



The Privatization and Self-Management of Irrigation

Final Report

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Editor**

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Preface

In recent years numerous countries around the world have begun to turn over responsibility for managing irrigation systems from government agencies to farmer organizations or other non governmental entities. Most commonly, governments adopt turnover programs in order to reduce the cost of irrigation to the government and enhance the long term sustainability of irrigation systems through local management. Sometimes farmers promote turnover with the intent to improve the cost effectiveness of management through local control.

This Final Report for the research project on the Privatization and Self-management of Irrigation presents the most detailed comparative research to date on the subject. Results are presented from case studies in the USA, Colombia, China, Sri Lanka and Sudan. Each of the studies assesses the basic arrangements of the management turnover programs, the implementation process and aspects of the context which were either supportive or detrimental to the objectives of management turnover. But the most important theme pervading each of the studies is the importance of measuring impacts of management turnover on the performance of irrigation systems. The Report also reviews the emerging evidence from the literature on the impacts of irrigation management turnover and hypothesized conditions for successful outcomes. The first international conference held on this subject, the International Conference on Irrigation Management Transfer in Wuhan, China, September 1994, was partly sponsored by this project. The Report contains a summary of key issues identified at this important meeting.

Finally, this Report provides an integrative framework for analyzing the options for management reform for irrigation. We recommend this Report to policy makers, planners, technical assistance experts and researchers who are looking for empirical evidence about the results of this widespread phenomenon.

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April 15, 1996

The Privatization and Self-Management of Irrigation in Developing Countries

Executive Summary

1. Project Background

This is the Final Report for the research project on the Privatization and Self-Management of Irrigation in Developing Countries. The project was financed by both the BMZ of the Government of Germany and the International Irrigation Management Institute, based in Colombo, Sri Lanka. The GTZ provided technical support to the project. The research program was implemented between 1992 and 1995.

Objectives of the project were to:

- Document the impacts of turnover arrangements and processes on irrigation performance in five case studies.
- Identify key issues, hypotheses and findings about impacts of turnover through review of the literature.
- Facilitate international exchange of information about irrigation management turnover.
- Facilitate more effective strategic change processes for irrigation management turnover programs through production of general guidelines for analysis and planning.

Under the project five case studies were carried out on the process and results of management turnover in the USA, Colombia, China, Sri Lanka and the Sudan.

The site in the USA was the Columbia Basin Project in Washington State. The main collaborators in the study were the United States Bureau of Reclamation Office in Euphrata, Washington and the Department of Agricultural Economics at Washington State University. Principal investigators were Dr. Douglas Vermillion (IIMI) and Dr. Mark Svendsen (consultant).

The study in Colombia included the Coello and Saldaña irrigation districts in the Tolima Valley in Central Colombia. The main collaborator was the Institute for Hydrology and Meteorology and Land Development (HIMAT) and staff of the Coello and Saldaña irrigation districts. Principal investigators were Dr. Carlos Garces-Restrepo (IIMI) and Dr. Douglas Vermillion.

The study in China was conducted in the Nanyao and Bayi irrigation districts in Shijiazhuang Prefecture in Hebei Province in North China. IIMI collaborated with the Shijiazhuang Institute of Agricultural Modernization of the Chinese Academy of Sciences and staff of the two districts. Principal investigators were Dr. Douglas Vermillion, Dr. Sam Johnson III (IIMI) and Dr. Mark Svendsen.

The sites in the study in Sri Lanka included the Kaudulla irrigation district and the Mahaweli System C located in the dry zone. IIMI conducted this study in collaboration with the Irrigation Department, the Mahaweli Economic Authority and staff and farmer representatives in both systems. Wim Kloezen (IIMI) was the principal investigator.

The four irrigation systems in the study in Sudan are river lift pump schemes located in the middle region of the White Nile. Collaborators included the Ministries of Irrigation and Agriculture, the White Nile Agricultural Services Administration and staff in the study systems. Dr. M. Samad (IIMI) and Dr. Dingle (consultant) were the principal investigators.

2. Problem statement

Irrigation management turnover is defined as "the transfer for management responsibility and authority for irrigation systems from government agencies to farmer or other non-governmental organizations." Turnover is occurring in many countries in Asia, Africa, the Americas and the Pacific. Early efforts to transfer management from government to farmer organizations occurred in the USA, France and Taiwan in the 1950s, 1960s and 1970s. In the 1980s and 1990s, turnover became a national policy in Chile, Peru, Mexico, Brazil, Dominican Republic, Haiti, Senegal, Mauritania, Niger, Zimbabwe, Tanzania, Sudan, Somalia, Madagascar, Turkey, Pakistan, India, Sri Lanka, Bangladesh, Lao, Vietnam, China, Indonesia, and the Philippines. The policy is referred to as "turnover" in Indonesia and the Philippines, "management transfer" in Mexico and Turkey, "privatization" in Bangladesh, "disengagement" in Senegal, "post responsibility system" in China, "participatory management" in India and Sri Lanka, "commercialization" in Nigeria and "self management" in Niger.

Turnover programs are often adopted when governments are no longer able to finance the routine costs of irrigation and are unable to collect sufficient fees from farmers. Due to under financing the systems deteriorate and performance declines. Management is transferred to the users normally with the expectation that they will be able to sustain an acceptable level of performance.

3. Case studies

Each of the case studies identified the basic policies, institutional arrangements and management responsibilities included in management turnover. Basic information on technical, agricultural and socio-economic contexts was provided. The transfer process was described. Most of the cases analyzed the effects of management turnover on the performance of operations and maintenance, financial management and agricultural and economic productivity of the irrigation systems.

Management Turnover in the Columbia Basin, USA This case study examined the context, institutional arrangements, process and results of turnover of management from the government to three farmer-controlled irrigation districts in 1969. In a context of well-established water rights, volumetric water charging, strong legal status of farmer organizations and a strong policy of bureaucratic reorientation, management turnover led to a substantial reduction in government subsidies and staff. Operational performance remained high after turnover, with little change indicated either in irrigation efficiency or equity of water distribution. Farmers achieved their primary interest in reducing the cost of management. By the late 1980s water charges were only 78% of their level before turnover (in real terms). The districts diversified their revenue sources to cross-subsidize the cost of irrigation. There is evidence that the farmer interest in cost containment is causing a modest decline in the quality of maintenance.

Management Turnover in Two Irrigation Districts in Colombia This study examines the context, institutional arrangements, process and results of management turnover in the Coello and Saldaña irrigation districts which occurred in 1976, after farmers petitioned the government to take over management. Farmers argued that they had already repaid the construction costs and could manage the systems more efficiently than could the government. Although the government continued to exercise partial control over budgets and staffing, the farmer controlled districts managed to reduce staff by 35%, keep cost of irrigation to farmers constant over time, improve financial viability of the districts and diversify revenue sources. Coello district expanded its irrigated area and sustained high crop yields while decreasing the average volume of water delivered per hectare. A survey of infrastructure in both systems shows that the systems have been well maintained for nearly 20 years after turnover. Crop diversification and gross value of output increased significantly after turnover.

Management Reform in Two Irrigation Districts in North China This study found that the general reforms introduced by the production responsibility system, following the collapse of the communes, were in evidence at the level of the two irrigation districts in the study, Nanyao and Bayi. Reforms introduced in the two districts during the mid and latter 1980s included collection of area and volumetric water fees, saleable water rights, creation of village irrigation organizations, incentive systems for management staff and development of sideline enterprises to cross subsidize the cost of irrigation to farmers. Operational and agricultural performance was relatively high after reforms. Financial viability of the districts gradually improved after reforms. Irrigation fees rose while value of agricultural output gradually fell during and after the time of reforms.

Results of Participatory Management in Two Irrigation Systems in Sri Lanka The key elements of participatory management in the study systems is the turnover of responsibility for operations and maintenance of distributary canals in return for which farmers become exempt from paying water charges. Although the Sri Lankan government has assumed that participatory management would help to increase farmers' willingness to invest in O&M, the two study systems show that this strategy has actually discouraged farmer organizations from investing in irrigation O&M. Funds provided by the government to the distributary canal organizations for maintenance were instead used to start bulk purchasing of agricultural inputs for farmers and group sale of the rice harvest to the government paddy marketing board. While this helped increase the economic returns to irrigated agriculture, expected improvements in the performance of operation and maintenance have not materialized.

The study recommends that in order to achieve locally sustainable irrigation, O&M grants to farmers organizations should be reduced or eliminated and matching investments should be required for farmer organizations to obtain government subsidies. It is also recommended that the legal status of farmers organizations be strengthened and measurable water rights be established. Farmer organizations and the irrigation agencies should be made financially autonomous and current ambiguities and overlapping roles between the two should be eliminated.

Impacts of State Disengagement from Pump Irrigation Schemes in Sudan In 1991, the Government of Sudan adopted a policy to reform management of agricultural production in river lift irrigation schemes along the middle section of the White Nile. About 70 per cent of the staff of the White Nile Agricultural Services Administration (NASA) were laid off and its administration withdrew from managing all but 38 or some 175 irrigation schemes in the region. The government expected farmers in the schemes to form their own management organizations or to entrust private companies to manage agricultural production in the schemes. Ownership and operation and maintenance of the irrigation facilities were retained by the state. By the end of 1991, one private company had taken charge of 16 schemes relinquished by the WNASA. Thirty schemes were brought under a farmer organization and the rest were either abandoned or were limited to rainfed cultivation. A comparison of schemes managed by WNASA, a private holding company and the farmer organization showed that agricultural, economic and financial performance was highest in WNASA schemes. This was partly due to limited channels of credit and inputs in the open market. The study concludes that in an environment lacking effective private sector institutions for providing agricultural services, owning and managing land and water and marketing agricultural products, transfer of management for either agricultural production or irrigation management should not be attempted.

4. Information exchange activities

The project provided support for initiation of the Short Report Series on Locally Managed Irrigation in which twelve Reports have been published and disseminated through a network of over 1400 members. The reports included papers on the following topics:

- Turnover of pump schemes in Indonesia
- Privatization of irrigation in New Zealand
- Policy reform and water law in Chile
- Management turnover in the Philippines
- Results of management transfer in two systems in Colombia
- Locally managed irrigation in Japan
- Turnover of a distributary canal in Bihar, India
- Privatization of tubewell irrigation in Bangladesh
- Turnover of river lift schemes in Senegal
- A summary of the 1994 International Conference in Wuhan
- Locally managed irrigation in Israel
- and a summary of issues addressed at the September 1995 Expert Consultation on Irrigation Management Transfer in Asia, held in Thailand.

With partial funding from the project, IIMI, in collaboration with the Ford Foundation, the Canadian International Development Agency, FAO, the Chinese Ministry of Water Resources and the Wuhan University of Hydraulic and Electrical Engineering sponsored the International Conference on Irrigation Management Transfer, which was held in Wuhan, P.R. China, September 20-24, 1994. 220 participants from 30 countries attended the Conference. A book of selected papers from the Conference was published in 1975 and distributed to all participants, donors and several hundred professionals and organizations around the world who have some interest or involvement in the topic.

5. Evidence of impacts of irrigation management turnover

Despite the widespread adoption of irrigation management turnover programs, little information is available internationally about impacts of turnover. Evidence from literature on management performance after turnover is presented on irrigation operations and maintenance, financial viability, agricultural and economic productivity, government subsidies and the environment. More data is available in the literature on operational and financial performance than on maintenance and economic results.

Of the 24 sources reviewed, 21 provide data on operational performance after turnover. 15 provide data on financial and agricultural performance and nine provide information on the quality of maintenance and economic effects. Most sources reported positive effects on operations, including improved water supply, equity and efficiency of distribution, timeliness or reliability of water delivery and extension of area irrigated, although there were some negative reports about equity and efficiency after turnover. Most sources which included information on financial performance reported decreased costs of irrigation to farmers and the government, increased collection of water charges, declines in staff, improved financial viability of the management entity and diversification of revenue sources. Four sources reported increases in cost of irrigation to farmers. More sources reported increased in crop yields, cropping intensity and diversification than declines. Contrastingly, more of the sources on economic performance reported negative results, with five of nine sources indicating declines in value of production after turnover (although this can not be attributed solely to turnover).

6. Hypothesized conditions for successful management turnover

Research to date indicates that management turnover will be effective only where:

- Turnover is cost-beneficial to the majority of farmers.
- Social divisions are not serious enough to disrupt communication and decision-making between farmers.
- The turnover program has high-level political commitment.
- The irrigation agency is assigned new roles which do not overlap with farmer organization.,
- Farmer organizations should have clear water rights and legal status.
- Conflict resolution arrangements and accounting and auditing systems should be in place before turnover.
- Rehabilitation should be done in turnover programs only if farmers are involved in decision making and investment.

7. Analytical framework for irrigation management reform

Planning irrigation management reform should include analysis of four basic dimensions of irrigation management: the water service, hydraulic technology, management functions and organizations. The analysis should start from a precise definition of the water service which is required and then proceed to specify the nature of technology and management which is best suited to achieving an acceptable standard of performance in the water service. Analysis should be made of gaps between the existing and required water services and gaps between the required water service and the compatibility of existing technology and management. This analysis will largely determine whether or not reforms are actually required and, if so, how extensive they should be.

The water service may include regulation of the water source, acquisition of water at the source, conveyance, distribution through the canal network, application of water on fields, drainage and flood control. For irrigation, the water service is primarily defined by the amount (or proportion) of water to be delivered to specified locations at specified period (or sequences) of time. These expectations are normally embodied in water rights. The water service requires actions to be taken at one hydraulic level of an irrigation system which provide an agreed service across three main interfaces: between the main and distributary subsystems, between the distributary and watercourse subsystems, and between the watercourse and farmers' fields. The water service is constrained by the type of hydraulic technology in the system.

The four basic management functions which support the water service are operation of structures, maintenance of structures, dispute resolution and resource mobilization. There are eight basic types of organizations which exist to either govern irrigation systems or perform any of the above four basic management functions. These are a government agency, public utility, local government, farmer association, irrigation district, mutual shareholding company, private company and contractor. Organizational accountability to performance objective is achieved through internal governance arrangements, central regulation, competition, inter-dependence between organizations and common property arrangements.

What types of organizations are appropriate for managing a given irrigation system is largely determined by the "maturity" of a country's institutions, government policy toward water resources management, the complexity and political sensitivity of the water service, the sophistication and organizational traditions of water users and the degree of corruption and available measures to control it. The following characteristics are typical of irrigation organizations which are considered successful and sustainable:

- they are self-financing utilities,
- they are primarily government by the water users,
- they have a carefully defined and measurable water service which is backed by a legally recognized water right,
- ownership of the assets resides in the managing authority,
- they have rights of eminent domain,
- they have powers to swiftly enforce rules and collection of revenue,
- they have transparent administration and performance,
- they set, collect and use water charges according to strict accounting principles, and
- they cooperate with an independent body which provides auditing services and oversight.

Irrigation management turnover, if needed, may require changes in the basic water service, hydraulic technology, responsibility for management functions and organizational design. It may require changes in any of the above organizational characteristics. It is essential that reforms involve the complete and balanced set of essential management requirements. Given the complexity of issues associated with reform, policy makers and planners should be careful to analyze all essential aspects of integrated irrigation management. The report recommends that the following eight questions be addressed by any countries which are considering the possibility of adopting irrigation management turnover policies:

1. How should the planning process be organized?
2. What is the potential scope for reform?
3. What is the set of feasible options for reform?
4. To what extent do performance gaps justify reform?
5. What kinds of changes are needed in the water service, hydraulic technology and management functions at different hydraulic levels?
6. What kinds of organizations and accountability mechanisms are required to ensure effective performance of management functions?
7. What kinds of information and experimentation are needed? and
8. What kinds of resources and time schedule are needed to implement reforms?

An effective reform process will likely require participation and agreement of all key stakeholders in irrigation management, including high level officials, field operations staff and farmers. It will require formulation of a common vision of a new future, both for the farming community and for government agencies.

This report makes three main recommendations for future research and development on irrigation management turnover. First, more systematic and comparative research is needed on the impacts of management turnover. Studies should include a complete and balanced set of indicators of changes in performance in operations and maintenance, financial management, agricultural and economic productivity, government spending and environmental impacts.

Secondly, policy makers and planner who are considering option for irrigation management reform should recognize that the following five conditions should be present before management turnover can be expected to have favorable results:

- a clearly recognized and sustainable water right,
- irrigation infrastructure which is compatible with water rights and local management capacity,

- clear and balanced designation of responsibility and authority for all essential management functions,
- effective accountability and incentive mechanisms, and
- adequate resources for sustainable irrigation management.

Thirdly, action research on management transfer at higher levels or larger scales of management is needed. It should involve new management structures with multiple entities which are inter-dependent for financing and service delivery.

CHAPTER 1

INTRODUCTION

1.1 Overview Of The Privatization And Self Management Program

Background

This is the Final Report for the Project, "Privatization and Self Management of Irrigation." It is submitted by the International Irrigation Management Institute, or IIMI, to the German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit) or GTZ. In May 1992, the German Federal Ministry for Economic Cooperation (Bundesministerium für wirtschaftliche Zusammenarbeit) or BMZ, agreed to finance the Project, "Privatization and Self Management of Irrigation" (or PSM Project). The contract agreement for this Project is between the GTZ and IIMI. IIMI communicates and cooperates with the GTZ on all technical and administrative aspects of this Project. The Project is implemented through the program staff at IIMI which are or will be attached to the Local Management Program, other IIMI staff which are involved in this Project and through other institutions or consultants with whom IIMI collaborates on the Project. This Report was prepared by Dr. Douglas L. Vermillion with written inputs from S. Johnson, M. Samad, C. Garces-Restrepo, Mark Svendsen and Wim Kloezen.

Objectives and activities

The objectives and activities for Phase I of the Privatization and Self Management Program are summarized as follows.

- 1) Document the relationship between turnover arrangements, the privatization process and performance impacts through five case studies on management turnover approaches, management and policy environments and results in selected countries.

In collaboration with national research or irrigation agencies, IIMI has conducted case studies of irrigation privatization or turnover in the USA, China, Colombia, Sudan and Sri Lanka. Each case represents a different kind of policy, organizational, agricultural and technical environment within which the role of government in irrigated agriculture has declined and the role of farmers and/or other non-governmental entities has increased in recent years. The case studies examine the nature of the turnover arrangements and processes, how these effect financing and management practices and what impacts turnover may has on agricultural productivity and profitability, water distribution and use and the physical sustainability of irrigation structures.

The case study in the Colombia Basin, USA examines the results of a 1969 management turnover to farmer districts in a context of established water rights, volumetric water charging, strong legal recognition of farmer organizations and a clear policy of bureaucratic reorientation of the government out of irrigation management.

The case study in Colombia examines the nature and results of a 1976 management turnover in two irrigation districts where water rights and legal status of the farmers' organizations were somewhat

and volumetric water charging, strong incentive and accountability systems and legally recognized village irrigation organizations.

The case study in Sri Lanka analyzes the formation of federated farmer organizations and their take over of operations and maintenance at tertiary, distributory and, in one site, system levels in medium and large scale systems which are jointly managed by government agencies and farmer organizations. Particular attention is given to management roles, farmer perceptions and financial viability of irrigation management turnover in a context of joint management.

The case study in Sudan compares management practices and performance of three management models for river surface lift irrigation systems along the middle section of the White Nile at a time when the government was privatizing their management. The three models are the White Nile Agricultural Corporation, farmers' organizations and a private holding company contract management.

- 2) Identify key patterns, issues and hypotheses about irrigation privatization and turnover at the international level through a comparative analysis of data and literature about turnover policies and arrangements, change processes and results.

Through analysis of data from the five case studies, information from the series of Short Reports on Locally Managed Irrigation, review of literature and information obtained through workshops and networking, IIMI has identified key problems and issues and specific hypotheses about turnover. Originally it was expected that more firm conclusions and hypothesis confirmation could be done during Phase I of the PSM Program but research and information review revealed that a considerable variation in approach to turnover, farmer responses and outcomes exists between countries. Also, it became apparent during the Study that significant gaps often exist between official turnover policies and actual implementation in the field, often due to resistant agency staff at operational levels. Hence a systematic comparison to confirm hypotheses about management turnover would require comparison of actual turnover arrangements at the system level for a large number of systems. And it became apparent that more work was needed in first identifying key issues and more specific hypotheses about privatization and turnover from the complex variability of turnover approaches before a more tightly-controlled systematic comparative study could be conducted effectively.

- 3) Facilitate exchange of information between countries through country level seminars and workshops, presentations at international workshops and conferences and publications in existing newsletters and IIMI and non-IIMI outlets.

Through the series of case studies, short reports solicited from experts, workshops, literature review and information networking, IIMI has developed a center of information on irrigation management turnover and privatization and has disseminated the information through its publications, journal articles, national and international meetings and the International Conference on Irrigation Management Transfer, held in Wuhan, China in September 1994.

- 4) Facilitate strategic change for irrigation management turnover through preparation of general guides for policy, program formulation and training and development of methodologies for pilot turnover experiments possibly in two countries.

It was decided to postpone preparation of the guide books until more systematic comparative assessment was done, partly due to comments of Phase I Advisory Committee members and others that IIMI should not promote turnover uncritically and should obtain more systematic evidence before recommending turnover

practices. Nevertheless, Chapters 5 and 6 provide guidelines for turnover policy making and planning. They identify necessary conditions, arrangements and questions which should be addressed to ensure effective decision making which will result in appropriate reforms.

Staff assignments and collaborating institutions

Dr. Douglas L. Vermillion, rural sociologist and irrigation specialist and Dr. Sam H. Johnson III, agricultural economist and senior irrigation specialist, were joint project leaders for the Privatization and Self Management of Irrigation Program during 1994 and were based at IIMI headquarters in Colombo, Sri Lanka.

Dr. Vermillion and Mark Svendsen, an agricultural engineer based at IFPRI in Washington, DC during the first half of 1994 (and after June 1994 as a private consultant), were principal investigators for the case study on irrigation management transfer in the Columbia Basin, USA. This study was done with the assistance of Mr. Bernd Maier, a German graduate student at Washington State University, USA.

For the case study on irrigation management turnover in Colombia, Drs. Vermillion and Carlos Garces-Restrepo, irrigation engineer, were principal investigators. Mr. Juan Fernandez, agricultural engineer and consultant, assisted with the field research. IIMI collaborated with the Colombian Institute for Hydrology, Meteorology and Land Development (HIMAT) in this study.

Dr. Vermillion and Johnson were principal investigators for the case study on irrigation management reform and devolution in north China. Dr. Mark Svendsen assisted with the study as a part-time consultant with IIMI on the China Case Study. This study was done in collaboration with the Shijiazhuang Institute of Agricultural Modernization, Chinese Academy of Sciences, under the leadership of Professor Liu Changming.

For the case study on irrigation management turnover in Sri Lanka, Wim Kloezen, Agricultural Engineer and Association Expert was the principal investigator. IIMI collaborated with the Irrigation Management Division, Ministry of Lands, Irrigation and Mahaweli Development, Government of Sri Lanka.

For the case study on the privatization of pump irrigation systems on the White Nile, Sudan, Dr. M. Samad, agricultural economist, was principal investigator. Dr. M. Shafique, IIMI irrigation engineer, and Dr. Dingle, agricultural economist worked part-time on the case study in Sudan. Dr. Samad was based at IIMI headquarters and made several trips to Sudan. Drs. Shafique and Dingle were based in Khartoum.

1.2 Causes and implications of irrigation management turnover

World population is increasing at a rate of approximately 90 million people per year. The World Bank predicts that this rate will continue until around the year 2040. Agricultural production will have to increase by 2.5 percent per year to keep up with the steadily rising demand for food. However, two basic challenges to sustaining this rate of increase exist in the agriculture sector. First, since the mid 1980's average yields of major grain crops have been leveling off. Second, there is little potential remaining to increase production through expansion of area cropped. This is because (1) almost all arable land is already cultivated, and (2) existing agricultural land is going out of production in many developing countries due to rapid urbanization and environmental degradation, especially soil erosion, waterlogging and the salinization of soils and water (World Bank, 1992).

Two key challenges to sustaining the rate of increase in food production also exist in the water resources sector. First, environmental degradation and rising competition for water from urban and industrial users are making water for agricultural uses more scarce. There are strong pressures in many developing countries to reduce the average 80 percent share of total water supply which is used for agriculture in developing countries and to increase the amount available for non-agricultural uses. Hence, the 250 million hectares of irrigated land worldwide is not likely to increase significantly in the coming decades. Indeed, it is likely to decrease. Forty countries have less than 2,000 cubic meters of water available per capita per year, which is a level which involves temporary-to-continuous water shortages for both agriculture and domestic use (World Bank, 1993). The second key challenge posed by the water resources sector is that both international and national financing for irrigated agriculture have been on the decline since the mid 1980's. International aid for agriculture in developing countries declined in real terms from US \$11.7 billion in 1980 to about US \$10 billion in 1990 (Carruthers, 1994). The extensive irrigation construction and rehabilitation of the 1960's and 1970's has been replaced with an emphasis on sustainable management of existing resources and infrastructure (World Bank, 1993).

These trends point to two urgent needs in irrigated agriculture. First, while today more than one third of the world's supply of food comes from irrigated lands (mainly in developing countries), in the future about two thirds of the needed marginal increase in food production will have to come from irrigated agricultural land. Also, assuming that green revolution technologies are not likely to be replaced soon by another biotechnology revolution, much of the needed increase in productivity must come from management improvements such as more efficient irrigation management, land tenure improvements, credit arrangements, etc. Hence, the first need is to find ways to produce more food with the same amount of land and less water. More intensive and productive irrigated agriculture is needed both to increase world food supplies and to provide rural employment to limit urbanization. Decreases in government spending and involvement in the irrigated agriculture sector mean that a second basic need in the sector is to achieve more intensive, efficient and sustainable irrigation management through new institutional arrangements. These must rely primarily on local and private sector organizations which are accountable to farmers. Among the guiding principles of the Earth Summit held in Rio de Janeiro in 1992 were the recommendations that water should be treated as an economic good (with a right attached to it), that water management should be decentralized and that farmers and other stakeholders should play a more important role in the management of natural resources, including water (Keating, 1993).

Hence increasingly, local management solutions are being sought for global problems of food and resource management problems (Ostrom, 1990). Irrigation management turnover has become a widespread strategy in more than 25 countries in Asia, Africa and Latin America, where governments are reducing their roles in irrigation management while farmer groups or the private sector expand their roles (Vermillion, 1992). Irrigation management turnover is most often an attempt by governments to reduce their expenditures on irrigation and to stabilize deterioration of irrigation systems (Vermillion, 1994).

Turnover policies are often based on the assumption that local management which is accountable to farmers will be more sustainable, cost efficient and responsive to the interests of the majority of farmers than are irrigation systems which are managed by centrally-funded agencies (Meinzen-Dick, 1994b; Vermillion, 1991). The string of logic often used to justify turnover policies is as follows:

Government bureaucracies tend to lack the incentives and responsiveness to optimize management performance. Farmers have a direct interest in enhancing and sustaining the quality and cost efficiency of irrigation management. Where management turnover includes a decline in government subsidy to irrigated agriculture, it will involve an increase in the cost to farmers of irrigated agriculture.

When management turnover occurs in a supportive socio-technical context, and through arrangements which enable local organizations to take over management, it will result in improved quality and cost-efficiency of irrigation management. This, in turn, will normally enhance the profitability of irrigated agriculture enough to more than offset the increased costs to farmers of irrigation management.

Management turnover will also save money for the government, as it divests itself of the responsibility to finance routine costs of operations and maintenance of irrigation systems. The savings can then be used either to reduce government expenditures in the irrigation subsector or to reallocate funds to other functions which can not be handled or financed directly by the private sector.

1.3 Working hypotheses about management turnover

The above string of logic can be broken down into individual hypotheses, each of which can be tested through rigorous assessment of impacts. These are as follows:

- 1) Management turnover programs which:
 - are implemented in a supportive socio-technical context,
 - involve requisite reform in the agency, and
 - involve arrangements to enable local organizations to take over management, will result in improved quality and cost efficiency of irrigation management after turnover.
- 2) Improvements in the quality of management will improve agricultural and economic output at the level of the irrigation system after management turnover.
- 3) Management turnover will increase the cost to farmers of irrigated agriculture when it includes a decline in subsidies from the government.
- 4) Improvements in economic output at the level of the irrigation system will exceed the increased cost to farmers for irrigation management after turnover.
- 5) Where management turnover has strong high-level political support and is implemented across the subsector, it will result in decreased costs to the government for O&M and this will result in either a decline in government expenditures for the irrigation subsector or a reallocation within the subsector.

To date, little research has been done to either substantiate or discount hypotheses about performance impacts of irrigation management turnover. However, evidence is beginning to emerge. This is reviewed in section 2 below.

- 1) On the basis of prior research (Vermillion and Johnson, 1994; Johnson, et al., 1995; Ostrom, 1992) , we identify the following variables as key aspects of a supportive socio-technical context for management turnover:
- 2) Social divisions are not serious enough to disrupt communication and decision-making between farmers;

- 3) Costs and benefits of turnover are perceived to be proportionately allocated among farmers;
- 4) Water rights are recognized at the level of farmers and the new managing entity; and
- 5) Irrigation system infrastructure turned over to farmer management is compatible with local management capacities.

By "requisite reform" in the agency, we mean changes required by the prior managing agency in mandate, staff, budgets and authority to withdraw itself from involvement in and control over management functions which are turned over to the new local managing entity. This generally involves a clear policy—with strong, high-level political support—about, "What functions are to be turned over?," "At what level?" and "To what organizations?"

We posit the following arrangements are necessary for a turnover process to enable local organizations to take over management of irrigation systems:

- 1) Full authority over all management decisions related to cost and benefit streams of management are turned over to the farmer organization taking over management;
- 2) The entity taking over management should be organized with supportive by-laws, management plan, enforcement mechanisms, financial accountability arrangements, locally supported leaders, trained staff and legal status needed to discharged its functions; and
- 3) Physical repairs or improvements to system infrastructure should be done with farmer participation in decisions and investment.

1.4 Key concepts

The International Irrigation Management Institute has stated that its mission is to enhance the management of irrigated agriculture in developing countries. We define irrigated agriculture as the human production of food crops through the use of irrigation. Following Small and Svendsen (1992), we define irrigation as:

human intervention to modify the spatial or temporal distribution of water occurring in natural channels, depressions, drainage ways, or aquifers and to manipulate all or part of this water to improve production of agricultural crops or to enhance growth of other desirable plants (p. 34).

"Irrigation systems" include the physical, technical and social components used to acquire water, control its movement to agricultural land and disperse it into the root zones of agricultural crops (Small and Svendsen, *ibid.*, p. 34). The management of irrigation systems many include the following functions: 1) irrigation system operations, 2) maintenance, 3) rehabilitation, 4) resource mobilization, 5) governance and 6) ownership.

Operations includes decision-making and manipulation of technology to acquire, convey, distribute and apply water from the source to the crop in the field. Maintenance includes the preservation and repair of irrigation system technology in order to meet operational objectives. By rehabilitation of irrigation infrastructure we mean the restoration of damaged or deteriorated irrigation structures to a given standard. Resource mobilization involves the acquisition and use of finances, labor, skills and materials to support irrigation management. Governance relates to the charter of authority, legal status, determination of basic rules and leadership for irrigation management and regulation, through information and enforcement

systems, to ensure that irrigation management practices are in compliance with governance rules and policies. Ownership of irrigation systems includes the set of liabilities and rights connected with holding title for irrigation infrastructure, as defined by law.

The agricultural component of irrigated agriculture may include the management and preparation of land, the planting, cultivation, harvesting, processing and marketing of crops, and the control of weeds and pests for crop production on irrigated land. So the phrase, “management of irrigated agriculture,” may include any or all of the functions listed above for irrigation or agriculture.

In this chapter we define “**management turnover**”, or “**turnover**” (as it is also frequently referred) to mean:

the shift in responsibility and authority for the management of irrigated agriculture from the government to non-governmental entities.

Management turnover can be defined according to three dimensions: **functions, levels and organizations.**

Regarding **functions**, management turnover may involve any of the following irrigation functions: operations, maintenance, rehabilitation, resource mobilization, governance and ownership. When management turnover includes ownership, it becomes synonymous with “privatization” (Vermillion, 1992). For agriculture, management turnover may involve land management and preparation, planting, cultivation, harvesting, processing and marketing of crops, and control of weeds and pests for crop production.

Except for some countries in Africa (Samad and Dingle, 1995), state plantations, and collective farms in some communist countries, the agricultural production component of irrigated agriculture is not managed by national or state governments. While agricultural production and distribution is often partially regulated by the state, it is not normally managed by the state. By comparison, irrigation systems have often been developed and managed by government agencies and the turnover of management for irrigation systems from governments to farmer or other non-governmental groups has become a widespread phenomenon. Hence, in this chapter we use the term “management turnover” generally to refer to irrigation management turnover, unless otherwise designated.

Management turnover for irrigated agriculture may also be defined according to the hydrologic **level** at which it occurs. Irrigation systems can be divided into the following levels or subsystems: **water acquisition, conveyance, main and secondary distribution network, field channel network and farmers’ fields.** For example, in small-scale irrigation systems, responsibility and authority for irrigation management may be turned over from government to farmer organizations for the acquisition, conveyance and distribution levels. If the field channel and farmer field levels were not previously managed by the government then these would not be considered to have been turned over (although these levels may be indirectly effected by the turnover which occurred at higher levels). In large-scale irrigation systems it may be that only the secondary distribution network is turned over to farmer organizations, since field channels may have only been initially developed but not managed by the government and since the government may consider that farmer organizations are not capable of managing higher levels of large-scale systems (e.g., main, conveyance and acquisition). In large-scale systems management turnover often results in the government retracting upwards and turning over one or two of its lowest levels to farmer or other local organizations. Where single irrigation systems are managed by two or more kinds of organizations, such as a government agency and farmer groups, we refer to these as “jointly managed” systems.

After functions and levels, the third dimension for defining management turnover is the types of **organizations** which "turn over" versus "take over" management. These can be divided into the following categories: 1) centrally-funded government agency, 2) financially self-reliant public utility, 3) private company, 4) non-profit, non-governmental agency, 4) farmer group and 5) individuals.

The three dimensions of management functions, levels and organizations must be consistent with the needs and constraints of each other, and be in balance. Organizations vary in legal status, political power and management accountability and these characteristics partially determine the levels and management functions which can be taken over effectively by new organizations. It may be that the functions of enforcement and financing at lower levels can not be handled effectively by separate organizations which only have jurisdiction at field or secondary channel levels; integration at a higher level may be necessary to perform these functions. On the other hand it may be that operations and maintenance at lower levels may be handled adequately by independent organizations at lower levels.

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CHAPTER 2

CASE STUDY RESULTS

2.1 Results of Irrigation Management Transfer in the Columbia Basin Project, USA

Mark Svendsen and Douglas L. Vermillion

This case study was initiated before the PSM Project began under IIMI unrestricted core funding. Later phases of data collection, analysis and preparation of the final research monograph were done after the PSM Project began in 1992 and 1993. The final text was completed by the end of 1993 and was submitted to IIMI's Information Office for publication. The study was published by IIMI in 1994 as a Research Paper and a paper was prepared for presentation at an international conference (Svendsen and Vermillion, 1994b).

Currently there is keen interest in many developing countries in transferring responsibility for operating large publicly-constructed irrigation systems to the farmer-beneficiaries of the systems. To understand the implications of such a shift on the performance of a system and the conditions under which such transfers can take place successfully, a case study was undertaken to document the causes and results of such a transfer. The Columbia Basin Project (CBP) in Washington State, USA was selected for this study. This selection was based on the facts that the United States has had a policy mandating transfer of managerial responsibility for publicly-developed irrigation to users for almost 100 years, that good quality historical records describing system hydrology and financial performance were available, and that transfer in the CBP occurred more than 20 years ago, providing ample time for the post-transfer situation to stabilize and for longer-term problems to emerge.

The following is a summary of this study.

Introduction

This chapter discusses a representative case of transition to farmer management in the American west. It first discusses the national policies which govern irrigation management in the United States and institutions which implement them, and then describes the Columbia Basin Project. Then follows a summary of the results of the analysis of the impacts of the transition, organized around four topics—technology adoption, hydrologic performance, financial performance, and farm profitability. It then offers several general conclusions and goes on to identify conditions felt to have influenced and facilitated the successful transfer. Finally, it suggests important lessons for those attempting similar transfers in developing countries.

Background

Currently there is keen interest in many developing countries in transferring responsibility for operating large publicly constructed irrigation systems to the farmer beneficiaries of the systems. To understand the implications of such a shift on the performance of a system and the conditions under which it can take place successfully, a case study was undertaken. The Columbia Basin Project (CBP) in Washington State, USA was selected for this study. This selection was based on the facts that the United States has had a policy mandating transfer of managerial responsibility for publicly developed irrigation to users for almost 100 years, that good quality historical records describing system hydrology and financial performance were available, and that transfer in the CBP occurred more than 20 years ago, providing ample time for the post-transfer situation to stabilize and for longer-term problems to emerge.

The CBP is a large multipurpose reservoir-based project located on the Columbia River in the state of Washington near the Canadian border (Map 1). Construction of the dam was begun in 1933 and water first reached the command area in 1951. The current irrigated area is about 230,000 hectares (ha), while facilities for a roughly equal area included in the original plan have never been constructed. All water used by the irrigation system must be lifted 85 meters, from which point it is distributed to the command area largely by gravity flow.

The national irrigation development agency, the US Bureau of Reclamation, constructed the project and operated it from 1951 until 1969, when management was turned over to a set of three farmer- controlled irrigation districts. These districts had been established in 1939 while construction was still underway and had signed repayment contracts with the Bureau obligating their members to reimburse the government for part of the cost of building the system. Each district today consists of 2,000 to 2,500 landowners and is controlled by a board of 5 to 7 persons elected from among them. The districts operate on a nonprofit basis and are required to cover their own operating costs. Districts purchase water from the Bureau and then resell it to their members. Payments to the Bureau include an energy charge for basic water lifting from the reservoir, but the rate applied is highly subsidized. The Bureau continues to operate some common facilities and retains formal ownership of all system facilities, though the right to operate and maintain them and to collect revenue from the sale of irrigation service, rests with the districts.

Districts require farmers to pay for basic water services in advance of the season or no water is delivered. Districts have the right to foreclose on farm property in the event of unpaid bills and have done this on a number of occasions. Water delivery to farms is on an arranged demand basis, and deliveries to individual farms are measured volumetrically for accounting and billing purposes.

The Transfer

The transfer process

The primary interests of farmers in the transfer were in obtaining more local control over water allocation, water fee structures, O&M expenditures, and drainageways and in minimizing water charges. In negotiations with the Bureau, farmers and their lawyers asserted the right to local control over a resource for which they were paying, with the underlying assumption that local management would be both cheaper and more responsive.

Bureau officials in the Columbia Basin had a long-standing mandate to transfer management to the farmer-controlled districts as soon as they could reach agreement on the terms and conditions. The Bureau was also interested in shedding responsibility for farm-level water deliveries and water service contracts to enable it to focus on its development mission and on basin-level regulatory functions. These interests were reciprocal. The farmers did not like the cumbersome administration and unresponsiveness of government management and the Bureau did not want the troubles of having to deal with thousands of individual farmers.

In the early 1960s, Floyd Dominy, Commissioner of the Bureau of Reclamation, gave the CBP a strong push to move ahead quickly with transfer negotiations. The districts hired lawyers who, together with elected district board members, entered into a protracted process of negotiation, hydrologic and economic studies, and legal analysis with project staff. The research helped reduce some of the uncertainties about the cost and equity implications of various options being considered. Negotiations began in earnest in 1966, and transfer agreements were signed in late 1968.

Over a period of about five years, the districts gradually came to an agreement over water and cost allocation and which works should be (a) reserved by the Bureau, (b) managed jointly between districts, and (c) transferred to individual districts. Mutual concessions were made by districts regarding alignment of O&M responsibilities and

apportionment of costs. One of the last obstacles was overcome when the Bureau dropped its insistence that districts cover severance payments for Bureau staff transferred to the districts.

In 1963, farmers agreed to repay a total of US\$325 per hectare to the Bureau for the cost of scheme construction and additional drainage facilities. This allowed a 10-year deferral period and a repayment period of 50 years, without interest. Hence the repayment rate was US\$6.50 per hectare per year. However, this agreed repayment constitutes only about 12 percent of the total construction costs of the project. The remaining 88 percent is recovered through hydroelectric power sales.

In contrast to many transfer programs in developing countries, the transfer process in the CBP was characterized not by efforts to organize and motivate farmers to comply with government programs, but by extended negotiation until terms and conditions mutually acceptable for the government and the farmers were agreed upon.

Terms of transfer

The following are the more important terms and conditions which were negotiated and agreed to between the farmer-controlled irrigation districts and the US Bureau of Reclamation. The key rights transferred to the districts include the following.

- A measurable, volumetric water right.
- The right to plan and implement all system operations and maintenance.
- The right to apply fines and other sanctions against members who violate district rules.
- The right to deny access to water to district members who fail to pay fees or to nonmembers of the district.
- Districts can set the levels of basic and excess water charges to farmers, although charges for the basic allocation remain related to land productivity classes.
- Districts can enter into water service contracts to sell excess water to farmers outside the districts. However, districts may not sell water *rights* since the transfer of water rights from one landholding to another is prohibited.
- The districts have rights of eminent domain and foreclosure on land. They are not liable for damages resulting from the storage, conveyance, seepage, overflow, and discharge of water either to other districts or to individuals.
- Districts are allowed to purchase heavy equipment and supplies from the project with a ten-year payment schedule. This includes such vehicles as tractors, road graders, and pick-up trucks.
- The districts have the right to obtain revenues from sources other than water, including power generated by stations within the system. The right to generate power was considered concessional by the Bureau, since the districts pay an extremely low rate for the primary lifting of water from the FDR reservoir.

Key district responsibilities include the following:

- Districts must comply with the agreed construction repayment schedule, which includes partial repayment for drainage construction.
- Districts are responsible for all operation and maintenance for facilities used individually and jointly by the districts, in accordance with Bureau standards of performance and financial viability.
- Districts are responsible for paying their mutually agreed proportions of the recurrent costs of special "reserved works" which were retained for management by the Bureau.
- Districts are responsible for making annual payments into a capital replacement reserve fund at a rate equal to 30 percent of five-year average annual O&M costs. They must eventually replace deteriorated facilities using this fund.

