment of (*ad hoc*) working groups that would address specific topics of regional as well as subregional importance.

As these working groups should be created in accordance with arising needs, the mission does not want to comment on possible areas or regions for which the establishment of a working group could be considered. It just wants to draw attention to a possibly valuable instrument in program implementation.

The mission's conclusion that IIMI's program in Latin America requires the establishment of a regional office still leaves open the question of staff location.

Here, a distinction can be made between a centralized or a dispersed mode of staff employment. In a dispersed mode of operation, one could in the extreme, have one Head of Operations at IIMI's regional office with other staff "dispersed" in residence in different countries of the region. In a centralized mode of operation there would be at least a minimum critical (multidisciplinary) mass of expertise at IIMI's regional office. Though there might be factors beyond IIMI's own control that could oppose a centralized

mode of operation (modes of financing in particular) the mission strongly recommends such a mode of operation. The main arguments are:

* The very nature of the regional approach itself requires as strong a nucleus as possible from where the operations are initiated, monitored and controlled.

* Needs and possibilities for interdisciplinary interactions as much of the work will be highly interdisciplinary in nature (like all of IIMI's work).

* The strength of national institutions, which are expected to play an important role in program implementation, is such that it generally does not necessarily require the permanent presence of IIMI staff.

In combination with the recommended centralized mode of operation, it is, however, suggested that as much use as possible should be made of "junior research associate staff" who would work, at country level, on collaborative research programs under the guidance and supervision of both IIMI and national staff of the collaborating institutions. As IIMI will work mainly with and through national institutions, it is expected that direct recruitment of national staff by IIMI can be kept at a minimum.

Concerning the integration of IIMI's Latin America program into IIMI's overall program, three aspects should be briefly mentioned.

The first concerns procedures. IIMI has a well-established mechanism of program planning, through its Program Committee, Internal Program Review and Program Planning Meeting. These mechanisms provide a sufficient guarantee that IIMI's Latin America program will remain in line with IIMI's overall program. Though there might be differences in emphasis, irrigation management problems in Latin America are not fundamentally different from those encountered elsewhere.

The second point to be mentioned is the role of the private sector in irrigation management and development in Latin America. This role is substantially more important than in most of the countries IIMI has worked so far and will probably be even more important in the future.

How does IIMI want to relate to private sector irrigation, therefore, seems a legitimate question, that goes, however, beyond the competence of the mission.

The last point concerns language. To be effective, the working language of the regional office should be Spanish. Special efforts will be required to lower the threshold of information exchange with the other components of IIMI's program.

Summary

The main features of the mode of operation of an IIMI program in Latin America should be the establishment of a regional office in one of the countries of the region. The office will be headed by a "*Jefe de Operaciones en Americo Latino*" who will be responsible to the Director for International Cooperation.

The program will be regional in nature, guided by a regional Consultative Committee. The formation of topic or subregional specific working groups should be considered in accordance with arising needs. A minimum critical mass of high-level, multidisciplinary expertise should be established at IIMI's regional office, combined with "outposted" junior research associate staff working on collaborative research program with national (research) institutions.

IIMI should work as much as possible through national organizations and keep direct recruitment of national staff at a minimum.

4.6. LEVEL OF EFFORT

It is difficult to give a precise answer to the question, "What is the level of effort a Latin America Program is able to justify?" Such a level will depend very much on IIMI's total resources as well as on the resources it is capable of mobilizing for exclusive use in the Latin American subcontinent.

Therefore, the mission rather prefers to formulate the question in a slightly different manner: "What is the minimum, or threshold level of effort that an IIMI program in the area justifies that could be expected to contribute in a cost-effective way to the fulfillment of the overall mission of the Institute?"

If such threshold level cannot be achieved, IIMI should basically renounce any activity in the area that could be labelled as an IIMI Latin America Program.

The mission is of the opinion that such a threshold requires a level of effort that permits the posting of at least four internationally recruited staff members at IIMI's regional office, including the Head of Latin America Operations. This would bring the effort more or less to the same level as those in Pakistan and West Africa.

The disciplines to be covered by the internationally recruited staff should definitely include:

* Agricultural economics
* Irrigation engineering (agricultural/civil/hydraulic)
* Management/institutional analysis.

As much as possible, use should be made, through consultancy contracts, of expertise locally available.

4.7. LOCATION OF THE REGIONAL OFFICE

As IIMI's program in Latin America is of a regional nature, the following criteria should be considered in selecting a regional office location through a process of consultation with the countries in Latin America:

* Geographical location vis-a-vis irrigated agriculture of the region.
* Importance of the irrigated agricultural sector of the country; less emphasis to be given to this criterion because of the regional approach intended for the program.
* Good communication facilities, both internal and external.
* Interest of the government concerned in hosting an IIMI office.

4.8. PROGRAM DEVELOPMENT

To initiate a program in Latin America, the following activities should be considered for early implementation:

1. Completion of documentation on irrigation policies and development in Latin America (and the Caribbean) on the basis of material available at the World Bank and the Inter-American Development Bank.
2. Consultations (informal) with WB and BID on IIMI's intentions for Latin America.

For both these activities (1 and 2), use should be made of the Institute's relationship with IPTRID. This should also help to bring the intentions of both institutions with regard to Latin America more in line with each other.

3. Enter into further negotiations with interested governments on the issue of establishing a regional office in a particular country.

4. Explore, in general terms, the interest and possibilities for collaboration with IICA, in particular, and with CIDIAT, and the CGIAR centers that have relations with Latin America: CIMMYT, CIP, CIAT, ISNAR and IFPRI.

5. Liaise with donor agencies and prepare a review at their activities and interests in regard to irrigation development in Latin America.

6. Initiate the process of establishing a regional Consultative Committee.

7. Elaborate further on the various program areas identified and formulate more detailed action programs.

8. Organize a first and constitutive meeting of the Consultative Committee, with the participation of IIMI's management and staff who are responsible for certain program areas.

The first meeting of the regional Consultative Committee is considered an important milestone in the development of an IIMI program for the area. Following that event, negotiations with regional and national agencies and institutions should be initiated and geared to program implementation.

To implement a program as described above, the mission proposes the early appointment of an interim Head of Operations, who would, at least for a considerable period of time, take up residence in one of the countries of the region. Administrative and logistical support could possibly be mobilized and negotiated through INERHI.

The process of staff recruitment for the regional office should possibly be initiated after IIMI's Board Meeting in 1993.

4.9. RELATIONS WITH REGIONAL ORGANIZATIONS

There are a number of organizations with a regional mandate with whom IIMI should remain in contact. Certain of these organizations have more interest in questions related to irrigation management than others. The more important of them are:

ECLAC

ECLAC or the United Nations Economic Commission for Latin America and the Caribbean, with its headquarters in Santiago de Chile has a special Division on Water Resources and Energy.

As was pointed out earlier, IIMI should remain in close contact with ECLAC on its initiatives in the area of training and in particular on its policy workshops and seminars.

ECLAC is currently considering the establishment of a regional network for training, research and consultancy on the integrated use of water resources; an initiative welcomed by a number of countries of the region.

CIDIAT

CIDIAT -- *Centro Interamericano de Desarollo Integral de Aguas y Tierra* -- in Merida, Venezuela, is mainly involved in training. The implementation of an eventual IIMI program on professional development in Latin America should be in close collaboration with CIDIAT (and national institutions in the area of management training, like CELA in Argentina for instance).

IICA

IICA -- *Instituto Interamericano de Cooperacion pare la Agricultura* -- is an institute of the Organization of American States (OAS) and is mainly involved in technical assistance, including that for irrigation.

IICA provides the secretariat for a network of a Cooperative Program for Exchange and Performance of Agricultural Research, financed by the BID. The network distinguishes four subregions (Sur, Andino, Centramerica and Caribbean). The Board members of the network are the Directors of Research of Natural Agricultural Research Systems.

Participants in the meeting include CGIAR centres as CIAT, CIMMYT, CIP, IBPGR and ISNAR.

The work of IICA in the field of technical assistance could be considered as highly complementary to that of IIMI.

As IICA has offices in all Latin American countries and maintains close relations with national systems (of research or otherwise), as well as with a number of CGIAR centres, the mission recommends a further exploration of the possibilities for collaboration or other forms of interaction between IIMI and IICA.

CGIAR Centres

The mission, due to time constraints, was unable to explore potential areas for collaboration with the International Agricultural Research Centres having their headquarters in Latin America (CIAT, CIP, CIMMYT) or those with activities in the region that could be of interest to IIMI (IFPRI, ISNAR).

As the basis for a sustainable use of water resources for irrigation purposes lies, for a major part, in the profitability of the agricultural production systems, it proposes that collaboration and interaction between IIMI and the CGIAR centres active in the area would definitely benefit an IIMI program for Latin America. Therefore, the potentials for collaboration should be explored further.

FAO

Regular contacts should also be maintained with FAO's regional office in Santiago de Chile. FAO's interest lies mainly at tertiary and field-level (water management extension, for instance) areas where IIMI has no comparative advantage.

Organization of workshops or expert consultations in areas of interest to both IIMI and FAO could be considered as a potential area of collaboration.

References

Banco Mundial 1990. "Capacitación para riego en el sector Público." Documento Técnico IDE Banco Mundial. Washington DC.

Banco Mundial, 1991. "Informe sobre el Desarrollo Mundial 1991." Banco Mundial. Washington DC.

BERTRANOU, A., 1990. "Aspectos socioeconómicos del riego" en "El manejo del riego en América Latina." IIMI, Colombo, Sri Lanka.

BID 1988. Progreso Económico Social en America Latina. Informe.

BID-PNUD 1990. "Nuestra propia agenda."

BRACELI, O. 1980. "Analisis de las Administraciones de riego." INCYTH-CELA, Mendoza, Argentina.

BURTON Y. PHILOGENE 1986. "An overview of Pesticide usage in Latin America." Ottawa Canada.

CARRUTHERS, I. 1989. "Irrigation under threat: a warning brief for irrigation enthusiasts." IIMI Review, April 18.

ECLAC 1988 a) "Agricultura Comercio Exterior y Cooperación Internacional." Estudios ECLAC no. 73. Santiago de Chile.

ECLAC 1988 b) "Desarrollo Agricola y Participación Campesina." Libro de la ECLAC no. 20. Santiago de Chile.

ECLAC 1989 a) "La gestión de los Recursos Hidricos en America Latina y el Caribe." Estudios e Informes de la ECLAC no. 71. Santiago de Chile.

ECLAC 1989 b) "Capacitación en Gestión de los Recursos Hidricos en América Latina y el Caribe: Diagnóstico y Propuestas." LC/G. 1580/89. Santiago de Chile.

ECLAC 1990 a) "Transformación productiva con equidad." Libros de la ECLAC no. 25. Santiago de Chile.

ECLAC 1990 b) "América Latina y el Caribe: Inventario de los recursos hidricos y su utilización." Vol I y II ed. T. Lee y M. Renard. Santiago de Chile.

ECLAC 1991 a) "Panorama económico de América Latina 1991." Santiago de Chile.

ECLAC 1991 b) "El desarrollo sustentable: Transformación productiva, equidad y medio ambiente." ECLAC, Santiago de Chile, 1991. p. 146 Cap. V. Pobreza y desarrollo sustentable.

CHAMBOULEYRON, J. 1989. "Reestructuración de las inspecciones de cauce en Mendoza."

CHAMBOULEYRON, J., SALATINO, S. and FORNERO, L. 1991. "Irrigation Efficiency and Users' Performance in Water Management" in 3rd International Workshop of the FMIS Network. Mendoza, Argentina. IIMI, Colombo, Sri Lanka.

COLMENARES, AGUIRRE 1986. IICA. "Inversión en Regadio y capacitación en preparación de proyectos agricolas." En Seminario Iberoamericano de Riego y Drenaje. Madrid, España.

COTLER, Julio 1978. "Clases, Estados y Nación en el Perú." Instituto de Estudios Peruanos. Lima.

DE JANVRY, A. 1981. "The agrarian question and Reformism in Latin America." The John Hopkins University Press, Baltimore.

DE JANVRY, A. 1989. "Rural Development in Latin America. An evaluation and a Proposal." IICA. San José. Program Papers Series no. 12.

ECHENIQUE, B. and ROLANDO, J. 1989. "La pequeña agricultura." Ed. Agraria. Santiago de Chile.

FAO 1986. "Informe de la Consultoría de expertos en tarifas de agua para riego." Roma.

FAO/CEPAL 1986. "Agricultura Campesina en América Latina. División Agricola Conjunta." CEPAL/FAO. Chile.

FAO 1990. Anuario Estadistico 1990. Producción. Vol. 44.

FAO/Banco Mundial 1991. "Ecuador, Programa Nacional de Desarrollo del Subsector de Riego."

GERSON GOMEZ 1979. ECLAC. "El proceso de modernización de la agricultura Latino Americana." Revista de la ECLAC. Agosto 1979.

GRASSI, C. 1990. "La gerencia del riego" en "El manejo de la irrigación en América Latina." IIMI, Colombo, Sri Lanka.

HOTES, F. 1986. "La experiencia del Banco Mundial en el Subsector." En Seminario Iberoamericano de Riego y Drenaje. Madrid, Spain.

IICA 1991 "Regional Overview of Food Security in Latin America." San José de Costa Rica.

LEE, T. 1990. "Water Resources Management in Latin America and the Caribbean." Westview Press, USA.