- Districts must report maintenance plans annually in advance to the Bureau.

Key rights held by the Bureau after transfer were as follows:

- The Bureau has the right to resume direct management of the system if the districts fail to make their construction repayments, pay for the O&M of reserved works, or properly maintain the system.
- Bureau staff members affected by the management change would be transferred either to other Bureau projects (as was the case with most construction staff members) or to the districts themselves (as was the case with most O&M staff members). By agreement, most of the initially-employed district management staff members were former Bureau CBP employees.
- Salaries and benefits of transferred Bureau staff members such as ditchriders and watermasters remained at the levels prevailing before transfer. Federal retirement plans for transferred staff members were cashed in or suspended and new district retirement plans were started, although without seniority.

Key responsibilities of the Bureau relative to the districts, after transfer, were as follows:

- The Bureau has responsibility to manage the "reserved works" which serve the entire project. These included the Grand Coulee Pumping Plant, Banks Lake, the Main Canal, and Potholes Reservoir.
- The Bureau conducts operation and maintenance reviews (or "examinations") every three years to audit O&M performance standards of the districts and make recommendations for improvements.
- The Bureau retains ownership of the facilities operated by the districts at least until completion of repayment or replacement of facilities by the districts. However, under current law, wholesale transfer of ownership of system facilities to the districts would need an act of Congress. The districts favor the retention of legal title for facilities by the Bureau, since they believe this protects them from certain legal liabilities.
- The Bureau must report, in advance, its maintenance and repair plans for its reserved works to the districts on an annual basis.
- The Government will acquire needed rights-of-way for water movement within the project area.

The negotiations between the Bureau and the districts regarding the terms and conditions of the transfer were complex and occurred over the course of several years. A legal council was involved on both sides and political influence was sometimes invoked by the districts. The results were embodied in a set of three legally binding transfer agreements, which were, in essence, contracts between each district and the Bureau of Reclamation. These agreements remain in force.

The strong legal position of the farmer irrigation districts and the protracted period of negotiation between them and the Bureau resulted in a relative balance between district rights and responsibilities. In developing countries there is a tendency for governments to emphasize transfer of responsibilities to the neglect of transfer of rights. A balance between transferred responsibilities and rights, and expected increase in local control and net financial gain to the farmers, were motivating conditions which made the transfer acceptable to CBP farmers. Where this is not the case, considerably greater resistance to transfer on the part of farmers is probable.

Impacts of the Transfer

Technology adoption

There was substantial technological change in the CBP following transfer of management in 1969. Some of this change, such as the widespread shift from open channel water application to center pivot systems, resulted from individual decisions of farmers responding to prices and returns. Other changes, such as installation of automatic

gaging stations and telemetry systems, were initiated by the districts. It seems clear that the transfer to district management has not hindered the adoption of new technology in the CBP and may have accelerated it.

Causes and effects of technological change are sometimes complex and indirect. For example, the reduction in water demand which accompanied the rapid shift to sprinkler irrigation in the 1970s was shown to be largely a result of a shift to crops with lower water demand, rather than to the adoption of more efficient sprinkler systems *per se*. However, it is likely that the installation of center pivots improved water control and facilitated the shift to new, less water intensive, often higher value crops. The willingness of farmers to invest in expensive new water application technology is itself, in part, a function of their confidence in the reliability of water supplies delivered by the district. District managers assert that the shift to center pivot irrigation has also had implications for main system management, requiring less frequent changes in turnout settings, but causing larger, more abrupt changes in demand, leading to increased main system losses.

Hydrologic performance

The quality of the irrigation service received by CBP farmers does not appear to have been affected significantly by the change to district management. Quantity of water delivered did not change markedly after 1969 and reductions in water supply in later years can be explained largely by reductions in aggregate water demand resulting from changing cropping patterns. Demand-based equity of water distribution among the districts did decline in the 1970s and 1980s following transfer, but then improved again and, on average, equity among districts was about the same before and after transfer. The CBP operates on an arranged demand system of allocation wherein timeliness of water deliveries must be measured against the timing of orders for water. Farmers appear to have been satisfied with the timeliness of deliveries both before and after transfer and generally rate this aspect of service highly.

An examination of the hydrologic efficiency of the system reveals some interesting changes (Figure 1). It appears that the system's new managers had a learning period of five or six years after transfer before they were able to operate the conveyance system as efficiently as did the Bureau prior to transfer. This demonstrates the complex and subtle nature of the control that is required to operate a large system like the CBP efficiently. Farmers increased tertiary-level efficiency steadily from the mid-1970s. Improvement in water use efficiency was driven by a shift from surface to sprinkler irrigation across much of the project area. That rise has now stopped and overall tertiary-level efficiency may even be declining slightly at present.

One very puzzling aspect of system hydrology is the continuing 15-year decline in conveyance efficiency which began in 1978. This decline appears to be a result of deterioration in the condition of major system canals resulting in increased conveyance losses. Evidence from the maintenance audits conducted by the Bureau, supplemented by statements of project managers, lends support to the idea that system facilities are deteriorating (Table 1). Whether or not this has resulted in increased conveyance losses is not known with certainty but it is reasonable to assume so.

Financial performance

Upon assuming management responsibility, districts moved quickly to cut water assessments to district members. On average, real per-acre assessments (adjusted for inflation) under district management were only 78 percent of their level during the Bureau period, dropping from approximately US\$27 per acre in 1969 to US\$21 per acre in 1989 (Figure 2). At the same time, districts diversified income sources, increasing the share of revenue from hydropower generation, water sales and interest on deposited funds. This partially offset lost water assessment income (Table 2). Sale of water to non-members of the district also increased sharply, demonstrating the power

of vested water rights, financial autonomy, and quasi-volumetric pricing to shift water to more profitable uses within the irrigation sector.

On average, costs of operating the system do not exhibit well-defined shifts associated with management transfer, and average expenditure levels before and after 1969 are roughly similar. Although it is impossible to know what expenditure patterns would have prevailed had the Bureau retained operating responsibility, the Bureau's agency-wide O&M cost index has grown to a higher level than more general cost indices, suggesting that CBP operating expenses under Bureau management might have been higher than they presently are, other things being equal.

Three-quarters of operating expenses are made up of staff and O&M costs, and, ignoring the one-time costs of the transition, these have held remarkably constant across the transition. However, USBR staff levels have fallen sharply since 1969, above 500 in 1969 to below 100 in 1983 (Figure 3). Major expenditure components show peaks just after transition, reflecting the one-time costs of the transfer. A ten-year decline in total expenditure from the 1969 peak is largely attributable to falling costs of reserve works. During the last decade, total costs have risen again to their long-term average, driven by increases in reserve works expenditures (which include primary pumping costs and costs of maintaining the main system components serving all three districts) and administrative and other costs.

Since district O&M costs have not declined since transfer, it can be assumed that maintenance levels at the district level have not been reduced appreciably. However, conveyance efficiency has declined in all three districts. It is possible that, while district expenditures on O&M have held constant, they should in fact be increasing to counter accelerating deterioration as the system ages. Some support for this hypothesis is provided by an analysis of maintenance audits, which show an increasing number of problems being flagged in recent years (Table 2). This would suggest that if O&M expenditures continue to hold constant, gradual system deterioration will continue and that more general rehabilitation will be required in the future.

Farm profitability

Gross returns to irrigated agriculture have risen steadily in the CBP over the past 30 years (Figure 4). Although information on net returns is sketchy, there is some indication that real net returns have risen also. Water assessment levels have fallen by about one-third since districts assumed management responsibility. This is very roughly estimated to comprise about 15 percent of average net farm income.

Enabling Factors

Policy context

The established federal government policy mandating transfer to farmer management of all irrigation systems constructed by it gave the transfer an air of inevitability. It also meant that considerable experience with the transfer process had accumulated before transfer was attempted in the CBP. Farmers were brought into the picture at the outset through their irrigation districts. Their agreement to participate in the project, to undertake partial capital repayment, assume eventual management of the project, and to cover the "full" cost of O&M (which in fact is only partial) was required. The offer could be refused and was by some. The legally binding nature of the agreements reached provides a sense of legitimacy for the districts in the eyes of farmers and permits strong sanctions to be applied by the districts against members, when required.

Federal policy also requires a continuing Bureau presence in the project as a repository for the project water right, the legal owner of the system physical facilities, and provider of ultimate oversight. This presence is also valued by the districts as it offers certain sovereign immunities and an ongoing relationship with the Bureau. The

"partnership culture" between the districts and the Bureau permitted joint problem-solving during the transfer, leading to a mutual decision to continue Bureau management of jointly-used reserved works, contracting by the districts for technical work to be performed by Bureau staff, and the creation of satisfactory Bureau-to-district personnel transfer arrangements. The relationship is currently being utilized in implementing a program of artificial drainage installation within the project and could possibly facilitate future assistance for system rehabilitation or major repairs.

Federal water resource policy allows cross-subsidization of irrigation construction costs by power revenues and this tends to increase the profitability of irrigated agriculture under Bureau projects. By providing power for lifting water at rates which are far less than current market rates, the government continues to subsidize system operating costs. The government charges the districts only 1/2 cent per kilowatt hour for pumping water out of the Columbia River. The open market price for electricity during the summer season is approximately 17 cents per kilowatt hour. However, within this subsidized context, irrigation districts are required to operate with balanced budgets.

Perhaps most importantly, federal irrigation policy has remained fairly constant since its inception. Although there have been changes in particular features from time to time, the basic outlines and the principle of system management by financially autonomous irrigation districts have remained. This consistency provides farmers with the confidence to make investment decisions and other longer-term commitments which might otherwise seem excessively risky. It also provides the assurance that private investments which they might decide to make will not be duplicated or provided to others at no cost at some future date.

Social context

By contrast to the situation in many developing countries, the project area consisted originally of a relatively homogeneous population of settlers who were well educated and commercially oriented. There were virtually no landless poor or others with insecure tenure resident in the project area. Farmers were experienced at creating voluntary associations for a variety of purposes and appreciated the usefulness of joint action. Farmers and their districts had considerable legal and political power and secure land and water rights. Farmers were able to negotiate as equals with the Government and obtained numerous favorable concessions for themselves, such as low power and construction repayment rates and relaxed limits on farm sizes. Such concessions ensured that farming would be a relatively stable and profitable enterprise. Initially farmers employed their considerable political clout to influence Bureau decisions through their elected national representatives. More recently, farmers have begun to rely more heavily on legal action to pursue and promote their interests in the public arena.

Institutional context

A number of important institutions undergird the successful assumption and execution of management responsibilities by the three CBP irrigation districts. Fundamental is the existence of a reliable system for specifying, allocating and recording rights to the use of water. Without this, it is unlikely that farmers would have been willing to assume responsibility for the common irrigation facilities and make the requisite corollary private investments in on-farm equipment and facilities. The strong legal basis underlying the creation of quasi-municipal irrigation districts also contributed to successful devolution and management by the districts. The relative autonomy of the districts allows them flexibility to control costs and to diversify sources of income. The relationship between the Bureau and the districts rests on a set of repayment contracts which spell out the duties and obligations of each party. The legitimacy and enforceability of these contracts is an important feature of transfer. Supporting and enabling all three of these institutions—firm water rights, legally constituted quasi-municipal irrigation districts, and contract law—is a relatively impartial and accessible legal system which provides a mechanism for enforcing contracts and adjudicating disputes.

Another area in which underlying institutions are important is that of financial probity. The state, which charters the districts, requires that regular audits of district accounts be carried out by certified public accountants. This system of mandatory external audits is another important element in the institutional environment facilitating the viability of the irrigation districts.

US Bureau of Reclamation

The Bureau of Reclamation has been characterized by a high degree of competence and professionalism both before and after transfer. Bureau staff receive salaries which provide for an adequate standard of living and enjoy job security under the federal civil service system. That security was preserved during the transfer process, since most staff were transferred to new positions with the districts, retaining former salary levels and insurance and pension benefits. Remaining staff were reassigned elsewhere, accepted early retirement, or were given new roles within the Bureau. These steps no doubt helped limit opposition on the part of affected Bureau employees which might otherwise have been considerable.

It is noted that the Bureau is not financially autonomous in the sense that its operating expense budget is unconnected with the revenue its activity generates. The three CBP irrigation districts do meet this criterion. Financial autonomy has been identified as a key attribute of effective irrigation service providers in developing countries (Small and Carruthers 1991; Svendsen, Adriano, and Martin 1990) and appears to play a critical role here as well.

Irrigation system

The physical elements and basic operating rules of the irrigation system also form a relevant part of the transfer context. First, the system has an ample and reliable water supply. Second, allocation has been capably handled on an arranged demand basis both before and after transfer. This permits considerable flexibility and responsiveness to market conditions by farmers in choosing crops and cropping patterns. Third, there are clear points of demarcation of responsibility and control where transfers of measured quantities of water are undertaken according to widely accepted agreements and rules, including payment rules. Deliveries to districts and to individuals are thus treated as contractual obligations and water is regarded as an economic good rather than a social entitlement. Fourth, the system has adequate conveyance capacity to deliver required amounts of water throughout the system. Fifth, system physical facilities were upgraded as a part of the transfer agreements and were received by the districts in good working order. The transfer was thus not the disposal of a dilapidated public property, but rather the concessional sale of a valuable and productive asset. Additionally, much of the technical expertise needed to operate the system was transferred with it through the hiring of Bureau staff members by the districts.

Lessons for Ttransfer in Developing Countries

Lessons which can be taken from the CBP experience for use in developing country settings can be grouped into two categories. The first of these comprises policy and institutional issues which can affect the success of a transfer program. The second relates to the process of transfer itself.

Policy and institutional issues

An assessment of the relative effectiveness of the various policies and conditions supporting successful transfer of management responsibility in the CBP is beyond the scope of this chapter. Moreover, large public irrigation

systems occur in a tremendously wide range of situations around the world, and even if such an assessment were carried out, the lessons learned could not be conveyed directly to new settings.

Nevertheless, it is possible to identify from the preceding analysis some policies which appear to have been influential in enabling a successful transfer of management responsibility. Some of these factors will be important only in the context of this particular case, or a relatively narrow range of cases, while others will have more wide-ranging importance. Listed below are policy conditions which are judged to be important and to possess a measure of general applicability. They are recommended not for immediate and uncritical implementation but for careful consideration of their relevance for particular situations by planners and managers of management transfer programs in developing countries.

- *Put in place a clear and consistent policy mandating irrigation management transfer.* Transfer is a slow and deliberate process, and basic outlines of policy governing transfer must remain relatively constant for an extended period to elicit desired responses. Where policy on transfer shifts repeatedly, meaningful and sustainable change is unlikely to occur. On the other hand, the USBR experience in general, and the CBP experience in particular, demonstrates that where sustained commitment to the practice of transferring system management responsibility exists, the process can work effectively.
- *Do not require full cost recovery* (for both capital and operational costs) in the first instance. In most cases, such insistence will result in such a drastic increase in the farmers' costs for irrigation service which may place any proposed management transfer program into a sea of political protest. Cross-subsidizing irrigation service delivery costs with other water resource-related revenue streams, such as power generation or aquaculture, maybe a more practical option.
- *Manage financial autonomy* (on the part of the managing entity). This has been shown to be effective and critically important in a wide variety of circumstances in both higher and lower income countries. Causing the irrigation district or farmers' organization to generate sufficient income to cover its costs in operating the system provides an essential set of feedback links needed to make system management accountable to its members. It is not necessary that no public subsidies be involved, but only that they be specified in such a way that they do not increase automatically to make up shortfalls in revenue from irrigation operations.
- *Provide a strong legal basis for irrigator organizations.* Such organizations should have the authority to make contractual agreements, obtain credit, and apply sanctions against members.
- *Provide a system of secure, well-specified and long-term water rights* which can be assigned to irrigation systems to offer security for investments of time and money.
- *Invest to bring physical facilities up to standard.* Experience in a number of countries, including the United States, has shown that programs which couple physical upgrading (if needed) with transfer are more likely to succeed than transfer of systems with faulty infrastructure.
- *Create a fair and transparent professional auditing system* and mandate its use by managing organizations. This system can be established in either public or private sectors, but should be carefully regulated to ensure its integrity.
- *Provide new employment or compensation for displaced irrigation agency staff.* Civil service employees of public irrigation agencies often have considerable political influence and must not see themselves as losers in

the transfer process. They should be integrated into the planning for the transfer and compensated for lost employment through early retirement inducements or transfers to new positions.

Process issues

The following issues relate to the processes employed in facilitating management transfer. Some of these have policy and institutional implications which should not be ignored. In general, there is a well-developed literature and body of experience with the process of organizing farmers into associations. (FAO 1985; Uphoff 1986; Korten and Sij 1989; Uphoff 1992) Less attention has been devoted to some of the other factors listed below.

- *Involve farmers early on in the planning for the transfer.* A sense of full partnership in the process on the part of farmers is essential for successful assumption of responsibility.
- *Empower farmers* to successfully negotiate with the public irrigation agency. This is difficult to do, though one new approach worth exploring is the vesting of farmer groups with water rights, rather than granting them to the managing agency.
- *Use contracts* between irrigator groups and the managing agency to specify roles and responsibilities. This can be a very powerful tool as it implies a voluntary relationship between equals and creates mutual obligations and rights, i.e., mutual dependencies.
- Develop a locally appropriate water allocation system with *volumetric measurement and payment* at some level. Measurement does not have to be at the level of the farm turnout, as in the CBP, but can apply to groups of farms and farmers.
- *Provide experience* with organization and management for farmers and farmer leaders. This is a central subject of the farmer organizational literature mentioned above.
- *Provide assistance* to operating agencies to improve management and human relations skills. Technically trained personnel often lack this kind of expertise which they need to work effectively in a decentralized management environment.
- Specify an *ongoing role for the operating agency* in "partnership culture" with the farmer-based organizations assuming management responsibility. Experience has shown that there often remain tasks which a public agency is better equipped to perform. Relative comparative advantage should be clearly identified and means for continued cooperation worked out.

Conclusions

From many angles, the transfer of management from the US Bureau of Reclamation to irrigation districts in the Columbia Basin Project can be considered a success on a large scale. While the Bureau was able to back out of its partly unwanted role in O&M, the districts gained local control over management and costs. This was an extended process, beginning in 1939, 13 years before water began flowing through the irrigation system, and culminating with the signing of the transfer agreements 30 years later.

The study made a concerted effort to document the hydrologic and financial results of the transfer. In general, there appears to have been little or no effect on the quality of irrigation service received by farmers. Service was of high quality before the transfer and it remained so afterwards. However, conveyance efficiency in the main

and branch canals of the three districts declined following transfer and took five or six years to recover to previous levels. This is interpreted as a learning period, during which the new managers learned to operate the system efficiently. Subsequently, a long steady decline in conveyance efficiency set in which is thought to be a result of a failure to keep up with increasing maintenance demands as the system ages. Even though system O&M expenditures held roughly constant, in real terms, before and after the transfer, an increasing number of maintenance problems were observed as time passed, suggesting that maintenance requirements were accelerating.

In the wake of the transfer in 1969, Bureau staff levels fell dramatically, and the Bureau assumed new roles as a wholesaler of water, an environmental regulator, and a water resource planner and manager. Many of the staff released by the Bureau were subsequently reemployed by the districts providing some operational continuity, but the managers of the districts were selected from outside this personnel pool.

Districts moved quickly to develop supplementary sources of income and to reduce operating expenses and water charges to district members. Supplementary income sources included investment income, power generation revenues, and sales of water to non-district members. Average water charges following transfer were only 78 percent of their level during the Bureau period. Real gross returns to irrigated agriculture have risen steadily in the CBP over the past 30 years with some indication that net returns have risen also. This trend appears unrelated to the management transfer. The fall in water assessment levels as a result of the transfer, however, appears to have increased net farm income by about 15 percent.

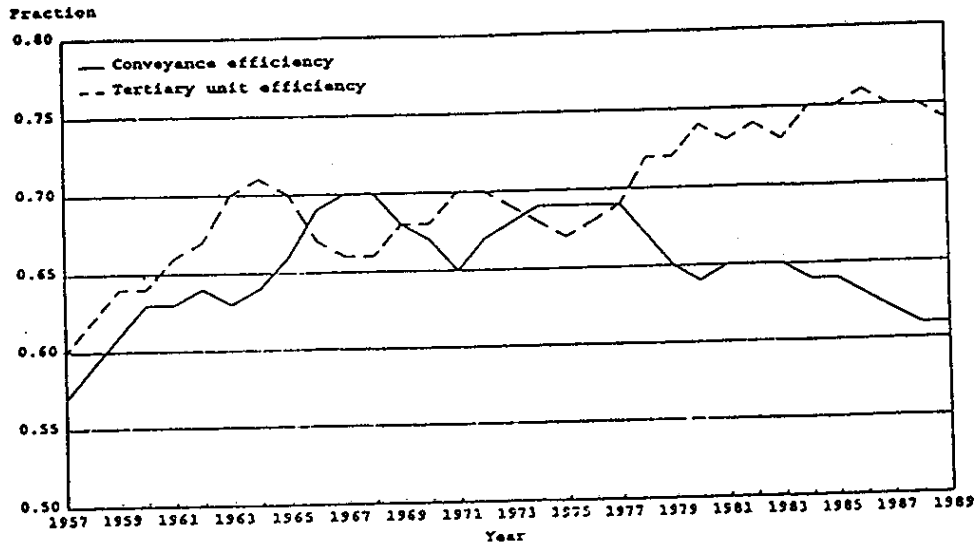
It is impressive that management of irrigation for 230,000 hectares (with approximately 7,000 landholders) can be handled by three local irrigators' organizations. Indeed this is a recurring pattern throughout the American West, even on larger scales. The King's River Irrigators' Association near Fresno, California, for example, successfully services an area more than twice as large as the CBP. A number of lessons relevant to developing country policy makers and implementers emerge from this experience. These do not comprise a prescription for change, but are factors which should receive serious consideration in planning programs involving transfer of irrigation management responsibility to farmer-based groups.

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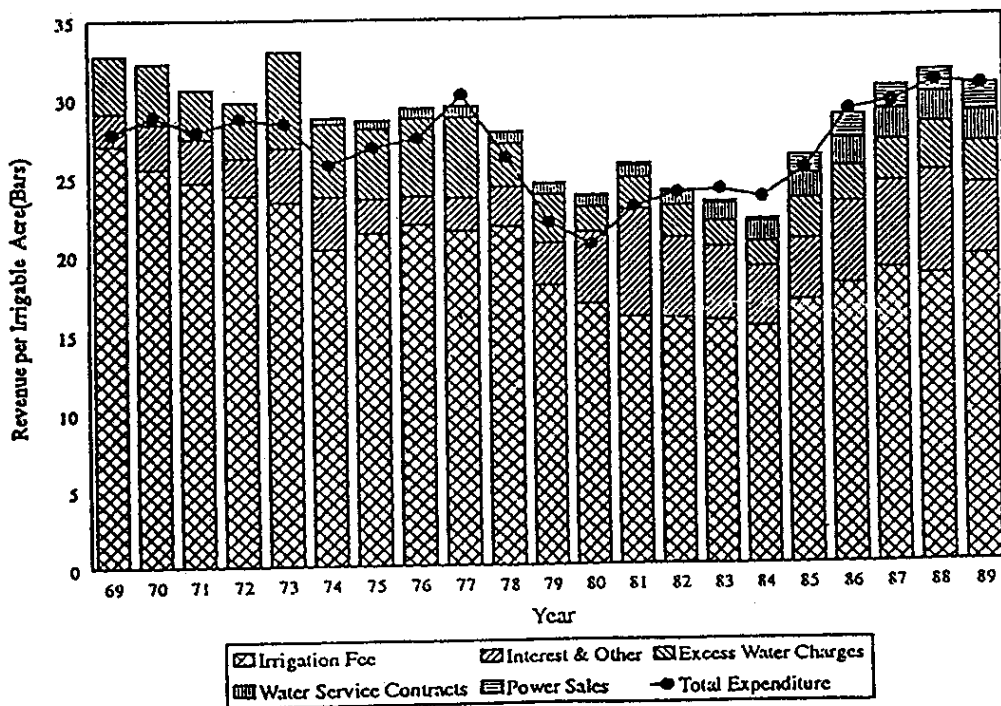
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Figure 1. Conveyance and tertiary unit efficiency for the three CBP districts, 1955-89 (3-year moving average).



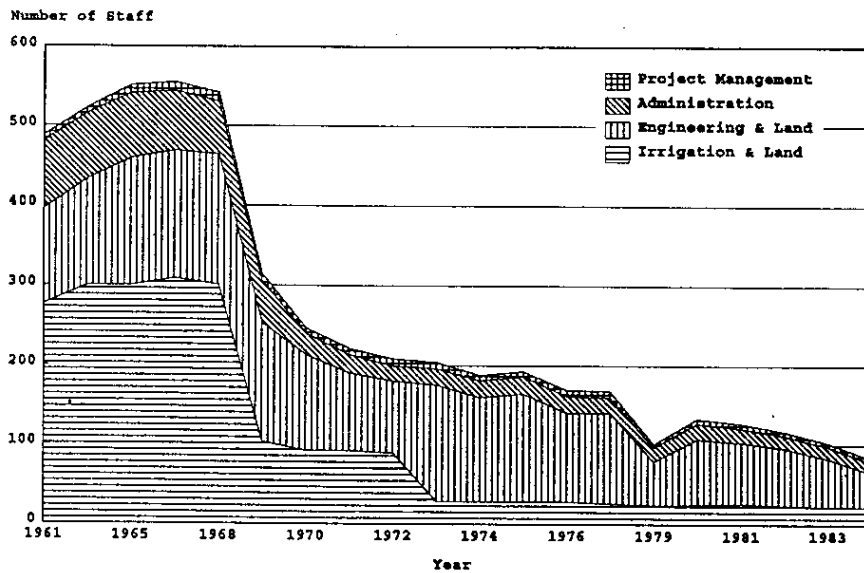
Source: Water Distribution and Crop Production Reports for the CBP, U.S. Bureau of Reclamation
 Note: Years shown on graph scale are final years in each 3-year period.

Figure 2. Revenue and expenditure per irrigated acre, the CBP, 1961-89



(Adjusted for inflation, in 1989 Dollars)

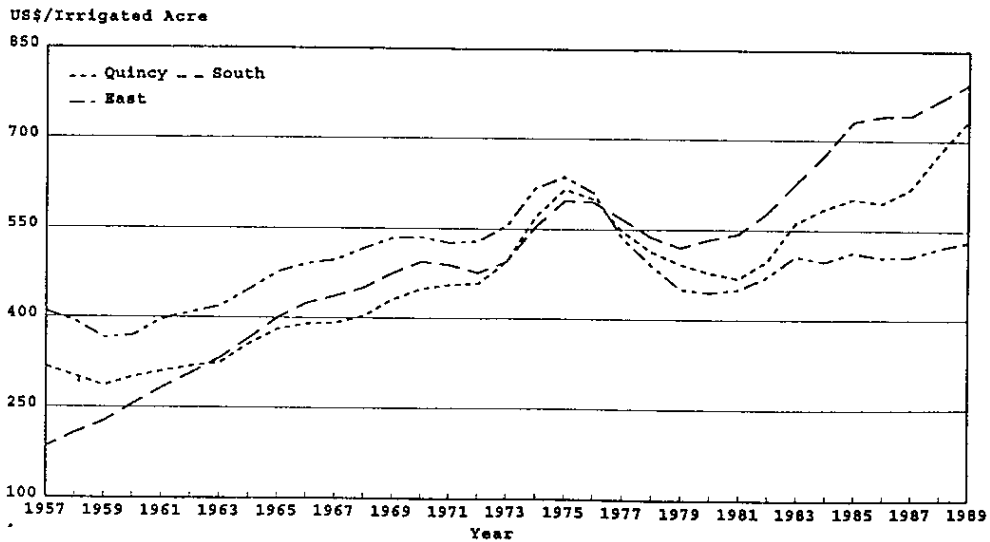
Figure 3. Number of USBR staff assigned to the CBP, by division, 1961-85.



Source: U.S. Bureau of Reclamation data.

Note: Data are missing for the years 1962, 1964, 1966, 1978 and 1984. Figure excludes Power Division which became independent in 1969.

Figure 4. Average value of total crop production per acre, the CBP, 1960-89 (3-year moving average).



Source: Crop Production Reports for the CBP, U.S. Bureau of Reclamation. President of the United States, Economic Report of the President (Washington, D.C.: U.S. Government Printing Office 1991).

Note: Prices adjusted by index of prices received by farmers in the U.S.A., (1982=100).

Map 1. The Columbia Basin Project.

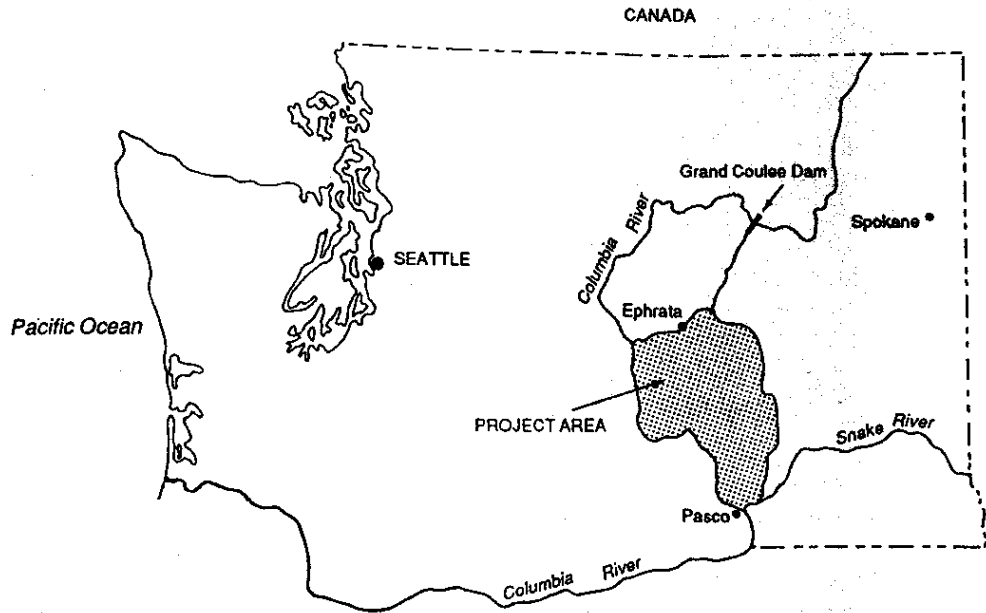


Table 1. Results of the USBR O&M audits in the three districts of the CBP.

Number of Recommendations					
Year/s	Previous Recommendations Uncompleted	Category 1	New Recommendations		
			Category 2	Category 3	Total
1973	2	0	0	0	0
1975	0	0	5	1	6
1977	3	0	0	1	1
1979-81 ^a	4	0	12	2	14
1982-84	1	0	8	2	10
1986-88	3	0	5	1	6
Total	13	0	30	7	37

Source: O&M audits, USBR, Columbia Basin Project.

Note: Category 1: Urgent remedial maintenance required; Category 2: Important preventive maintenance needed; Category 3: Less important, preventive maintenance would help improve O&M.

^aIn later years, audits were not conducted in each district during the same year.

Table 2. Share of total revenue, 5-year averages, the CBP, 1969-89.

Year	Water Assessment	Water Service Contracts	Excess Water Charges	Interest and Other Income	Power Revenue	Total
1969	0.806	0.003	0.122	0.070	0.000	1.000
1970-74	0.764	0.014	0.126	0.095	0.000	1.000
1975-79	0.778	0.033	0.116	0.075	0.000	1.000
1980-84	0.729	0.042	0.060	0.166	0.004	1.000
1985-89	0.674	0.057	0.076	0.148	0.045	1.000

Source: Data from CBP irrigation districts

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

Douglas L. Vermillion and Carlos Garces-Restrepo

SYNOPSIS

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

This chapter assesses the extent to which turnover of management to farmers in these two irrigation districts has had an impact on:

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

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

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

1. Management turnover achieved the government's objective of discontinuing subsidies and making the districts financially self-reliant for operations and maintenance. The "delegation of authority", however, did not result in full turnover of authority to the farmers associations. The agency continued to exercise partial influence over budgets and staffing. Nevertheless, after turnover the districts began a gradual process of reducing staff, while continuing virtually the same level of management intensity as before turnover. Most sample farmers felt that communications with district staff and their responsiveness to farmers had improved after turnover.
2. The districts have been only partially successful in containing costs. Staff levels have been reduced 35% since transfer. However, the cost of irrigation remained relatively constant for a decade after turnover. Coello District has been financially solvent ever since turnover, with a decreasing margin of budget surplus over time. It has also diversified its revenue sources beyond water charges. Saldaña, however, has had continuing problems balancing its budget, but made progress toward solvency with growth in revenues outpacing growth in expenditures over time. Both districts raised irrigation fees for rice over time and costs of irrigation to farmers rose in real terms--although as a percentage of the total cost of rice production, or gross value of output, the cost of irrigation dropped substantially. In Coello, financial viability has been achieved by spreading the cost of irrigation among more farmers through expansion of area, by increasing volumetric fees for rice, and by diversification of revenue sources.
3. After turnover the districts were able to expand irrigated area and sustain high levels of agricultural production while decreasing the annual average volume of water delivered. However, the study indicates

there is a moderate problem of inequitable water distribution to tail enders, which is due partly to siltation and some lack of control at the tertiary level.

4. Nineteen years after the transfer only 2% of total canal length in Coello, and 8% in Saldaña, was dysfunctional (mostly in tertiary canals). Of all water control and measurement structures only 15% in Coello and 12% in Saldaña were dysfunctional. The vast majority of dysfunctional structures were field outlet measurement structures (which were not normally used). We conclude that the districts have been able to sustain preventive maintenance so far. And owing to statements by sample farmers, we conclude that system maintenance has not yet been ill-effected by turnover. The intensive and costly maintenance investment the districts have been able to support, relative to the serious siltation problem, has been impressive.
5. However, since the government retained ownership of the scheme assets, farmers insist that the government should finance future rehabilitation and modernization. Neither association is raising a capital replacement fund. It is apparent that this arrangement is preventing the associations from achieving complete local financial sustainability. Although the systems are being well maintained until the present, this may lead to some deferred maintenance in the future.
6. After turnover, the farmers associations soon established new crop rotation and irrigation scheduling arrangements designed to permit extension of irrigated area while decreasing the average amount of water delivered per hectare. Coello district was able to substantially expand its area irrigated through steadily delivering less water per hectare and diversifying cropping. Saldaña, which had heavier soils, continued to irrigate only for rice, though it staggered planting dates in order to spread out irrigation demand over the year.
7. It is apparent that the transfer did not inhibit long-term expansion of the area irrigated or the ability of irrigated agriculture to sustain high levels of rice yields. Despite rising costs of agricultural production and a decline in crop prices, yields and area irrigated remained stable after transfer.
8. Perhaps the most important finding of the study was that increases in the gross value of output per hectare and per unit of water increased dramatically while the cost of irrigation to farmers remained roughly the same after turnover. Irrigation constituted a relatively small and declining proportion of the total cost and value of production. Improvements in economic performance after turnover can only partially be attributed to broader factors such as cultivation improvements and crop prices. After turnover new district policies to restrict rice production in sandy areas and reduce average volume of water delivered per ha. supported crop diversification and improved the value of irrigated output. Cost containment policies such as reductions in staff and cessation of flow of funds outside the schemes undoubtedly helped prevent rises in the cost of irrigation to farmers.

Irrigated Agriculture in Colombia

Colombia is a mountainous country in South America with an area of 1.1 million sq km and a population of 31.8 million people (Annex Figure 1). The country has relatively abundant water resources, including more than 1,000 perennial rivers. It has both tropical and temperate climates and an average rainfall of 1,500 mm per year. A marked bi-modal distribution in April/May and October/November makes the need for irrigation primarily supplemental (Annex Figure 2).

Coello and Saldaña irrigation districts are located in the Tolima valley in central Colombia. The valley is at an elevation of 380 meters and is surrounded by the Andes mountains. It sits between the central and west mountain ranges of the country with the large Magdalena river running through the middle of the valley. The valley has a mostly flat topography with undulating terrain towards both mountain ranges and has primarily alluvial soils, fans, terraces and narrow valleys with minor rivers. Main soil characteristics are sandy and loam in Coello and clay and loam in Saldaña. Soil erosion is evident as one moves up the hillsides but is not yet a problem in the valley floor, except that it creates a high silt load in rivers and irrigation canals. Yearly precipitation in the valley is between 1000 and 1500 mm. The median temperature is 27.90C. Average relative humidity is 74% and the yearly average tank evaporation is 1800 mm (Annex Figure 2).

Agricultural and Socio-economic Context

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

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

DEVELOPMENT OF COELLO AND SALDAÑA DISTRICTS

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

Coello Irrigation District is a river diversion system which has a lateral intake with a design capacity of 28 cubic meters per second (m^3/s). The intake consists of an approach channel formed by an earthen levee, which facilitates flow intake during low river levels in the dry season. The intake has two radial gates with provision for both sediment intake and water depth control (HIMAT, 1991a). The intake channel leads to the main conveyance canal (Gualanday) which has a capacity of 25 m^3/s and extends for 5.7 km before reaching the command area. The main canal divides into four branch canals, each of which leads to unlined secondary and tertiary canals. Field turnouts are sliding gates.

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

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

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

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

Rehabilitation of both irrigation canals and natural drains was done in Coello and Saldaña well before turnover. In Coello between 1968 and 1973, about US\$ 8.69 million (in 1988 dollars) was spent on rehabilitation. In Saldaña between 1969 and 1972, about US \$2.28 million (in 1988 dollars) was spent on irrigation and drainage works². By the time of management turnover in 1976, the systems were in good physical condition and rehabilitation was not an issue in negotiations between the government and farmers. Rehabilitation was not done in connection with turnover.

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

TURNOVER PROCESS

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

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

Negotiations for management transfer were completed within a year, between 1975 and 1976. The associations hired their own lawyer to represent them in negotiating the terms of the transfer. Issues to be resolved included the disposition of district staff, ownership status of scheme assets, and the future degree of involvement of HIMAT³ in the districts. It was finally agreed that most of the existing staff would be retained by the districts and others would be transferred out. Ownership of irrigation structures would remain with the government, although some equipment and facilities were transferred to the farmers associations. The government concluded that under existing laws it could not relinquish ownership of scheme assets. HIMAT would retain a role of oversight for district management, to ensure that the systems were properly maintained. In practice this meant HIMAT

continued to give its advice and consent for annual budgets, O&M workplans, setting water fee levels, and personnel changes. The farmer association obtained direct control over the operation and maintenance of the entire system, including the intakes..

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

The transfer process employed a legal rule in the country's constitution referred to as "Delegation of Administration," by which a public good (in this case, an irrigation district) could be turned over to a private-sector corporate entity (a water users association) for administration on behalf of the state. The users were then empowered to recruit staff and organize and manage operation and maintenance of the two systems with the proviso that it would be financially self-reliant and government subsidies for O&M would be discontinued. The delegation of administration created a continuing labor relations conflict between the districts and the government which resulted in numerous legal debates and proceedings until the 1990s. Labor laws prohibited the firing of existing staff previously hired by the government. In 1993, a new Land Development Law was enacted, intended to grant full control over irrigation district management to farmers associations. (Min. of Ag, 1993).⁴

CHANGES IN MANAGEMENT

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

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

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

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

Personnel One of the more noticeable outcomes of turnover was the significant reduction of personnel. Before transfer, in 1975, the two districts combined had a total of 300 employees. By 1993, the total staff for both districts was 189, which was a 37% reduction since transfer (Annex Table 3). Accounting for changes in area irrigated, in 1975 there were 62.3 ha of service area per district staff. By 1993 this had risen to 147 ha per staff. Most reductions were made in maintenance and technical support staff. Reductions were gradual and occurred mostly through attrition and non-replacement. Labor laws made it difficult for district managers to release unneeded government employees. Nevertheless, district board members and agency officials reported that paper work was diminished and administration became more efficient after transfer, especially in irrigation scheduling, fee processing and communications between users and district management.

Operations and Maintenance Water is allocated to farmers on the basis of area and crop type. In theory, all users who plant the same crop type receive a basic allotment and are charged area and volumetric charges based on assumed deliveries relative to per ha. targets by crop type. Before turnover, irrigation was scheduled on the basis of pre-season crop plans, modified during the season by water requests submitted by registered farmers. District management prepared irrigation schedules based on orders received from farmers. Irrigation requests were approved to the extent that predicted water availability met the aggregate demand. The user was responsible to go to the district office before the season to sign an agreement with the seasonal irrigation plan. The user was informed of the day and time of his or her irrigations and the ditchtender made an inspection of the farm to make sure that the canals, turnout and measuring device (if any) were in working condition. The ditchtender was responsible to deliver water to farm turnouts according to the agreed schedule and to record the total water delivered for the season. This system continued after turnover and was implemented mainly by the same staff as before, only thereafter they were under the hire of the farmer associations.

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

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

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

After turnover, the new district administrations introduced practices to improve irrigation efficiency and enable continued expansion of irrigated area. Attention was given to reducing staff where possible and revising cropping patterns consistent with the relative scarcity of water in the two systems. Water is more scarce in Coello. In 1993, the average target discharge or duty in Coello was 8.64 mm per day versus 15.5 mm per day in Saldaña. In Coello, annual water demand was 1,097 mm, 948 mm of which was supplied by irrigation. In Saldaña, annual water demand was 1,318 mm, which was exceeded by an annual irrigation water supply of 1,517 mm. During the same year, relative water supply (i.e., ratio of total supply--including effective rainfall to demand, calculated at the secondary canal level) was 1.4 in Coello and 1.75 in Saldaña (Annex Tables 4 and 5). Coello has a relatively scarcer water supply in other years as well.

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

Organization After turnover, the general assemblies of the farmer associations for Coello and Saldaña Districts elected boards of directors to supervise their districts. Each board had, and still has, seven members with fixed quotas for two categories of farmers--four members having farm sizes less than 20 ha⁵ and three with farm sizes of more than 20 ha. Each is elected in a general assembly every two years. The board recruits and selects the general manager and participates with the general manager in the selection and releasing of other district staff.

After transfer each board recruited general managers who were engineers. The districts then became responsible for day-to-day operation and maintenance of the systems. The reduction in personnel allowed management to streamline the organizational structure by combining sections and integrating functions. In both districts, the general manager supervises an administrative unit and three technical units--operations, maintenance and technical services (see Annex Figure 3).