LLOP, A. 1982. "Sistema Hidrologico. El caso de la zona andina central." INCYTH-CELA.

LOPEZ, J. 1976. "Global Water Law Systems." Vol. 2. Colorado State University. USA.

MATTIELLO, H. "La Administración Hidrica en America Latina." INCYTH, Mendoza, Argentina.

MEREA CANELO, A. 1990. "Problemática del Manejo de los sistemas de Riego. El manejo de la irrigación en America Latina." IIMI, Colombo, Sri Lanka.

ORTEGA, E. 1982. "La agricultura campesina en América Latina." en Revista de la ECLAC, April 1982.

PALACIOS VELEZ, E. 1990. "Irrigation Systems in Mexico." Chapter 7 of "Irrigation Management in Latin America - Present Situation, Problem Areas and Areas of Potential Improvement." IIMI, Colombo, Sri Lanka.

República de Colombia. Departmento Nacional de Planeación 1991. "Programa de Adecuación de Tierras 1991-2000." Bogota.

SAGARDOY, J. 1986. "Los costos de Operación y Mantenimiento" en "Informe sobre Consultoria de Expertos en tarifas de agua para riego." FAO. Roma 1989.

TRAVA, José 1991. "Transfer of management for large-scale districts to WUAs in Mexico." Mexico.

WHITAKER, M. and ALZAMORA, J. "Ecuador: el riego y el desarrollo agropecuario." Capitulo 7.

WITTFOGEL, Karls 1955. "Development Aspects of Hydraulic Societies" in Steward, Julien (ed) Irrigation Civilizations.

WORLD BANK/ICID 1989. Planning the Management, Operation and Maintenance of Irrigation and Drainage Systems. World Bank Technical Paper No. 99. Washington DC.

WORLD Resources 1990-91. "Latin America: Resource and Environment Overview." Oxford University, Press-USA. 1990.

Appendix 1

CHARACTERISTICS OF THE "LOST DECADE" IN LATIN AMERICA

a) Loss of Dynamism

The main economic thrusts of the three previous decades -- an expanding export sector, basically of raw materials; an industrialization process based mainly on domestic demand; and a sustained investment growth (mainly public) -- have lost their dynamism and, in some cases, died out.

As regards the export sector, for most countries the value of the sales of traditional products in foreign markets fell sharply due to a decrease in their unit prices. The unfavorable trend of the terms of trade stems from substantial changes in the demand for basic commodities. With a weighted index of real prices, ECLAC detected a 25 percent drop in the value of the 27 commodities (including fuel) the region exports between 1980 and 1990. This underscores the fact that Latin America has gradually lost its relative position in world trade (ECLAC 1990).

This gradual loss of dynamism of Latin American economies was also associated with a marked decrease in net investments during the 1980s. In previous decades, the expansion of the productive capacity relied on relatively high private and public investment levels (between 22 and 25 percent of the GDP).

The deterioration of the terms of trade and the foreign debt service, together with a reduction in the net capital income, drastically reduced the availability of net resources. In 1989, the net investment rate in the region dropped below 16.5 percent.

b) Increase in Macroeconomic Disequilibria

The region had to face the adverse consequences resulting from macroeconomic disequilibria, so much so that they now constitute another element with which to establish differences among countries. Although many countries managed to adjust the balance of trade -- usually by means of recessive adjustment policies -- few of them have been able to curb inflation and reduce foreign deficits at the same time. This is mainly due to the foreign debt service and its consequences both upon public sector finances and on the balance of payments on current account.

In general, the countries that achieved better success with their adjustment and stabilization policies carried out an important transfer of resources to foreign countries and improved the financial situation of the public sector. On the other hand, when the value of exports fell, as has been the case of oil exporting countries in recent years, there was a tendency to increase the fiscal deficit and the foreign disequilibrium worsened.

Two of the most drastic consequences of macroeconomic disequilibria were that they left economic policymakers with little margin for maneuvering and that they brought about a weakening of state action due to severe budgetary restrictions.

c) Regressive Adjustment and Social Deterioration

The social cost of adjustment was borne mostly by the middle class, workers, and by the poorest sectors of the population. The economic crisis and the use of adjustment policies led to marked reductions in the funds allotted to housing, education, health, social security and welfare. This situation aggravated the economic and social conditions in the continent which were already critical because of a decrease in real income levels, high unemployment levels, and the fast growth of the informal labor sector.

Population growth rates should also be taken into account. At the beginning of the decade, there were 362 million inhabitants in the region but at the end there were 448 million. If the incorporation of women to the labor market is added to this, the EAP (Economically Active Population) increases 2.8 percent per year.

The lack of economic dynamism, the decline in employment and income levels, and the restrictions on public expenditures led to an increase of extreme poverty in urban areas. In 1980, there were 112 million Latin Americans living below the poverty line; in 1986 this figure rose to 164 million, which represents 38 percent of the households.

d) Weakening of the Public Sector -- The Need for State Reform

In the 1980s, the public sectors in Latin American countries were confronted with a crisis during which their inefficiencies, marked bureaucratization levels and inadequate resource allocations became highly evident.

This crisis and the recession caused a great reduction in fiscal revenue and inflationary processes brought about lags in public services tariff payments. On the other hand, current expenditures kept on increasing as a result of the foreign and domestic debt service. The financial debt burden increased due to successive devaluations and extremely high interest rates. In view of the increasing deficits in current account, decisions were made to reduce the funds allotted to those areas (public investments and social) which were not considered essential despite their high social cost expenditures.

Financial problems revealed both great inefficiencies and the need to reform and modernize the state while strengthening the state's ruling capacity. In order to achieve these objectives, it is necessary to make regulations more flexible and to privatize public utilities. In most cases, the privatization of public utilities has been looked upon as an instrument for an improved and efficient adaptation to financial restrictions.

In short, the weakening of the public sector in the 1980s calls for a restructuring of the public sector in general and for the modernization of taxation systems in particular.

e) Difficulties in Achieving Equitable Growth

If the criterion for dynamism is the expansion rate achieved by developed countries in the last twenty years (2.4 percent per year of GDP/inhabitant), and if it is considered that there is an equitable ratio between the income of 40 percent of the population with lowest incomes and the income of 10 percent of the population with highest incomes, the resulting average ratio for Latin America is 0.4, i.e., half the ratio reached by industrialized countries (World Bank 1986).

When growth and equity variables are related, the result is a double entry matrix with an empty box: no Latin American country has simultaneously achieved growth and equity. (See Table A-1).

It has been observed that dynamic but socially disarticulated countries (Brazil, Mexico, Colombia, Ecuador) generate 73 percent of the regional gross domestic product; socially integrated but economically stagnant countries (Argentina) produce 11 percent; and the remaining 16 percent comes from countries where conditions of disarticulation and stagnation prevail simultaneously.