MANAGEMENT PERFORMANCE AFTER TURNOVER

Through management turnover, farmers hoped to enhance the cost efficiency and quality of operations and maintenance, without sacrificing the agricultural productivity and financial and physical sustainability of the districts. Performance of the districts is assessed according to these criteria. The government's main interest was to reduce its own recurrent costs of irrigation without sacrificing agricultural productivity of irrigated agriculture.

Impacts on Government

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

Financial Viability

After transfer, the farmers' irrigation policy was essentially to balance the budget, contain the cost of management and achieve a more responsive irrigation service. This was only partially successful. Data on Coello indicates that the farmer districts were fiscally responsible in the sense that expenditures never exceeded revenues after transfer occurred. Figure 1 shows the changing patterns of revenue and expenditures before and after turnover. During the initial stages of scheme development, expenditures exceeded revenues, partially because of external subsidies and development assistance. The early drop in revenue and expenditures was due to the transition from scheme development to scheme management.

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

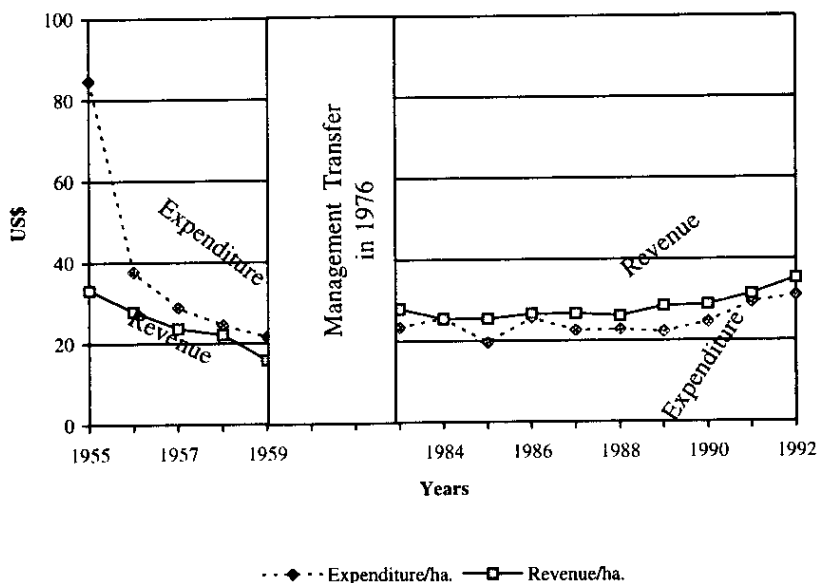
(Annex Table 5). "Sideline" revenue sources--such as rental of farm equipment and district property, technical services, fines against members, sale of materials and charges for transporting equipment and materials--increased from about 10% to 20% of revenue between 1983 and 1992 (Annex Figure 5). Before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

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

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

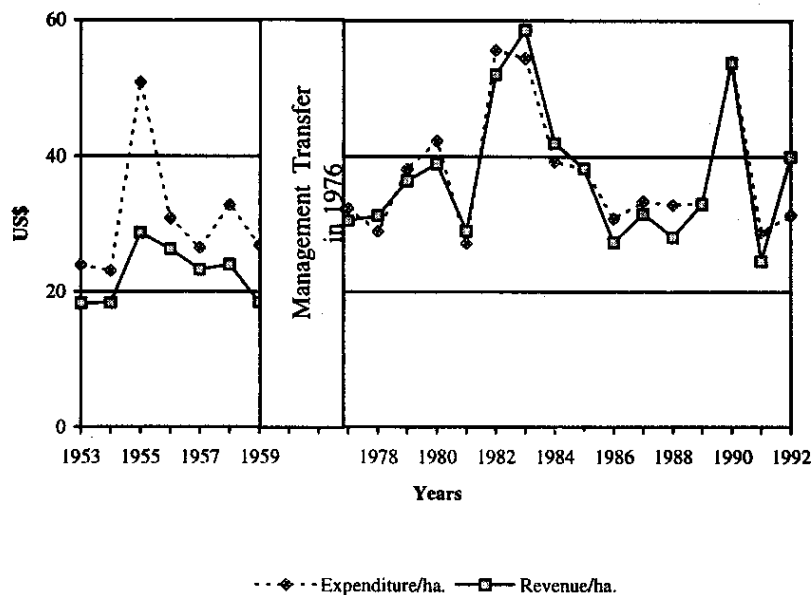
Both districts improved their financial positions after turnover, although from opposite directions. Coello reduced its surplus and enhanced efficiency; Saldaña diminished its pattern of deficits.

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



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

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



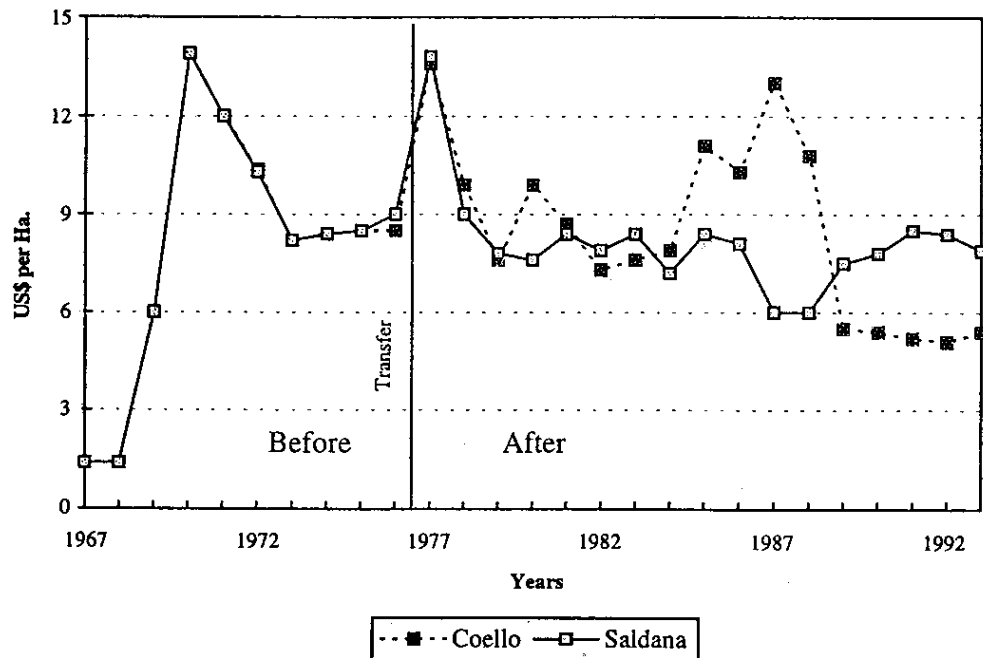
* In constant 1988 US Dollars. 1988 exchange rate was 333 Colombian Pesos per US Dollar. In April 1994, exchange rate was 820 Colombian Pesos per US Dollar.

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

In Saldaña both area and volumetric fees for rice are higher than in Coello. In Saldaña the area-based fee dropped only slightly after transfer, from US\$ 9.00 per ha at transfer to US\$ 7.96 per ha in 1993 (Figure 3). The volumetric fee rose from 13 cents (US) at transfer to 18 cents (US) per 100 m^3 in 1993 (Figure 4). The difference in the cost of water between Coello and Saldaña may be due to the fact that Saldaña has a serious problem of siltation in the intake canal and continuously employs costly floating drag lines on boats to desilt the canal year round. The most significant finding from Figures 3 and 4 is that trends in both fees reversed directions at the time of transfer. Volumetric fees rose for two reasons: 1) the need for revenue to be linked to rising operating costs and 2) board policy to discourage rice production and encourage crop diversification, reduce allocation of water per ha and encourage expansion of irrigated area.⁷

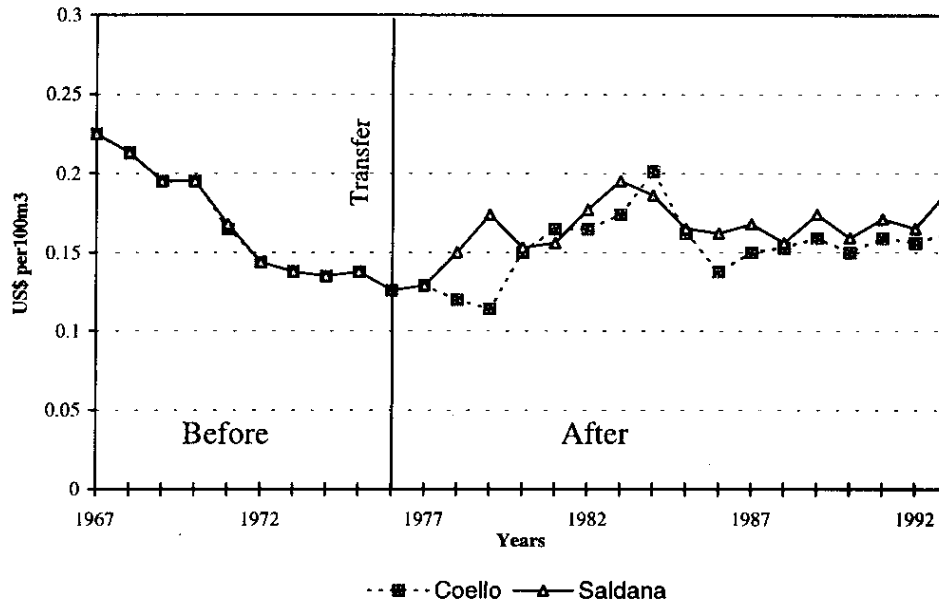
The rising area fee reversed to a long term decline, while the volumetric fee reversed from a decline to a long term rise after transfer. Farmer boards in both districts preferred to charge farmers more on the basis of volume of water used than by the flat area rate.

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



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

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



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

The total amount of area and volumetric fees collected in Coello District between 1983 and 1992 (for all crops) was \$ 75,990 in 1983 and \$ 92,041 in 1992 (in 1988 US\$). Taking into account changes in annual net area

irrigated, this means the actual cost of irrigation to farmers declined 13% from \$ 6.63 per ha. in 1983 to \$ 5.74 in 1992 (1988 US\$; Annex Table 7).

Physical Sustainability

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

To answer this question complete surveys of all canals and structures were conducted in 1994 in each district⁸. The survey classified canal sections as either fully functional, partially functional, or dysfunctional. Criteria are distinguished primarily according to the extent to which original hydraulic design conditions are supported. Partially functional canal sections still have at least 70% design capacity; dysfunctional sections have less than 70% design capacity.

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

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

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

In 1984 HIMAT, in agreement with the users, conducted feasibility studies on modest rehabilitation and system expansion in both Coello and Saldaña. Some portions of the canal and road networks had deteriorated and were in need of repair. Drainage improvement was needed in Saldaña and a supplemental feeder canal was planned for Coello. Farmers in Coello agreed to pay 90% of the cost of the feeder canal while farmers in Saldaña refused to pay any of the cost of the rehabilitation. Construction is underway in Coello but not in Saldaña⁹.

Irrigation Operations

There is no indication that the operational performance of the Coello or Saldaña systems changed significantly as a result of turnover. Water continues to be delivered without being measured below main canal offtakes. In Coello average annual discharge at the intake varied from 14 cubic meters per second (m^3/s) in 1977 to 16 m^3/s in 1993, with an average fluctuation between minimum and maximum discharge levels of 4 m^3/s (Annex Figure 8). Average annual water supply has not declined over time, but has shown a slight rise. Historical data on discharge at the intake was not available for Saldaña.

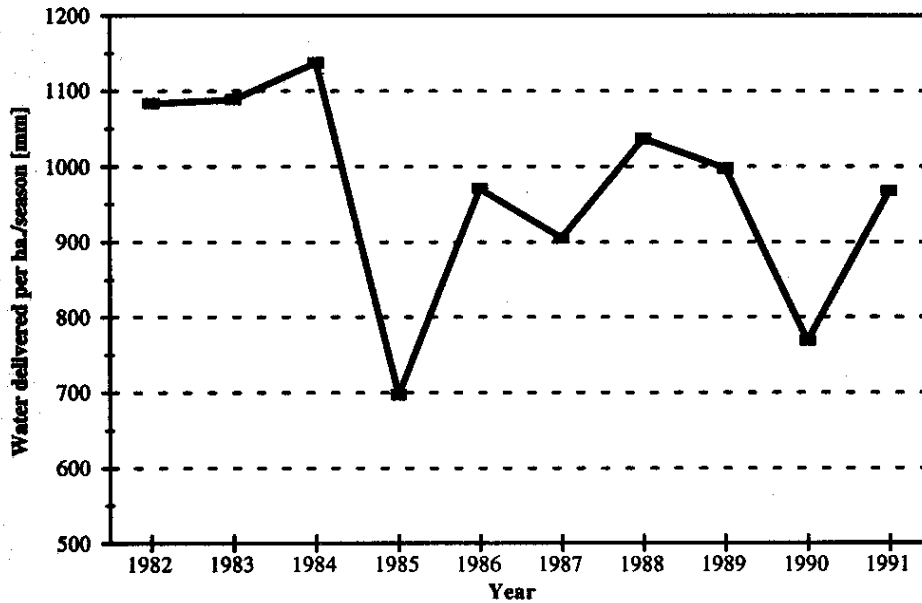
Comparison of data from 1982 to 1993 of the annual volume of water diverted at the headworks with the aggregate amount of water delivered to all tertiary canals, provides a measure of what is termed herein, "total conveyance efficiency" (Annex Figure 9). Annual average measures of total conveyance efficiency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

As a simple effort to assess equity of water distribution along tertiary canals, a field check was made on July 15, 1993 comparing actual and target discharges into farm outlets along a tertiary canal located at the Florencia Secondary Canal in Saldaña District. The ratio between actual and target discharges is termed the Delivery Performance Ratio, or DPR. From the first outlet at the headend to the 18th outlet at the tail, the DPR exhibited a clear downward trend from head to tail, ranging from 260% at the head to 75% at the tail (Annex Figure 10). One such test can not verify a pattern but it does suggest a distribution problem may exist in Saldaña at the tertiary level¹⁰. The distribution arrangement at the time of inspection was continuous flow.

We have noted above the stable or slightly rising trend in annual average discharge at the intake in Coello between 1977 and 1993. Annex Figure 11 shows that the annual water supply delivered for the rice crop rose 25% from about 2,000 mm/ha in 1977 to about 2,500 mm/ha in 1991. However, Figure 5 shows a decline in the overall average annual volume of water delivered per hectare of 12%, from approximately 1,100 mm per season in 1982 to 970 mm in 1991. This was influenced by two basic changes in irrigated agriculture in Coello.

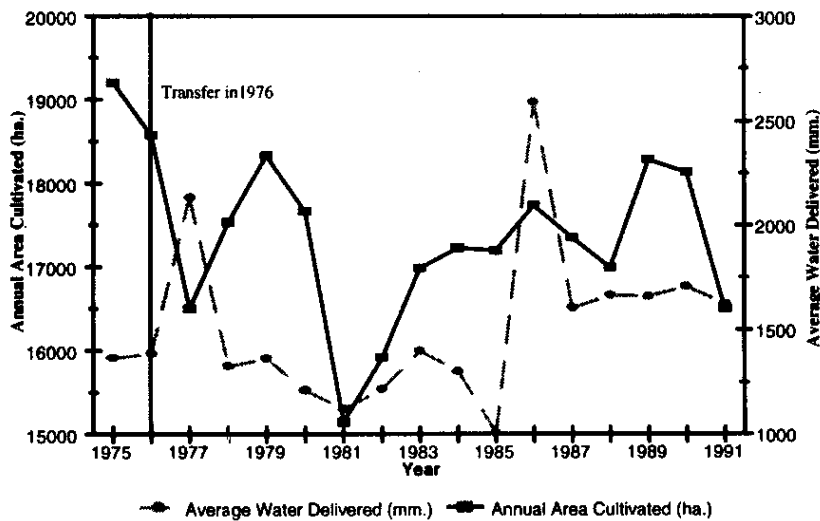
The first is the increase in gross annual irrigated area (total for two seasons) from approximately 21,000 ha in 1977 to between 27,000 and 37,000 ha in the latter 1980s and early 1990s (Annex Figure 12). The second was the shift away from rice monocropping to crop rotation as administered by the district. After transfer the districts excluded sandy area from rice production¹¹. This permitted rice to be grown only once per year and led to an expansion of area planted in cotton, sorghum, soybean and other non-rice crops. The area planted in rice was about 19,200 ha in 1975, the year before turnover. It dropped to about 16,450 ha by 1991, a drop of 14% in area (Figure 6).

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



* Per season average

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



* Per season average

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

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

In short, operational and maintenance problems appear to be more prevalent at the tertiary and distributary level than in the main system, as indicated by the maintenance survey, DPR analysis and farmer perceptions. While the problems do not appear to be severe, there is clearly room for improvement.

Agricultural Productivity

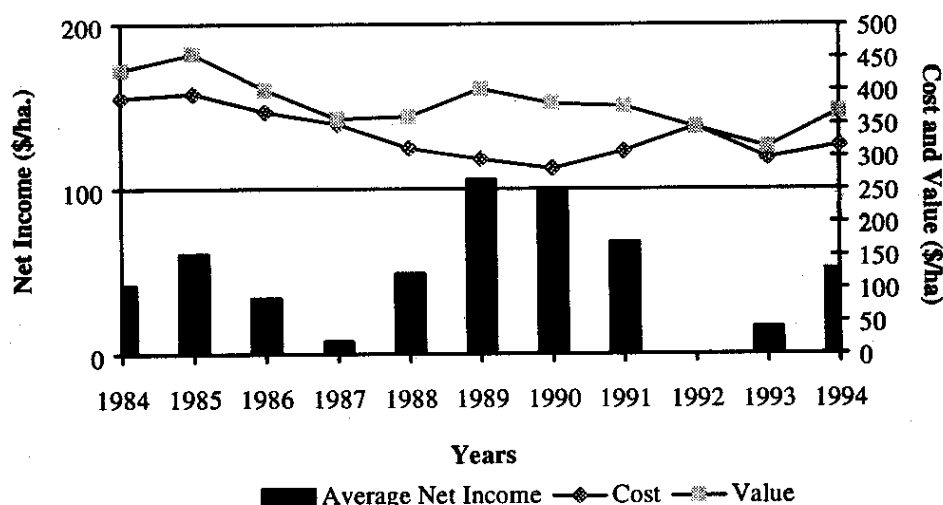
The gradual expansion of irrigated area after construction halted for about four years at the time of turnover, perhaps because of uncertainties and inefficiencies temporarily created by the change in management. But the expansion resumed after this apparent learning period and only began leveling off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

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

Largely as a result of the introduction of green revolution varieties in the 1960s and 1970s, average rice yields increased dramatically from approximately 2,500 kgs in the mid 1950s to approximately 6,000 kgs in 1976, at the time of transfer (Annex Figure 15). By the 1990s average rice yields were between 6,500 and 7,000 kgs per ha. Most of the increase in yields occurred before transfer, but high yield levels were sustained afterwards through the early 1990s, with a slightly increasing trend. We conclude that the transfer did not have any noticeable detrimental impact on yields.

Both the cost and value of rice production declined moderately during the eleven-year period from 1984 to 1994. The cost declined from about US \$380/ha in 1984 to about \$320/ha in 1994 (in constant 1988 dollars; Figure 7). Average net income for rice production varied widely from zero to about \$105/ per ha. during the period, peaking in 1989 and falling to about \$45 per ha in 1994.

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



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

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

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

Coello District also achieved impressive gains in gross value of output per unit of water, which increased 298%, from \$ 2.35 per 100m³ in 1983 to \$ 9.35 per 100m³ in 1991 (Figure 8 and Annex Table 10).¹³ This reflects the gain in output relative to water resulting from crop diversification and this intensification brought on by the "green revolution."

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

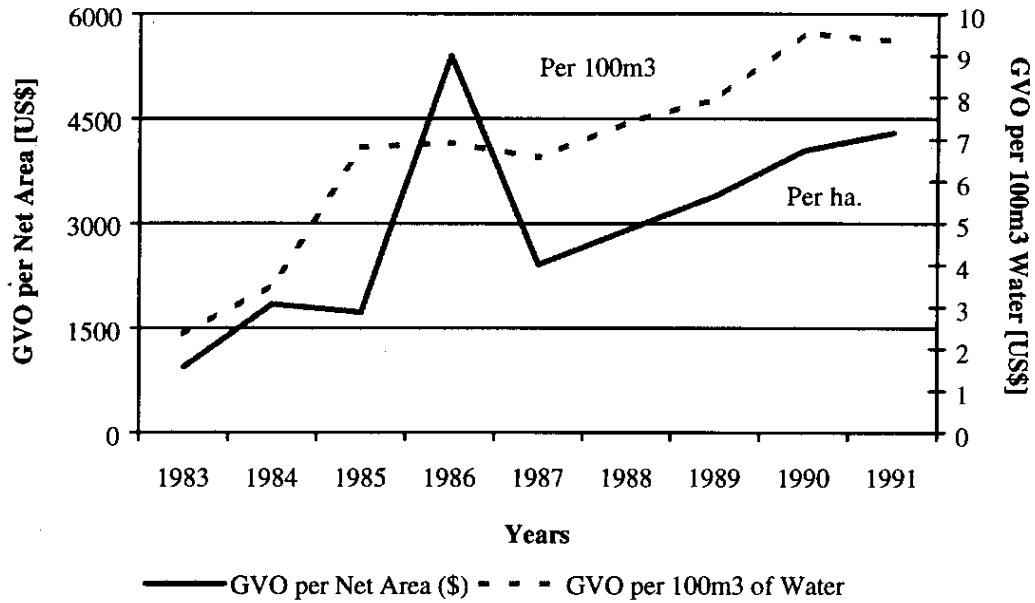
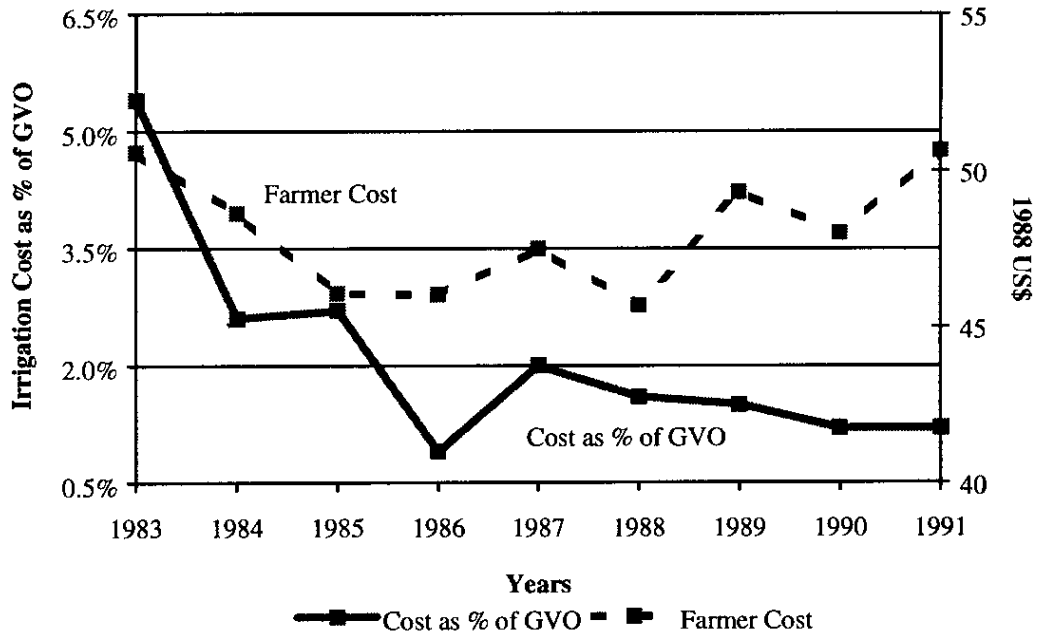


Figure 9. Cost of irrigation per ha. to farmers and irrigation cost as a percentage of gross value of output (GVO), Coello District, 1983-1991 (1988 US\$)



PERSPECTIVES OF STAKEHOLDERS

Farmers

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

Role of government In 1976, farmers agreed that HIMAT should continue to provide oversight and advice to the farmers associations about management of the districts. But it soon became apparent that HIMAT's role in the districts after turnover was more than just "oversight." Many farmers saw HIMAT as restricting their ability to further reduce staff and budgets, as the associations had wanted. Therefore, farmers perceived the transfer as being only partial and not enough to give them full control.

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

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

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

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

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

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

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

Impacts on operations Sample farmers were asked the question, "Over the last two years was the irrigation water delivered to your farm always enough for your crop water requirement, enough most of the time, not enough most of the time, or never enough?" In Coello, 45% said it was always enough and 32% said it was enough most of the time. Only 20% said it was not enough most of the time and 2% said it was never enough. In Saldaña, 59% said water was always enough and 31% said it was enough most of the time. Only 4% said it was not enough most of the time and 2% said it was never enough. In Coello, a surprising 96% said water was delivered to their field on time all or most of the time. In Saldaña, 90% said water was delivered on time all or most of the time. This question did not address the issue of change, but it did demonstrate a widespread satisfaction exists among farmers about water distribution after turnover.

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

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

District Staff

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

Agency Staff

At first, HIMAT staff at the district and higher levels were generally resistant to the transfer. They perceived that jobs would be lost and the role and power of the agency would diminish as a result of management turnover, first in Coello and Saldaña, and eventually elsewhere as well. For several years after turnover the agency pressured the farmers associations in Coello and Saldaña against releasing staff and reducing budgets. This resulted in law suits between the farmers and the agency, mainly over the issue of releasing staff. After the new Land Development Law of 1993, the government granted full authority over district staff and budgets to farmer associations.

CONCLUSION

Perception

Most farmers see turnover as having produced a more responsive and cost efficient management. Most, however, favor a continuing limited role for the agency, primarily in providing technical advice and in helping with dispute resolution. The majority believe that the association should own the irrigation infrastructure. However, most farmers appear satisfied with the performance of operations and maintenance. Many believe that management

performance, especially cost efficiency, would have improved even more had the users been granted full control over staff and budgets after turnover. Board members perceived that the partial turnover brought only partial benefits.

Professional staff in the districts are less sanguine about the results, expressing concern that cost cutting measures are compromising the quality of operations and maintenance. The agency was concerned about the implications of turnover on agency staff and budgets.

Main Results

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

1. Management turnover achieved the government's objective of discontinuing subsidies and making the districts financially self-reliant for operations and maintenance. The "delegation of authority", however, did not result in full turnover of authority to the farmers associations. The agency continued to exercise partial influence over budgets and staffing. Nevertheless, after turnover the districts began a gradual process of reducing staff, while continuing virtually the same level of management intensity as before turnover. Most sample farmers felt that communications with district staff and their responsiveness to farmers had improved after turnover.
2. The districts have been only partially successful in containing costs. Staff levels have been reduced 35% since transfer. However, the cost of irrigation remained relatively constant for a decade after turnover. Coello District has been financially solvent ever since turnover, with a decreasing margin of budget surplus over time. It has also diversified its revenue sources beyond water charges. Saldaña, however, has had continuing problems balancing its budget, but made progress toward solvency with growth in revenues outpacing growth in expenditures over time. Both districts raised irrigation fees for rice over time and costs of irrigation to farmers rose in real terms--although as a percentage of the total cost of rice production, or gross value of output, the cost of irrigation dropped substantially. In Coello, financial viability has been achieved by spreading the cost of irrigation among more farmers through expansion of area, by increasing volumetric fees for rice, and by diversification of revenue sources.
3. After turnover the districts were able to expand irrigated area and sustain high levels of agricultural production while decreasing the annual average volume of water delivered. However, the study indicates there is a moderate problem of inequitable water distribution to tail enders, which is due partly to siltation and some lack of control at the tertiary level.
4. Nineteen years after the transfer only 2% of total canal length in Coello, and 8% in Saldaña, was dysfunctional (mostly in tertiary canals). Of all water control and measurement structures only 15% in Coello and 12% in Saldaña were dysfunctional. The vast majority of dysfunctional structures were field outlet measurement structures (which were not normally used). We conclude that the districts have been able to sustain preventive maintenance so far. And owing to statements by sample farmers, we conclude that system maintenance has not yet been ill-effected by turnover. The intensive and costly maintenance investment the districts have been able to support, relative to the serious siltation problem, has been impressive.
5. However, since the government retained ownership of the scheme assets, farmers insist that the government should finance future rehabilitation and modernization. Neither association is raising a capital replacement fund. It is apparent that this arrangement is preventing the associations from achieving complete local

financial sustainability. Although the systems are being well maintained until the present, this may lead to some deferred maintenance in the future.

6. After turnover, the farmers associations soon established new crop rotation and irrigation scheduling arrangements designed to permit extension of irrigated area while decreasing the average amount of water delivered per hectare. Coello district was able to substantially expand its area irrigated through steadily delivering less water per hectare and diversifying cropping. Saldaña, which had heavier soils, continued to irrigate only for rice, though it staggered planting dates in order to spread out irrigation demand over the year.
7. It is apparent that the transfer did not inhibit long-term expansion of the area irrigated or the ability of irrigated agriculture to sustain high levels of rice yields. Despite rising costs of agricultural production and a decline in crop prices, yields and area irrigated remained stable after transfer.
8. Perhaps the most important finding of the study was that increases in the gross value of output per hectare and per unit of water increased dramatically while the cost of irrigation to farmers remained roughly the same after turnover. Irrigation constituted a relatively small and declining proportion of the total cost and value of production. Improvements in economic performance after turnover can only partially be attributed to broader factors such as cultivation improvements and crop prices. After turnover new district policies to restrict rice production in sandy areas and reduce average volume of water delivered per ha. supported crop diversification and improved the value of irrigated output. Cost containment policies such as reductions in staff and cessation of flow of funds outside the schemes undoubtedly helped prevent rises in the cost of irrigation to farmers.

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END NOTES

¹ This study was conducted during 1993-1995. It involved analysis of data from the records of the two irrigation districts, group and individual interviews with farmers, district management staff, board members and agency staff. The study sampled 93 randomly-selected farmers, 44 in Coello and 49 in Saldaña. IIMI is grateful to INAT for its support for this study. IIMI gratefully acknowledges the financial support for this research from the Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ) of the Government of Germany and the Ford Foundation.

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

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

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

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

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

⁷ It should be noted that fee structure differs by crop and by whether farmers are classified as "small" (< 20 ha.) or "large." The rate is higher for larger farms. The fee for rice for small farmers is used herein as this has been an important crop in both systems. 76% of all farmers are "small holders" in Coello; 90% are "smallholders" in Saldaña.

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

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

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

¹¹ Prior to transfer some sandy areas were reportedly receiving up to as much as 30,000m³/ha./year water supply for rice production. After transfer that water was reallocated for area expansion and for heavy soil areas that were not receiving enough water before transfer.

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

¹³ Unfortunately, similar data was not available for Saldaña.

ANNEXES

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

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

Annex Table 2. Basic information, Coello and Saldaña Districts

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

Annex Table 3.

Staff levels before and after transfer, Coello and Saldaña Districts, 1975 and 1993

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

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

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

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

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

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

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

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

Year	Coello District		Saldaña District	
	Total Revenue	Total Expenditure	Total Revenue	Total Expenditure
1983	756,760	633,930	715,920	664,560
1984	705,710	711,410	700,900	655,560
1985	860,060	660,660	842,940	842,940
1986	855,260	825,530	578,380	652,550
1987	936,640	791,890	657,360	695,8,00
1988	936,040	795,200	647,150	757,360
1989	1,054,650	822,220	733,930	737,540
1990	1,063,060	904,200	711,410	713,210
1991	1,014,950	948,050	624,320	730,930
1992	1,086,790	955,260	923,420	725,230
% Change	+44%	+51%	+29%	+20%

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

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

Year	Fixed Charge Paid	Volumetric Charge Paid	Total Water Charge Paid	Total Water Charge Paid (1988 US\$)	Net Irrigated Area (ha.)	Cost to farmers per ha. (1988 US\$)
	<i>In million 1988 US \$</i>					
1983	246,246	439,039	685,285	685,285	13,550	50.57
1984	259,459	414,830	675,375	675,375	13,890	48.62
1985	292,793	486,786	779,579	779,580	16,925	46.06
1986	281,081	458,258	739,339	739,339	16,070	46.01
1987	342,643	491,591	834,234	834,234	17,565	47.49
1988	342,642	494,294	817,417	817,417	17,900	45.67
1989	330,330	584,384	914,714	914,715	18,550	49.31
1990	306,306	577,177	883,483	883,483	18,410	47.99
1991	319,219	496,996	816,216	816,216	16,120	50.63
1992	309,909	520,120	830,030	830,030	15,410	53.86

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

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

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

Maintenance condition:

Fully functional: Original hydraulic design conditions are intact, including canal capacity, bed slope, slide slopes and freeboard. Any canal erosion, breaches, cave-ins, siltation or weeds are not significant enough to noticeably interfere with operational objectives.

Partially functional: Original design conditions are compromised by some deterioration in bed slopes, side slopes, freeboard etc., although operational capacity is still at least 70% of original design.

Dysfunctional: Operational capacity is below 70% of design capacity. Major rehabilitation is needed.

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

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

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

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

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

**** Flume-type measuring structure.

Maintenance condition:

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

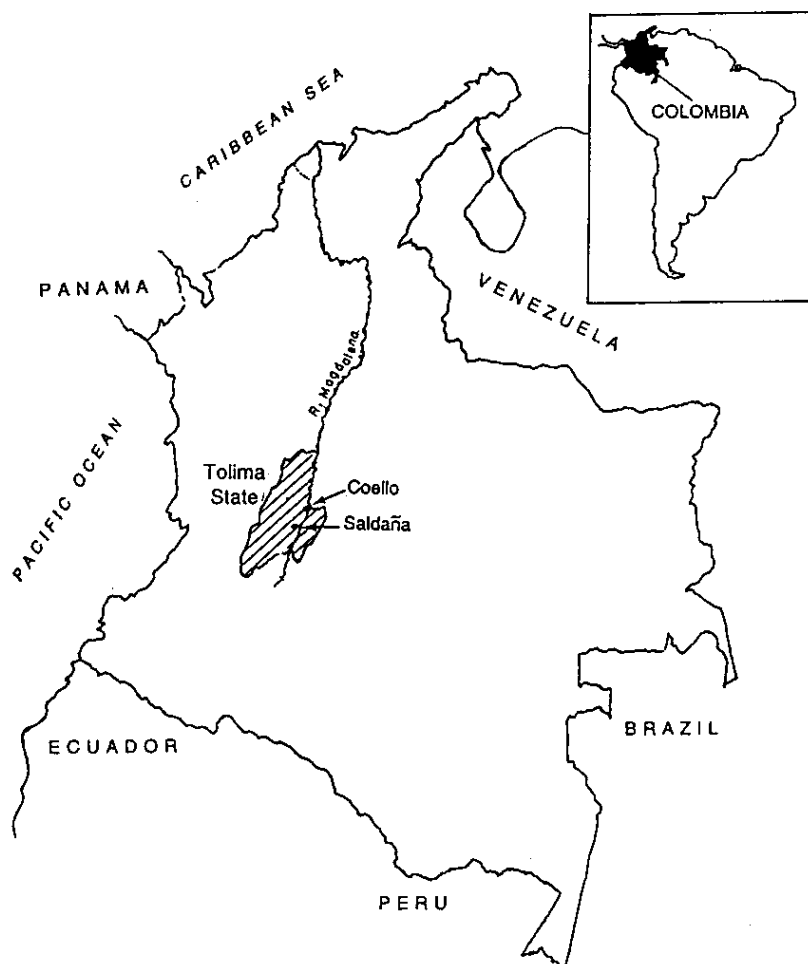
Partially functional: Some deterioration is evident; minor components missing; requires minor maintenance [painting, grease]; still functions with 15% of design requirement.

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

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

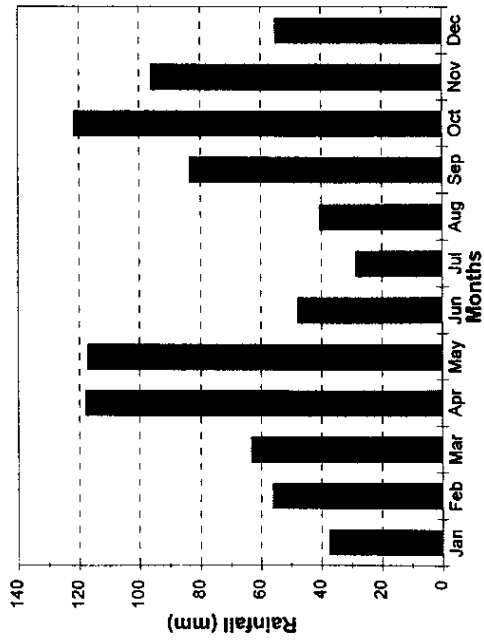
Year	Irrigation Cost per Ha. [US\$]	GVO per Ha. [US\$]	GVO per 100m ³ Water	Irrigation Cost as % of GVO
1983	50.57	944	2.35	5.4%
1984	48.62	1,844	3.53	2.6%
1985	46.06	1,722	6.81	2.7%
1986	46.01	5,394	6.92	0.9%
1987	47.49	2,410	6.57	2.0%
1988	45.67	2,909	7.41	1.6%
1989	49.31	3,391	7.96	1.5%
1990	47.99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

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

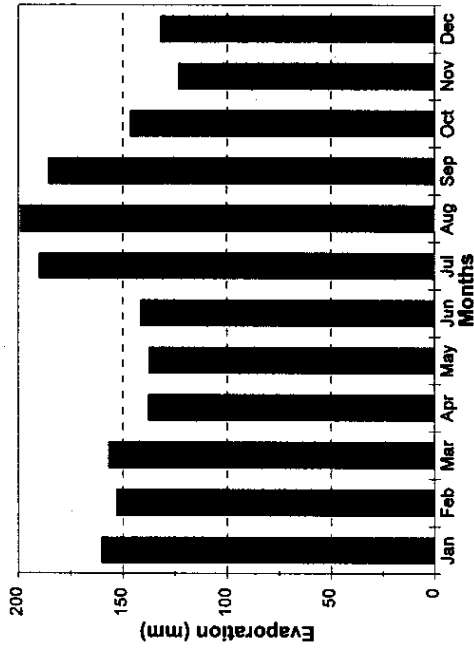


Annex Figure 2. Climatic data for Tolima Valley, Colombia

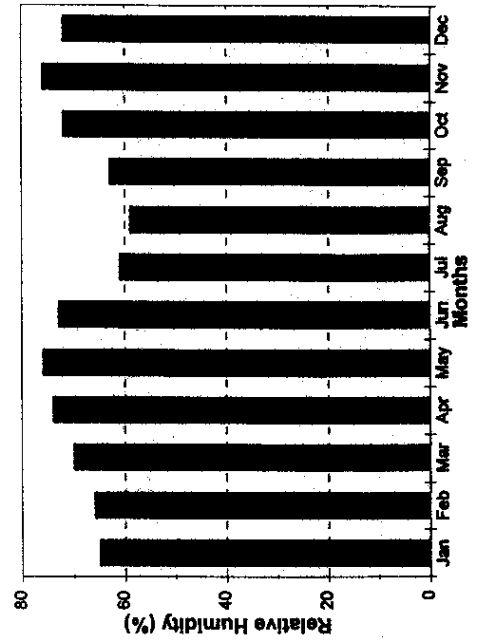
Average monthly rainfall - 1962-1992
(1976 data not available)



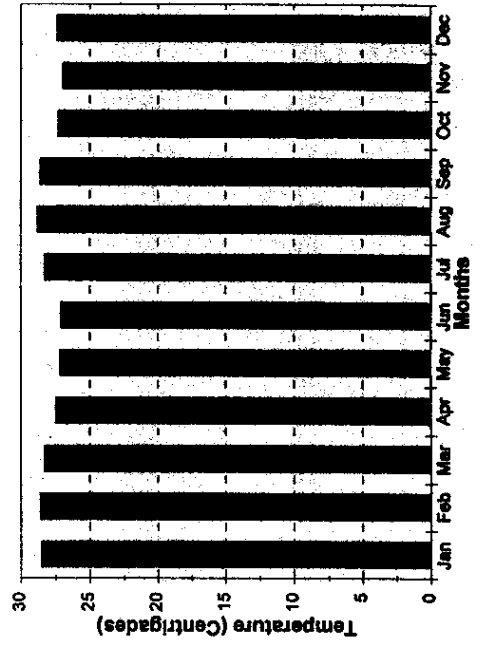
Average monthly evapotranspiration - 1971-1981



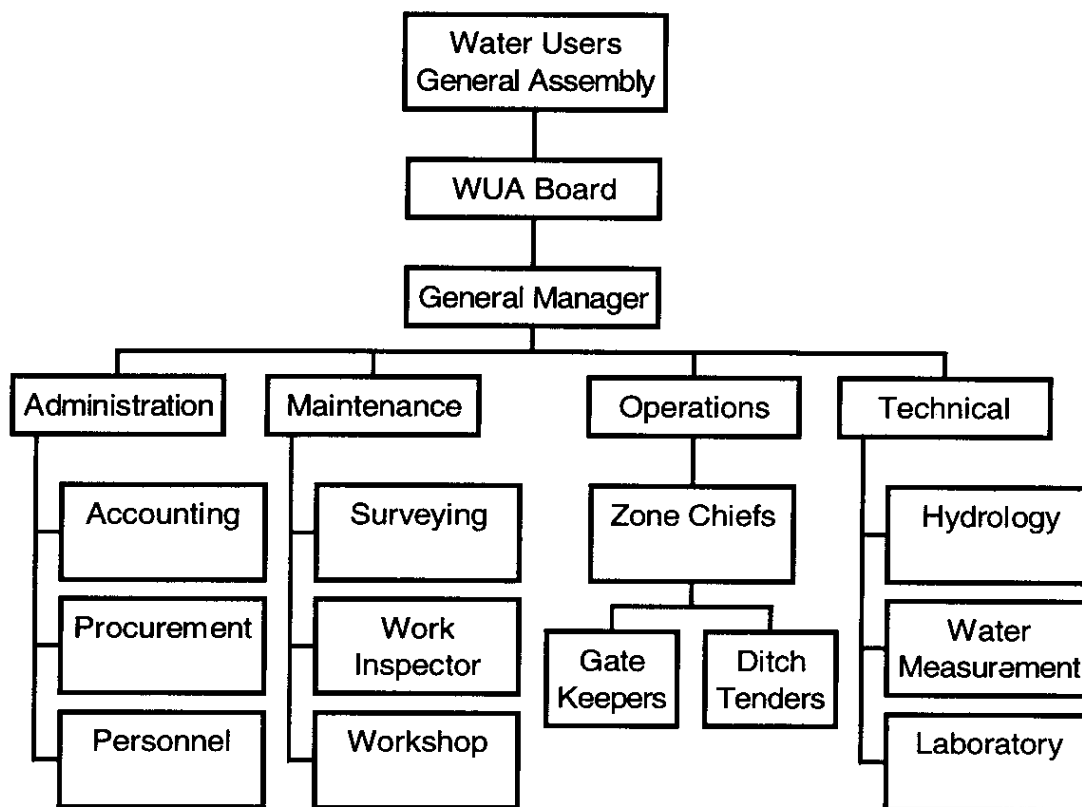
Average monthly relative humidity - 1971-1981



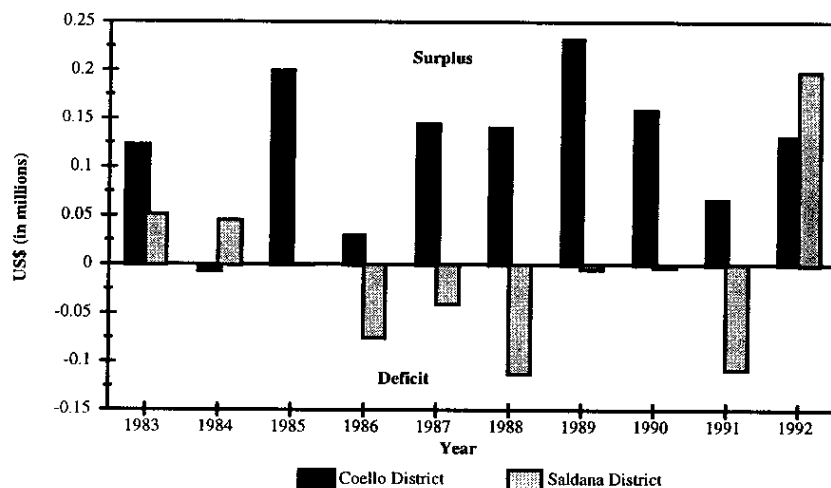
Average monthly temperature - 1971-1981



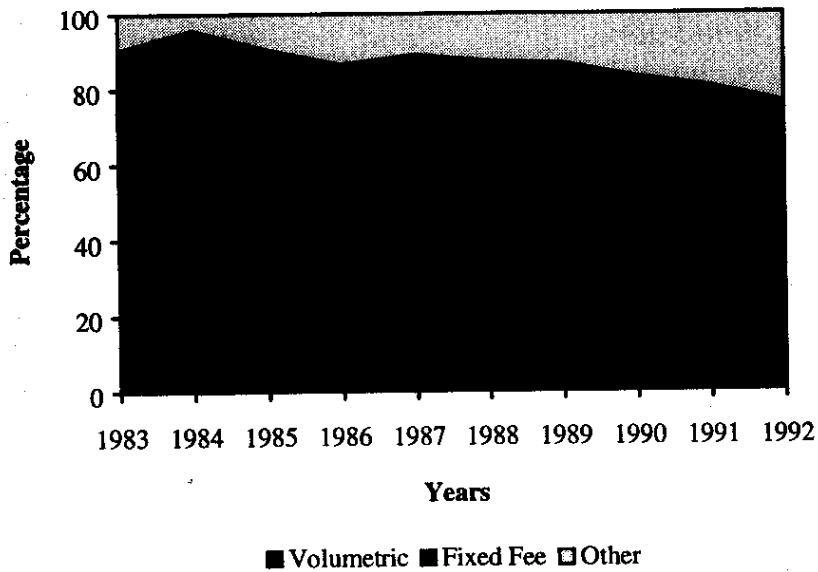
Annex Figure 3. Organizational structure, Coello District



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

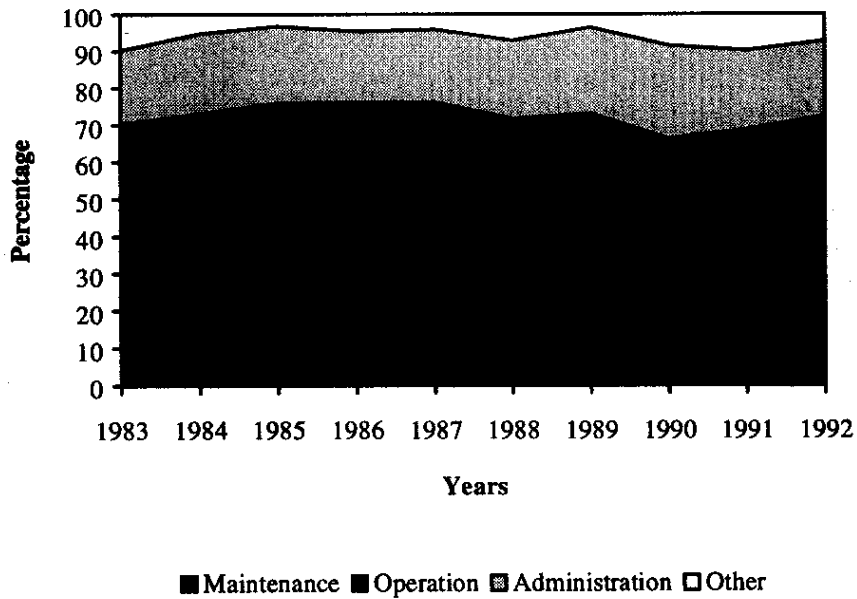


Annex Figure 5. Revenue sources, Coello District*



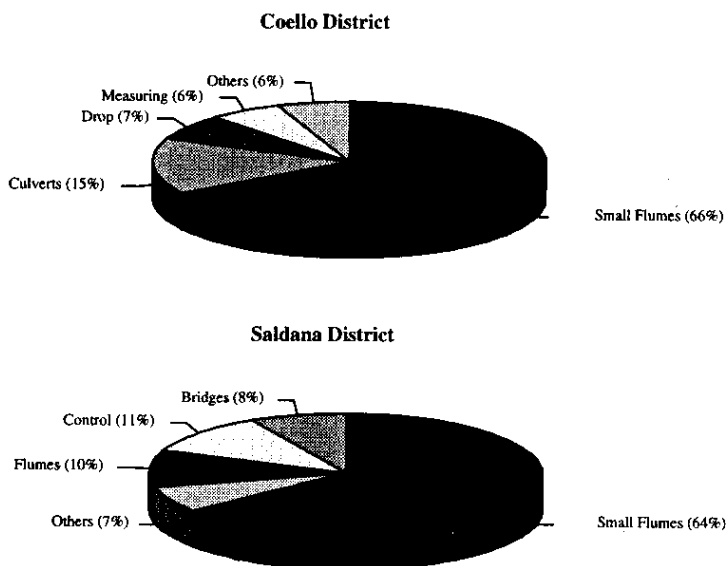
* In constant 1988 Colombian Pesos, 1983-1992

Annex Figure 6. Types of expenditures, Coello District*



* In constant 1988 Colombian Pesos, 1983-1992

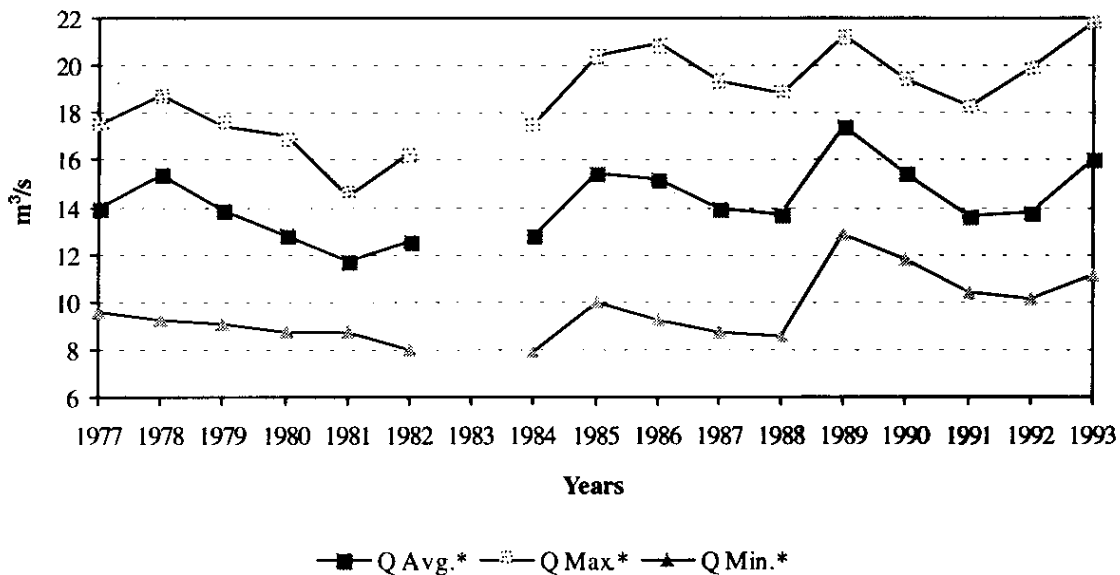
Annex Figure 7. Composition of dysfunctional structures*



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

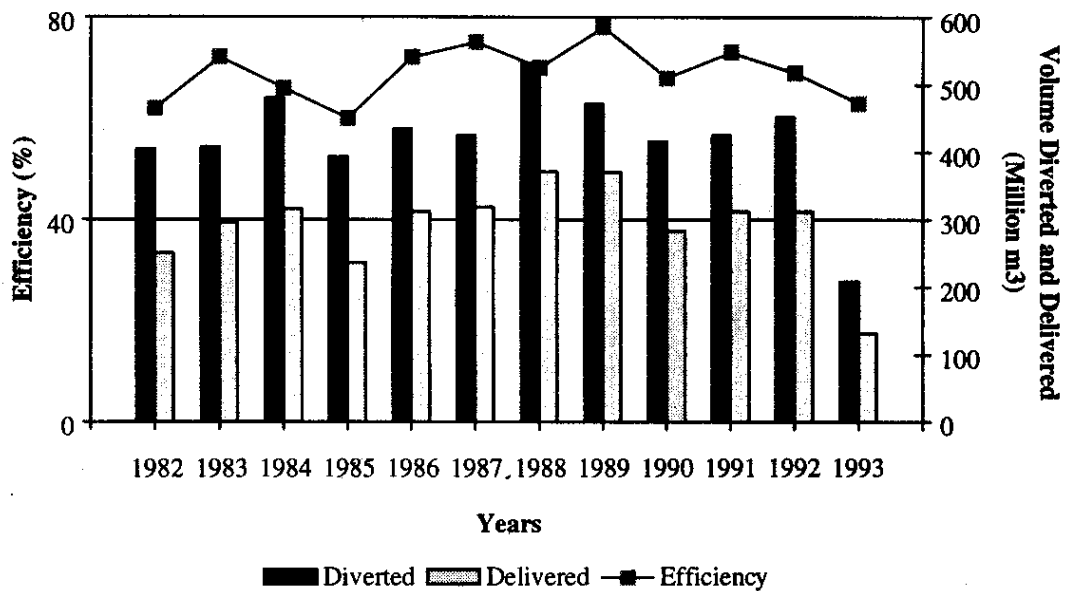
"Dysfunctional" is defined as: heavy deterioration; broken damaged or missing components; is not functional within 70% of design requirement.

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



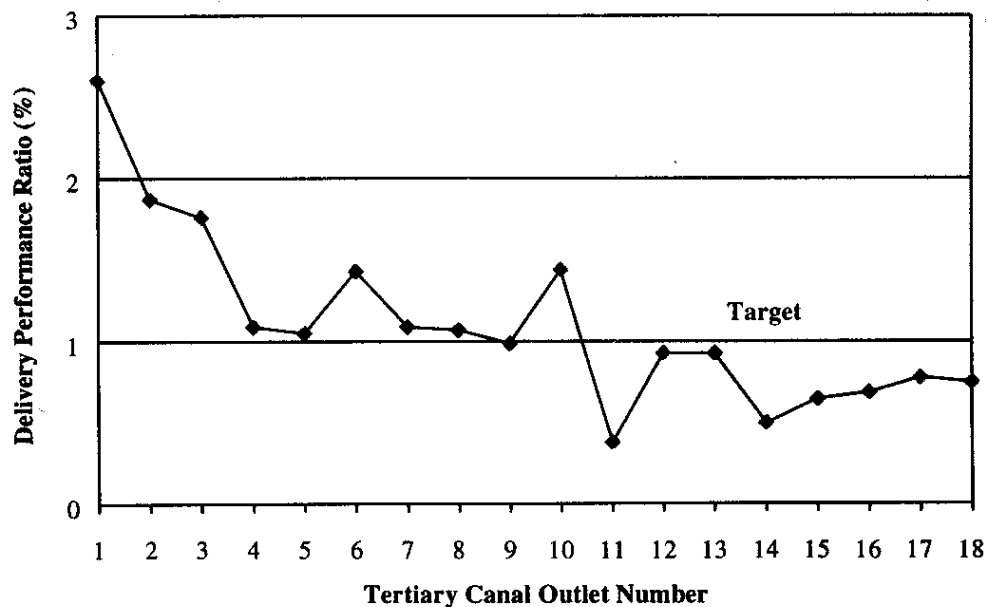
* Average 12 months. Data not available for 1983.

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



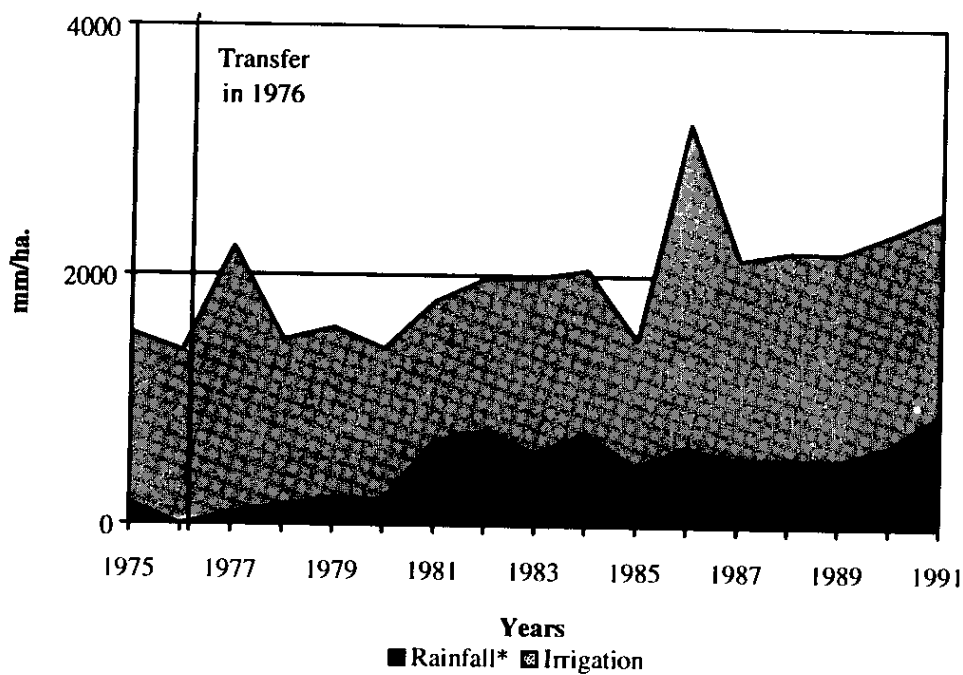
(Ratio of water delivered to diverted, 1982-1993)

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



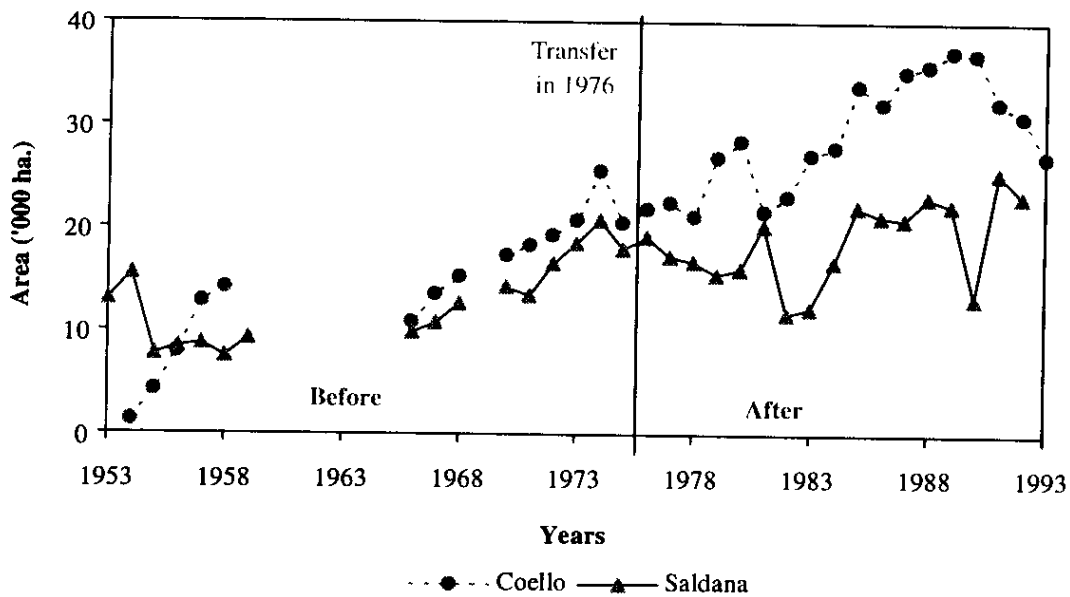
[Ratio of water delivered to targeted. Measured July 15, 1993. Distance from tertiary head increases as outlet number increases]

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



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

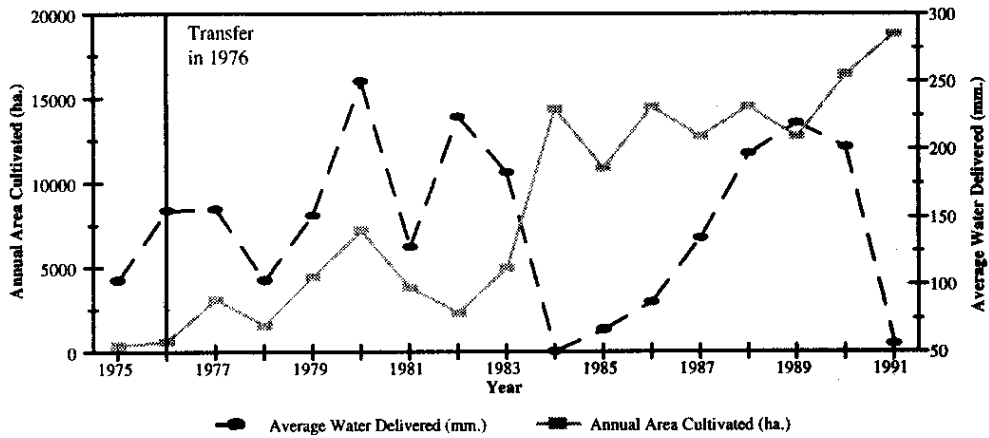
Annex Figure 12. Gross annual irrigated area* before and after transfer, Coello and Saldana Districts



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

Annex Figure 13.

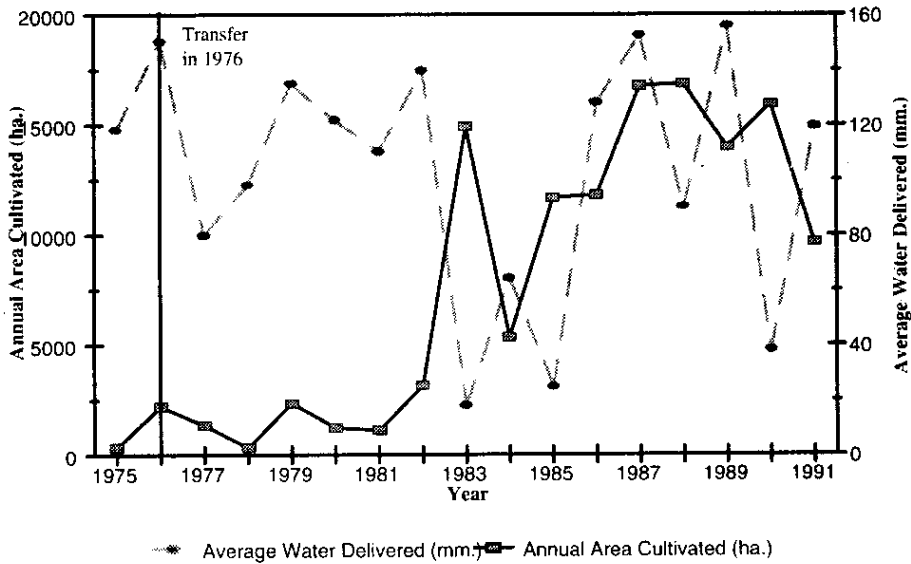
Area cultivated and water delivered per hectare for cotton, Coello District*



* Per season average

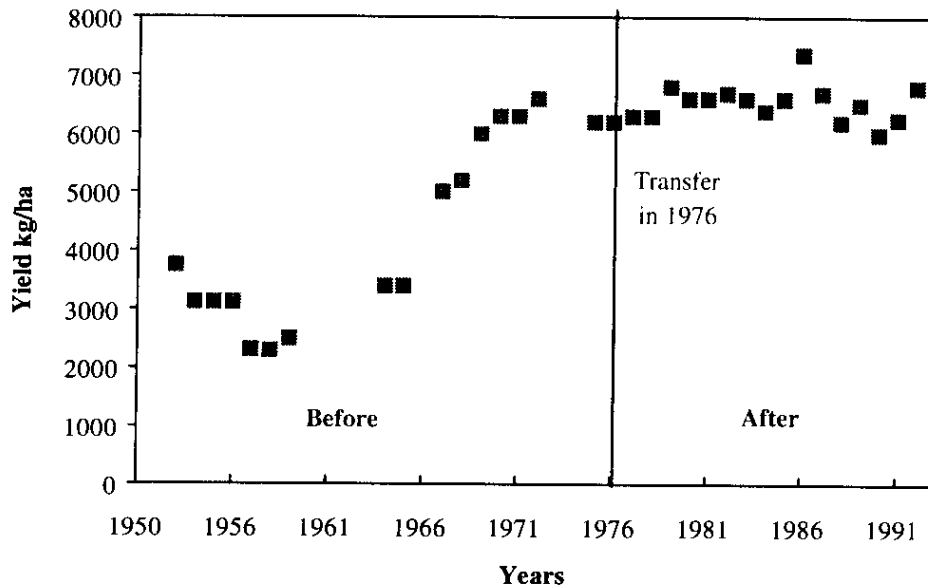
Annex Figure 14.

Area cultivated and water delivered per hectare for Sorghum, Coello District*



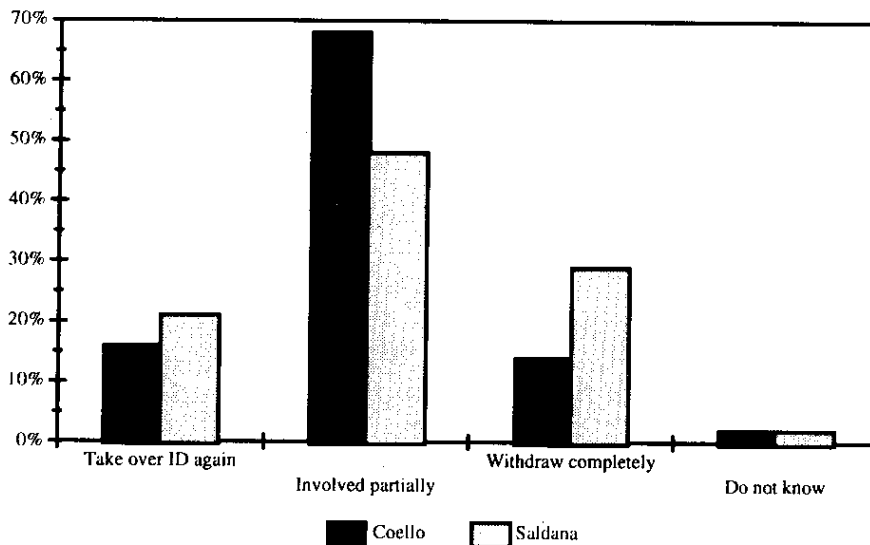
* Per season average

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



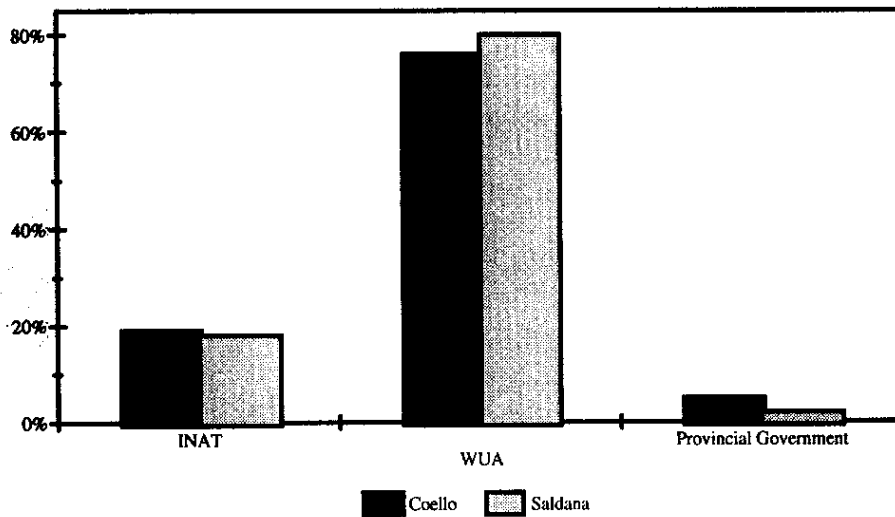
(For years 1963-1993)

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



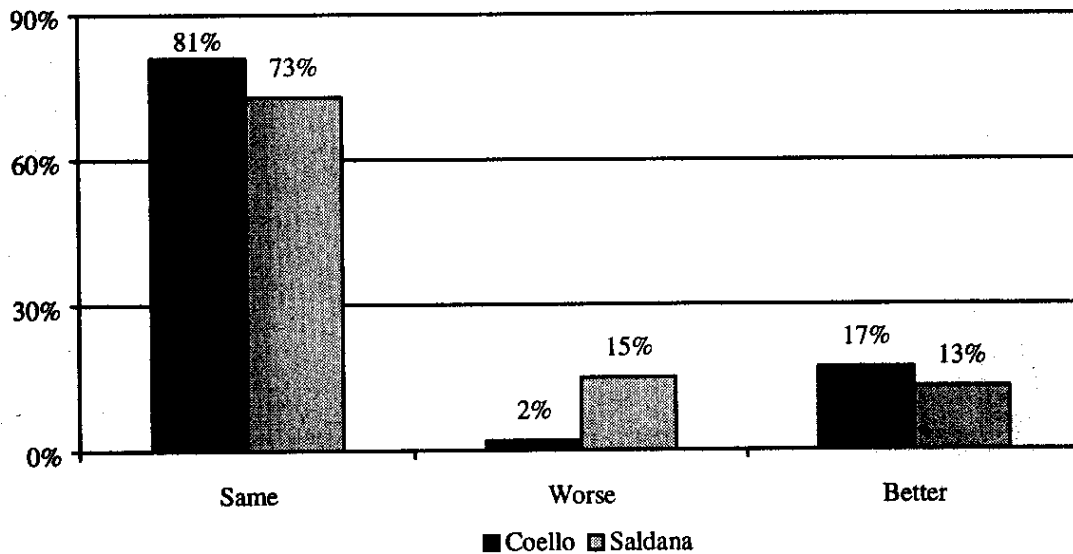
* Sample farmer responses to question, "Should INAT or a government agency continue to be involved with the irrigation district or leave it up to the farmer organization entirely?" N = 44 in Coello and 48 in Saldaña.

Annex Figure 17 Farmer perspectives about ownership of irrigation structures*



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

Annex Figure 18 Farmer perceptions about secondary canal maintenance*



N = 42 in Coello and 48 in Saldana

2.3 Management Reform and Performance Changes in Two Irrigation Districts in the North China Plain

Sam H. Johnson III, Douglas Vermillion, Mark Svendsen, Wang Xinyuan, Zhang Xiying and Mao Xuesen

Introduction

As one of the oldest societies in the world, irrigation in China has a very long history with documented development of large scale irrigation schemes as far back as 605 B.C. By 1949, China had approximately 16 million ha of irrigated land. However, after the founding of the People's Republic of China irrigated area expanded rapidly to almost 48 million ha by 1992. This includes 144 large irrigation districts of over 20,000 ha of effective irrigation area each covering 7.9 million ha in total. There are 5,198 medium size irrigation districts (between 667-20,000 ha) covering 13.3 million ha. Large and medium systems serve about 47% of the total irrigated area in the country. Small reservoirs, ponds, and pumping schemes with an area less than 667 ha are managed by local organizations. This accounts for 27% of the irrigated area in China, while other smaller irrigation systems including tubewells are managed by farmers. The command area of irrigated land directly managed by farmers is 26% of the total area (Ministry of Water Resources, 1991).

With a population exceeding 1.2 billion, China is extremely concerned about ensuring that it can feed its population. In this regard, irrigated land is critically important as 65% of the food grains, 75% of the cash crops and 90% of the vegetables are produced on irrigated land. In addition, irrigation districts supply 70-80% of the drinking water for people and livestock in rural areas (Xueren Chen and Renbao Ji, 1994).

After the founding of the People's Republic of China, initially a major push was made to rehabilitate existing irrigation systems in order to reestablish the system of food production that had been disturbed during the long civil war. From the 1950s to 1970s a number of new irrigation systems were developed. The majority of the existing medium and large systems were developed during this period. With its increased manufacturing and industrial capacity, China constructed a number of pump-based irrigation systems, primarily large systems lifting water from rivers and other surface water sources. From the 1970s, tubewell technology was developed and widely distributed to exploit the vast underground water resources that existed in the country (Liu, et al, 1994).

By the late 1970s, the negative impacts of such a massive irrigation development program were beginning to manifest themselves. A combination of substandard irrigation construction and ineffective management was combined with poor national and local economic conditions. This resulted in a situation where unsuitable management, structural deterioration and inadequate maintenance all held irrigation performance far below actual potential.

Beginning in 1978, Deng Xiaoping introduced a new era of economic reform and opened the Chinese economy to the outside world. At the beginning of the economic reforms, irrigation management agencies found it difficult to fit their existing management structure within the requirements of the reforms. As a result, irrigated area in China declined. After ten years of effort, the declining trend in irrigated area was reversed and irrigation management has been now been strengthened and consolidated (Xueren Chen and Renbao Ji, 1994).

Under the reform program, a central aspect of improved water resource management has been the issue of financing. Significant efforts have been made to encourage lower level water conservancy bureau and irrigation district officials to achieve financial independence from the Central and Provincial Governments. Measures advocated include (Turner and Nickum, 1994):

1. Increasing irrigation fees and collection rates;
2. Stimulating investment from private sources;
3. Creating joint stock cooperatives;
4. Borrowing from domestic and international banks;
5. Soliciting aid from international organizations; and
6. Establishing and managing sideline economic enterprises to earn additional income.

Institutional Reform in the Irrigation Subsector

Before the Peoples' Communes were dismantled in 1983 (Shue, 1984), they were at the top of a three-level arrangement for organizing agricultural production and distribution and irrigation development and management. Communes were generally the size of townships and consisted of 10 to 15 production brigades. A brigade generally consisted of several production teams which were the basic units for organizing agricultural production. Teams consisted of 10 to 20 households. Payments to farmers in cash and goods were made on the basis of the amount of work points farmers earned through their farm labor and attendance at communal works activities, including irrigation construction and maintenance.

Irrigation development and management was directed by county level water resources (or "conservancy") bureaus, under the Ministry of Water Resources. At the irrigation system level, bureau staff coordinated irrigation management with the aid of labor assignments made by the commune. During the 1950's, 60's, and 70's about two-thirds of government funds allocated to the water sector were for construction and one-third were for operations (Gitomer, forthcoming). Subsidies from both central and provincial funds and from the communes supported the management of irrigation systems. General labor on irrigation systems was paid by communes in work points. Irrigation managers were salaried officials of the county water resources bureau. The costs of irrigation O&M not paid by commune revenues was generally funded by the Ministry of Water Resources.

Change at the National Level

As a result of considerable inefficiencies and declining central government revenues available for investment in rural development, the production responsibility system (PRS) replaced the Peoples' Communes in the early 1980's. Under the PRS households were allocated long-term leases on farm land and were free to organize their own production and marketing and retain profits. With the advent of the PRS government subsidies for irrigation construction declined by over 60% from 3.49 billion yuan in 1979 to 1.3 billion yuan in 1981 (Gitomer, *ibid*). Between 1979 and 1985 government irrigation construction investment declined as a percent of gross domestic product from 0.87% to 0.21%. This precipitous decline in government subsidies to the local level, combined with a disruption of the communal organization of irrigation maintenance, leading to a 2% net decline in the total irrigated area in China between 1979 and 1985 from 45 to 44.04 million ha, respectively. During the early 1980's there were widespread reports of chaos, water conflicts and rapid deterioration of irrigation infrastructure.

Alarmed at these trends, in the early 1980's the government began introducing a series of reforms, starting with relatively modest measures and moving to progressively more fundamental changes. The first reform was the work post responsibility system introduced in the early 1980's. This was an attempt to introduce a system of incentives to water resources bureau officials to improve their work productivity. Monetary bonuses and penalties were introduced in annual work performance evaluations amounting to 20% or more of base salaries. Nickum (1985) notes, however, that this modest reform tended to amount to only, "a threat to withhold a small amount of nominally discretionary wages for poor attendance." The county water resources bureaus remained intact with the demise of the communes. After decollectivization the Ministry of Water Resources added a lower tier below the county level, the water resources stations which were

created to replace production brigade functions at the township level. Village irrigation management groups (VIMG) were created at the village level following the demise of the multi-functional production teams. These were to be under the jurisdiction of village governments but were managed and financed independently from the village government.

Two more far-reaching reforms were introduced through national regulations, both of which were decreed in 1985. These were: 1) the national Regulation on water fees and 2) the State Council Regulation on Diversified Sideline Enterprises. The regulation on water fees stated the principle that revenues for operations and maintenance of irrigation districts should come mainly from fees collected from water users. The precise level of fees should be determined at the system level according to the local cost of O&M. However central and provincial governments continue to place ceilings on the maximum level of fees which can be charged to farmers. Even assuming 100% collection rates, fees generally did not provide for the full cost of O&M, let alone for rehabilitation and capital replacement costs. The water fee regulation supported development of a widespread tri-partite system of resource mobilization. This included a fixed area fee (based on the area irrigated by a farmer), a volumetric fee (based on an estimate of the amount of water diverted into a farmer's field), and an annual labor contribution for system maintenance. The latter is not a minor input. Chen and Ji (1994) estimate that contributed farmer labor constitutes more than one-third of the total value of resources invested in existing irrigation districts. While the introduction of volumetric fee assessment is spreading, it is not universal since measurement is frequently difficult and costly. Irrigation fees cannot legally be used for purposes other than operations and maintenance for the system from which they are collected.

Irrigation districts often had underutilized assets and resources which had potential economic value. There was generally a gap between the level of resources which could be raised by the irrigation fees (because of political reluctance to require farmers to pay for the full cost of irrigation service) and the actual costs of operations and maintenance. By 1988 it was official policy that no central or provincial government funds could be used for regular O&M in irrigation districts. By the 1980's salaries of irrigation district officials were dropping in real terms below alternative employment opportunities in rural China. Many skilled staff were leaving the service due to low salaries and poor working and housing facilities in irrigation districts. In order to bridge the gap between the limited revenue which could be raised from fees and the amount needed for O&M and to boost salaries and facilities for irrigation workers, the government introduced the concept of diversified sideline enterprises into the irrigation sector. Irrigation districts were encouraged to develop sideline enterprises to raise additional revenue from the profits of businesses to cross-subsidize the costs of irrigation management. Such enterprises developed gradually during the latter 1980's and early 1990's, first beginning with underutilized existing assets such as reservoirs (for sale of water outside the district, fisheries, recreation, tourism) and reservoir bunds and reserved lands (for tea, orange and tree plantations). Later sideline enterprises spread to all sorts of businesses, from bottling and food processing to restaurants, construction contracting, bicycle repair shops, petrol stations, production of shirt collars, and so on. Although income from sideline enterprises is growing it still generally provides a small percentage of the total resources invested in irrigation.

The Water Law enacted in 1988 introduced a water extraction permit system, new authority to apply sanctions against water use violations at local levels, and procedures for mediating water disputes. The Law establishes measurable water rights and facilitates the allocation of water between sectors through buying and selling. However implementation of the new Law has proceeded slowly. By 1993 only 11 provinces or autonomous regions had passed implementing regulations for the Law.

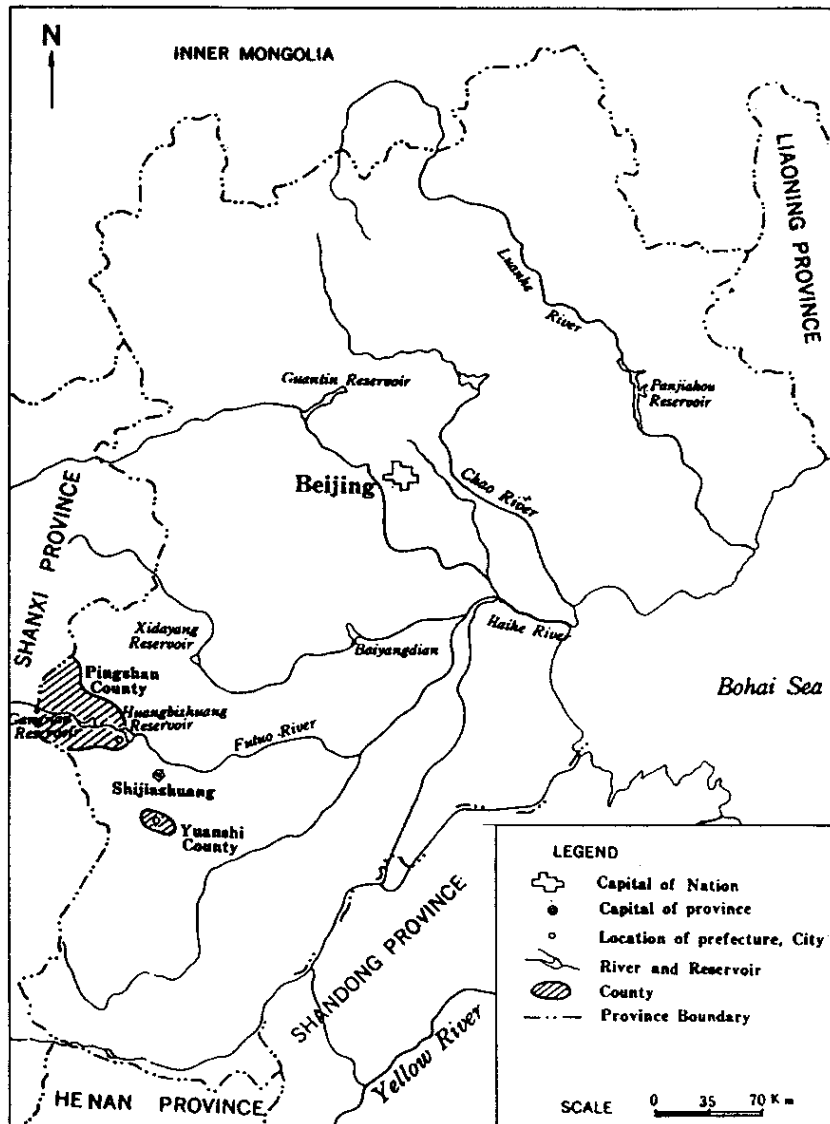
These broad national policy reforms were partly the result of a combination of financial and managerial pressure at the national level and "a process of experimentation and trial and error" at the local level (Gitomer, 1994, p.1). They have resulted in a variety of organizational arrangements throughout China at

the level of irrigation districts. What the reforms have in common is an evolution towards local financial and managerial autonomy (both vertical and horizontal). The tri-partite irrigation fee (area and volumetric fee plus an annual labor duty), diversified local financing and village irrigation management groups have resulted in irrigation districts which are increasingly multi-functional and multi-organizational entities with extensive inter-organizational linkages for cross-subsidies and joint accountability. Irrigation districts are also increasingly managed by small, locally-contracted "irrigation management firms" which receive multi-year contracts from villages or irrigation districts, depending on the level of management involved (Svendsen and Vermillion, 1992).

Nanyao and Bayi Irrigation Districts, Hebei Province

The two irrigation districts selected for the research study are located in Shijiazhuang Prefecture of Hebei Province. Bayi Irrigation District (Bayi ID) is located in Yuanshi County while Nanyao Irrigation District (Nanyao ID) is located in Pingshan County, both of which are near 38°N latitude. The location of these counties within Hebei Province can be seen in Figure 1.