When countries from other continents are analyzed, it can be seen that for Latin America's empty box (of the double entry matrix) there is a large group of countries -- representing three fourths of the developing countries' GDP -- which did attain equitable growth within the same period and in the same external context.

Table A-1. Latin America: Growth-Equity (percentages) Latin America compared with other selected countries.

Equity : 40% lower income / 10% higher income (1970-1984)

Growth GDP Per Capita (1965-1984)

	<0.4	>0.4
<2.4%	Bolivia, Chile, Peru, Venezuela, Haiti; Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua	Argentina, Uruguay
>2.4%	Brazil, Colombia, Ecuador, Mexico, Paraguay; Panama, Dominican Republic	

Sources: ECLAC-ONUDI.

Appendix 2

OTHER CHARACTERISTICS OF RURAL AGRICULTURAL DEVELOPMENT IN LATIN AMERICA

a) Rural Development and Environmental Sustainability

The technological approaches in Latin America, the ultimate goal of which is to increase production, have not considered a sustainable management of natural resources and the environment, and have put at stake the heritage of future generations, and not met the requirements of rural populations.

The modernization process of the agricultural sector has not necessarily entailed an improvement in the rural sector. There are regions in which agricultural growth has been accompanied with an increase in rural poverty and serious threats to environmental sustainability (ECLAC 1991b).

The region has experienced a significant and irreversible loss of soils due to erosion and deforestation. Some examples of environmental deterioration and of the restrictions to rural development in Latin America are given below.

Of the region's total area (over 2 billion ha), more than half is forest; only 7.5 percent is cultivated (arable plus permanent crops) land (see Table A-2). Agricultural soils have restrictions on use and expansion: the number of projects for the expansion of cultivated lands range between 16 percent and 32 percent of the total, depending on the source of the data.

From 1970 to 1987, land devoted to agriculture and pasture land increased by 70 million ha. This was a spontaneous process with no technical assistance (except for some specific projects), and at the expense of forest conservation (Table A-3).

Deforestation proceeds at an alarming rate: almost 10 million ha every year. Of these, 7 million ha is thick forest, 1 million ha is bush forest, and the rest is selectively exploitated for timber production (IDB,UNDP 1990).

A large part of the increase in arable land (12.5 million ha) is used for highly technicalized cultivation. In the Amazonia, agricultural exploitation is based on the clearing of forests and the introduction of inadequate agricultural products, practices and methods.

Erosion constitutes the main cause of soil degradation in the region. On hillsides, this phenomenon is extremely severe and has led to the abandonment of large tracts of land. In some parts of El Salvador and the Dominican Republic, erosion levels -- measured in terms of sediment transport -- range between 190 and 346 tons/ha/year, whereas in well-managed areas, sediment transport does not exceed 5 tons/ha/year. This means that in less than a decade these lands may have no possible economic use.

Other examples will further illustrate the problem: by the early 1980's, 51 percent of Mexican soils, 60 percent of the Plata Basin, 72 percent of the Central Valley of Tarija (Bolivia), and 82 percent of 3,500,000 ha in the Magallanes region in Chile were completely eroded (ECLAC 1991b).

In arid and semiarid regions, erosion and desertification problems are worse due to the accelerated deforestation process. In irrigated areas, these problems arise from the salinization and alkalinization processes caused by the use of inadequate irrigation practices. If the different economic, technological

and climatological causes are considered, it may be stated that 20 percent of the Latin American territory is affected by desertification, high levels being reached in almost half of it (World Resources 1990, 90-91).

Table A-2. Growth-Equity (percentages) of selected countries other than those in Latin America.

Growth GDP Per Capita (1965-1984)	<0.4	>0.4
<2.4%	Kenya Zambia Philippines	Bangladesh India
>2.4%	Nigeria Malaysia	China, Indonesia Korea, Sri Lanka Egypt, Thailand Spain, Israel Hungary, Portugal Yugoslavia

Sources: ECLAC-ONUDI.

Table A-3. Land use in Latin America and the Caribbean.

Category	Estimated area ('000 ha)			Percentage	
	1970	1987	Change from 1970 to 1987	1970	1987
Cultivated land	120,258	150,720	30,462	6	7.5
Land for permanent crops	24,750	30,330	5,580	1.2	1.5
Pasture	529,646	563,542	33,896	26.4	28.1
Forest	1,038,975	967,144	-78,831	51.8	48.2
Others	290,960	292,853	1,893	14.5	14.6
Total	2,004,589	2,004,589	0	100.0	100.0

Source: Book No. 31 ECLAC "El Desarrollo Sustentable" 1991.

In Argentina, desertification threatens 60 percent of its territory; in Chile 45 percent, Bolivia 20 percent and Peru 25 percent.

This brief account of the degradation of the productive resources of the region points to the need for the implementation of a sustainable rural development program aimed at equitable economic growth and the preservation of natural resources.

Agroecology constitutes a new approach to agricultural and rural development. It is more sensitive to local agricultural complexities since it comprises sustainability, food security, biological stability, resource conservation and equity criteria and aims at achieving greater production. It is exerting decisive

influence on agricultural research and on extension activities of many Latin American nongovernmental organizations.

b) Technical Progress in Latin America's Agricultural Sector

Latin America's increased physical capacity for agricultural production has been achieved through technical improvements. However, despite more than three decades of technological and institutional innovations, rural poverty and low productivity still persist (*Agricultura y Desanollo,* No.25 1989). The extremely inequitable income distribution has evolved for the benefit of those farmers with more capital, more land and more resources. In many areas, this has meant further land concentration, rural stratification, and larger numbers of landless farmers. The import substitution strategies and policies practiced since 1950 have favored a capital-intensive and energy-intensive industrial development, while agriculture remained as a subordinate activity which had to be modernized.

The precapitalist structure of land tenure and low agricultural productivity hindered capital expansion in Latin America. Therefore, agrarian reforms were introduced and technological innovations were promoted on the basis of the "green revolution" package (*de Janvry* 1981). Some examples will help to illustrate the point. Between 1950 and 1972, the annual consumption of chemical fertilizers grew by 13 percent until it reached a point of diminishing returns for many crops. Between 1980 and 1984, Latin American countries spent US$430 million on imported pesticides, the massive use of which has upset natural ecological balances. Present trends indicate that by the year 2000, Latin America will have spent US$3.97 billion on chemical pest control (Burton and Philogene 1986).

Since the 1970s, emphasis has been laid on investments in technology for the productive process, the state playing a central role through the application of different policy mechanisms: subsidized loans; tariff reductions for imports of machinery and agrochemical inputs; construction, expansion and diversification of the extra-farm infrastructure and large irrigation works; land reclamation; and technical assistance. Estimates of the International Institute for Food Policy Research show that some 10 percent of the agricultural growth that took place in Latin America between 1950 and 1978 was due to the incentive generated by public investments in agriculture.