Figure 1. Hebei Province showing location of Pingshan and Yuanshi Counties

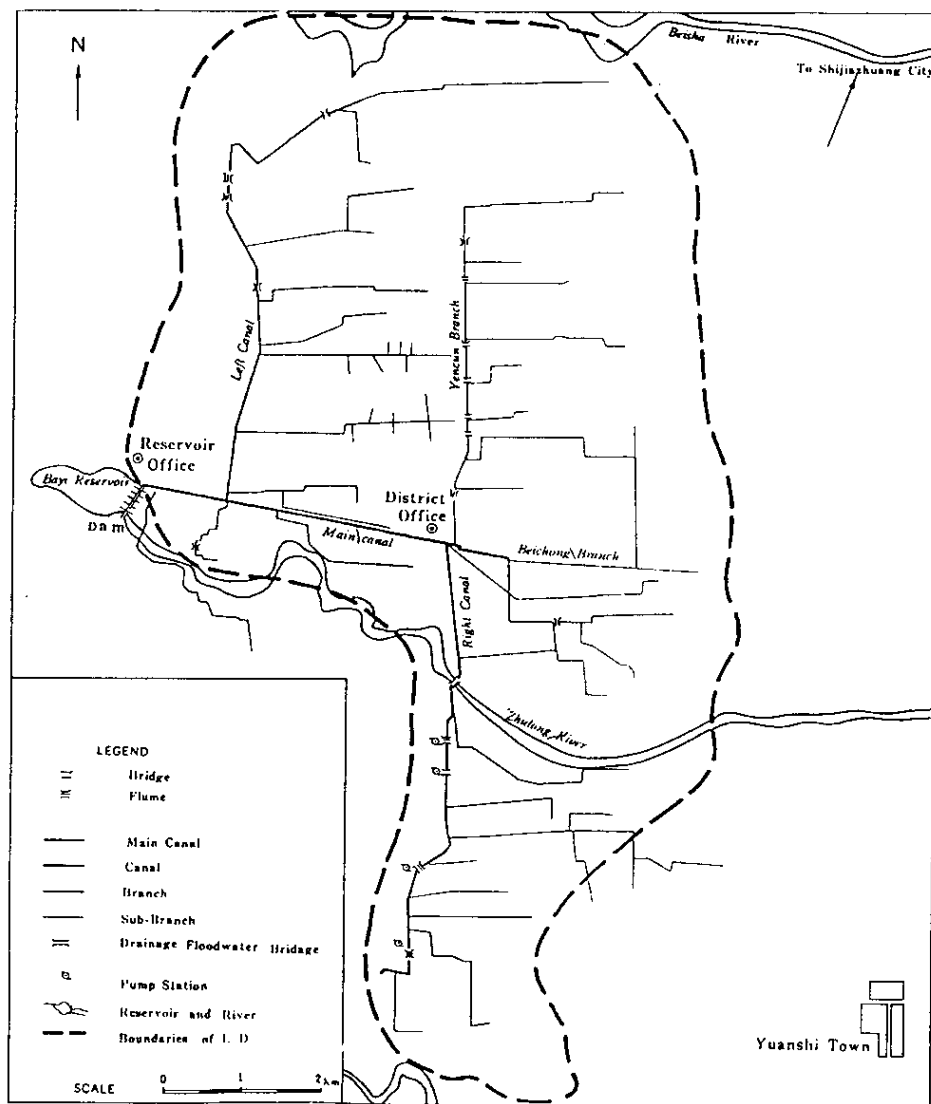


Bayi ID

The arable land area of Bayi ID is 10,415 ha. Within the district most of the soil is loamy with a medium level of soil fertility. Average annual rainfall is 544 mm, with the majority of this concentrated from June until September. However, the annual amount varies widely, from as low as 250 mm to over 1,200 mm.

The source of water for the district is the Bayi Reservoir with an overall capacity of 73.87 million m³. The development of Bayi ID was started in 1959 with the construction of the Bayi Reservoir. Originally, the design area was 13,000-20,000 ha. Starting in 1961, a small area was irrigated, until by 1967 the construction of the reservoir was completed and the irrigated area eventually adjusted to 5,333 ha. Within the irrigation district the main canal is 5.4 km long with two main branch canals of 13.5 km in total length. Primary canals are 16 km long and the secondary canals extend 104.4 km. Within the system there are over 1,400 structures. There has been no rehabilitation since 1976 when a limited amount of canal lining was done on the main canal and some of the branches. Figure 2 illustrates the canal layout of the irrigation district.

Figure 2. Canal schematic layout for Bayi Irrigation District



However the Bayi Reservoir was not able to provide all the irrigation water required for Bayi ID. Consequently, a canal from the Gangnan Reservoir--a large reservoir on the Mountain Taihang--was started in 1970 and completed in 1976. Since the completion of the Yingang Canal, Bayi ID has been able to purchase water from Gangnan Reservoir. This transbasin conveyance project ensures irrigation water for Bayi ID. Water purchased annually is 20-30 million m³.

In addition to surface water, there are 383 tubewells within the command area, of which 363 are in operation annually. About 4,000 ha can be conjunctively irrigated with both canal and well water. However, due to overpumping the water table in the county fell dramatically during the 1980s. In 1979 the average depth to the water table was 11.9 meters, while in 1993 it the depth to the water table was 25.5 meters. In some areas it declined at the rate of 1.1 m/year while in other areas it declined in excess of 1.5 m/year. In the entire In the country, the pumping rate is 120 million m³ while the annual recharge is 100 million m³. In order to address this problem, since 1989 the county has received about 20 million m³ each year from the Yehe River to attempt to stabilize groundwater levels within the county. In 1989, the district paid Yuan¹ 0.7 100 m³ and in 1991, 1992, and 1993 they paid Yuan 1.1 per 100 m³ for this water. As a result of their efforts, the groundwater table is at present around 17 m from the surface. On the average, around 8 million m³ are pumped annually in Bayi.

The population in Bayi ID is approximately 90,200 which includes 18,531 male laborers and 13,808 female laborers. There are off-farm employment opportunities as well as agricultural income, and therefore the income in Bayi ID was 670 yuan in 1991, while the average in Shijiazhuang Prefecture was 650 yuan. The literacy rate within the district is estimated at 80%.

Nanyao ID

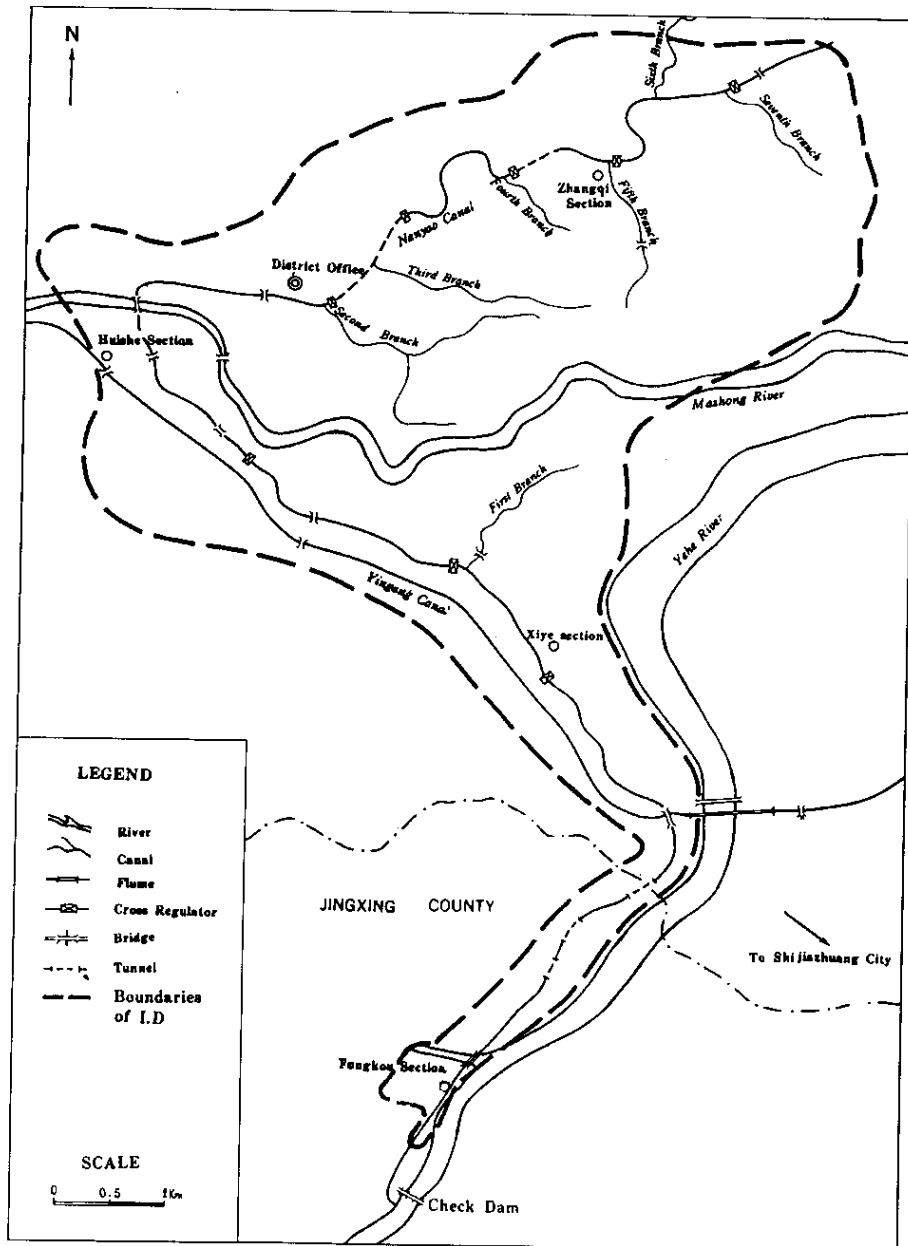
Nanyao ID was designed in 1957 and in 1958 construction was started. Funds for purchasing materials were provided by the townships and volunteer labor was provided by the involved villages. Therefore the degree of government subsidy in the system was very small. There was a significant amount of rehabilitation in 1977-80, with almost all the labor coming from the farmers. The County contributed 200,000 yuan for materials only.

Within Nanyao ID the total arable land area is 3,333 ha. The soils in Nanyao are a sandy loam with lower levels of fertility than Bayi ID. Average annual rainfall is 535 mm, with the majority of the moisture concentrated in the period from June until September. However, the annual amount varies widely, from as low as 200 mm to over 950 mm. The water source for Nanyao is the Yehe River that originates on the Shanxi Plateau and passes through Pingshan County before joining the Hutuo River. The average discharge of the river is 100 m³/s, although during the flood season discharge increases to 500 m³/s and during the dry season decreases to 20-50 m³/s.

Design discharge at the head of the main channel is 15 m³/s. Within the irrigated area of 2,473 ha, the total length of main canal, branch canals and sub-branch canals is 111.5 km, of which 39.6 km is lined. The main canal is 30.3 km with 18.6 km lined. There are 339 structures within the system and total water discharge varies from 10.4 million to 59.4 million m³/year. System level water use efficiency is 53%. Figure 3 presents the canal layout of the irrigation district.

¹ Exchange rates for the Chinese yuan for the last six years have been one US dollar equals: 1989 4.72 yuan; 1990 5.22 yuan; 1991 5.34 yuan; 1992 5.78 yuan; 1993 8.8 yuan; and 1994 8.6 yuan.

Figure 3. Schematic canal layout for Nanyao Irrigation District



The population in Nanyao ID is 35,545 with 7,112 male laborers and 5,405 female laborers. Income is almost exclusively from agriculture and was 414 yuan/capita in 1991. The literacy rate is approximately 77%.

Once irrigation water was available, agriculture production in the two districts shifted from rainfed to irrigated crops. In Bayi and Nanyao, winter wheat and summer maize are the main two crops, with cotton, vegetables, water melon and fruit orchards making up the other major crops. In addition, a small area is planted in rice in Nanyao ID. Table 1 contains the detailed area of the different crops as well as the percentages of the total.

Table 1. Crop areas in Nanyao and Bayi Irrigation Districts [average in 1990s]

Crop	Bayi Irrigation District		Nanyao Irrigation District	
	Area [Ha.]	Percentage [%]	Area [Ha.]	Percentage [%]
Winter - wheat maize	7738.9	74.3	2473.3	74.2
Cotton	1385.3	13.3	333.3	10.0
Vegetables	364.6	3.5	93.3	2.8
Rice	0	0	66.7	2.0
Water melon	250.0	2.4	36.7	1.1
Fruit orchard	177.1	1.7	10.0	0.3
Sweet potato	166.2	1.5	180.0	5.4
Spiked millet	93.7	0.9	50.0	1.5
Drug plants	0	0	16.7	0.5
Beans	83.3	0.8	40.0	1.2
Sorghum	62.5	0.6	23.3	0.7
Others	104.2	1.0	10.0	0.3
Total	10425.8	100	3333.3	100

As the climate in the area is hot and wet in the summer and dry and cold in the winter, rainfall during June to September is about 80% of the total annual rainfall. From October to May, the growing season for the winter wheat, only about 150 mm of rainfall is available. As this is far below the requirements for wheat, irrigation is required to produce a wheat crop. In contrast, in general, the rainfall during the summer is sufficient for a maize crop and therefore no irrigation is required during normal and above normal rainfall years. Table 2 presents the winter moisture regime for the two irrigation districts. As can be seen in the table, a wheat crop requires at least 350 mm of supplemental moisture.

Table 2. Water requirements of winter wheat, Bayi and Nanyao Irrigation Districts

	Developing Stage	Before Over-Wintering	Over Wintering	Turning Green to Jointin	Jointing to Heading	Heading to Maturing	Total
	Duration	1/10-30/11 61 days	1/12-28/2 90 days	1/3-31/3 31 days	1/4-30/4 30 days	1/5-10/6 41 days	263 days
Bayi Irrigation District	Etp mm	55.4	44.1	55.2	118.8	213.8	484.9
	Average rainfall [mm]	47.0	13.1	10.2	20.5	56.6	147.4
	Difference	8.4	31.0	45.0	96.1	157.2	337.7
Nanyao Irrigation District	ETP mm	50.7	44.1	57.9	118.5	219.6	498.9
	Average rainfall [mm]	43.3	13.5	12.2	22.7	54.2	147.5
	Difference	17.4	30.6	45.7	93.9	166.4	351.4

The water requirements for maize are in stark contrast to the water requirements for wheat. As can be seen in Table 3, during the average year moisture from rainfall is such that it actually exceeds the evapotranspiration requirements. Thus, in many years maize does not require irrigation. In order to ensure

the maize has sufficient moisture, farmers often relay plant the maize in the wheat and then germinate the maize seeds using moisture from the last irrigation on the wheat. In this case, the last irrigation for wheat has a dual purpose. However, during dry years maize will often require one or two irrigations to obtain high yields².

Table 3. Water requirements of maize, Bayi and Nanyao Irrigation Districts

	Developing Stage	Early Growing Period	Jointing Period	Heading Period	Milky Period	Total
	Duration	10/6-30/6 20 days	1/7-30/7 30 days	1/8-20/8 20 days	21/8-20/9 31 days	102 days
Bayi Irrigation District	Etp mm	44	118.7	85.6	116.6	384.9
	Average rainfall [mm]	38.8	142.2	110.1	87.89	378.9
	Difference	5.2	-23.5	-24.5	28.8	-14.0
Nanyao Irrigation District	ETP mm	43.2	118.7	81.3	116.3	359.5
	Average rainfall [mm]	34.7	147.1	99.3	88.8	369.9
	Difference	8.5	-28.4	-18.0	27.5	-10.4

In addition to the increased use of chemical fertilizers and pesticides, new seed varieties along with the availability of irrigation have resulted in significant yield increases. The annual combined per ha production of wheat and maize (for the two seasons) has increased from 1,125 kg in 1960 to 11,905 kg in 1992 for Bayi ID and from 5,250 kg in 1972 to 8,500 kg in 1992 in Nanyao ID. At present, the net income for the two seasons of wheat and maize is 4,200 yuan/ha for Bayi ID and 3,300 yuan/ha for Nanyao ID.

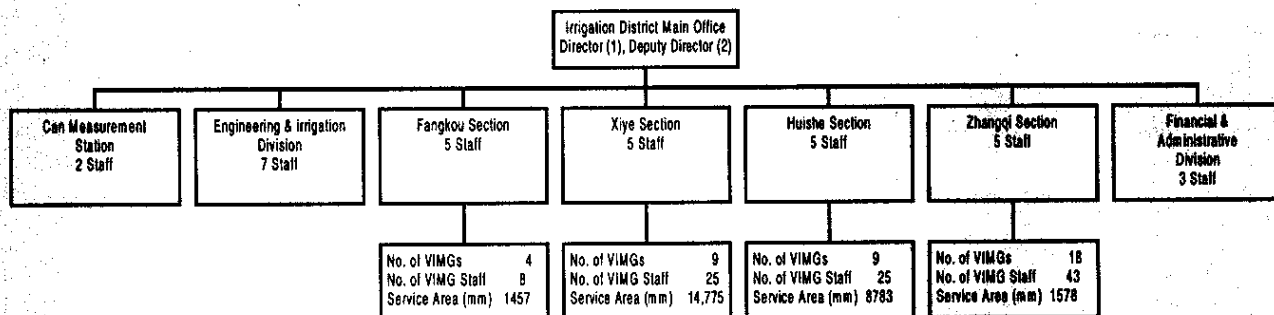
Organizational and Managerial Change in the Two Districts

Under the commune system, operations and maintenance of the districts was handled first by water conservancy groups, created in 1964. These were soon absorbed financially and managerially by the collectives and later, villages. Irrigation staff interviewed in this study reported that under the commune system responsibility was often confused and coordination was difficult because irrigation matters were handled by busy multi-functional production brigades and later, by village committees. Irrigation district staff had little authority relative to the communes. When the production responsibility system replaced the collectives, water resource stations and village committees replaced brigades and production teams, respectively. Water conflicts and system deterioration increased dramatically in Nanyao and Bayi ID during the transition period after the collapse of communes but before the new reforms of village irrigation management groups (VIMG), the new system of irrigation fees and sideline enterprises began to be adopted locally. These were phased in during the mid 1980's in Bayi ID and the latter 1980's and early 1990's in Nanyao ID.

² Tables 2 and 3 were developed using the UNFAO CROPWAT program, as part of the collaborative SIAM-IIMI case studies.

At present, Nanyao ID in Pingshan County, the top two levels of canals are managed by the irrigation district and the third and lower-level canals are now managed by VIMGs. Nanyao ID has five levels of canals (as do most districts in both counties). The district office has two tiers, the main office and four sections which are subdivisions of the system (Figure 4). Nanyao ID has 30 staff plus 5 temporary workers. All receive their total salaries from the water charge. There are four geographic sections and three managerial sections supervised by the district office, canal measurement, engineering and irrigation, and financial and administrative. Nanyao has 40 village irrigation management groups (VIMG). Nanyao ID has not yet developed any sideline enterprises under a "Diversified Management Division."

Figure 4. Organizational chart for Nanyao Irrigation District, Pingshan County, Hebei Province

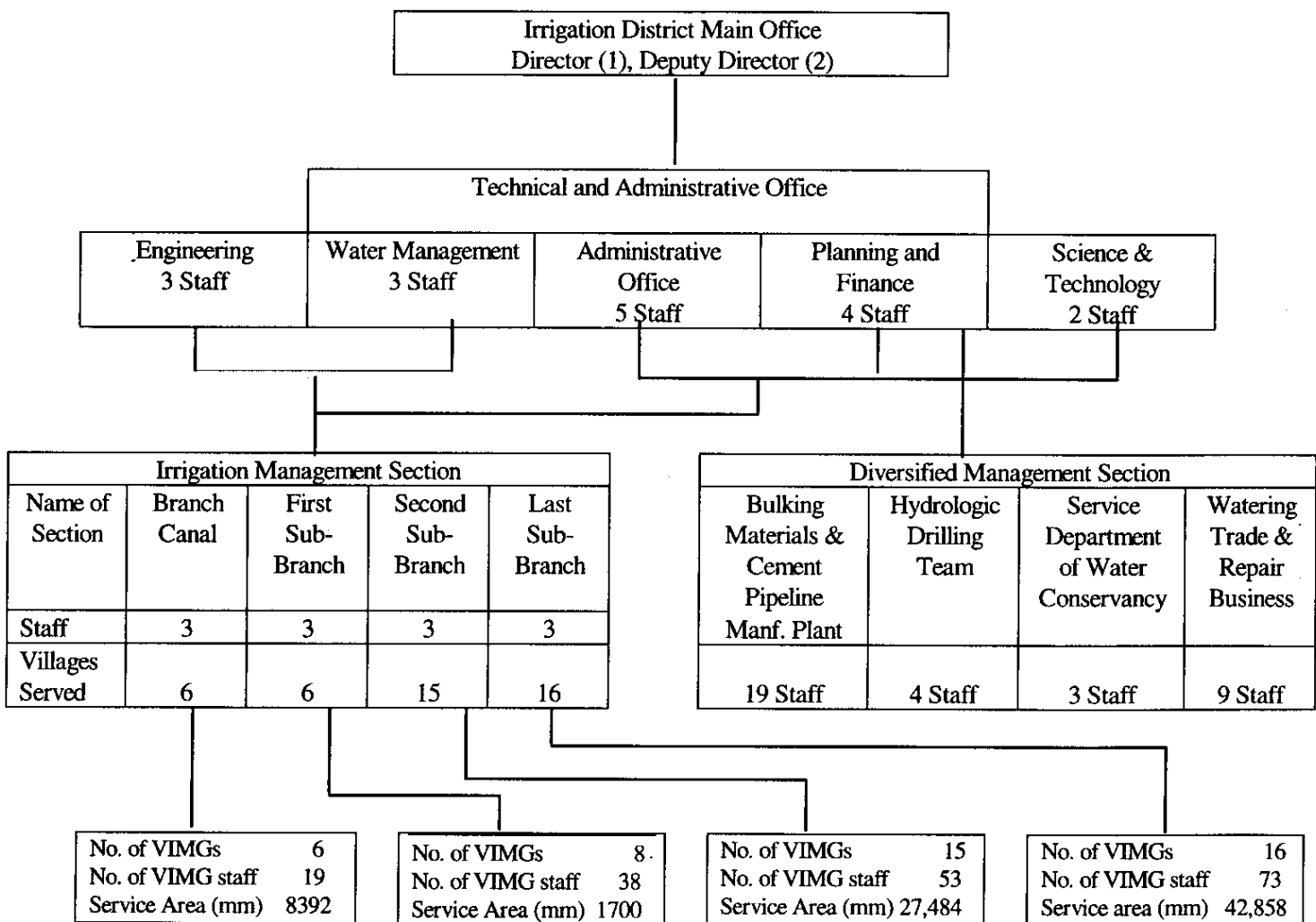


Permanent Staff 30
Temporary Staff 5

Bayi ID office has three tiers, the main office, which oversees the entire system and operates the reservoir, five technical and administrative units, and below them, four sections, which manage the main and branch canals and liaise with VIMGs (Figure 5). Bayi ID (including the Reservoir) has a total of 67 staff, 20 of which have temporary status. Thirty-two staff are performing water management functions (12 are engineers) and 35 are in the "Diversified Management Division," producing revenues from sideline enterprises. All 32 staff in the Irrigation Management Division (IMD) are ID employees and receive all of their salaries and pensions from Bay ID, not the county water conservancy bureau. None of the staff are civil servants under the water conservancy bureau. Hence the irrigation district is an independent public utility, not part of the government bureaucracy. Bayi ID has four levels (including VIMG) in contrast to Nanyao's three levels. It has five technical and administrative offices which in turn supervise the Irrigation Management and Diversified Management Divisions. It incorporates 45 VIMG's.

As part of the reforms begun in the early 1980s, VIMGs were organized in Pingshan and Yuanshi counties to take over direct responsibility for managing irrigation. A VIMG generally has about three to five members, selected by the farmers in a village. VIMGs normally have a head, a deputy (who inspects canals for problems or damages), a treasurer, a head of water fee collection and a head of maintenance. Their duties are to clean canal sections which pass through the village (normally branch canals and below), distribute water among village farmers, collect water charges ("under the supervision of the ID"), ensure proper passage of water through the canals and maintain, organize schedules among farmers for water delivery and protect field-level irrigation facilities of the county water conservancy bureau (WCB). The VIMG head often is also an official on the village committee. Each VIMG staff has responsibility for coordinating water distribution between roughly 200 households farms.

Figure 5. Organizational chart for Bayi irrigation District, Yuanshi County, Hebei Province



Irrigation fees

Both Nanyao and Bayi ID are attempting to implement the new system of water fees. Irrigation districts in the two counties each have different water fee levels, according to availability of revenue sources, variable O&M costs and how many irrigation turns are delivered in a year. While Nanyao ID calculates water charges according to its estimate of water volume delivered, the VIMGs translate an otherwise volumetric water fee into an area-based charge levied against individual farmers. The Hebei Province official water charge rate is 3 yuan per 100 m³ (maximum allowed). Nanyao ID is charging less than the allowed amount because the farmers refuse to pay more than the current rate. The fixed area fee is Yn 7.5 per mu³ and the volumetric fee is Yn 2.5 per 100 m³. The amount of the fee is estimated by the district based on village area irrigated. Both components are combined into a single fee, treated as a fixed area fee, at the rate of 15 yuan per mu. This assumes five irrigations per year.

³ 15 mu = 1 hectare.

In Nanyao, if the VIMG collects 100% of the fee by the end of March, the VIMG retains 5% of it. If they collect 10% by the end of April, the VIMG retains only 3%. If the VIMG collects less than 100% by May then the VIMG must pay a fine of an additional 3% of the remaining amount uncollected. The entire fee for the year is collected once a year, in February, 10 days before the first irrigation. Fee collection rates for 1993 were 97%, 90% and 95% for each of three sections.

In Bayi the volumetric water fee is 7.11 yuan (Yn) per 100 m³. The area fee is 1.5 yuan per mu. Before 1984 the water fee was only a fixed area fee so the use of water was very inefficient. The volumetric water fee was introduced in the mid 1980's, after 1984, as part of the reforms. The Hebei Province standard rate for the volumetric fee was 3.3 yuan per 100 m³, but since Bayi ID purchases water from the Bayi Reservoir and sometimes from another county (Pingshan) and have more than 100 kms of canal to supply this water to the district, they have a higher fee based on the actual higher costs for water. The Bayi Reservoir and ID propose a fee level which is approved by the county government, based on the provincial standard modified to take into account actual local costs. So there is some slippage between central or provincial standards and what irrigation districts actually charge for water fees. The fee standards seem to be considered more as guidelines than rules.

Diversified Sideline Enterprises

Nanyao ID is in a poorer area than Bayi and it began implementing the reforms later. It has still not developed any sideline enterprises. Its officials state the desire to establish them but report difficulty in raising initial capital and getting organized. Bayi ID's Diversified Management Division was created in 1984. By 1994 it has become highly diversified. It has 11 kinds of sideline business: 1) survey and design of small scale irrigation projects, 2) fitting of water pipes and taps, 3) repair of farm machinery and irrigation and drainage equipment, 4) well boring and pump installation, 5) building construction, 6) small restaurant, 6) bicycle repair shop, 7) agricultural products store, and the production of 8) cobblestone, 9) cement tile, 10) cement pipe and 11) talcum powder. Since 1984 Bayi ID has received many prizes and awards from the county, prefecture and province for its successful Diversified Management Division (Wu, 1994). Profits from sideline enterprises provide approximately seven percent of the total revenues of the district. The businesses also provide employment for family members of district staff (as well as others) and thereby enhance the standard of living of staff families.

At the level of Hebei Province, in 1992 a total of 450 million yuan (US \$52.3 million) gross income was raised province-wide by the Water Conservancy Bureau from diversified sideline enterprises. Sixty-six million yuan (US \$7.7 million) of it was invested in construction and rehabilitation of water projects. These enterprises also provided employment for 13,155 people.

Post-reform Management Practices in Nanyao and Bayi Districts

Performance Standards

Under the work post responsibility system, yearly personnel evaluations of district and water conservancy bureau staff are required. For irrigation district staff these include an assessment of water fee collection rates, the quality of maintenance work and water distribution. Both Nanyao and Bayi make annual assessments of staff and district management performance according to the same basic set of eight "economic norms" (or performance standards) promoted by the work post responsibility system. They vary in how they calculate points, bonuses or fines. Assessment is done at the level of individual staff, section offices, divisions and at the district office level. The eight criteria used are: irrigation efficiency, proportion

of structures which are functional, balance of income and expenditures, total water use, irrigated area, water use efficiency, irrigation schedule targets and crop yields obtained.

Table 4 shows the system of performance measures used by the Nanyao ID itself in 1993. The rating was 96.5% of potential. In comparison with problems of advancing siltation and deterioration, this rating lends some support to Nickum's argument (1985) that the water fee assessment system in China is only used in a modest way to remind staff not to shirk duties too much. Performance standards are set for each of these criteria and percentage figures are used to measure levels of achievement relative to that standard. If a staff gets a rating below 60%, no annual salary bonus is given and salary is reduced by one grade for that year. This has never happened yet. As a gesture to increase work incentives, Nanyao ID recently decided that from 1994 onwards, if a staff is ranked below 79% they get no bonus and the salary will be reduced by one grade. For scores above 79%, the higher the score the higher the bonus. Scores tend to be stable in most years. The overall annual performance rating for Nanyao ID increased from 81 points in 1987 to 96.5 points in 1993. This was likely a combination of some "rating inflation" and real improvements.

Staff grades generally increase according to seniority, promotion and performance ratings according to the guidelines of the National Personnel Ministry. Grade levels determine salary. The Labor Ministry designates base salary levels for all kinds of positions, even in financially independent irrigation districts.

Table 4. Annual performance assessment for Nanyao Irrigation District, 1993*

Item	Planned [104 m ³]	Actual [104 m ³]	Potential Points	Points Awarded
1. Water Delivery				
Total discharge	4500	5600.6	4	4
Irrigation water	2000	2150.6	5	5
Delivery to Yingang canal	1500	3450.0	3	3
Water delivery days	300 days	307 actual	3	3
Total points			15	15
2. Irrigated Area				
Irrigated area	273.3	273.3	5	5
Irrigated area x times	12,000	12,000	5	5
Total points			10	10
3. Water Use Efficiency [WUE]				
WUE of main canals	0.715	0.715	4	4
WUE of branches	0.82	0.82	4	4
WUE of sub-branches	0.91	0.91	4	4
WUE of whole canal system	0.534	0.534	4	4
Total points			16	16
4. Irrigation Duty & Efficiency				
Irrigation duty at the head of main canal [m ³ /ha.]	1522.5	1519.5	3	3
Irrigation duty at the outlet of sub-sub branches [m ³ /ha.]	892.5	892.5	2	2
Irrigation duty in field [m ³ /ha.]	813	811.5	2	2
Annual gross irrigation water per ha.	6870	7875	3	3
Irrigation efficiency at the head of main canal [ha/m ³ /s]	56.7	56.8	3	3
Irrigation efficiency at the outlet of sub-sub branches [ha/m ³ /s]	96.9	97.1	2	2
Total points			15	15
5. Rate of Functional Structures				
Structures	447	447	4	4
Canals and branches [km/number]	48	48	3	3
Total points			7	7
6. Maintenance				
Lined canals [km]	10	10	6	4
Silt clearance [km/number]	271/62	271/62	4.5	4.5
Structures maintained [number]	35	35	4.5	4.5
Total points			15	13
7. Income and Expenditure				
Total income	US\$ 31,395.3	US\$ 38,372.1	5	5
Total expenditure	US\$ 26,744.2	US\$ 36,627.9	5	5
Operating and managing costs	US\$ 20,930.2	US\$ 6,046.5	3	3
Annual maintenance costs	US\$ 5,813.95	US\$ 12,558.0	3	3
Total points			16	16
8. Crop Yield Assessment				
Grain	3262.5	3045	2	1
Wheat	442.5	4605	2.5	2.5
Cotton	600	585	1.5	1
Total points			6	4.5

Grand total of potential points = 100

Grand total of points awarded = 96.5

* This is the irrigation district's own performance evaluation and is not derived from this research

Financial Management

Under the collectives or village committees, general commune or village revenues subsidized routine irrigation costs. Central and provincial level funds are now only available for construction and rehabilitation, on a cost-sharing basis with villages or farmer groups. Financing routine operations and maintenance has always been the responsibility of the irrigation districts and farmers. Officials report that neither Nanyao nor Bayi ID have ever received central government funds for routine operations and maintenance.

While no funds are provided by the government for O&M, between 1988 and 1992 the county water conservancy bureau provided 519,000 yuan (approx. US \$85,000) to Bayi ID for canal lining and extension. This amount was one-third of the total expended. As required matching investments, the same amount was invested by both Bayi ID and member villages (mainly in the form of labor), respectively.

In 1992 Nanyao ID's total budget was approximately 365,000 yuan (about US \$ 63,000), 350,000 yuan of which was from the collection of current and back accounts for water fees. Expenditures totalled 341,500 yuan, including a 36,500 yuan repayment of its 1991 budget deficit. Nanyao spent 36,500 yuan to purchase supplemental water from the Yie He river. Therefore, Nanyao had a budget surplus in 1992 of approximately 13,500 yuan.

Between 1984 and 1992 Bayi's Diversified Management Division produced 400,000 yuan (approx. US \$60,000) in profits. Of this, 260,000 yuan (65%) was submitted to the ID office to finance water management. The other 140,000 yuan (35%) went to salaries and bonuses for staff of the Diversified Management Division, many of whom are spouses of ID staff. In 1992 total revenues from irrigation fees in Bayi ID amounted to 906,000 yuan, while total revenues (i.e., profits) from sideline enterprises amounted to 70,000 yuan. This total income of 976,000 yuan (approx. US \$ 168,000) produced a surplus of 258,000 yuan (US \$45,000) over total expenditures of 718,000 yuan (US \$ 124,000). Purchase of water constituted 360,000 yuan (US \$ 64,000) or 52% of total expenditures.

In about two-thirds of the villages in Nanyao ID, the VIMG collects water fees from individual farmers, in the other third the villages produce enough off-farm collective income that the village committee pays all of the water fees charged to the village and often also pays for other agricultural taxes, educational fees and village fees. For example, Dong Hui She village has successful collective enterprises, including a brick factory, fertilizer bag production plant and fruit orchard. 80% of the factory workers are also farmers from the village. Workers are paid on a piece rate basis. Dong Hui She village paid 100% of its water fee by March 5 in 1992 and 93 and thereby received a 5% rebate.

The Bayi ID collects the water fee from farmers, through the VIMGs, three to five days before the village's scheduled water turn. The VIMG broadcasts with megaphones announcements of pending water delivery three to five days in advance, reminding farmer to come and pay their water fee before delivery. Two members of the VIMG wait at a designated location for farmers to come and pay. At least two VIMG staff must together receive water fees. A receipt is issued to farmers upon payment. Normally 90% of the farmers pay the fee in advance of the water delivery. Others still get water but must pay afterwards or they won't be allowed the next water turn until they pay up--but this is reportedly "very rare."

Compensation of VIMG staff is sometimes from the village committee funds and sometimes from a village-levied surcharge on the water fee. Compensation to VIMG staff ranges from 400 to 1,000 yuan between different villages, varying by the size of village irrigated area, amount of work required and differences in

wealth between villages. Most villages in Bayi ID have a surcharge on the water fee of about 2 to 5% to pay for the cost of compensation for VIMG staff.

Water Management

Nanyao ID normally obtains its full water supply from the Yie He river according to a withdrawal permit. Occassionally, as in 1992, supplemental water is purchased. Bayi ID obtains water from the Bayi Reservoir. Before 1976 the amount of water in the Bayi Reservoir was 3 to 5 million m³. By purchasing water from other counties by feeder canals, the amount of water in the Reservoir expanded to 35 million m³ today. Purchased water constitutes 95% of the water in the Reservoir today. All imported water directly or indirectly comes from the Yie He ID. Seventeen to 25 million m³ of water is imported per year into the Bayi Reservoir. Seventeen million m³ of water was purchased by Bayi ID in 1992. Bayi pays between 100,000 and 200,000 yuan per year to purchase water. The amount varies according to rainfall and how much BID requests, which can depend on how many turns are requested from Bayi and the VIMGs. In both Nanyao and Bayi ID's wheat and corn are the main crops. Farms normally receive five irrigations per year. Water is distributed by the ID to respective VIMGs according to a pre-announced schedule.

All VIMGs are responsible to schedule, manage and record water deliveries within the village area. Deliveries are arranged to irrigate one farm at a time along a given canal, starting from the farm nearest the top end and working downstream. The duration of each turn depends on how long it takes the water to reach the entire field. This varies between 10 minutes to one-half an hour per mu for furrow irrigated wheat. A member of the VIMG opens and closes canal offtakes for each water turn and records the time of start and finish and assesses the individual volumetric fee on the basis of the actual duration of the turn. If a farmer has not paid the water fee before his scheduled irrigation delivery, the VIMG pays his fee to the district (so that the village-level payment is complete before its scheduled irrigation) and his turn is delayed until he pays. Sometimes water delivery to a village is delayed if the VIMG is late in paying the fee to the ID. Information on volume of water delivery scheduled, schedule dates and times and target fee level assessed to the village are all posted publicly in the village. After the irrigation the information is completed with comparative information on actual schedule and volume of delivery implemented. Actual assessable fee is recorded for comparison with target fee assessment. Adjustments to payments on the basis of actual recorded deliveries, for either adding or reimbursing, are normally made at a meeting of VIMG representatives with irrigation district staff at the end of the cultivation year, usually in December.

In Bayi ID actual discharges are monitored by superiors and compared with targets. Bonuses are given or refused on the basis of the evaluations. The Director of Bayi ID fines staff who do not deliver the right amount of water on time and for the right duration, to branch canals. District staff and a VIMG staff jointly measure actual discharges at the head of each sub-sub-branch canal once a day for the duration of the village's water delivery period. In Nanyao and Bayi, staff gauges, current meters, v-notch and cipoletti weirs and flumes are used to measure water deliveries from the main canal to branch offtake levels. In Bayi water is also measured down to the level of "sub-sub branch" outlets..

Since Bayi ID purchases a considerable amount of water each year in wants to improve water use efficiency. To encourage greater efficiency, Bayi ID gives a small cash bonus to VIMGs for using less water than planned (+ Yn 10-20). These bonuses are paid from money collected from fines ID gives to some villages who waste water. (Sometimes a village doesn't prepare all its land or repair or clean channels properly so they need and request more water than planned.)

The irrigation districts generally settle irrigation disputes which are not settled by the VIMGs or which are between villages. Common sanctions for breaking rules, such as taking water out of turn are given a fine

(the most common method). Farmers who damage structures are required to repair the structures and pay a fine. Irrigation districts also have the legal right to cut off water delivery to farmers, but this is very rarely used.

In Bayi ID farmers caught illegally opening field offtake gates must pay twice the area and volumetric water fee assessed for that irrigation. The last time this happened was in 1985. For repeated offenses they would pay an extra Yn 200 to Yn 500. For closing cross regulators, farmers would pay double the water fee for the estimated amount of illegal extra water taken, plus an additional Yn 100 to Yn 200. If the farmer refuses to pay, he is sent to the police station. This happened sometimes before 1985, but rarely thereafter, except in 1987 which was a drought year. The district never fines farmers for absence at the time of scheduled delivery; they just move his or her turn to the end of the schedule for the village. For damaging structures, farmers must pay for the repairs and the police give a fine. This last happened in Bayi the winter of 1990.

Maintenance

In Nanyao the average annual unpaid maintenance labor contribution from farmers is about 11 days, 10 days for sub-branch canals, plus normally one day on main or branch canals. The actual number of farmer unpaid maintenance labor required varies between villages according to the amount of land served and the length of channels used in the village. In Bayi maintenance labor requirements for farmers varies between villages but is in the order of 15 to 20 work days per year. Most of this labor is for maintenance and repair of channels below the main and branch canal levels. Farmers are permitted to substitute a payment in cash for a day of maintenance labor not worked, paid at the rate of a standard day's labor cost.

Performance Impacts of the Reforms

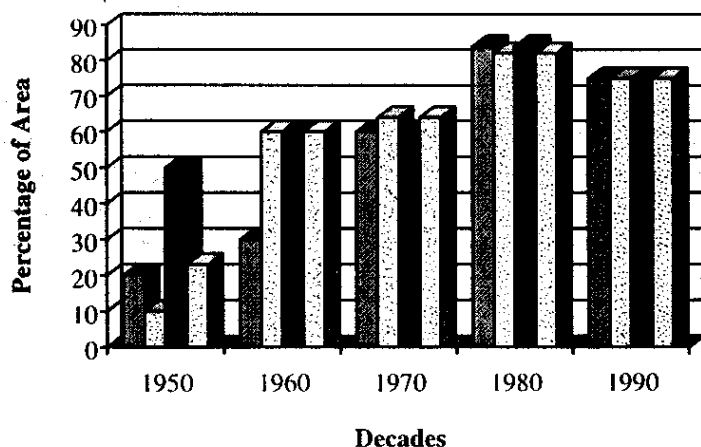
Although there is no question that the rural reforms have resulted in significant changes in the way water resources and, in particular, irrigation are managed in China, the critical question is whether these changes have resulted in improvements in performance. In this section, performance impacts of rural reforms are examined in terms of three aspects: agronomic changes, financial sustainability, and hydrologic efficiency.

Agronomic Changes

As indicated earlier, access to irrigation water significantly changed the cropping patterns in the two districts. Before construction of the irrigation districts in Bayi and Nanyao, the main crops were maize and other spring sown crops such as spiked millet, sweet potatoes, buckwheat, and beans, which are all drought tolerant crops. Very little winter wheat was grown. During the 1980s, after the irrigation systems had been established and were working well, the percentage of irrigated winter wheat and maize in the cropping system reached its highest levels. This is illustrated in Figure 6. Recently, however, farmers have shifted to growing more cash crops such as watermelon, vegetables and fruit trees in order to maximize their income.

Prior to development of Bayi and Nanyao irrigation districts, farmers living in the two regions consumed all their grain production within the household. In fact, in dry years the Government was forced to provide grain to the rural families in the area at below market prices. After the irrigation systems were constructed, as illustrated in Figure 6, irrigated grain production increased significantly. As a result, the farmers sold 1/6th of their winter wheat and 1/10th of their maize production in Nanyao ID and 1/3rd of their winter wheat and 1/10th of their maize production in Bayi ID to the Government. With the development of the agricultural production responsibility system there has been sufficient grain after providing their quota to the Government for farmers to have grain for consumption and still have grain to sell on the local market.

Figure 6. *Percentage of area in irrigated grain crops, Bayi and Nanyao - by decades, 1950s-1990s*



■ Bayi Wheat □ Nanyao Wheat ■ Bayi Maize ▨ Nanyao Maize

Data from IIMI-SIAM collaborative study, 1993-1994

Currently in Bayi ID about 1.5 T/ha of wheat is sold to the Government, about 1.5 T/ha is left for farm family consumption and 1.0 t/ha is sold on the free market. For maize about 10% of the total production is sold to the Government, about 65% is sold on the free market and the remainder is used for animal feed. In Nanyao ID, about 0.75 T/ha winter wheat is sold to government, the remainder is left for family consumption and only a small percentage is sold on the open market. For maize, about 0.75 T/ha is sold to the Government, half of the remainder is sold on the open market and the remaining stock is used for animal feed.