Not only the state but other international funding agencies (IDB, IBRF, World Bank, AID) have contributed in large measure to the technical progress of Latin America by financing agricultural and rural development projects.

In spite of the above, most of the expectations that technological progress had raised were thwarted. As pointed out by many authors, the social impact of exogenously induced technological increases in productivity, as a result of the adoption of a technological package with a strong bias towards modernization, were counterbalanced by a polarization or greater increase in the heterogeneity of the productive structure.

The imitative repetition of modernization models, with no generation of local technology or endogenous adaptation of the technological package, had polarizing and concentrating effects.

For over four decades of agricultural development, the importance of elements external to the farms and rural communities (modern inputs, equipment, advanced technology, infrastructure, subventions, subsidized loans, etc.) was emphasized and, in some cases, overestimated. Large, complex and sometimes inefficient public service structures were created. On the other hand, the importance of internal elements (rational management of the farmers' own resources, adoption of input- and energy-saving technologies; improved performance of productive units and farmers' organizations) was underestimated. Particularly underestimated were the needs to train rural families in the rational use of these technologies and resources, and to encourage them to solve their own problems by being less dependent on external decisions, services and resources which were often inadequate, inefficient and non-sustainable (FAO 1990).

In short, it will be necessary for Latin America to generate its own environmentally sustainable technological development less dependent on exogenous elements.

c) Rural Poverty, Peasant Agriculture and New Social Actors

By the end of the 1980s, there were 183 million poor in Latin America -- 71 million more than in 1970. Of them 88 million lived in a state of indigence (ECLAC 1991a). Today, poverty is a mostly urban phenomenon stemming from the expansion of large cities and from the increase in the poverty indices during periods of crisis.

So, while in 1970 only 37 percent of the poor lived in urban areas, by the end of the 1980s this figure increased to 57 percent. On the other hand, today, as in 1970, most of the extremely poor or indigent are to be found in rural areas. Estimates based on 16 case studies show that some 60 percent of the rural population in Latin America lives in a state of poverty -- about 65 million persons, of which 35 million may be considered indigent (Ortega 1986).

Statistics reveal that 62 percent of rural families in the region live below the poverty line; the percentage is 65 in Ecuador, 67 in Colombia, 68 in Peru, and 73 in Haiti. Rural poverty varies in extension and depth in different Latin American countries: it constitutes a general and structural phenomenon in Andean countries (particularly, Bolivia and Peru), or is concentrated in certain regions (NE Brazil), or is focused in small rural areas (Chile, Argentina).

d) The New Social Actors: the NGOs

During the last fifteen years, Latin America has witnessed a proliferation of nongovernmental organizations (NGOs) which have benefitted society in providing development options. They have fostered rural organizations and training in order to take advantage of the democratic reforms and the state's negotiating capacity.

When Agrarian Reform Processes came to an end in the 1970s, Rural Development Programs (RDPs) mushroomed in the region (Altieri 1990). The governments in the region set up some agricultural development programs for the improvement of services such as research, credit and extension. Other broader programs, such as integrated rural development (IRD) projects, aimed at the integration of economic and social objectives, coordinated institutional action, and the integration of the poorest sectors into the rural and national community.

Budget cuts in most Latin American countries, sharp reductions in foreign financial aid and the technological transfer of inputs unsuitable for the economic, social and ecological conditions of the peasantry have led to the failure of many a RDP.

The gradual withdrawal of governmental support to rural development has turned the NGOs into the main institutional actors in the struggle against rural poverty.

Since the early 1980s, the NGO strategies on rural development have been guided by some basic concerns: the extreme vulnerability of the peasants, the factors conditioning the peasants' subsistence level, etc. But the main objective of all NGOs is peasant organization. A classification of NGOs and of their respective programs are given below (Altieri 1990).

The first group is made up of RDPs which focus on productive and technical processes as well as on improving marketing techniques. The NGOs engaged in these programs direct their efforts towards small-scale producers who are capable of adopting modern technologies and of reaching higher production levels.

The second group is made up of NGOs whose programs focus on organizational aspects. These programs have strongly influenced and rescued the peasants' traditional production culture and logic, especially among native groups.

Finally, there is a third group of NGOs with programs focusing on adequate technological development and use, with special emphasis on the peasants' own technological experience.

Due to economic crises and the degradation of natural resources, these approaches have not contributed much to the mitigation of rural poverty.

In recent years, a minor group of NGOs has begun to focus on agroecological principles in view of the conditions confronting many small-scale producers who are being compelled to cultivate ecologically

fragile areas. For these areas, the farmers' know-how is insufficient. These NGOs aim at improving the peasants' quality of life through the development of ecologically sustainable subsistence strategies and at raising resource productivity.

In short, the dynamic integration of peasants into the productive rural-agricultural growth requires the peasants' organization, participation and management with their own alternative strategies. Here, the NGOs play a critical role in facilitating negotiations with public agencies for the incorporation of the sector into the decision-making process.

Appendix 3

INVENTORY OF WATER RESOURCES AND THEIR USE IN LATIN AMERICA
ECLAC (LC/G 1563 / 1990)

Introduction

Knowledge of the spatial distribution of the water resource and of the human use of that resource is fundamental for an understanding of water management in Latin America and the Caribbean. The purpose of this publication is to provide basic information on both the natural availability of the resource and on the use of water. It is hoped that from this information the reader can gain an appreciation of the diversity of the water management issues facing the region.

The inventory is presented in two volumes. Volume I covers Mexico, Central America and the Caribbean and Volume II, South America. Within each volume the presentation is divided into chapters on each major hydrographic region. Hydrographic systems are made up of a number of smaller basins; this differentiates them from the major basins, in which all the watercourses flow into one main river. For each region, a series of maps describe and locate the basic geographical characteristics. These maps are accompanied by a short text covering the climate, geomorphology and soils of each region. The descriptive text is supplemented by statistical tables of climatic data for representative stations and of average streamflow for the major rivers.

The information on water use is provided in a set of tables of relevant social and economic data. These tables supply data on the population by administrative division, the cities in each region with populations of over 100,000, dams and reservoirs, hydroelectric plants, and on the major water-using and waste-generating industries. The formation of this data base has taken considerable time and effort. No one has previously attempted, for a region as large and complex as the whole of Latin America and the Caribbean, to present social and economic data or even administrative divisions on the basis of hydrographic boundaries. The work was begun in 1975 and is still not complete. For example, two major industries, sugar and coffee, are not included as it has not been possible as yet to obtain region-wide information on the location of individual plants.

From the beginning of this work, the intention has been to keep the data files on water use, constantly updated. For this reason, the basic information is kept in computer files. This not only permits rapid and easy updating, but allows the manipulation of the basic records to support specific applications of the data.