As a result of increased yields, facilitated by access to irrigation water, chemical fertilizers and pesticides, and new high yielding seed varieties, net returns per hectare have increased significantly. Table 5 compares the yields, input levels and net incomes for Bayi and Nanyao IDs for the 1950s, 1960s, 1970s, and 1980s. As can be seen, development of the irrigation systems, combined with implementation of the rural reforms, resulted in impressive improvements in net income in the two districts. Bayi ID, due to its higher yields, has been able to sustain its growth in net income, while Nanyao ID has seen a drop off of net income as annual per ha production of wheat and maize has stagnated during the 1990s.

Table 5. Cost of Inputs, Yields and Returns, 1950-1990

Item	Bayi Irrigation District					Nanyao Irrigation District				
	1950s	1960s	1970s	1980s	1990s	1950s	1960s	1970s	1980s	1990s
Chem. Fert. (yuan/ha.)		8	187.5	740	1535		8	187.5	645	1260
Pesticide (yuan/ha.)			7.5	105	135			7.5	150	150
Manure ¹ (yuan/ha.)	30	30	45	55	55	30	30	45	75	75
Seed (yuan/ha.)	150	180	200	210	390	150	180	200	210	390
Labour ² (yuan/ha.)	270	270	300	310	270	270	270	300	350	380
Machinery (yuan/ha.)			10	157.5	322.5			10	150	202.5
Water fee (yuan/ha.)		6	8	50	240				52.5	225
Total input (yuan/ha.)	450	494	758	1628	2948	450	488	750	1633	2683
Average yield (t/ha.)	1.05	1.6	3.6	8.8	11	0.9	1.4	3.7	7.6	7.6
Market price ³ (yuan/ha.)	0.66	0.87	0.67	0.58	0.69	0.66	0.87	0.67	0.58	0.69
Total output (yuan/ha.)	693	1392	2412	5104	7590	594	1218	2479	4408	5244
Net income (yuan/ha.)	243	898	1654	3477	4643	144	730	1729	2776	2562

[Converted to 1991 Chinese yuan]

¹ Manure price = 1 yuan/m³ for 50s, 60s and 70s; 2 yuan/m³ for 80s and 90s.

² Market price using 0.4 x wheat price + 0.6 x cotton price.

³ Labour = 0.3 yuan/day in 50s and 60s; 0.5 yuan/day in 70s and 1 yuan/day in 80s and 90s.

Financial Sustainability

Central to the transfer of irrigation management, development and reform has been the issue of financing. In this process it has been critical that farmers and irrigation officials alike recognize that irrigation water is not a free good, but a valuable production resource. Since the implementation of the rural reforms, education and propaganda schemes have been used to educate users and suppliers of agricultural water on the importance of financial stability to ensure long-term security of irrigation supplies.

Prior to the reforms, water fees were paid by the communes and thus "collection rates" were always 100 percent. However, as the reforms were instituted, collection rates dropped drastically as there was confusion within the irrigation systems about management responsibility. Improved management services and extensive education programs have been used as a mechanism to increase water fee levels as well as collection rates. These approaches have been successful as water fee collection increased from 4.36 hundred million yuan in 1984 to

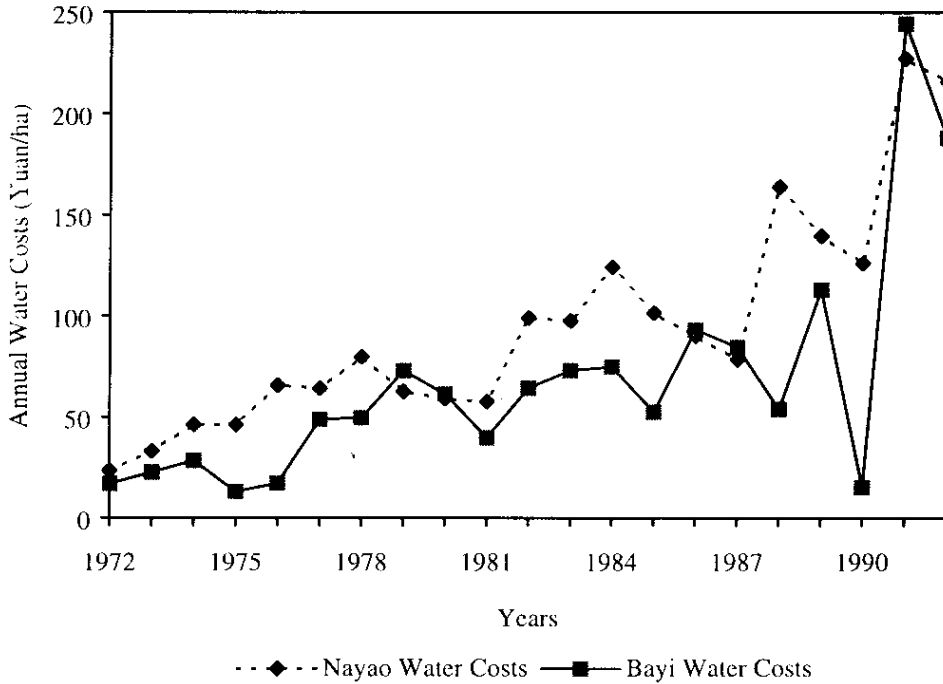
18.3 hundred million yuan in 1991 and in 1992 they doubled to 35.7 hundred million yuan (all in current yuan). In addition to increased fee levels, collection rates increased from 30 percent in 1984 to 70 percent in 1991 (Turner and Nickum, 1994). The reduction in subsidies and the obvious necessity to increase local funding to support operation and maintenance (O&M) expenses also served as catalysts to improved fee collection in many areas.

The situation has been the same in Nanayao and Bayi irrigation districts. Fee levels and collection rates have increased since the institution of the rural reforms. For example, in Nanyao ID the water fee collection rate was 100% until 1984 while it was paid by the commune. After, 1984, when the rural reforms were first introduced, due to the confusion and an actual reduction in irrigation service, combined with an increase in the volumetric water fee, the collection rate fell to 85 percent. It fell even further from 1988 to 1991 as the district struggled with instituting a revised management system, including the WPRS. It wasn't until 1993 that the collection rate rose above 90 percent (95 percent). The case of Bayi ID is even more striking. Again the collection rate for irrigation water fees was 100 percent while paid by the Commune. When the rural reforms were first introduced in 1983, the water fee collection rate fell to 5 percent. It rose to 80 percent the following year and has been fairly close to 100 percent since then.

Water rates and, therefore, actual water costs to the farmers have gone up significantly since the mid 1980s when the reforms were implemented. This is based on the principle, *He who benefits must take responsibility for management and make investments*. In both sample districts, irrigation water fees are a combination of a fixed fee based on irrigated area, and a volumetric fee based on water used. For Nanyao ID the rates are 1.5 yuan/100 m³ and 112.5 yuan/ha, while Bayi ID presently charges 7.19 yuan/100 m³ and 15 yuan/ha. In addition, in Bayi ID irrigation from groundwater costs about 150 yuan/ha. In Nanyao, volumetric charges are only charged at the main canals as they do not have measuring devices at the sub-branch level. Therefore, at the Village Irrigation Management Group (VIMG) level farmers are charged a flat rate of yuan 225 per ha for irrigation water.

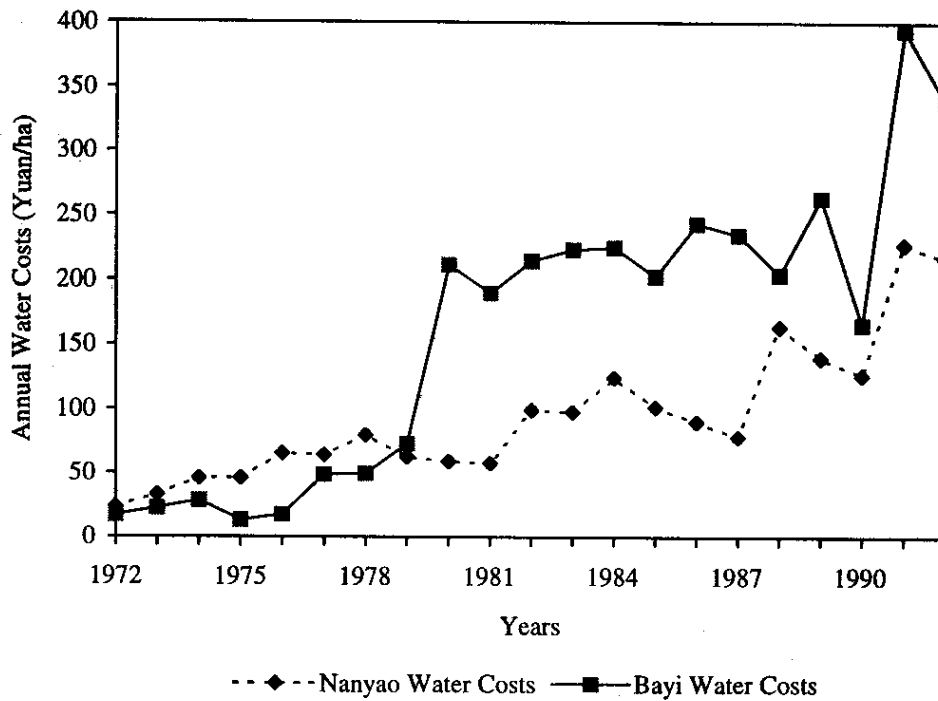
Figure 7 illustrates the historical trend of surface water fees for the two districts. This data is in constant 1991 Chinese yuan so the significant increases are real, not just reflections of inflation in the Chinese yuan. As can be seen, in Nanyao the rate based on volumetric flow is less than the 225 yuan per ha. The additional funds collected are used to pay lower level irrigation staff and provide incentives to the VIMGs to ensure they collect 100% of the water fees. Figure 8 includes the cost of groundwater irrigation for Bayi. It is readily apparent what impact this makes on water costs in the irrigation district. Yet, as the net returns in Bayi about 2,000 yuan/ha more than in Nanyao, the farmers can afford the additional costs.

Figure 7. Per ha. water costs in Bayi and Nanyao Districts



[Converted to 1991 Chinese yuan. Water charges for surface water only]

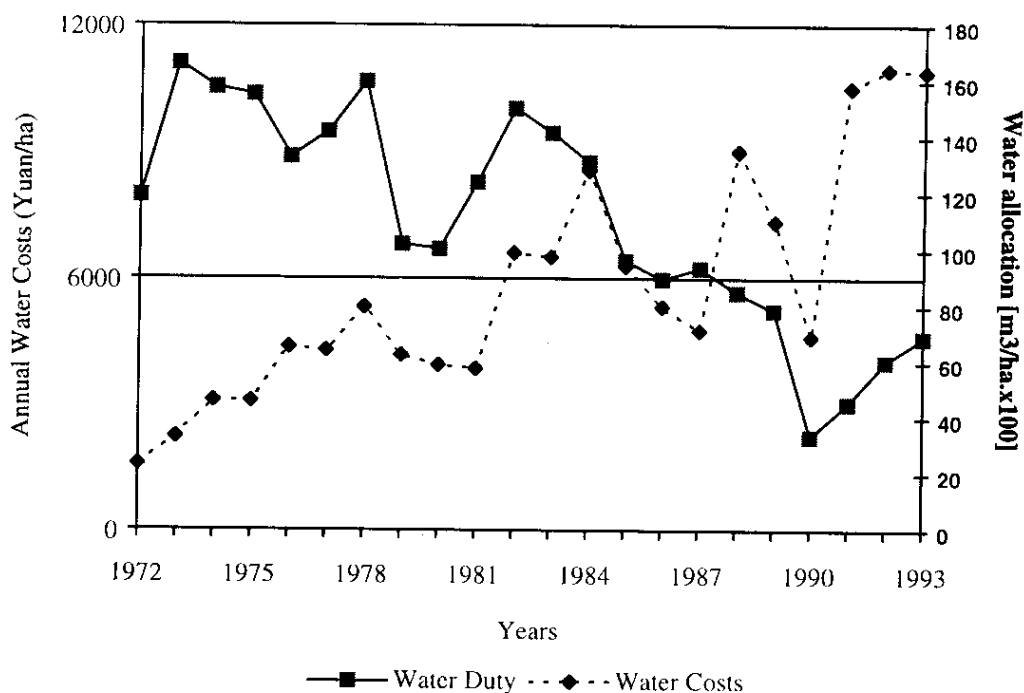
Figure 8 Per ha. water costs in Bayi and Nanyao Districts



[Converted to 1991 Chinese yuan. Including costs of groundwater in Bayi District]

Even though Nanyao is known as a water surplus area and both buys and sells water, the increases in O&M costs as the rural economic reforms and the WPRS have been implemented have forced the actual per ha water costs to increase. As can be seen in Figure 9 the steadily increasing water costs have encouraged conservation in water use, thus per ha water use has declined significantly since the early 1980s.

Figure 9. Annual water costs and duty per ha. Nanyao District. 1972-1993



[Costs converted to 1991 Chinese yuan]

Expenditures and revenues have both increased since the implementation of the economic reforms. As indicated earlier, one of the mechanisms encouraged to address the need for additional revenue is the development of supplemental market-oriented enterprise. To date, Nanyao ID has not developed any such enterprises, but Bayi ID has been extraordinarily successful in this area. At present Bayi ID has 9 enterprises, of which 8 are making a profit. These include:

1. Building materials (producing limestone, cement and bricks)
2. Food and services (two restaurants and a barber shop)
3. Engineering services (design, feasibility studies, and technical consulting)
4. Machinery repairs (farm equipment and pumps)
5. Well installation (well digging and pump installation) and
6. Construction (building and renting apartments and small houses).

Within the district, the ratio of gross income from water fees to gross income from enterprises is 5:3. In terms of net income, the ratio is 2:1. Of the 67 employees in the irrigation district, 30 work in water management while 37 are involved in enterprise management. For diversified enterprise management, targets are established based on anticipated net profit. These are normally negotiated between the irrigation district and the enterprise managers. Up to the level of the target, all profits go to the irrigation district. Profits above the target are retained by the enterprise and are usually distributed as profit-sharing among the enterprise employees. In 1992, the irrigation district received 103,000 yuan in enterprise profits. This combined with the 873,000 in water fees paid by farmers and a small amount of maintenance funds from the county allowed Bayi to cover all of its expenditures, including paying 375,000 yuan to purchase water from Gangnan Reservoir. Thus, Bayi ID has been able to use profits from sideline enterprises to maintain financial stability. In the past Nanyao ID has been able to remain financially stable without requiring other

income. However, with constantly increasing expenditure levels, the district is actively exploring alternative revenue possibilities.

Hydrologic Performance

One of the most important hydrologic relationships in irrigation management is that between available water and land. In this context, one of the primary tasks facing irrigation system managers is to match area to be irrigated with the current water supply. Other things being equal, good managers will try to maximize the area served while producing acceptable yields on all of the area. Viewed another way, the manager's task is to make each available unit of gross water supply go as far as possible.

In Nanyao, irrigated area has remained almost constant for the last 20 years, suggesting that this is the maximum service area of the system. Water supply has shown considerable variability over this period (Figure 10), and these two facts taken together indicate that water supply is not constraining in Nanyao. Combining area and discharge information results in a set of figures portraying the duty of water supplied, which is the amount of water supplied per unit area irrigated. Figure 11 shows that for the period 1972 to 1988, Nanyao had an overall supply in excess of 10,000 m³/ha per year available to it. Following the canal lining program during the 1977-80 period, it can be seen that water deliveries increased sharply before beginning a steady decline from the 1982 peak of almost 25,000 m³/ha. Because area irrigated held steady during this period, the result is reflected in Figure 11 as a steady and dramatic decline in the duty of water supplied in Nanyao. Water use per unit area today is just one-third of the amount supplied in the early 1980s. This is said to be a result of increasing upstream abstractions, as well as the impact of increasing water costs.

Figure 10. Annual discharge into Nanyao District main, branch and sub-branch levels

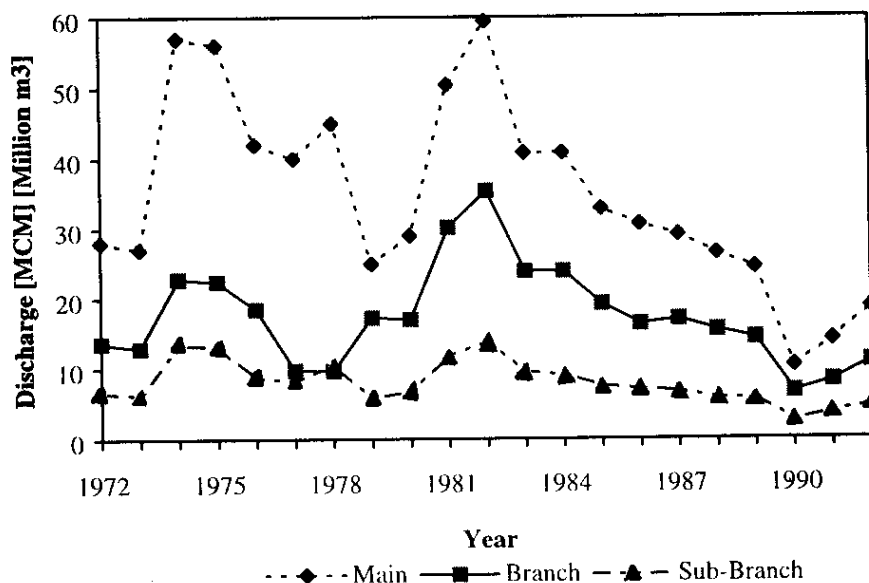
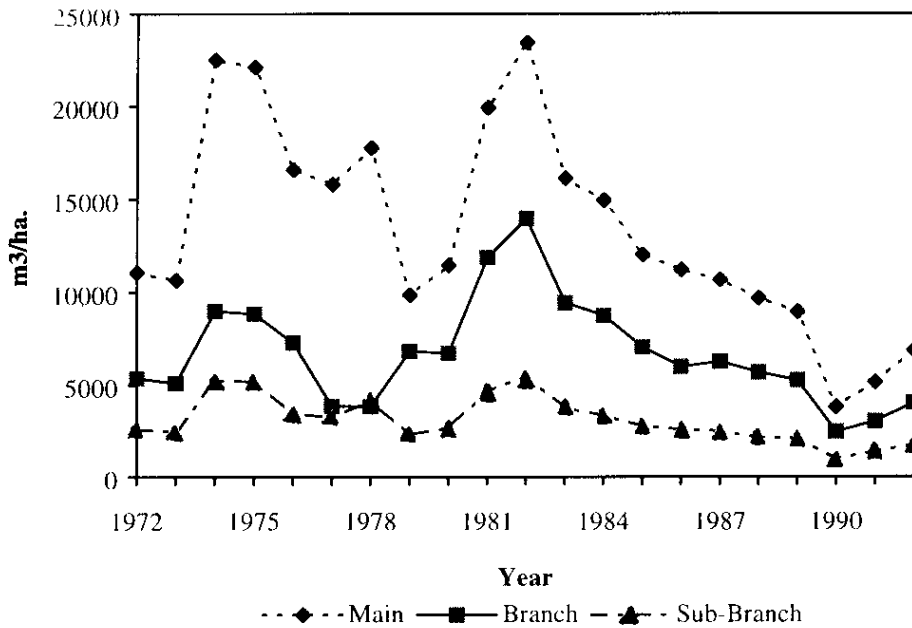


Figure 11. Surface irrigation duty in Nanyao District main, branch and sub-branch levels



In Baiyi, which is located in flatter terrain, only a fraction of the potential command is irrigated, and area irrigated has fluctuated considerably from year to year. Figure 12 shows clearly the result of the completion of the Yingang supply channel from Gangnan Reservoir in 1976, as irrigated area increases dramatically in the following two years, peaking at around 6,600 hectares. In subsequent years, area stabilizes at around 4,500 hectares. Figure 13 shows the main canal discharge, which also increased substantially after 1976, but then shows a continuing downward trend from 1979 to the present. Duty figures (Figure 14) show more variability than do those for Nanyao, but have also declined somewhat from peak years.

Figure 12 Irrigated area in Baiyi and Nanyao Districts

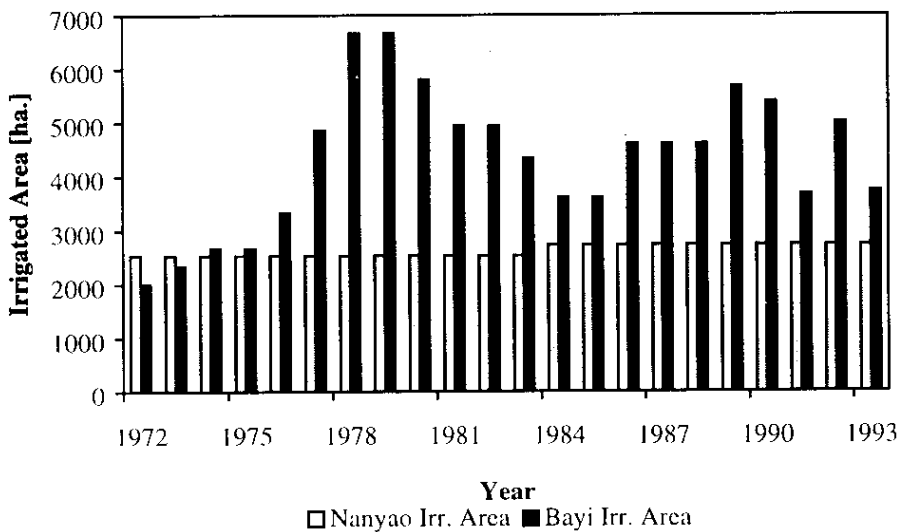


Figure 13. Annual discharge into Bayi District main, branch and sub-branch levels

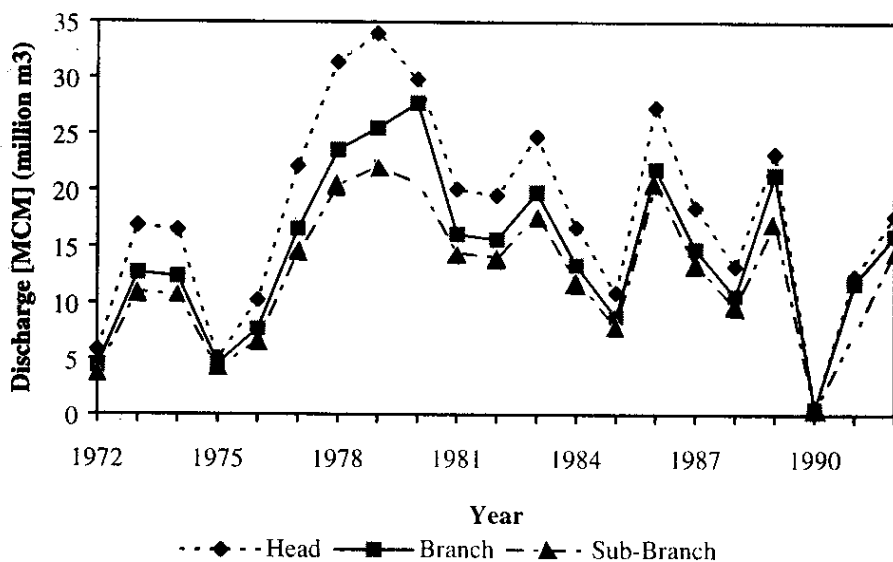
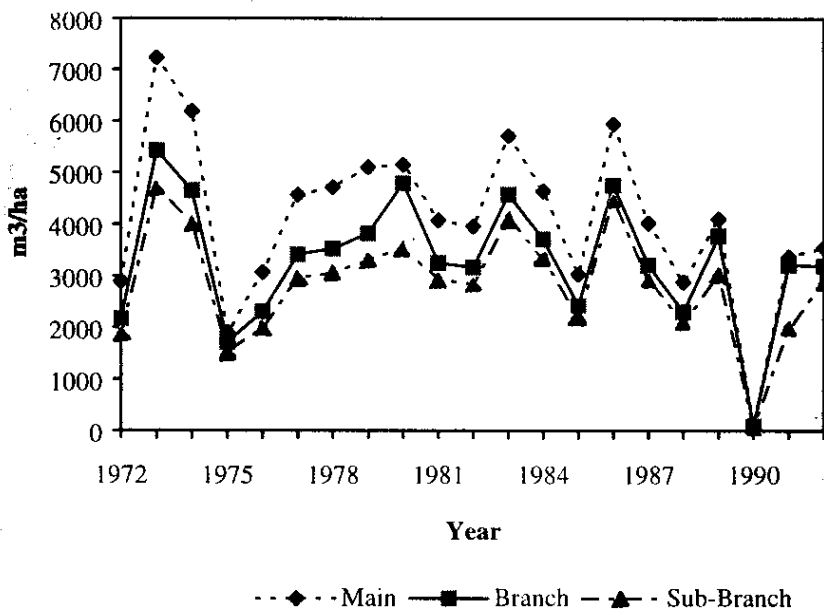


Figure 14. Surface irrigation duty in Bayi District main, branch and sub-branch levels



Even though both systems have shown declining duties over their lifetimes as they come to use water more efficiently, duties in Nanyao and Bayi, though rainfall and cropping patterns are similar, vary widely. What is also quite striking is that although the main system duty in Nanyao is far greater than that for Bayi, as can be seen in Figure 15, the number of surface irrigations for the systems are remarkably similar. The explanation for this can be drawn from Figure 16. As can be seen, in Nanyao on the average about 23 percent of the discharge at the main canal actually reaches the sub-branches while in Bayi on the average 68 percent of the discharge at the main canal is available in the sub-branches for irrigation. Figures 11 and 14 illustrate this same relationship as the duty at the sub-branch level in Nanyao is less than the duty at the sub-branch level for Bayi even though the duty at the main canal is much greater for Nanyao. Access to

groundwater in Bayi and the high distribution losses in Nanyao result in a situation where water in the main canal is much greater in Nanyao than Bayi, yet the water actually available for irrigation is more in Bayi than Nanyao. This can be seen in Figure 17 where the water available at the sub-branch level is around 4-5,000 m³/ha while in Nanyao on the average the water available for irrigation is less than 3,000 m³/ha.

Figure 15. Annual number of surface irrigations sub-branch level discharge, Nanyao and Bayi

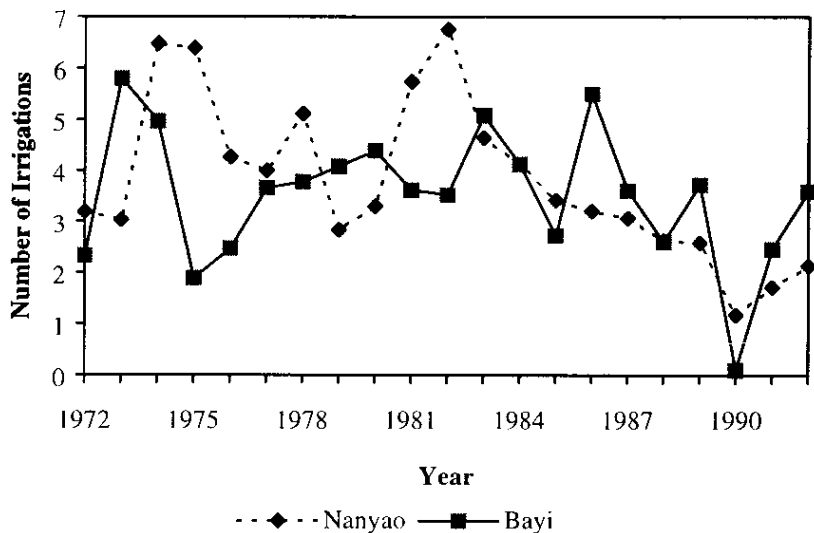


Figure 16. Percentage of discharge reaching sub-branches, Bayi and Nanyao

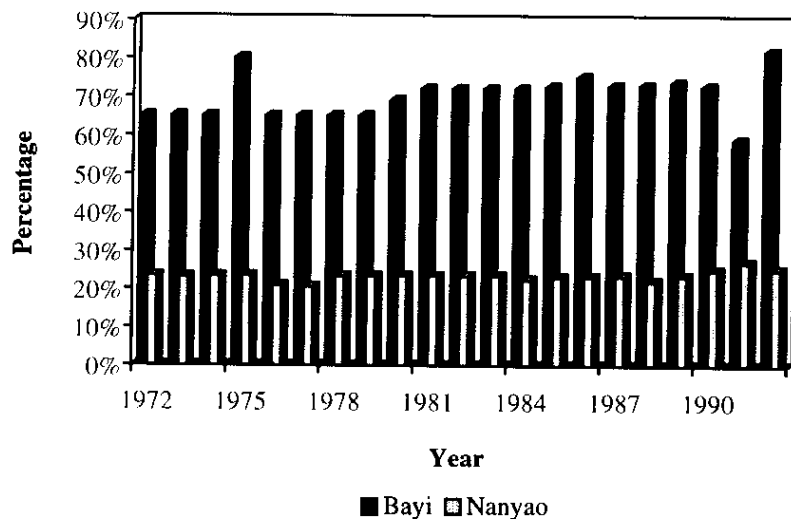
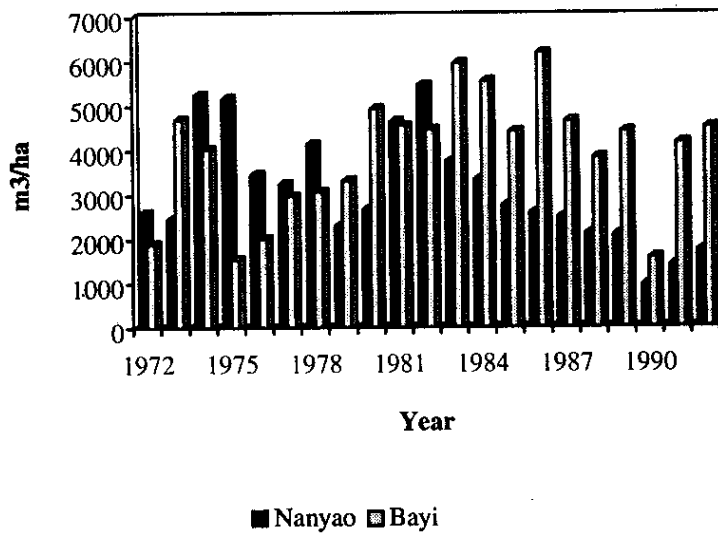


Figure 17. Surface + groundwater irrigation sub-branch level for Bayi and Nanyao



An interesting comparison is presented in Figure 18. This figure shows the annual grain output in Nanyao and Bayi, respectively. Since 1984 the growth in per hectare annual grain output in Bayi has significantly exceeded that of Nanyao. However, when surface water and groundwater supplies are combined, the output per unit water in both systems is remarkably similar. As can be seen in Figure 19, for 1992, Bayi produced about 1.5 kg of grain per cubic meter of water while in Nanyao they produced about 1.3 kg. of grain per cubic meter of water.

Figure 18. Annual wheat and maize yields for two seasons, Nanyao and Bayi Districts

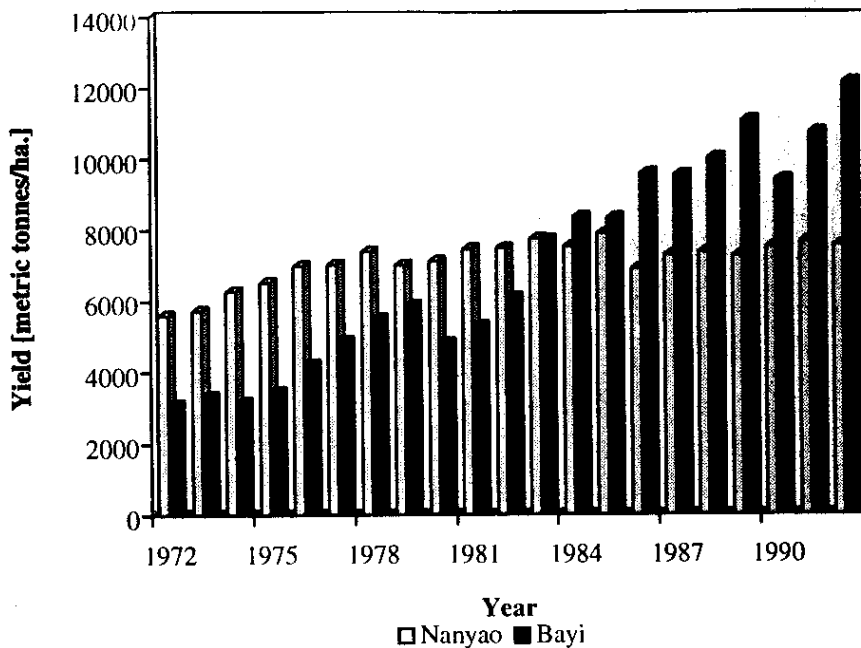
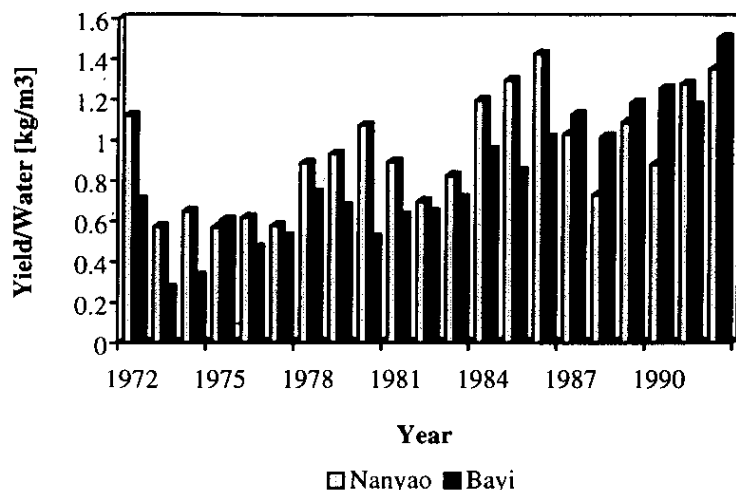


Figure 19. Annual grain yield per unit of water, Nanyao and Bayi Districts



Although the levels of other input use must be considered in making a comparison of overall production, it can be seen that Bayi is producing almost 12 tons of grain/hectare per year while the annual output in Nanyao is only about 8.5 tons/hectare. It is unlikely if Nanyao can increase its grain output without additional irrigation water supplies at the field level. Therefore, the challenge facing Nanyao is to reduce the internal distribution losses. This will require the development of more effective irrigation institutions as well as additional funding for O&M. This, in turn, will require additional funding. Unless the farmers want to pay a significantly higher water tariff, these funds will need to come from sideline enterprises. Thus, it is probably necessary for Nanyao to follow the path taken by Bayi and concentrate on the expansion of sideline enterprises.

Conclusion

National level policy reforms promoting local financial and managerial self-reliance are being adopted, although in a somewhat variable manner, at the level of Nanyao and Bayi Irrigation Districts. Nanyao ID is a smaller system in a less productive area, relative to Bayi. Nanyao ID has been slower in introducing the volumetric water fees and creating village irrigation management groups. It has still not yet developed sideline enterprises. Bayi ID started its first sideline enterprises in 1982. Nanyao ID has a relatively abundant, river-based supply of water and has often been in water surplus. Bayi ID on the other hand is in a water deficit situation and must purchase large amounts of water each year. This dependence on water purchasing, together with the apparent greater ability of farmers to pay (due to higher productivity), may be the driving influences for development of sideline enterprises in Bayi and more concern about improving water use efficiency. Both Nanyao and Bayi ID's have implemented numerous rules and practices which create various financial incentives and accountability mechanisms aimed at enhancing water use efficiency and the transparency of financial accounting and water delivery.

It is apparent that the reforms are producing more viable local management of irrigation. They provide reasonably clear delineation of responsibilities, water rights and linkage between rights to water and paying for it. Where sideline enterprises have developed they are helping to stem the flow of skilled staff out of the irrigation sector by improving facilities and standards of living for families of irrigation district staff and water resources officials.

Farmers must pay the water fee in advance in order to receive water. If they do not in fact receive water their fee is refunded. Within limits, farmers may pay a higher level of fee to receive more water. In Bayi ID, this appears to be a powerful mechanism which achieves an impressive level of performance of water and financial management. The village acts as a mediating guarantor to see that these rules apply to the individual farmer. This appears to be resulting in gradual enhancement of self-reliance of irrigation districts. However, as indicated in Nanyao ID, it is apparent that some irrigation districts in less favorably endowed areas may be in need of external technical and financial support services to implement volumetric water delivery, fee assessment and diversified sideline enterprises.

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2.4 Results of Participatory Management in Two Irrigation Systems in Sri Lanka

Wim H. Kloezen

INTRODUCTION

Similar to other countries in south Asia (Sampath, 1992), in Sri Lanka the cost of operation and maintenance of irrigation systems has been rapidly increasing (Aluwihare and Kikuchi, 1991). At the same time, however, new settlements and programs to rehabilitate physical infrastructure have not realized full productive potential (Gunatilleke, et al., 1992). These developments raise serious questions about state intervention to increase crop productivity and the crisis in financing recurrent costs involved in operation and maintenance. After an era of technological solutions in the 1970s and the early 1980s, the past decade has shown an increasing interest in participatory management strategies which claim to recognize the importance of local knowledge and give a greater role to local people in making decisions, (Bruns, 1993). In Sri Lankan irrigation systems, participatory management is seen as a strategy to develop irrigated agriculture jointly, between irrigation agencies and local farmer organizations. Local organizations take over a share of the responsibility to mobilize resources necessary to manage irrigation systems.

This chapter focuses on reforms in financing operations and maintenance (O&M) in two irrigation systems in Sri Lanka where responsibility for O&M at the field and distributary canal levels has been partially turned over to farmer organizations.

There are two reasons why we would like to focus on financing O&M:

1. The major reason for many participatory management and turnover policies is to reduce the cost of public expenditures for irrigation O&M. However, so far little evidence has been provided whether these policies actually enabled agencies to reduce their costs in the long run. We posit that the performance of O&M and financing farmer organizations in partially turned over irrigation systems will be largely determined by financial constraints in government agencies.
2. Most participatory or management turnover programs in South Asia emphasize the need for establishing *organizational arrangements* and concentrate on crafting institutions for collective action, such as selecting farmer leaders, organizing and training farmer groups and creating internal operating rules. A number of case studies shows that there is concern about the sustainability of newly established water users groups (Meinzen-Dick, et al., 1994). Few studies have addressed the problem of financial sustainability of local organizations in resource management. We posit that many *organizational* problems are linked to a lack of supportive *financial* arrangements. This lack is the result of poor accountability within organizations, as well as continuing political influence and government control over O&M financing. This leads to continuing O&M subsidies and resistance of agency staff to sharing financial control over irrigation.

The key element of participatory management in Sri Lanka is the turnover of O&M responsibility for distributary canals in reform for which farmers become exempt from paying water charges. Although the Sri Lankan government has assumed that these strategies would help to increase farmer willingness to invest in O&M, the two case studies presented in this chapter show that this strategy has led to farmer organizations turning away investments from O&M to non-O&M activities. As a result, some farmers now have better access to agricultural services, but the expected improvements in O&M performance have not materialized.

THE SETTING

This chapter is based on field research in two systems in the Dry Zone of North Central and East Sri Lanka in the period October 1993 to May 1995. The chapter focuses on two water users organizations, one in each system studied: Pubudu organization in Kaudulla Irrigation System and Diyawiddagama organization in Mahaweli System C.

Kaudulla Irrigation Scheme

Kaudulla irrigation scheme is a re-settlement project of more than 5,000 ha situated in the North Central province of Sri Lanka. The reservoir was restored in 1958 as part of nation wide resettlement and colonization policy, in which allottees from the densely populated wet zone in the South West of Sri Lanka were resettled. More than 4,700 allottees were given 0.8 to 1.2 ha of paddy land and 0.4 to 0.8 ha of highland to develop home garden cultivation. The infrastructure of Kaudulla was dramatically modernized and its command area was expanded in two phases. Both phases were completed in 1976. Aluwihare and Kikuchi (1991) report that the cost of construction of new works in the low level main canal area in Kaudulla was US\$ 1,686 per hectare¹ (in 1986 prices or US\$ 2,490 in 1994 prices²). Although this new system was originally designed to irrigate 4,225 ha, owing to encroachment the actual command area is now estimated to be more than 5,000 ha.

In 1986 a USAID-funded participatory management project was initiated to improve the Kaudulla system. The project included development of farmer organizations, system rehabilitation and improvement of O&M management. The responsibility to implement this program was vested with the newly-established Irrigation Management Division (IMD). In the early 1990s farmers were organized in 23 organizations. Farmers developed a system-level federation of farmer organizations, which mainly deals with supplying agricultural input to both farmer organizations and individual farmers. At the end of 1994 (when more than 90% of the work was completed) the cost of the rehabilitation and participatory management program was US\$ 323 per hectare.

Kaudulla receives most of its 1,500 mm annual rainfall during the *maha* season between October and March when most farmers grow paddy. Farmers receive much less rainfall during the *yala* season between April and September, which makes irrigation in this period totally dependent on water availability from the tank. Paddy is the most important crop in both seasons.

The command area is fed by two main canals and it is divided into 23 hydrological units which vary greatly in size from 80 to 260 ha. Each unit generally has one or two distributary canals (DC) which take water from the main canal by means of fully adjustable disc-gates with a screw. Most DC head-gates are operable and are in good condition. Most field channels take water from DCs, but some take it directly from main or branch canals. Screw controlled disc gates are the standard form of outlet from DCs into the FCs. Although some of these outlets have been improved during rehabilitation, the condition of many of these gates is still very poor, with many gates being inoperable. Each FC serves about 10 to 25 farmers, who take water by means of a pipe through the field channel bank.

Mahaweli System C

Mahaweli System C is one of the five major settlement schemes under the Accelerated Mahaweli Ganga Development Project. In 1979 the Mahaweli Authority of Sri Lanka was established under the new Ministry of Mahaweli Development. The accelerated plan covered 160,000 ha of irrigable land, of which approximately 20,000 ha. comes under Mahaweli System C in the eastern part of Sri Lanka.

The estimated total system development expenditure up to 1992 is nearly US\$ 2 billion, which is US\$ 12,500 per ha (Wickramasekera, 1985)³. Construction of Mahaweli System C started in 1981. The two major reservoirs, Ulhitiya and Ratkinda, were completed in 1982 and construction in the last six zones of the system was finished in 1994.

Most settlers arrived after 1984 and came from submerged reservoir areas. At present there are about 21,000 farmer families in System C. The Mahaweli Development program allocated 1 ha. of paddy land and 1-2 ha. for the home stead. Paddy is also the main crop in System C.

Mahaweli System C receives more rainfall than Kaudulla: about 1,750 mm per year (Nippon Koei, 1990). In addition to the two major reservoirs there are about thirty medium and small tanks within the system which are linked in cascades by main, branch and minor canals. These tanks create an enormous buffer capacity within the system and make water management at the level of distributary canals independent from short term changes in main system management. Each tank releases water to one or more distributary canals. Generally, the condition of these structures is much better than the ones in Kaudulla and can be operated as designed.

In the late 1980s Mahaweli System C started experimenting with so-called turnout groups and farmer leaders and in 1992, the Mahaweli Economic Authority (MEA) adopted a participatory management model in which farmer organizations are given O&M responsibilities at and below the level of distributary canals.

Two sample units

In each system one distributary canal unit was selected to study the organizational and financial involvement of farmers in local management of water and services. In Kaudulla "Pubudu" unit is situated along the high level main canal (Annex Figure 1). "Diyawiddagama" is the selected sample unit in Mahaweli System C. The unit has only one distributary canal, which takes water from the small Wewmedagama tank (Annex Figure 2). The general features of the two selected distributary canals are given in Annex Table 1.

PARTICIPATORY MANAGEMENT IN TWO SYSTEMS

The official objective of the participatory management program in Kaudulla is to "establish a harmonization of the various inputs and services necessary for increasing agricultural productivity, with special focus on the use of irrigation water, which has been identified as the most critical and limiting resource in agriculture" (IMD 1984). The emphasis under the program would be on the increase of agricultural production, improvement of water distribution, improved arrangements for inputs supply, establishing farmer organizations, recovery of O&M fees from water users, maintenance by water users and farmer education. In the long term, the program would focus "on handing over to farmer organizations some of the management and operational functions of these projects" (ibid.), which would help relieve pressure on the government budget (IIMI 1993).

The participatory management program launched by MEA explicitly focuses on expanding the role of farmers in water management and in guaranteeing the physical sustainability of the system. The Mahaweli Authority of Sri Lanka states that the main objectives of participatory management are to ensure optimization of the benefits of the massive investments of the Mahaweli project (MASL 1992).

When asked about the main objective of farmer organizations, 28% of water users in the Pubudu sample of farmers in Kaudulla see achieving equitable water distribution as the main objective of the farmer

organization⁴. Improving maintenance of the distributary canal and field channels is considered by 23% of the farmers to be the most important objective. Five percent of the farmers believe that the farmer organization should mainly do rehabilitation contract work, whereas 10% feels that the organization should primarily be involved in supply of inputs and paddy marketing. This means that 61% of the farmers mentioned that O&M and rehabilitation related objectives are most important roles of farmer organizations.

Survey answers by 40 farmers from Diyawiddagama in Mahaweli System C give an entirely different picture. Input supply (58%) and paddy marketing (13%) are considered to be the most important objectives. Only 13% believes that improving water distribution is most important and 10% feels that the main objective of the farmer organization is to improve maintenance. Five percent believes that the farmer organization should mainly deal with rehabilitation contracts. The majority of farmers feel that the only objective of the farmer organization is to provide better access to cheap inputs and better marketing facilities.

The agencies

Participatory management or "turnover" is 'executed' as top-down, planned intervention strategies, in which management-by-objectives, formalization and standardization are the *modus operandi*.

One of the major components of participatory management in both systems is the creation of joint management committees at different levels of the system, in which agency staff and representatives of the water user groups mutually take decisions on water allocation, rehabilitation works to be done and seasonal crop planning. The major point of discussion within these meetings tends to be the 'need' for more repairs and rehabilitation.

Pubudu farmer organization in Kaudulla

The Pubudu farmer organization was established on 17 March 1987. In the first year of its existence the organization hardly functioned, but this changed after new leaders were selected in 1988 and a constitution was drawn and approved in the annual general meeting, attended by the majority of farmers. The organization comprises 377 farmers. Although Pubudu farmers have always been involved in cleaning parts of the two distributary canals in the Pubudu area, maintenance responsibilities were officially turned over to them in March 1990. In 1991 Pubudu got officially registered with the Commissioner of Agrarian Services under the Agrarian Service Act 58 of 1979. Registration provides the organization with rights to formulate and implement agricultural programs, carry out construction works, market produce and distribute inputs. It also helps the organization to obtain access to institutional credit. In 1994 Pubudu also took over responsibility for water distribution at the level of the distributary canal. The president of Pubudu is a very committed man who spends more time on the farmer organization than any other member of the Executive Committee. The president also attends most of the project management meetings in which he mainly discusses problems with contract work and paddy marketing.

Federation of farmer organizations in Kaudulla

Kaudulla was one of the first schemes in Sri Lanka in which farmers attempted to federate the distributary canal (DC) farmer organizations into a system-level farmer organization (SLFO). In April 1991 a president, a secretary and a treasurer were selected from among the presidents of the farmer organizations and the presidents of other DC-level organizations were made executive members of the SLFO. To develop its own funds, the SLFO (or "Federation") required all farmer organizations to deposit one thousand rupees as a membership fee. The Federation mainly helps farmer organizations obtain access to cheap inputs like

fertilizers, agro-chemical and seed paddy. It is also actively involved in helping farmer organizations to develop their own channels for paddy marketing. It is very active in the Joint Management Committee. Already, after a few years, the Federation became so heavily involved in activities which serve the overall goals of the Joint Management Committee, that it was decided that the president of the Federation should take over the chair of the monthly Joint Management Committee meetings from IMD project management. Although many of the issues discussed in the Joint Management Committee are similar to ones dealt with in the meetings of the Federation, the Federation continues to have its own meetings, normally directly after the Joint Management Committee meeting.

The Federation has not officially been registered with the commissioner of the Department of Agrarian Services. As a result it has no access to institutional services like bank loans. The Federation tries to solve this by involving the farmer organizations, which are registered, to get bank loans (which are subsequently used for the federation). This makes the Federation financially dependent on the farmer organizations. Although the Federation tries to keep their independent status, its leaders admit that it must be registered in order to be able to continue its activities. According to the president of the federation the main goal of the SLFO is to improve farmer living standards by providing lower prices for inputs and getting higher prices for paddy.

Diyawiddagama farmer organization in Mahaweli System C

Similar to other units in Mahaweli System C, turnout groups in Diyawiddagama barely functioned at first. The first Diyawiddagama unit level farmer organization was created by MEA in May 1990. The main goal of the organization was to solve general problems related to irrigated agriculture. These unit level farmer organizations never became very active. This changed in 1993 when MEA redefined the purposes and boundaries of the farmer organizations. MEA decided that farmer organizations should follow the hydraulic boundaries of distributary canals. In order to reactivate the farmer organization, new leaders were elected from among the farmers who participated in the first Unit Coordinating Committee in March 1993.

Almost immediately the new organization became involved in supply of fertilizers and agro-chemicals to farmers. Compared to neighboring organizations, Diyawiddagama was actively involved in several rehabilitation projects, both inside and outside Diyawiddagama area. In the *maha* season of 1993-94, Diyawiddagama organization became an official agent of the government Paddy Marketing Board (PMB), which means that it could buy paddy from farmers and sell it for a guaranteed price to the PMB. The farmer organization was provided a room in the office of the unit manager.

In July 1993, the Diyawiddagama farmer organization officially became registered under section 56a of the Agrarian Service Act. This meant that they then had the same authority as Pubudu in Kaudulla. In 1994, i.e. one year after the implementation of its participatory management program, MEA selected a number of farmer organizations with whom they started to actively negotiate about the conditions for full turnover of O&M at the level of the distributary. These negotiations forced Diyawiddagama to organize a number of meetings in which they tried to formulate their own position regarding turnover. In July 1994 they decided to sign the first agreement with MEA and in December 1994 the second agreement was signed in which they officially took over the responsibility to manage the distributary canal. The agreements stipulate the responsibilities, rights and authority of both MEA and the farmer organization. As in Pubudu, the evolution of the farmer organization in Diyawiddagama has been heavily determined by its leaders, especially by the president and the secretary, both of whom have been in office since inception.

FINANCING O&M IN THE DISTRIBUTARY CANALS AFTER TURNOVER

There are four key financial aspects of the Sri Lanka turnover policy:

1. exempting farmers from paying water charges to the government,
2. having farmers pay fees to water user groups,
3. granting O&M contracts to farmers,
4. involving farmers in rehabilitation contracts.

Under these terms the government continues subsidizing O&M. But at what level and for how long have not yet been made clear.

Exempting farmers from paying water taxes

In Sri Lanka O&M cost recovery has been subject to rancorous political debate and propaganda (see Annex A). Efforts in the early 1980s to establish a user fee in Sri Lanka failed. Political unrest in the late 1980s made water tax collection all together impossible, with the result that even up to the date of exempting farmers from paying water fees very few farmers paid them. The highest recorded amount of water fees paid in Kaudulla was in 1987 when almost US\$ 5,500 was collected, which is an average of US\$1.1 per hectare (compared with the levied US\$ 5.2 per ha.). Since then the payment has declined dramatically to almost nil, after 1991. The collected amount of water fees in Mahaweli System C has always been negligible, mainly because Mahaweli staff never really tried to collect the fees. Exemption from paying water charges, therefore, provided little motivation for farmers to take over O&M.

Granting O&M contracts

The Irrigation Department in Kaudulla pays farmer organizations a small sum for operations and maintenance of the distributary channel. The government expected farmer organizations to carry out weeding, cleaning and desilting and that the contract money is used to buy materials and hire a ditch tender. The Mahaweli participatory management program has adopted this strategy as well.

Interviews with farmers and agency staff and observations of joint management meetings show that there are several difficulties with implementing this strategy. The main problem for both farmers and local agency staff is the lack of clarity about the level of payment, the number of seasons into the future for which this payment will be provided and the stringent eligibility requirements and procedures that must be followed to apply for contracts. The agency only pays a part of the estimated maintenance cost, assuming that the difference will be covered by farmers providing 'free' labor. However, the percentage that the Irrigation Department in Kaudulla provides differs from year to year. In 1992, 1993 and 1994, 20%, 33% and 30% of the regular maintenance budget was allocated to farmer organizations. The amount paid in 1994 is approximately US\$ 1.10 per hectare. In addition to payments for maintenance, in 1994 about 30% of the operational budget was allocated to the organizations (being approximately US\$ 0.65 per hectare). It is not clear how long the Irrigation Department can and will continue paying these allocations. At the time of this study, the Irrigation Department continued to pay irrespective of the fact that the distributary canal had not been cleaned for two years.

The situation in Mahaweli System C is even less clear. Mahaweli started paying some farmer organizations O&M allocations from the beginning of 1993 onwards. It was not made clear which organizations would be paid and which ones would be excluded. Generally, organizations are poorly informed about the level of

payment, but the Mahaweli Authority claims that they pay US\$ 8.30 per hectare per year for O&M, plus US\$ 6.30 per hectare per year for system improvement. This is far more than the amounts paid to the organizations which are reported in this study. Most farmer leaders complain about delays in payments.

There is no apparent relationship between receiving O&M grants and farmer activity to improve operation and maintenance of the main canal. In both cases it was observed that the allocations are used to build up a fund from which they finance the development of non-O&M related services, without compensating labor contributed by farmers for O&M. The idea behind the operational allocation provided to Kaudulla farmer organizations is that the organizations can hire their own ditch tender. Nevertheless organizations in Kaudulla decided to leave operation of the distributary canal to the leaders and use the allocation for non O&M purposes. Farmer leaders of the organization studied in Mahaweli System C likewise decided to organize water distribution among themselves (with a major role for the president) after Mahaweli had withdrawn its ditchtenders.

Involving farmers in rehabilitation works

In 1986, the USAID-funded Irrigation System Management Project was started in Kaudulla. This included rehabilitation and improvement of irrigation structures at the distributary and field channels. In this project farmer organizations were given priority contract offers to undertake rehabilitation work in their respective distributary areas. In both Kaudulla and Mahaweli System C, farmer organizations agreed to deposit 5% of the value of contracts into the farmer organization's fund to build up savings.

Many farmer organizations received contracts, but many problems have occurred in financial management. In some cases there is a broad gap between the time the technical assistant made the estimate and the moment that the final payment was made. With the rapid inflation of both wages and costs for materials farmer organization have found it difficult to complete the work within the estimated budget. Although the turnover program makes clear that contracts should be taken in the name of the farmer organization, it was observed that many contracts were taken by individual farmers, (especially leaders of the farmer organizations) without involving the farmer organization. This caused conflicts and loss of credibility between the president of the organization and the members, especially in System C.

A survey done among Kaudulla and Mahaweli farmers shows that the majority of farmers perceive that contracts are exclusively taken by leaders of the organizations. Seventy percent of farmers in Kaudulla and 88% of Mahaweli farmers had no idea of the value of contracts taken and how much of the contract payments had been deposited into the organizations' funds.

An important question is, Whether farmer involvement in rehabilitation contracts has created positive mechanisms that enable farmers to improve their future O&M? Many interviews and observations indicate that there is no relationship between the organization's involvement in rehabilitation contracts and its sense of responsibility for maintaining rehabilitated structures. Farmer leaders repeatedly stated that the only reason to take a contract is to be able to earn additional income. They showed little interest in improving the system. Rather than using the income from rehabilitation works for future repairs and O&M, farmer organizations use their revenue from contracts to develop other, non O&M related service activities, such as wholesale provision of inputs and marketing.

Paying fees to water user groups

Although farmers generally did not pay water charges, in both schemes in this study the policy is that members should pay fees to their farmer organizations, for which 100% can be used by the organizations

themselves. In Kaudulla farmers pay a one-time membership fee of US 5 cents and a seasonal fee of US\$ 2.00. However, our survey shows that on average farmers have paid these fees for only three seasons since 1985. Farmer leaders complain that they have no authority to collect seasonal fees and that they do not want to start conflicts with members over these fees.

In System C in addition to a US 10 cents membership fee, Mahaweli farmers can buy *shares*, which give them the right to buy inputs from farmer organizations. Farmers initially paid US\$ 2.00, but later on many increased their shares to US\$ 10.00 or even US\$ 20.00. The organization decided that some one with a higher share has the right to buy more inputs. When they realized that this share is still not sufficient to prefinance the purchase of inputs by the organization some farmers increased their shares to US\$ 40.00. Farmer leaders expect that other farmers will follow this example. However, everyone who paid more than US\$ 10.00 has equal access, which means that so far those who bought higher shares have not received any benefit from purchasing marginal amounts of additional shares.

The number of shareholders increased dramatically during the two years after the inception of the farmer organization. The clear link between paying a share fee and having access to the services provided by the organizations explains why 63% of sample farmers know that virtually all the organization's income is used to expand the provision of inputs. None of the farmers think that fees are used for O&M and system improvement, which corresponds with our observations.

HYDROLOGIC AND AGRICULTURAL PERFORMANCE

Before we turn to an analysis of the financial performance of the farmer organizations and agencies, it is important to briefly discuss the impact of participatory management on the hydrologic and agricultural performance of both systems. It is hypothesized that this level of performance will shape the willingness of farmers and the agencies to invest in improving O&M⁵.

Water delivery performance

Seasonal water supplies for Kaudulla show a slight declining trend between 1984 and 1994 (Annex Figure 3). The tank water delivery in Mahaweli System C has always remained to be high: between 4,000 and 5,000 per year (Annex Figure 4)⁶. The main reason for these high supplies is that Mahaweli System C farmers have access to water which eventually will be allocated to the not-yet-completed neighboring Mahaweli System B.

Relative water supply

The above mentioned improvement in system level water delivery performance in Kaudulla is also reflected in the improvement in the Relative Water Supply (RWS) measured at the sluices of the main canals⁷. With a tank supply of 1519 mm and an effective rainfall of 62 mm, the total supply for yala 1994 is 1554 mm. With an ET_{paddy} of 838 mm and an additional consumption of 329 mm for land preparation and percolation, the total consumptive use is 1167 mm. This give us a RWS of 1.33⁸. The average RWS of the 1978-1993 *yala* seasons was 1.45. This is probably near to an optimum level if we assume conveyance losses of approximately 50 per cent.

Comparing RWS at the sluice level with RWS at levels at and within distributary canals gives us an indication of how equal water distribution was within the system. The measured water supply at the head of the distributary in Pubudu was 1,605 mm for *yala* 1994. The RWS at the level of the head intake of distributary is 1.40, which is higher than the system RWS of 1.33⁹. Water is distributed very inequitable

along the main canal. There are clear indications that Pubudu receives more water than some of its neighboring areas. As is shown below, the main reason for this is the way distributary canal operation (by the farmers) interacts with main system operation (by the Irrigation Department).

Comparing RWS at selected points within the distributary canal shows an even greater inequity in water distribution. Whereas the RWS at the head gate is 1.40, the RWS at the first field channel (FC23) was 2.17, at a middle reach field channel (FC30) it was 2.15, and at the last field channel (FC40) it was 0.98. This does not necessarily mean that fields in the upper and middle reaches receive more than twice their requirements and fields in the tail end reaches receive less than their requirements. Farmers of FC40 and other tail-end canals reported that they can heavily rely on drain water from fields in the middle and head end reaches of the distributary canal. Still, these farmers frequently reported problems with water shortages as this drainage supply is less reliable and predictable than direct supply from the distributary canal.

As Diyawiddagama in Mahaweli System C is fed by one of the many tanks that are relatively independent from main system management, we only consider the RWS at and within Diyawiddagama distributary canal. As reliable time series data on water supply at this level are not available, we cannot make a historical comparison. The ET_{paddy} requirement for yala 1994 was 723 mm. Owing to a high percolation rate of 6 mm/day, the total requirement for land preparation and percolation is 798 mm, giving a total consumptive use of 1,521 mm. With a total measured tank supply of 2,594 mm and an effective rainfall of 62 mm, the RWS is 1.75, which again is considerably higher than Kaudulla¹⁰. Also in Diyawiddagama there are great differences between the RWS at selected points in the distributary canal¹¹. Annex Figure 5 shows that the first field channel has an extremely high RWS of 3.2, while some other channels are lower than the average system RWS of 1.75. Still, the last channel along the distributary canal has a RWS of 1.89. Given the overall high RWS, none of the Diyawiddagama farmers reported difficulties with water shortages.

Water distribution practices

Although farmers frequently complained about inequitable water distribution and a failing rotation system, the leaders tried to convince both the water users and IIMI researchers that they were strictly following a rotation schedule in which all field channels would receive water for a certain number of days and would subsequently be closed to allow other field channels to take water. However our twice daily monitoring of water flows to all field channels show that there is no rotation pattern and that most field channels continuously receive some water. Observations and interviews show that the leaders mainly respond to farmers who come to visit them with complaints about irrigation turns.

Even after turning over O&M responsibilities to farmer organizations, the Irrigation Department remains responsible for controlling and operating the head gates of distributary canals. It was observed that farmers have some influence over these gate-keepers. They generally follow farmer requests to open or close head-gates. In some cases gate-keepers first consult the irrigation engineer and sometimes farmer organizations, but generally this does not result in refusing farmer requests. Also, officially the distributary canal only receives water for three days a week as the Irrigation Department tries to follow a rotation schedule at the main canal. However, only in a few occasions did the distributary canal not receive water at all.

An almost identical pattern can be found in Diyawiddagama. Our observations on gate settings and water flows show that during the entire yala season, all field channels continuously received water. The ditch tender mainly opened or closed the head gate of the distributary canal (for which he received instructions from the MEA irrigation engineer) and occasionally adjusted field channel turnout gates.

Impact of participatory management on O&M performance

Our observations of RWS and water distribution clearly show potential for improvement. Although in Kaudulla RWS is still high, the major problem seems to be unequal distribution of water. Also in Mahaweli System C there is a clear difference in the quantity of water in different sections along the distributary canal. But owing to the extremely high RWS numbers all along the canal, no farmer suffers from water shortage. This explains the relatively small interest Diyawiddagama farmers have in using the farmer organization to improve O&M. In Kaudulla there is clearly a need for O&M improvement, which explains why the majority of farmers feel that the organization should primarily work on O&M improvement.

From the above data it is hard to tell whether O&M performance at the level of the distributary canal has been improved as a result of participatory management. The O&M survey of 40 water users in each of the two systems shows that 49% of water users in Kaudulla did not see any change in O&M performance of the distributary canal after turnover, 16% saw a slight improvement, 8% reported a considerable improvement, and 23% felt that O&M performance deteriorated after the organization took over O&M responsibilities. Kaudulla farmers are especially critical about the organization's involvement in canal maintenance: 63% saw no improvement, 20% saw some improvement and 17% thought that canal maintenance had worsened. Data on actual maintenance done by Pubudu were incomplete, but the survey and interviews showed that very few farmers contribute 'free' labor for canal maintenance. At the time of the study, the distributary canal had not been cleaned for two years.

The responses in Diyawiddagama are more positive: 31% saw no improvement; 44% saw some improvement and 25% saw considerable improvement. None of the respondents perceived deterioration in O&M performance. 80% of the respondents said that canal maintenance had considerably improved owing to an increase in unpaid maintenance activities by farmers.

Agricultural performance

Normally, the Irrigation Department recommends that the farmers cultivate only 50% of the command area during the dry *yala* season. One of major achievements of farmers' involvement in deciding on the water delivery schedule was to encourage the Irrigation Department to shift away from the 50%, to cultivating the full command area. This resulted in an increase in annual cropping intensity in Kaudulla from 138% in 1989 to 200% in 1994 (Annex Figure 6).

This is a substantial improvement considering the fact that at the same time the total water supply (irrigation supply plus rainfall) of both the *maha* and the *yala* seasons declined slightly (Annex Figure 3). Annual crop intensities in Mahaweli System C have always been close to 200%.

Although in both systems attempts have been made to introduce a diversified crop system, more than 98% of the irrigated area remains planted with paddy. Our Kaudulla household surveys show an average yield of 3,660 kgs. per ha in the *maha* 1993-94 season and 4,360 kgs. per ha in the *yala* 1994 season. For Diyawiddagama these figures are 2,900 kgs. and 3,760 kgs. respectively¹². The gross value of output (GVO) was US\$ 1,136.00 per ha per year for Pubudu and US\$ 944.00 per ha per year for Diyawiddagama (with 200% crop intensities in both systems). As reliable water supply data for the *maha* season are not available, we can only compute the GVO per m³ for the *yala* 1994 season. In Pubudu the GVO was US\$ 38.00 per 1,000 m³ of tank water supply, whereas in Diyawiddagama it was US\$ 20.50¹³

From the household surveys we also found that the costs of materials, fertilizers, chemicals, rental of equipment and draught animals and hired labor for paddy production were US\$ 695 per ha per year in

Kaudulla and US\$ 400 in Mahaweli System C. With an assumed opportunity cost for family labor of US\$ 188 per ha per year (Bhatia and Samad 1995), the computed Net Profit of Production was US\$ 253.00 and US\$ 356.00 per ha per year in Kaudulla and Mahaweli System C respectively.

FINANCIAL PERFORMANCE OF FARMER ORGANIZATIONS

Having explained the major financial strategies in two schemes undergoing participatory management and the impact of these strategies on system performance, we now examine the impacts of these financial strategies on financial performance, both for the farmer organizations and the agencies.

In addition to membership or shareholder fees, farmer organizations generate revenues from a number of other activities which they are involved in, including taking on rehabilitation contracts, providing agricultural inputs, paddy marketing and renting out two-wheel tractors. Taking over rehabilitation contracts used to be the main source of income for both farmer organizations, but as most rehabilitation has been finished this source of funds has been discontinued.

The farmer federation in Kaudulla supplies inputs to both individual farmers (through the shop they have in the Kaudulla Project office building) and farmer organizations. The federation depends on the contributions of farmer organizations to build up funds to purchase agricultural inputs. Since the federation is not officially registered, it cannot apply for loans from banks. It can only get bank loans through individual farmer organizations, which are registered. The federation requests farmer organizations to deposit an average amount of US\$ 208, to be repaid with 5% interest, from which they buy inputs for the organizations. This means that a considerable part of farmer organization funds goes through the federation.

Income from rehabilitation contracts

Until 1992 one of the most important sources of revenue of the farmer organizations in Kaudulla was rehabilitation contracts. The total cost of rehabilitation in Pubudu between 1990 and 1994 was US\$ 88,800 (US\$ 296 per ha), of which US\$ 14,900 (17%) has been contracted out to the Pubudu farmer organization (Annex Figure 7). In theory, Pubudu should have earned approximately US\$ 745 (i.e. 5%) from its involvement in contract work. However, the organization's record books shows an earning of US\$ 1,270.

The total amount spent by the government for system improvement in the Diyawiddagama unit between 1990 and 1994, was approximately US\$ 10,100 (or US\$ 51 per ha).¹⁴ Neither the block office nor the farmer organizations keep clear records on the number and value of contracts given out to Diyawiddagama organization. This is partly because of the farmer leader's personal involvement in receiving contracts. From interviews with farmer leaders and minutes taken at joint management meetings, it can be learned that the value of contracts taken by the organization and or its leaders is about US\$ 6,900, which is 68% of the estimated US\$ 10,100 of system improvement works done in Diyawiddagama area. In theory, this means that US\$ 344 should have been deposited in the organization's account, however we could not find evidence of this in the organization's books.

Fee collection

As mentioned earlier, Pubudu organization in Kaudulla has almost no income from fees. Between 1990 and 1991, only US\$ 630.00 was collected from the members, which is an average of only US\$ 0.20 per season per farmer,¹⁵ instead of the proposed US\$ 2.00 per season, an average collection rate of only 10%. However, the number of shareholders of Diyawiddagama in Mahaweli System C increased rapidly, from 5% of the

total farmers in 1993 to 81% in 1995. Within less than three years the organization collected US\$ 1,750 from its shareholders, which is almost US\$ 10.0 0 per farmer per hectare.

Both organizations mainly use these fees to invest in the provision of fertilizers and agro-chemicals and paddy marketing. Nevertheless, the survey among Kaudulla farmers shows that 63% of the farmers believe that these fees are mainly used to pre-finance rehabilitation works. Thirteen percent mentioned the supply of inputs and paddy marketing as being the prime use of the fees, while only 10% thought that the fees are collected to improve O&M. In contrast, 85% of the Mahaweli farmers knew that their shares are primarily used to buy and sell inputs at a discount. None of the farmers mentioned that these payments are used to cover the cost of O&M. Fifty-eight per cent of the Kaudulla farmers interviewed are willing to pay a higher fee if these fees are used to considerably improve input supply (39% of the group that is willing), 30% are willing for maintenance and system improvement or other services like giving out loans. Ninety percent of the farmers in Mahaweli mentioned that they are willing to increase their shares, primarily to further improve the provision of inputs and paddy marketing (89%). Only one farmer mentioned that the assets should be used to improve O&M.

In Kaudulla there is a clear divergence in what farmers want the organization to do with the collected fees (improve O&M) and what leaders actually do (use the fees for input supplies and marketing, from which they can receive personal gain). This explains why farmers stopped paying into the organization. On the other hand, in the case of Mahaweli System C there is a clear relationship between what the organization does with the collected fees and what the farmers want it to do.

Supply of fertilizers and agro-chemicals

One of the organizations' key activities is to supply fertilizers and agro-chemicals at discounted bulk rates. Farmer leaders take an active role in contacting fertilizer boards and private suppliers of agro-chemicals and negotiating bulk rates. Kaudulla started their sales in 1991 and had peak sales in 1993 (Figure 1). They have been able to receive several trade loans to buy agricultural inputs. Owing to high costs of transport as well as their objective to keep prices as low as possible for the farmers, the maximum net profit the organization made was 5% in the first season. This came down to less than 1% of the total sales in the wet season of 1993-94, which was the last season they were involved in this activity. The total net profit in this period is approximately US\$ 100. After its peak in 1993, sales dropped dramatically and ceased all together in 1994. The leaders questioned whether they will ever be able to start the sales again.

The Federation in Kaudulla started providing inputs in Maha 1991-92. For the first three seasons it was able to hold or increase its market position.¹⁶ However, its initial success in selling inputs gradually declined after Yala 1993, with no sales of fertilizers at all in Maha 1994-95 (Figure 2). The organization managed to maintain a 4% net profit level from its US\$ 200,000 turnover between Maha 1992-93 and Maha 1994-95, which constituted an approximate net income of US\$ 8,300¹⁷. The major reason for the decline in selling inputs is the Federation's dependence on funds and loans from farmer organizations and the growing reluctance among the organizations to financially support the Federation. It was observed during joint management meetings that leaders of several farmer organizations expressed their discontent with the way the Federation was handling sales of inputs.

Figure 1. Sale of inputs and paddy marketing by Pubudu, Kaudulla, Maha 1991/92 to Yala 1994

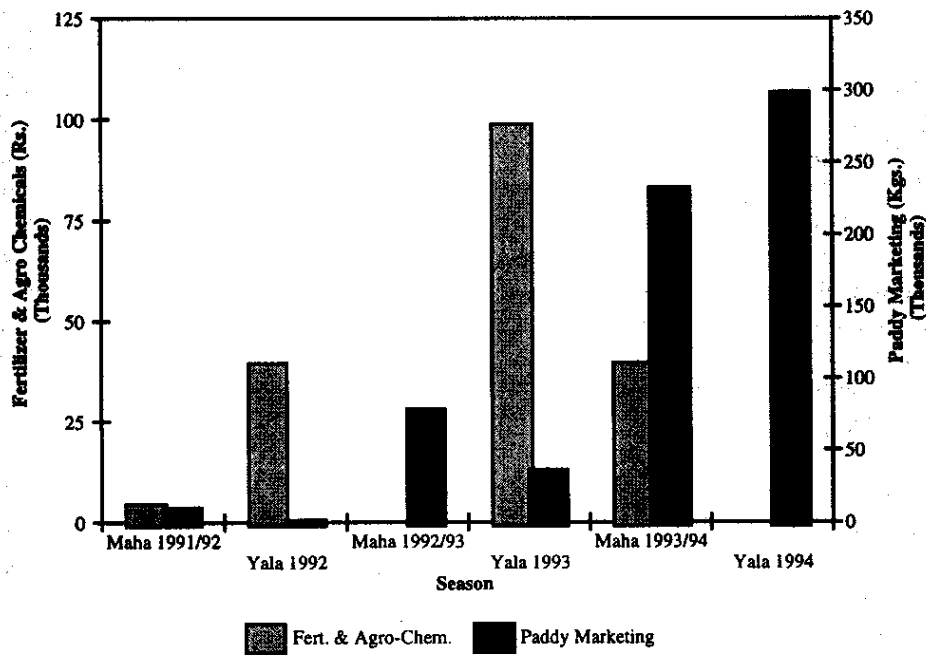
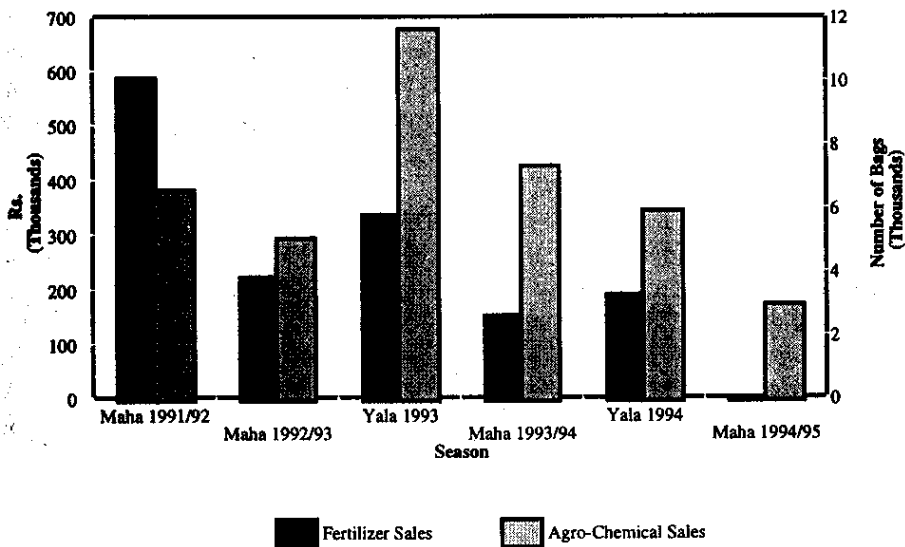


Figure 2 Fertilizer and agro-chemical sales, Kaudulla Farmers' Federation, Maha 1991/92 to Maha 1994/95



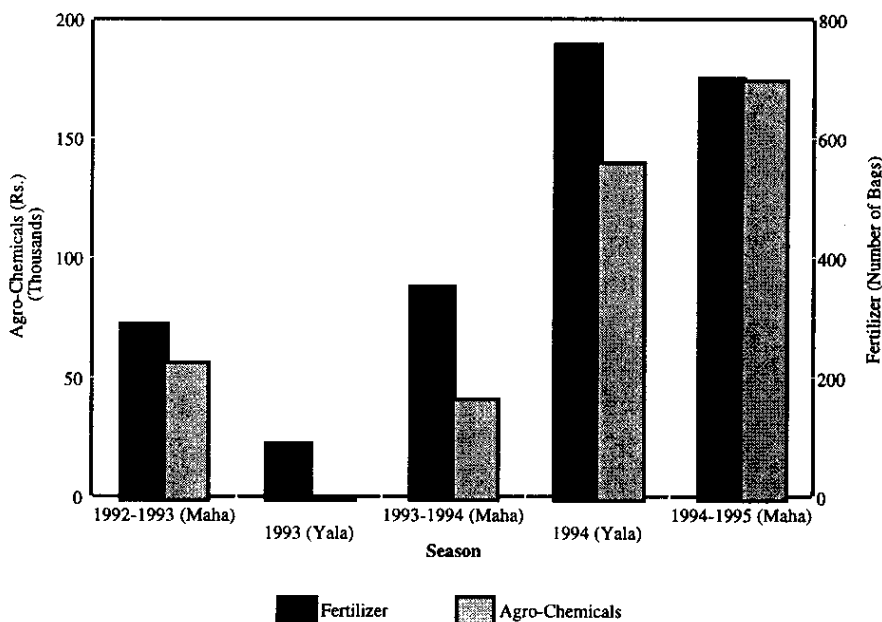
The complaints included:

- delays in delivery of inputs (so that in the end farmers had to go to local private traders),
- the marginal difference between the Federation's prices and those of private traders,
- the suspicion by some farmers that the president was using the Federation to profit personally from fertilizer sales and private companies, and
- the distorted relationship between the financial contribution of farmer organizations and the amount of inputs the Federation supplied to these organizations.

The Federation began providing inputs to farmer organizations that had not contributed to the Federation's funds, and even to farmers from outside Kaudulla. The last situation especially made several farmer organizations decide not to provide any funds to the Federation, which further aggravated the Federation's constraint of inadequate capital to purchase inputs in bulk.

Figure 3 shows that the farmer organization in Mahaweli performs well in terms of increasing sales of both fertilizers and agro-chemicals¹⁸. As the office of the organization is situated at the major road in Mahaweli System C, transport costs remain low. The organization obtained a steady profit of between 2.5% and 3% for fertilizer sales and around 2% for the sale of agro-chemicals. There is a proportional relationship between the shares they pay and the amount of inputs they can buy from the organization. Still, farmers feel that they cannot always buy as high an amount of inputs as they want because of the limited stock the organization can keep as a result of lack of sufficient capital. Similar to Kaudulla, because of this problem, shareholders started to question the practice of the organization of selling inputs to non-shareholders.

Figure 3. Sales of fertilizers and agro-chemicals by Diyawiddagama farmer organization in Mahaweli System C, 1992-1995



Paddy marketing

Farmer organizations in Kaudulla and Mahaweli have both been involved in paddy marketing. In 1994 the Government decided that registered farmer organizations can become agents of the government-controlled Paddy Marketing Board (PMB). This has advantages for both farmers and their organizations. For farmers, the price they receive from the PMB is generally Rs 0.5 to Rs 1.0 per kg higher than prices received from private traders and middlemen. Moreover, farmers do not have to deal with the PMB directly, which helps avoid problems with the quality of the paddy that is offered by individual farmers and the extra transaction costs involved in individual farmers dealing with the PMB¹⁹. Farmer organizations can generate extra income if they succeed in keeping the costs low for collecting, weighing and transporting paddy to the stores. There is a difference of about one cent (Sri Lankan) per kg between what the PMB pays the organizations and what the organizations pay the paddy producers.

In the dry season of 1994 the organization in Kaudulla marketed approximately 20% of the paddy produced in its area. It used its own two-wheel tractor plus trailer to transport the paddy to the stores. The net profit from paddy marketing remained around 1.5%.

The organization in Mahaweli also became heavily involved in paddy marketing. It expanded the marketed bulk from 172,000 kg in the wet season of 1993-94 (its first season) to 273,000 kg in 1995. Compared to Kaudulla, the organization in Mahaweli had lower transaction costs. The Mahaweli Authority provided the organization with a store and use of a truck, for which they only had to pay the cost of fuel. Additional costs are renting of a scale and hiring a number of laborers to weigh the paddy and load the truck. Because of the large number of laborers that were hired by the president in the first season, the net profit was only 1.5%. This increased to 3.3% in the wet season of 1994-95 after the president had been criticized by other farmers for spending so much on labor costs. As the Mahaweli farmer organization also bought paddy from neighboring units, it is not possible to assess the organization's share in marketing paddy from the Mahaweli area alone. In addition to the 172,000 kg bought directly from farmers, the president of the organization also made a deal with an employee of the Paddy Marketing Board and a private trader. With the unofficial permission of the PMB employee the president allowed the private trader to use the organization to sell 367,000 kg. to the Board, so that the private trader received a price higher than the current private market price.²⁰ As this was heavily criticized by other farmers, the president had to give up the practice.

O&M expenditures

In 1994, Pubudu organization received approximately US\$ 515 (or US\$ 1.70 per ha) from the Irrigation Department for O&M contracts. The ID estimated that the value of farmer involvement in maintenance in Pubudu would be approximately US\$ 1,000, which is US\$ 3.30 per hectare. This means that about two thirds of the total O&M cost was to be covered by the organization itself, in both labor and materials. However, in two years farmers contributed almost no labor to maintain the canal and spent only US\$ 45 on hired labor. The organization did not use its US\$ 200 grant for system operation to hire a ditchtender. The total amount spent on maintenance materials and fuel for maintenance equipment was US\$ 52, which is far below the anticipated amount. The rest was deposited in the organization's bank account and was not set aside to be used for O&M.

Financial investment in O&M by the Diyawiddagama organization in System C was negligible.

Non O&M expenditures

Expenditures made for input supply, paddy marketing and other operational costs are generally higher in Kaudulla than in Mahaweli System C. Both organizations have high labor and transport costs, which are associated with transporting inputs and paddy, and in the case of Mahaweli, hiring watchmen for the paddy store and people to load the truck. Pubudu spent a considerable amount on interest on bank loans and other banking costs. In 1994, the Kaudulla organization spent US\$ 4.50 per ha on administrative and support service expenses, without being heavily involved in providing inputs. Average expenses were US\$ 3.00 between 1990 and 1994. The organization in Mahaweli, which was heavily involved in both input supply and paddy marketing, spent US\$ 13 per ha.

Over the years both organizations managed to increase their assets. By the end of 1994, the Kaudulla organization had accumulated US\$ 3,000 (US\$ 10 per ha). The organization in Mahaweli had accumulated US\$ 2,800 (US\$ 14 per ha.). As the anticipated US\$ 3.30 per ha of own O&M contribution in Kaudulla was not spent in 1994, we conclude that the organization decided to build up reserve funds for non-O&M activities, thereby deferring maintenance.

Financial self-sufficiency

Farmer organizations do not collect fees for O&M, so that the financial self-sufficiency at the level of the distributary canals is zero.

One of our main questions is, Whether participatory management in Sri Lanka has helped farmers organizations to become self-sufficient financially? A comparison between internal revenue (fee collection and selling services) and external revenue (government financing) net income shows that the farmer organization in Mahaweli System C is more capable to raise its own funds than the organization in Kaudulla, Still, in both cases the organization heavily relies on O&M subsidies and income from rehabilitation contracts: 60% and 61% in Pubudu and Diyawiddagama, respectively. Especially in the case of Kaudulla, self-sufficiency has declined over the last few years owing to declining income from fee collection and provision of inputs (Table 1).

Table 1. Total net revenue of farmer organizations: internal versus government sources of income (in US\$)

		Pubudu Kaudulla 1990-1994	Kaudulla Federation 1992-1994	Diyawiddagama Mahaweli System C 1992-1994
Internal sources	*Seasonal fees	630		
	*Shareholder fees			1,750
	*Supply of fertilizers and agro-chemicals	100	8,300	770
	*Paddy marketing	700		
	*Providing seed paddy		1,040	3,300
	Sub Total	1,430	9,340	5,820
	Average per ha. per year	1.0	0.6	9.3
External sources	*5% from rehabilitation contracts	745		344
	*O&M grants	1,536		*2,920
	Sub total	2,281		3,264
	Average per ha. per year	1.5		14.6
	Total	3,711	9,340	9,084
Total average per year		2.5	0.6	23.9
External as % of total net income		60%	0%	61%

**Note: This is the amount officially reported by the Mahaweli Economic Authority for 1994. (Farmer leaders report that MEA has not paid this amount.)*

FINANCIAL PERFORMANCE OF IRRIGATION AGENCIES

Reducing O&M staff

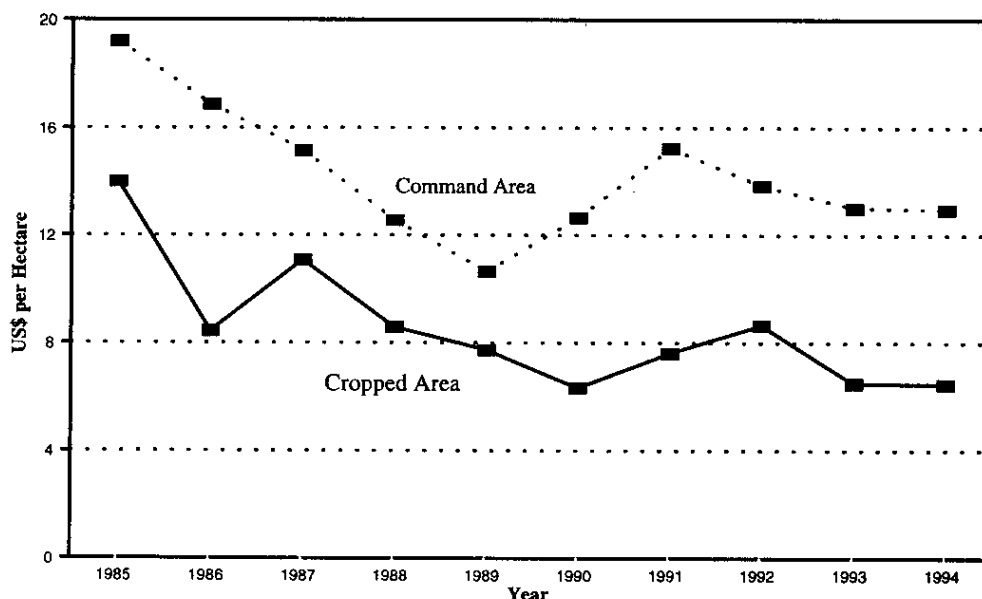
As pointed out earlier, the Sri Lankan government decided not to collect water charges in order for farmers to take over partial responsibility for financing of the cost of O&M. Another way to reduce public expenditures on O&M is to reduce staff. In the case of Kaudulla none of the regular staff have been made redundant as a result of the participatory management and the turnover process. Nor did the number of temporary employees decline.