Water Use in Latin America and the Caribbean

Latin America is the most humid of the regions of the world, but it contains some of the most arid areas on earth. South America, with a mean annual precipitation of 1,560 mm, has the highest rainfall and runoff of any continent. There are, however, some very arid areas. The Atacama desert, in northern Chile, is the driest region on the globe. These contrasts in the physical availability of water, coupled with

the variations in the density of human settlement, produce strongly contrasting patterns of use and transformation of the water resource.

The use of the water resource by man varies even more greatly than the availability of the resource. Latin America exhibits striking differences in the nature of human activities and in the density of settlement. Vast areas of the region are still relatively undisturbed, almost half of which is still classified as forest and woodland. There are also, however, industrial regions of global significance which have some of the largest concentrations of urban population to be found anywhere.

The main orographic system of Latin America, the Andes mountain chain, gives rise to three main types of hydrologic systems; the large river systems flowing to the Atlantic Ocean and adjacent seas; the short streams of the Pacific watershed; and the intermittent streams of the areas of internal drainage.

The Atlantic basins are the most extensive (84 percent of the total land area), and the three largest systems, the Orinoco, the Amazon and the Plate, account for two-thirds of total streamflow. They are characterized by slight gradients and the rivers maintain relatively steady flows in the lower reaches. There are broad floodplain areas subject to extensive regular flooding, as in Paraguay and Argentina.

In contrast, the Pacific basins, accounting for 11 percent of the total area, have steep gradients, and the rivers have marked variations in flow. The areas of internal drainage (some 5 percent of the total area) are mainly in the high central Andean plateau, in the Argentine interior and in northern Mexico, and exhibit very irregular patterns of flow.

The overall pattern of water use in Latin America and the Caribbean is spatially sporadic and highly concentrated. Much of the water use is concentrated in coastal areas and therefore has only a limited impact on the major drainage systems. Where drainage systems are influenced by man, the major effects have arisen from changes in land use and from the deliberate regulation of stream flow through the construction of dams and, to a lesser extent, through interbasin diversions. Regulation of streamflow on a large scale is mainly a characteristic of the last 50 years, while changes in the patterns of land use have been significant since the time of the earliest human settlements and remain, perhaps, the more important means by which human activities affect hydrographic patterns in the region.

Patterns of Land Use

The gross domestic product of Latin America has grown at an average annual rate of almost 5 percent for much of the last four decades. Even more important than this growth, however, from the point of view of water use, have been the changes in the internal structure of the economies of the region. Much of the change has been in the direction of the increasing importance of manufacturing industry and services in contrast to primary production, both agriculture and mining. Latin America is, however, the one region of the world where the agricultural frontier continues to expand and many hydrographic regions remain predominantly agricultural. The area defined as arable land and pastures expanded at ten times the global rate between 1970 and 1985, and large areas have been deforested in recent years. In Central America, 15 percent of the forest and woodland existing in 1970 was felled during that decade. Similarly high rates of deforestation are found in the Amazon basin.

At the same time, the proportion of the area cultivated under irrigation has increased. More than one third of the total area under irrigation is found in Mexico. Irrigation there, as in the other traditional areas of irrigated agriculture (Peru, the central valley of Chile, and adjacent areas of Argentina), predates the arrival of the Spanish. The greatest increases in irrigation in the last two decades have been in parts of central and southern Brazil, in Central America and in Cuba.

The Regulation of Streamflows

The early development of irrigation involved, at least locally, the regulation of streamflows. Large dams did not make their appearance, however, until late in the colonial period. The earliest existing large dam was built on the Saucillo river in Mexico in 1750 to provide irrigation, and irrigation has remained the

major purpose of the greatest number of dams ever since. With increasing industrialization, hydroelectricity power generation has become a significant secondary purpose and, in general, the dams built for this purpose provide greater storage.

Originally, regulation was restricted to smaller streams. The growth in the number of reservoirs and dams since 1950 has, however, led to the regulation of the large river systems draining into the Atlantic Ocean, particularly the Plate basin. Almost the total storage constructed since 1976 (120,111 x 106 cubic metres) has been in that basin.

Despite the growth in the regulation of streamflows in Latin America and the Caribbean, most river systems are still largely uncontrolled. Human influence on water flows continues to be exercised chiefly through the changes induced in vegetation cover, and it seems unlikely that this situation will change in the immediate future. The agricultural frontier continues to expand despite the decline in the relative size of the rural population.

The large metropolitan areas and some industries have a very significant influence on flow patterns and even more so on water quality, but in terms of the region as a whole the impacts are very localized. Industrial and urban activities are heavily concentrated in a few basins. The rate of dam building remains high, despite the hiatus induced by the debt crisis in many countries of the region, and the number of regulated streams continues to grow. Nevertheless, the wide variation in the intensity of use of the water resource is likely to remain characteristic of the region for many years to come.

The Distribution of Human Activities in Relation to Hydrographic Boundaries

In order to provide a more complete picture of the relationship between the water resources of the region and human activities, an attempt has been made to present some basic indicators on the basis of river basin boundaries. In constructing this table, various suppositions had to be made in assigning population and gross national product to a particular basin. It is necessary, therefore, to treat the resulting tabulations with considerable caution, although for comparative purposes the relationships are probably in the correct order.

The distribution of both population and economic activity is notably unequal, with high concentrations in three of the 26 major hydrographic divisions: the Gulf of Mexico, South Atlantic and Plate basins. These three basins account for 52 percent of the total gross domestic product of the region and are home to almost 40 percent of its population.

The considerable variation in the location of activity is accompanied by smaller differences in the structure of activities among the various basins. In most of the region, services and industry are the dominant sectors, although with differing relative shares of production. There are only five regions in which the share of agriculture is more than 20 percent.

In contrast, there are significant variations in the rates of population growth. The highest rates of growth are three times as great as the lowest, reflecting not only differences in natural growth rates, but also in rates of migration. Many river basins remain only lightly populated.

The inventory is still incomplete. It is hoped that this first edition will be only the first step in an effort to increase the availability of information on the use of water in Latin America and the Caribbean. Such information is an essential tool for the achievement of better water management and for maximizing the contribution of the water resources to the welfare of the population of the region.

Appendix 4

WATER DEMAND

Despite the serious economic crisis the region has suffered since the 1980s, water use has increased although at a rate lower than in the 1970s.

The combination of the different supply and demand systems has led to a complex water use pattern in the region. Water use patterns vary, especially among the large and small Latin American countries and the Caribbean islands, and there are conflict or complement processes among the different uses.

Most underground and surface waters are used for irrigation and drinking water supply purposes. As regards water supply and sanitation services, great improvements have been achieved over the last twenty years. In 1971, only 78 percent of the urban population and 24 percent of the rural population had access to drinking water supply systems; only 38 percent of the urban population and 2 percent of the rural population were served with drainage and sewerage systems. Seventeen years later, 88 percent of the urban population and 55 percent of the rural population had access to drinking water supply, while 80 percent and 32 percent of the population, respectively, had access to drainage and sewage systems (Panamerican Health Organization (PHO), Washington 1989). In spite of these improvements, there are still 89.2 million persons in Latin America with no access to drinking water supply systems and 141.1 million who lack sewage systems (PHO 1990).

There is not sufficient information on industrial water use, but estimates show that considerable volumes of water have been allocated to industry. A paper by ECLAC (1984) estimates that in Mexico the amount of water used in industry is 40 percent higher than the amount allocated to the public drinking water supply system. Industrial water use is highly concentrated, whether in industrial centers, in heavy industry or in agro-industrial development areas. This aspect must be pointed out because of its direct impact on the pollution of water courses. Indeed, in most countries in the region, industrial effluents are discharged untreated into water courses.

The increase in water use has brought about a growing regulation of water courses with different types of structures, the main non-consumption use being the generation of hydroelectric power. Other such uses are navigation, recreation, some types of aquaculture, and waste dilution and transport (which entails sustained water quality degradation).

Although non-consumptive uses have greatly increased in the last years, water use is still concentrated in large urban areas with a limited impact on the watersheds (ECLAC 1991).

The number of control structures (reservoirs, dams and sluices) has increased. Mexico, Brazil and Argentina have the largest number of dams (over 70 percent of the control and reservoir capacity in the region).

Ever since the energy crisis of the 1970s, efforts have been made to augment hydropower generation. The hydropower potential in the region is estimated at 805,792 Mw (35 percent of the world's total), out of which only 9.6 percent is currently used. Between 1980 and 1987, the annual growth rate in installed capacity was 6.5 percent, considerably lower than the one attained in the previous decade. The reasons for this decrease were the high cost of the infrastructure and the already mentioned economic recession.

At present, small countries of the region tend to direct their efforts towards the construction of microgenerating plants while the construction of large hydroelectric plants is undertaken through bilateral or trilateral projects.

The need to optimize water use and increase management efficiency with a view to avoiding water use conflicts is greater in areas with high population, industrial, agricultural and power generation growth rates, and are located in water-poor areas subject to droughts, floods or pollution conditions. In Latin America this combination of conflicting circumstances is often to be found.

The common trend in the region has been to plan use sectors for water resources planning -- irrigation, hydropower, drinking water supply. The main problems in water and irrigation systems management in Latin America will be dealt with later on. It should be pointed out here, however, that the excessive subdivision of activities, the little attention paid to social and environmental considerations, and the problems involved in the operation and maintenance of infrastructures have led the region to seek alternatives so as to organize, coordinate and integrate water-related activities and to achieve water management efficiency.

Appendix 5

IRRIGATION INSTITUTIONS IN SELECTED COUNTRIES

ARGENTINA

1. Instituto Nacional de Ciencias y Tecnicas Hidricas (INCYTH)

INCYTH comes under the *Direccion de Recursos Hidricos* of the *Secretaria de Obras y Services Publicos* [Secretariat of Public Works and Services] of the Ministry of Economic Affairs. INCYTH has various institutes in different parts of Argentina. Two of them are located in Mendoza: CELA and CILA.

2. Centro de Economia Legislation y Administration del Agua (CELA)

The main tasks of CELA include: studies and investigations to formulate sectional and regional strategies with a water resources development component, development and design of appropriate juridical and administrative systems for water use; provision of training opportunities for integrated water resources management; documentation and information.

The centre has five different departments:

Transferencia y Capacitacion
Sistemas Hidricos y Gestion
Sistemas Hidricos y Medio Ambiente
Sistemas Hidricos y Ciencia Tecnica
Sistemas Hidricos y Desarollo

The total number of employees is about 12.

3. Centro Regional Andino (CRA)

The centre has three different departments:

Hydrology
Irrigation and Drainage Engineering
Operation and maintenance of irrigation systems

Number of employees is approximately 14.

4. Institute de Economica y Sociologia Rural (IESR)

The IESR is part of the *Institute Nacional de Tecnologia Agropecuaria* (INTA) The purpose of the Institute is to generate and analyze pertinent socioeconomic information for the design of INTA's technological policy.

IESR conducts research and training activities in the fields of Agricultural Economics and Rural Sociology.

IESR has a staff of about 24 members.

The Institute cooperates closely with CGIAR centers like CIP and ISNAR. It has strong relations with CELA and the National University of Cuyo.

BRAZIL

1. Secretaria Nacional de Irrigacao (SENIR)

SENIR is part of the *Ministerio da Agricultura e Reforma Agraria.* SENIR implements government policies concerning irrigation. There are two important organizations under SENIR: CODEVASF and DNOCS.

2. Compantia de Desenvolvimento de Vale do Sáo Francisco (CODEVASF)

CODEVASF is responsible for the management of 68,000 ha of irrigated land in the Sáo Francisco Valley (SF). It has three regional subdivisions: Alto SF, Medio SF, Sub-Medio SF and Baixo SF. The Sub-Medio division with headquarters in Petrolixa has 37,000 ha of irrigated land and is the more important one from an irrigation point of view. From the 6 projects in the Sub-Medio region, 3 have been transferred to water users' associations.

3. Departamento Nacional de Obras Contra as Secas (DNOCS)

The original task of DNOCS included: construction of roads, electrification, construction of small reservoirs (*Acudes*), drinking water supply, etc. It was only after 1970 that irrigation was added as an additional task.

DNOCS currently operates 27 irrigation projects with a total area of approximately 24,000 hectares under irrigation.

4. Empresa Brasileira de Pesquisa Agropecuaria (EMBRAPA)

EMBRAPA is Brazil's national agricultural research organization. EMBRAPA, irrigation research is mandated to CNPAI (*Centro Nacional de Pesquises de Agricultura Irrigade,* located in Paranaiba [Piaui State]). Because of its more central location it is intended to involve CPATSA (*Centro de Pesquisa Agropecuaria do Tropica Semi-Arido*, located in Petrolina [Pernambuco State] in irrigation research. So far CPATSA has concentrated its efforts on water conservation.

EMBRAPA collaborates with CIAT and CIMMYT.

CHILE

1. Comision Nacional de Riego (CNR)

The objective of the CNR is to "*asegur el incremento y mejoramento de la superficie regada del pais*" [to assure the increase and improvement of the area under irrigation in the country].

The council of the CNR consists of:

The Minister of Economic Affairs (President)
The Minister of Public Works
The Minister of Agriculture
The Minister of Finance
The Minister of Planning and Cooperation

The day-to-day affairs of the CNR are in the hands of a *Secretaria Ejecutiva* [Executive Secretariat].

The main functions of the CNR include:

* Project preparation, planning and evaluation.
* Entering into agreements with specialists and national or international consultancy firms to carry out studies.
* Supervision and coordination of activities of public and private organizations in the construction of irrigation works.
* Allocation of national and international resources for irrigation development.
* Representing the government in obtaining foreign credits.

The CNR, therefore, is very much a policymaking body of the government.

2. Direccion General de Aguas (DGA)

The DGA is part of the Ministry of Public Works.

The main functions of the DGA are:

* Research and investigation, mostly in collaboration with Universities.
* Hydraulic/hydrologic measurement.
* Allocation of water rights and control over existing rights.
* Surveillance or control of rivers, canals, etc.
* Organization of water users.
* Protection/conservation of water.
* Water quality control (yearly census).

The DGA is currently engaged in setting up information systems (information that includes technical as well as organization information) for each basin.

3. Direccion de Riego (DR)

The DR also belongs to the Ministry of Public Works.
The main task of the DR is the implementation of large-scale projects (over US$200,000). After construction, the DR remains responsible for operation and maintenance for a period of 4 years. Then this responsibility is handed over to farmer organizations. The first step in this process is the organizing of farmers.

4. Confederacion de Canalistas de Chile (CCC)

The Chilean water law distinguishes three different categories of organizations. The *Junta de Vigilancia* [Supervisory or Vigilant Board]: Organizations at the level of the river. There may be more than one junta for a river; for instance: upper reach, middle reach and lower reach. The juntas are responsible for water offtakes from the river.

Below the offtake, the responsibility for water distribution is in the hands of *Asociaciones de Canalistas* [Canal Associations] and *Comunidades de Agua* [Water Associations]. One usually finds *Comunidades* at tertiary level. They have a different judicial form than the *Canalistas.*

The CCC is an organization that is not prescribed by the Water Law. It serves the interests of the *Asociaciones de Canalistas.*

COLOMBIA

1. Instituto Colombiano de Hidrologia Meteorologia y Adecuacion de Tierras (HIMAT)

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 was in charge of irrigation and drainage development as part of land reform. INCORA, the Colombian Institute for Agrarian Reform, initially concentrated on land reform but diversified its operations in later years to include land and water development projects.

HIMAT has a staff of nearly 2,000 members of which half are in the Irrigation and Drainage Sub-directorate (1950 in the regional offices and 50 at the central office).

It is not only in charge of irrigation and drainage districts but also operates an exclusive hydrological and meteorological network of laboratories.

Of the 28 irrigation and/or drainage districts, 21 are managed by HIMAT. These 21 districts cover an area of 120,000 ha of which 65,000 ha is for irrigation and drainage, 45,000 ha for drainage only and 70,000 ha for drainage and flood protection.

Responsibilities for operation and maintenance for one of the largest irrigation and drainage districts (Coello, 26,000 ha) was transferred from HIMAT to a users' association as early as in 1976. Since then, 7 other districts have also been transferred.

2. Instituto Colombiano Agropecuaria (ICA)

ICA, Colombia, National Agricultural Research Organization, has a Natural Resources Department which includes a small water management section (with 2 Ph. D. qualified staff members and 5 MSc. qualified staff members).

3. Federacion Nacional de Arroceros (FEDARROZ)

Colombia is a country with a large number of producer organizations. The most important one is the Federation of Coffee Producers. The Federation of Rice Producers is also influential.

There are approximately 160,000 hectares of irrigated rice fields with a cropping intensity of over 170 percent. Yields are in the order of 5.8 tons per hectare per season. Almost 2/3 of the annually harvested area is irrigated.

ECUADOR

1. Instituto Ecuatoriano de Recursos Hidraulicos (INERHI)

INERHI is an autonomous public body attached to the Ministry of Agriculture and Livestock, and headed by an Executive Director.

The Minister of Agriculture is President of the Board which has three directorates:

Direccion de Planificacion
Direccion Financiera
Direccion Tecnica

Under the *Direccion Tecnica,* there are four sub-directorates:

Sub-direccion de Administracion de Aguas y Ordenacion de Cuencas
Sub-direccion de Estudios y Diseño de Proyectos
Sub-direccion de Construccion
Sub-direccion de Operacion y Desarrollo Systemas de Riego

INERHI plays a crucial role in Ecuador in the construction of new systems, in rehabilitation and in operation and maintenance of existing systems. It also plays an important role in the legalization of water rights and solving water disputes.

The total area under public irrigation in Ecuador is approximately 115,000 ha. Of this area about 80,000 ha are under management by INERHI. Other areas in the public sector are managed mainly by Provinces or Municipalities.

INERHI also has different agriculturally oriented laboratories under its supervision.

MEXICO

1. Comision Nacional del Agua (CNA)

The CNA is a comision of the *Secretaria de Agricultura y Recursos Hidriculicos* (SARH), headed by a director general.

The CNA was created in 1989 to unite all aspects of water management, a task which, under the Mexican Constitution, falls to the federal government.

The organizational structure of the CNA distinguishes six levels:

Direccion General
Direccion
Sub-direccion General
Sub-direccion
Gerencia
Sub-gerencia

At the *Direccion* level, distinction is made between urban and agricultural water use.

Planning, design, construction and operation are four *sub-direccions* under the *Sub-direccion General* for Hydraulic Infrastructure.

Under the *Sub-direccion* for operations, distinction is made between four *Gerencias* [Managers]: *Tierras Aridas* [Dry land], *Distritos de Riego* [Irrigation Districts] and *Unidades de Riego* [Irrigation Units].

Under the *Gerencia de Districtos de Riego* there are again three *Sub-gerencias* (operation, maintenance and transfer) and one office for irrigation and drainage.

The *Gerencia de Distritos de Riego* is responsible for the operation and maintenance of 3.5 million hectares of irrigated land, spread over 77 districts.

The *Gerencia de Unidades de Riego* deals with approximately 18,500 units and an irrigated area of 1.8 million ha.

There is a special *Sub-gerencia* (under *distritos de riego*) that deals with transfer of responsibility for operation and maintenance from the government to water users.

2. Instituto Mexicano de Tecnologia del Agua (IMTA)

IMTA is an institute of the SARH that has close linkages with CNA. The Director General of CNA is the President of the Board of IMTA.

IMTA has three "Technical Coordinations" in:

* Industrial and urban use of water
* Watershed management (including hydro-meteorological studies)
* Irrigation and drainage.

The total number of employees is approximately 400 of which 85 are with Ph. D. and/or MSc. qualifications. Emphasis is on industrial and urban water supply.

IMTA has agreements with a number of universities in different parts of the country to carry out research.

3. Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP)

INIFAP is part of the SARH and is a national agricultural research organization. It has over 2,000 researchers and a large network of research stations all over the country.

So far, INIFAP's water related activities have focused on water use efficiency and crop water requirements.

INIFAP has recently moved into a new area of research: water management at district level, combined with technical assistance.