In the case of Mahaweli System C, the anticipated reduction in the number local agency managers did not occur. The number of unit managers remains the same. At the end of 1994, Mahaweli stopped paying some of its ditchtenders and handed over operational contracts to the water users organizations who could then hire their own ditchtenders. At this time, however, it was not yet clear when the Mahaweli Economic Agency would phase out subsidizing both the remaining ditchtenders and the operation contracts to the organizations.

Reducing O&M expenditures

Annual government O&M expenditures in Kaudulla decreased since 1984 from US\$ 97,000 in 1985 to US\$ 65,500 in 1994 (constant 1994 prices), a reduction of 33%. Figure 4 shows that these figures correspond with US\$ 19.40 per ha of command area in 1985 and US\$ 13.10 per ha of command area in 1994²¹. As the annual cropping intensity increased from 138% in 1989 to 200% in 1994, the O&M expenditures per cropped area decreased more than the expenditures per command area. The decline in O&M expenses between 1985 and 1989 was the result of the fact that part of actual O&M expenses was charged to the rehabilitation project which started in 1994.²²

Figure 4. O&M expenditure per hectare, Kaudulla 1985-1994 (in constant 1994 US\$)

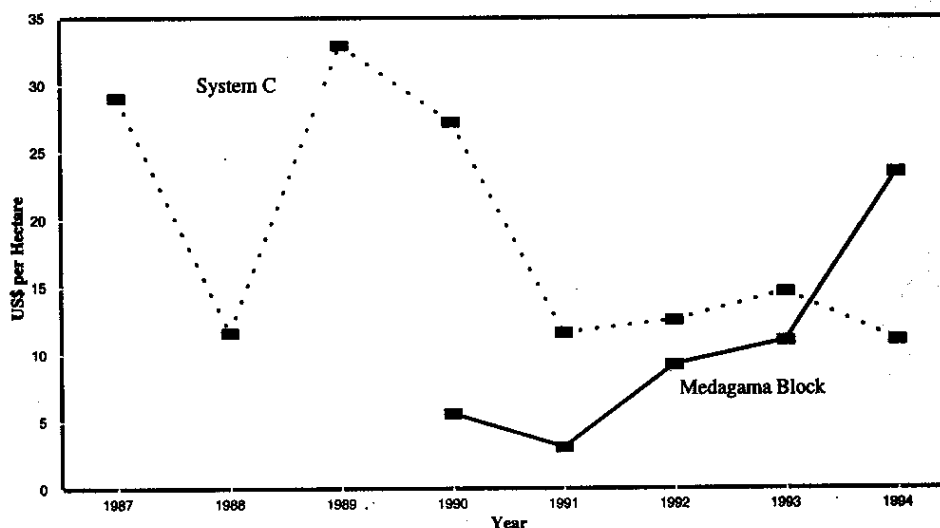


The decline in O&M expenditures per hectare can be explained by the fact that:

1. some of the regular O&M work is covered by funds under the rehabilitation program, and
2. the quality of O&M at the main system level been declined. (For example, desilting the main canal is changed from twice to only once per year).

Figure 5 shows the development in actual O&M expenses (in constant 1994 US\$) for both the entire Mahaweli System C and the area under the Diyawiddagama pilot organization in the Medagama Block. As far as the averages of the entire system are concerned, there has been a dramatic decline in O&M expenses per hectare: from almost US\$ 30 in 1987 to US\$ 11 in 1994. As the participatory management program only started in late 1992 it is not possible to attribute most of the reductions in O&M expenditures to this program. However, the trends are mutually supporting. At the level of the pilot organization we see a different picture arise, from almost US\$ 6 per ha in 1990 to US\$ 24 per ha in 1994, which is due to the extra attention (including an increase in O&M contracts) this area received, being a pilot area for system rehabilitation and participatory management under a Japanese aid program.

Figure 5. Actual O&M expenditures per hectare for System C and Medagama, 1987-1994



FINANCIAL PROBLEMS OF FARMER ORGANIZATIONS

The multi-functional farmer organizations in Kaudulla and Mahaweli System C performed well financially in the first few seasons of their involvement in new activities. However, the Pubudu organization has almost collapsed after four years of existence and the farmer federation in Kaudulla is facing severe difficulties. There are signs that the distributary organization in Mahaweli System C will follow the same pattern. There are at least seven reasons which explain this:

1. Lack of capital to bulk-purchase fertilizers and agro-chemicals from the fertilizer cooperation or private companies. Lack of access to credit facilities and the high 'transaction' costs of banking.
2. Increasing competition by other input supplying agents like the system level farmer federation in Kaudulla, other farmer cooperatives and private traders.
3. The inability of farmer organizations to supply inputs on time and on credit. Farmers prefer to pay for their inputs after completion of the harvest, even if they have to pay a high interest. The organizations neither have the resources to pre-finance these inputs, nor have the means to force farmers to pay their dues after they have sold their harvest.
4. The high cost involved in transporting inputs to the office of the farmer organization and the small savings farmers make by buying fertilizers from the farmer organization.
5. Mixed government support and resistance to water user groups being involved in the provision of non-O&M services.

6. Lack of interest of leaders to invest free labor in activities that are not remunerative to them and resistance from members to further deal with leaders that have tried to personally take profits from these activities. Rather than trying to replace influential leaders, farmers generally choose to drop out of the organization.
7. Lack of financial accountability and transparency within the organizations.

Organization members have little, if any, control over the leaders' involvement in financial transactions. The economic and political status of leaders as well as the lack of direct representation in the organization make it difficult to force leaders to become more accountable. Since leaders are not paid, members are further reluctant to dispose of them for poor performance or "rent seeking" behavior. With current levels of income generation and fee collection, hiring more professional leaders is not a feasible option.

FINANCIAL PROBLEMS OF IRRIGATION AGENCIES

Centralized financing

There has been more rhetoric than reality about implementing turnover and participatory management. Little has changed at higher levels of the irrigation bureaucracy. Although the government espouses farmer participation at the local level, they have not devolved financial control and authority over O&M. Operation and maintenance budgets are still centrally determined and allocated. Allocations are adjusted throughout the year. The government still largely finances O&M.

CONCLUSIONS

The four most important conclusions of this chapter are the following:

1. Owing to both political interference in irrigation fee policies and resistance from agency staff, participatory management in Sri Lanka has only involved turning over O&M responsibilities to farmers at the level of distributary canals. No financial responsibility or authority over the O&M budget was transferred. The government continues to be the primary source of finance for O&M.
2. The contradiction between farmers having partial responsibility for O&M versus government controlling the financing of O&M has resulted in disappointing O&M performance. The strategy has neither increased farmer financial contributions to O&M nor resulted in significant reductions in government expenditures in O&M.
3. However, participatory management in Sri Lanka created the environment for farmers to gain more control over surplus of inputs, marketing and some agrarian services. The Federation in Kaudulla and the Diyawiddagama organization in Mahaweli System C have the potential to raise their own funds by getting involved in providing these services to farmers. However, there are serious concerns about the financial sustainability of these organizations: about 60% of the capital of the farmer organizations comes directly from public O&M sources.
4. Instead of using public O&M funds to invest in O&M improvements, both organizations use the funds for non-O&M activities. In System C, farmers have no problem with access to water. Under these conditions farmers prefer to use their resources for agricultural support needs. Farmers have no control over leaders over how they use the organization's funds. The unconditional financial support for O&M from the agencies and government control over O&M financing do not create incentives for farmers to

invest in O&M. Also, the low level of net returns for paddy production prompted farmers to place priority on reducing input prices and increasing sale prices through the of government O&M grants.

Participatory management should include more than establishing farmer organizations and asking them to take over O&M responsibilities. Local reforms should be accompanied by reforms within the agencies as well. Organizational reforms can only be introduced if they are supported by financial reforms. This study supports the following recommendations, if the policy goal of local self reliance for irrigation is to be achieved:

1. O&M grants to farmer organizations should be reduced or eliminated;
2. Require local matching investments in order to obtain government subsidies;
3. Take measures to strengthen the legal status of farmer organizations and mechanisms for accountability of leaders to members;
4. Establish measurable water rights;
5. Require farmer payment for O&M services;
6. Reorient the gation agency to become service-providing authorities which are made accountable to the water users through dependence of the agency on service fees;
7. Declare clear policies about the separation of responsibilities between farmers organizations and government agencies.²³

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END NOTES

¹ These costs include irrigation infrastructure development expenditures, but exclude costs related to settlement, supervision and general administration and overhead.

² In 1986 US\$ 1 = Rs 28. In 1994 US\$ 1 = Rs 48. Unless mentioned otherwise, constant 1994 US\$ prices are used in the rest of this chapter.

³ Aluwihare and Kikuchi (1991) estimate the cost of construction of Mahaweli System C (i.e., excluding other settlement costs and general administration) at US\$ 7,200 per ha (1986 prices).

⁴ Sample sizes were 40 farmers each in Kaudulla and Mahaweli System C. Selections random, stratified by upper versus lower end locations.

⁵ Hydrologic time series data at the level of the main system were obtained from the government offices at the system level. At the levels of the selected distributary canals and field channels measurement devices were installed and calibrated at selected control points. Twice daily water readings were taken at these points, as well as the gate settings of all the gates in the distributary canals and field inlets of selected field channels. The readings were converted into daily and weekly supplies (in mm) and the observation of the gate settings were converted into actual rotation schedules. As the *maha* 1993-94 season was heavily distorted by floods, we only consider the *yala* 1994 measurements for this chapter. In order to be able to make a rough comparison of hydrologic performance before and after the participatory management program, our *yala* 1994 data are compared with averages of the *yala* 1978-1983 seasons, which were studied by Abernethy (Data for 1985). Agricultural production data were obtained from two household surveys of 40 farmers in Pubudu and 40 farmers in Diyawiddagama, respectively.

⁶ As reliable rainfall data were not available for all seasons, Annex Figure 3 only includes actual tank water supply. An average of 1,750 mm per year of rainfall can be added to these figures.

⁷ RWS is here defined as the ratio of Total Tank Water Supply plus Effective Rainfall to Consumptive Use. Consumptive Use is defined as the total water requirement for Et_{paddy} . Land preparation and daily percolation and have been calculated by using CROPWAT. Consumptive Use excludes conveyance losses and system runoff.

⁸ Considering only the ET requirement for paddy gives us Relative Water Supply of 1.85.

⁹ For the same distributary canal Abernethy reports an average RWS of 1.15 for the 1978-1983 *yala* seasons.

¹⁰ Considering only the ET requirement for paddy gives us a RWS of 3.70.

¹¹ Given the fact that the distributary canal and most field channels are lined, conveyance losses are assumed to be low.

¹² The relatively low *maha* figures are due to crop damage as a result of severe flooding.

¹³ These GVOs correspond with US\$ 52.00 and US\$ 35.00 per 1,000 m³ Water Consumed.

¹⁴ The total expenditure on system improvement in Medagama block (2,059 ha) is US\$ 104,069. The estimated expenditure in Diyawiddagama (200 ha) should at least be US\$ 1,010, but is probably higher knowing that Diyawiddagama organization received extra attention being 'a model unit'.

¹⁵ This equals about US\$ 2.00 per season per ha, as the average paddy landholding is 1 ha.

¹⁶ It is estimated that the Federation served approximately 30% of demand for fertilizer in the area in 1992 and 10% of demand in 1994.

¹⁷ 4% is actually an insignificant level of net profit given interest rates on credit in area of about 9% for government sponsored loans and much more in the private sector.

¹⁸ As the organization also sells to farmers outside Kaudulla it is hard to assess what percentage of the fertilizer market in Kaudulla the organization serves, but it is estimated for 1994 that this is more than 50%.

¹⁹ It is commonly known among farmers that for each load of paddy they deliver to the PMB farmers are expected to contribute one bag of paddy to the manager of the stores.

²⁰ Farmer organizations that are officially registered as agents of the PMB receive a guaranteed price, which unregistered private traders do not get.

²¹ These actual expenses are higher than the estimated average O&M expenditures of major schemes in Sri Lanka, which according to Fernando (1993) is approximately US\$ 8 per ha, but they are still much lower than the estimated required expenditures, which is estimated to be between US\$ 28 and US\$ 38.

²² As is shown earlier in this chapter, this change is a result of increased farmer involvement in seasonal planning and water allocation at the system level.

²³ The author would like to thank Anuruddha D.H.K. Kankanamage and Anura M. A. Ekanayake; Mr. Ivan Silva, Mr. M.G.S. Gunasekera, Mr. R.M. Punchibanda and their staff in Kaudulla; Mr. N. Bandara, Mr. D.A. Sarath Kumara, Mr. L.A.D. Karunaratne and Mr. Lakshman Fernando and staff at Mahaweli System C; as well as the leaders and the members of the farmer organizations in both systems for their hospitality and sharing their ideas and information so willingly with us.. Thanks are also given to Lionoel Siriwardena (Peoples Bank HQ) and Jeffrey Brewer, K. Jinapala, Ann Abeyewardene and C.M. Wijyaratna at IIMI-SLFO for their support.

Annex A

In the first week of May 1994 the Sri Lankan Parliament discussed and passed Amendments to the Irrigation Bill in which farmers' organizations are given the opportunity to operate and maintain irrigation infrastructure below the distributary canal level in exchange for exemption from paying water taxes. The following is an excerpt from the discussion in parliament:

The Minister of Forestry, Irrigation and Mahaweli Development:

'The Amendments to the Irrigation Bill seek to transfer to farmer organizations more powers to see that farmers get a better service. The bill does not intend to levy taxes on the farmers, but farmer organizations will be responsible for the maintenance of irrigation works.'

An opposition MP:

'These amendments could cause burdens on the farmer organizations who will have to undertake the maintenance of the distributary systems which hitherto was done by the Department of Irrigation. If this is the case you must think about allocating a grant for each farmer organization.'

Another opposition MP:

'You propose (...) farmer organizations to levy a tax for the supply of water (...). You are only using these organizations to collect the money for you and make them bear all the responsibilities for this.'

A Minister:

'The opposition gave a wrong interpretation to this bill. These amendments are geared to bring about more participation by the farmers in conducting their affairs.'

An opposition MP:

'These amendments will not benefit the farmers. It is like changing pillows for a headache. You have empowered farmer organizations to impose levies and supervise the distributary systems. This should be the responsibility of the government.'

The Minister again:

'The bill seeks to get the participation of the Farmers Committees in the management and the maintenance of the irrigation systems. This work is now being done by technical officers. I personally know how inefficient some of them are. (...) farmers themselves would decide whether any taxes are to be levied or not. There is no compulsion on the part of the government. As far as the government is concerned the tax is being abolished.'

(The Island' daily newspaper, May 4 and 5, 1994)

This parliamentary debate not only reflects the political sensitivity of farmer involvement in operation and maintenance (O&M) activities, but also illustrates how the debate on sharing financial responsibility for O&M by levying water taxes or fees is mystified by opportunistic and populist political statements.

Although farmers hardly paid irrigation fees under the then ruling UNP government, People's Alliance Presidential candidate Prime Minister Mrs. Chandrika Bandaranaike Kumaratunge said during the presidential election campaign of 1994:

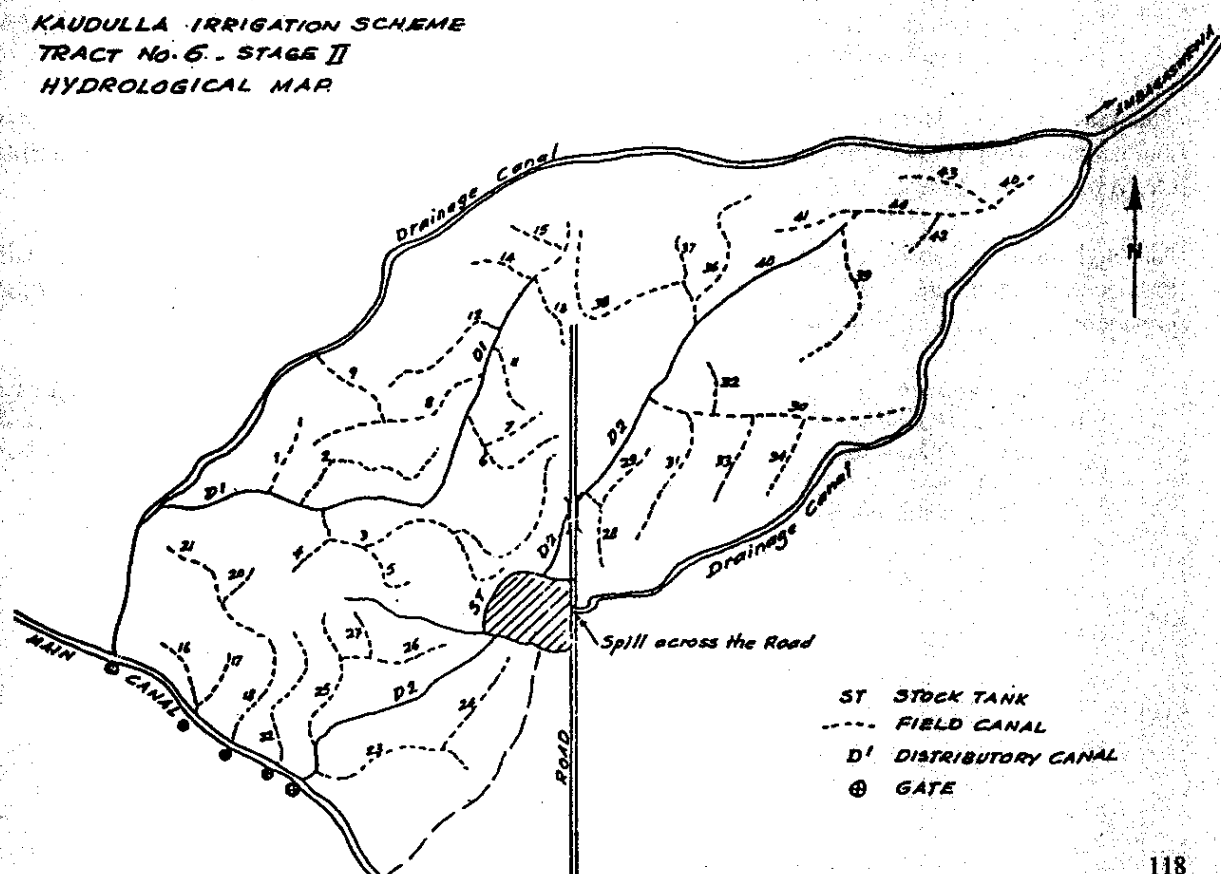
'farmers of this country who enjoyed free irrigation facilities down the ages had to pay a water tax for the first time when Mr. Gamini Dissanayake was Minister of Lands, Irrigation and Mahaweli Development. Added to that the UNP government abolished the fertilizers subsidy given to farmers. It is the People's Alliance who came to the rescue of the farmers ...'

(Daily News', October 18, 1994)

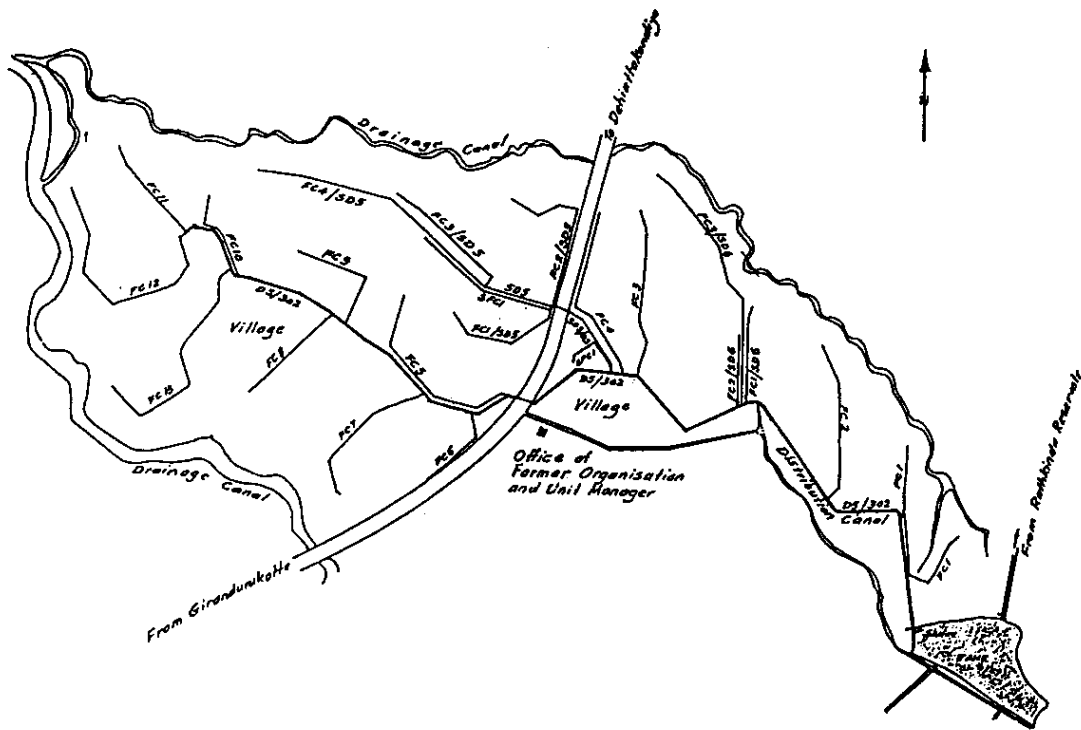
Annex Table 1. General features of the two selected distributary canals.

	Kaudulla Sample Canal	Mahaweli C Sample Canal
Name	Pubudu	Diyawiddagama
Command area (ha)	286	194
Average paddy land holding (ha)	0.8	1.0
DC takes water from	High level main canal	Minor tank
Length of DC	3.5 km	3.5 km
Number of FCs	20 from MC: 7	20
Average number of fields per FC	9	10
Maximum discharge and duty observed at head of the DC	0.37 m ³ /s 19.5 mm/day	0.54 m ³ /s 23.9 mm/day
Condition of DC	Poor; unlined, but some side walls; many bank cuts; siltation	Good; lined; few small cracks; well maintained
Condition of FCs	Fair; unlined, but some side walls; many cuts; siltation	Good; lined; few cuts; well maintained
Condition of control structures	50 % has no gates	5 % has not gate

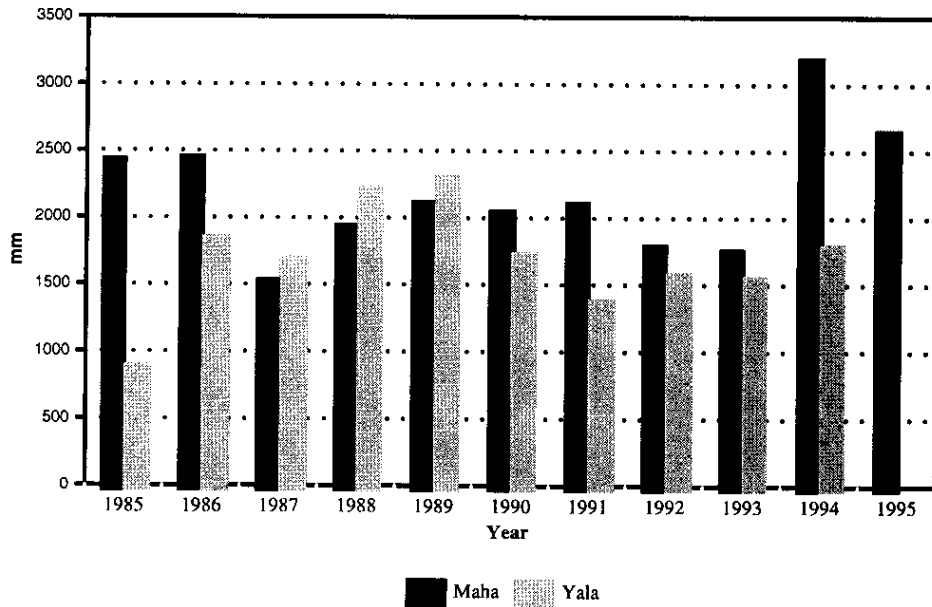
Annex Figure 1. Pubudu unit in Kaudulla Irrigation Scheme



Annex Figure 2. *Diyawiddagama unit in Mahaweli System C*



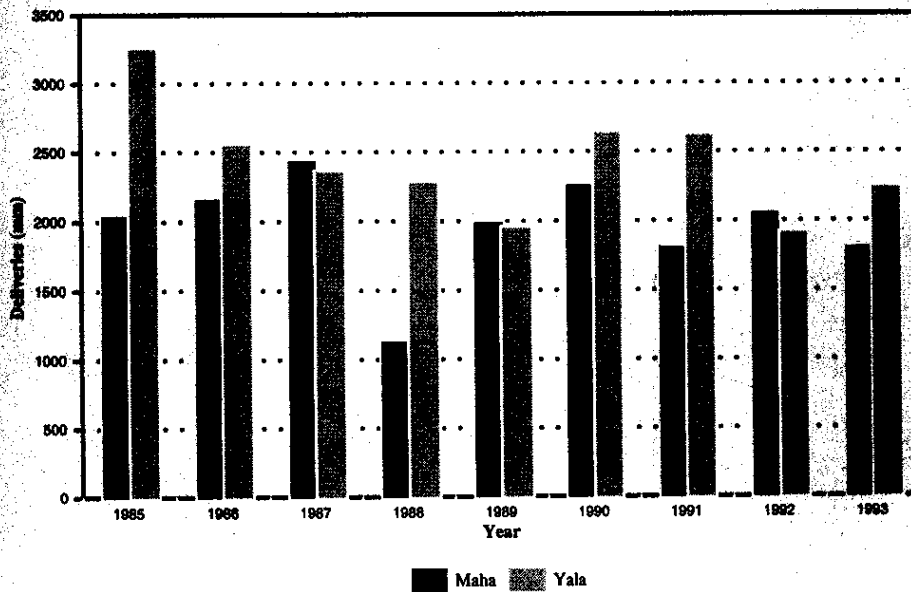
Annex Figure 3. *Total seasonal water supply, Kaudulla Irrigation Scheme, Yala 1983 to Maha 1995*



Source: *Office of the Irrigation Engineer, Kaudulla*

Annex Figure 4.

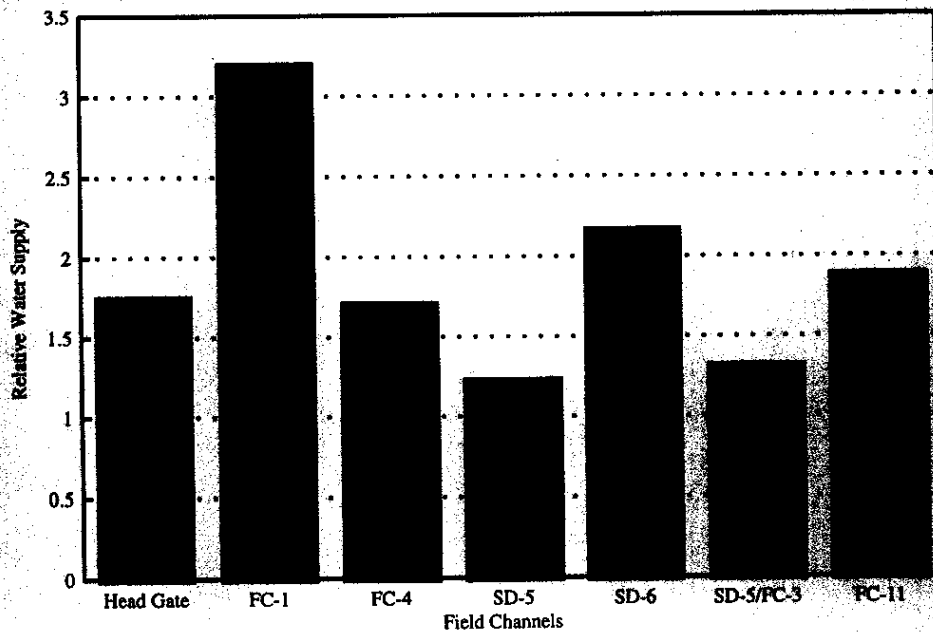
Seasonal tank water supply, System C, 1985-1993



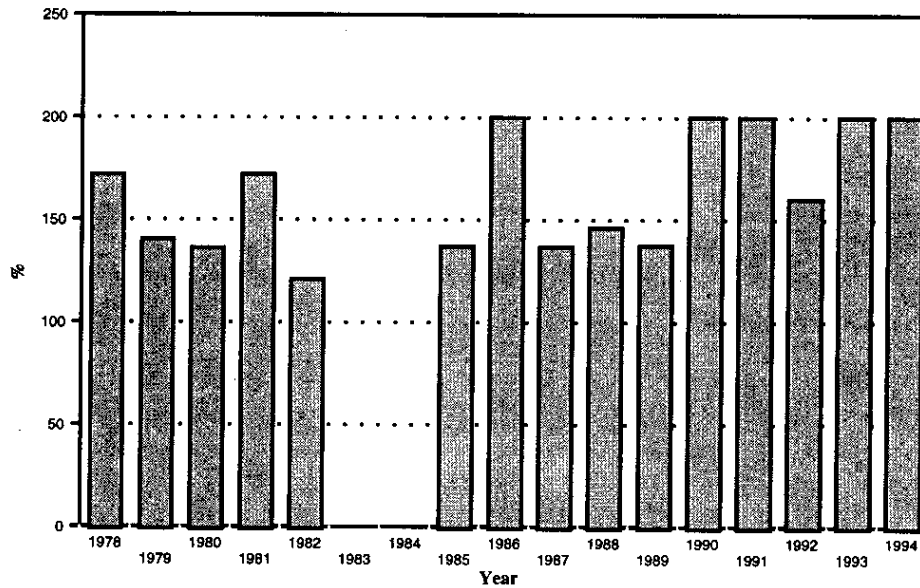
Source: MEA, System Project Office, Mahaweli System C

Annex Figure 5.

Relative water supply of selected field channels in Diyawiddagama, Mahaweli System C, Yala 1994

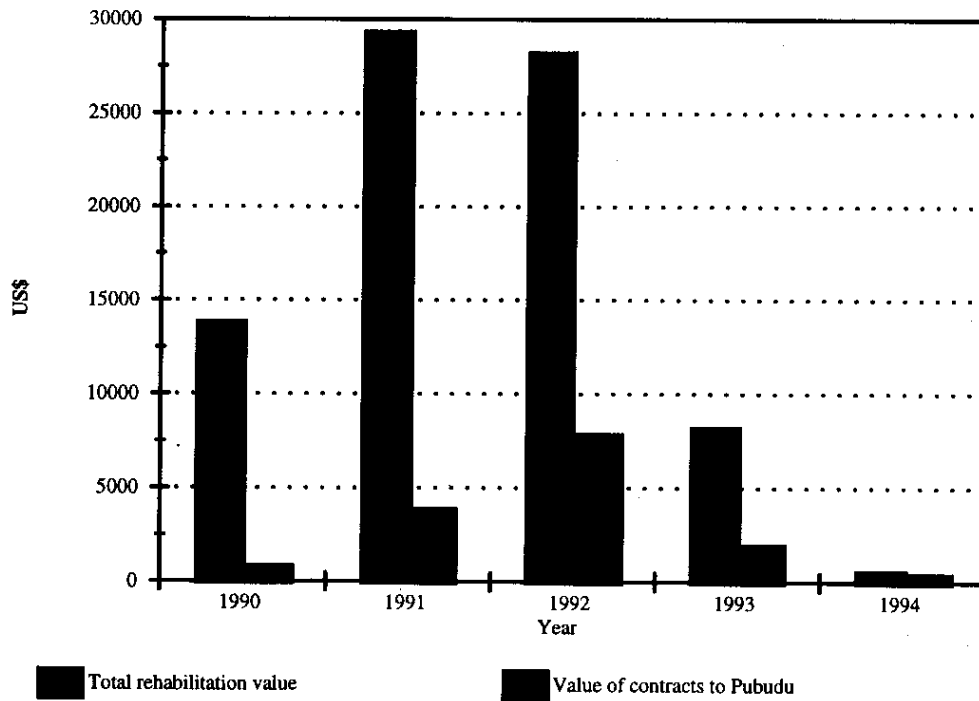


Annex Figure 6. Annual cropping intensity, Kaudulla Irrigation System, 1978-1994



Source: 1978-1982 data are computed from Abernethy, 1985; 1983 and 1984 data are not available; 1984-1994 data collected from the Office of the Irrigation Engineer

Annex Figure 7. Rehabilitation work in Pubudu area, total value and value contracted out to Pubudu



2.5 Impact of State Disengagement from the Management of Agricultural Production in the White Nile Pump Irrigation Schemes in Sudan

M. Samad

Introduction

Most discussions about privatization and turnover of irrigation systems have focused on the transfer of the management of public irrigation schemes to water users organizations. There has been little discussion of the changes in the provision of agricultural support services which are necessary to make investments in operation and maintenance more cost-beneficial to farmers and enhance the performance of irrigated agriculture.¹

Until recently, the agricultural sector in most developing countries was substantially supported by government. Farmers received subsidies on inputs, price supports for their products and state agencies have been responsible for the procurement and distribution of all agricultural inputs, irrigation pumps, machinery and equipment and marketing of produce. This has particularly been the case in Sub-Saharan Africa. A World Bank (1981) study revealed that in more than 60 percent of the African countries, the provision of inputs and services were monopolized by government or parastatal agencies. It is well documented that most parastatal agencies have been failures: inefficiently managed, inadequately controlled, debt ridden and offering poor products and services to their clientele. They have been identified as a major contributor to the poor performance of African agriculture (egs. World Bank, 1981).

In recent years, governments in many countries (egs: Senegal, Sudan, Bangladesh) in which government institutions were the principal providers of agricultural inputs and services have withdrawn or curtailed the scope of state provision of support services to farmers, and have transferred this function to private companies and farmer organizations.² Yet, very little known about the effect of this change on the efficiency in the delivery of support services, the cost-effectiveness to farmers and its impact on the performance of irrigated agriculture.

This chapter presents the results of a case-study on the consequences of state disengagement from the provision of support services for the irrigation schemes in Sudan. These schemes have had dual state management with parastatal agencies managing agricultural production³ and the Ministry of Irrigation managing the irrigation infrastructure (operating and maintaining all pumps, canals and the distribution of water up to the field outlets). Farmers' role was restricted to mobilizing labor and supervising cultivation activities on their holdings.

Parastatal management agencies in Sudan have often been criticized for the late delivery of production inputs and for delays in the performance of services, such land preparation, pest and disease control and harvesting, which led to a steady decline in the performance of the irrigated sector.⁴ Moreover, these agencies had accumulated substantial debts and were a financial burden on government.

In 1991, the Government of Sudan (GOS) took initiatives to reform the management of agricultural production in the irrigation schemes. It began with the downsizing of the White Nile Agricultural Schemes Administration (WNASA)⁵ which administered the pump schemes located along the White Nile (Figure 1). About 70 percent of the staff were laid off and its administration was abruptly withdrawn from all but 38 of some 175 irrigation schemes. The government expected farmers in the schemes excluded from parastatal management to form their own management organizations or to entrust private companies to manage agricultural production. However, the ownership, and operation and maintenance of the irrigation facilities were retained by the state.

By the end of 1994, one company had taken charge of 16 schemes relinquished by the WNASA. Thirty three schemes were brought under an organization set up by farmers on the initiative of the provincial administration. The fate of the remaining schemes was unclear: many were abandoned; others remained partially functional and limited to growing sorghum under rainfed conditions.

The main objective of this study is to compare the performance of the three modes of management of irrigated agricultural production: private company management, farmer management and parastatal management which emerged following the partial withdrawal of the state from the White Nile pump schemes. The second aim of this study is to examine whether, under the prevailing macro-economic and political environment in Sudan, management of agricultural production in the White Nile schemes by farmer organizations and private company management is financially viable ?

The fundamental premise underlying the study is that the shift from public to private provision of inputs and services is a necessary but not sufficient condition to improve support service delivery and the performance of irrigated agriculture in a situation where the state has dominated an inefficient agricultural sector. The study contends that such actions must be accompanied by supportive macro-economic and institutional reforms which would enable the freedom of entry to private providers of services, foster competition, and curtail rent-seeking behavior and political manipulations by private actors.

The remainder of this chapter is organized as follows: The next section gives an overview of the state disengagement policy in Sudan and its antecedents. The section that follows provides a comparative analysis of the performance of the irrigation schemes under the three modes of management. The next section examines the financial viability of agricultural production in the White Nile schemes under the three management modes. The final section gives the conclusion of this study.

Policy on State Disengagement and its Antecedents

Economic and political environment

Due to inappropriate economic policies, a costly civil war, deterioration in the terms of international trade and natural calamities, the Sudanese economy has been moribund for a better part of the period since independence in 1956. It has degenerated at an alarming pace since the mid 1980s. GDP declined by some 14 % between 1992 and 1993. There is a critical shortage of production inputs and energy. Inflation was estimated to be 250% in 1993 (IFAD, 1993).⁶ External debts are substantial.⁷ Foreign exchange reserves have been exhausted and exports have declined to half of previous levels.⁸ The exchange rate policy, which had been the bane of the country's economy, remains in a state of flux, causing confusion and uncertainty in national markets.

Political instability has been a hallmark of the nation since independence. Even at present the political landscape is murky. The "Islamization" of the economy and emergence of powerful religious-political groupings who have a controlling interest of key economic institutions adds to the complexities in the political environment⁹. Although official pronouncements espouse economic liberalization and free market policies, the changes enacted so far are cosmetic. There is little evidence of the state relaxing its political control over the economy. Political patronage is a key factor for private sector participation in economic affairs. These circumstances have resulted in the weakening of mainstream government institutions and the erosion of relations between the state and a larger part of the civil society.

Policy of disengagement

The basic policy framework for state withdrawal from management of agricultural production in White Nile irrigation schemes was drawn up under The Economic Salvation Program of 1990-93. This program symbolized a radical shift from the tradition of state dominance and was designed to provide a greater role to private actors and market forces to achieve social and economic goals.

Regarding the irrigated sector, the key provisions of the policy are as follows:

1. In the major gravity irrigation schemes (Gezira, Rahad and New Halfa) facilitate greater participation of farmers in scheme management by appointing farmer representatives to the Board of Directors of the parastatal agency managing each scheme. Ancillary service units of the parastatal agency (i.e.; machinery unit, Gezira light railways, ginnery) were to be privatized.
2. Divestiture of parastatal agencies managing agricultural production in the pump schemes and transfer of this function to private companies and farmer organizations.
3. Pump schemes were transferred to private companies only if farmers concurred with the terms and conditions offered by the company to manage agricultural production.
4. The period of management contracts was for one season or one year depending on the crop.
5. Private companies managing the schemes had to cultivate the crop and the variety specified by the Ministry of Agriculture and pay the stipulated water fee to the Ministry of Irrigation.

The policy was implemented in wheat season of 1991-92 with the partial divestiture of the White Nile Scheme administration and transferring the management of some of the schemes to private companies and farmer organizations.

Post-Turnover Management Modes

Private company management

To date, private company management has been limited to the sixteen schemes vested with the White Nile Holdings Company. This company began operations in 1991, inheriting many of the staff laid off by the parastatal agency. Most of the schemes are devoted to cotton. The company exercised stringent criteria in choosing its schemes, selecting only those in which facilities were in good order and soils were fertile. It avoided schemes where the farmers' union was strong and chose only those schemes where farmers were willing to negotiate terms and conditions directly, thereby bypassing the national farmers' union.

The company operates the scheme on a profit sharing basis. Under this system, the company provides all inputs, arranges for land preparation and harvesting, and advances a small amount of cash to farmers. After harvest, the company keeps part of the produce, equivalent to the value of the inputs supplied plus administration costs, water charges and other taxes and levies. The remainder of the harvest is shared on the basis of 54 percent to the farmers, 42 percent to the company and 4 percent credited to a social services account.

The participation of farmers in management is limited to representation on production and advisory committees. The company is not obliged to undertake long-term rehabilitation of its schemes and is entitled to withdraw from a scheme if it finds that major investments are required.

At present, private sector administration reflects the contradictions inherent in Sudan's peculiar blend of privatization and continuing state dominance. The company operates according to commercial principles, to maximize profits, yet farmers' activities remain strictly regulated by the company. Decisions about cropping patterns, cultivation methods and the use of inputs are all controlled by management. This system differs little from the past: all that has changed is that control over farmers' activities is now exercised by a private company instead of a parastatal agency.

Farmer management

Farmer management is confined to the Duiem Province where the provincial government set up an organization to take charge of 33 schemes which were abandoned by the parastatal agency. The schemes are grouped into ten units federated at the provincial level. Each unit has its own Board of Directors, consisting of five elected farmer representatives and a nominee of the Farmers' Union.

Production relations in the farmer managed schemes are more liberal than in under company management. There is limited freedom in the choice of crops. Farmers can make their own financing arrangements, buy inputs on the open market, and sell their produce where and when they wish. Management can organize loans through banks for those farmers unable to arrange their own credit.

Steps taken by farmers at Dueim to set up their own management organization are unique. For the first time in Sudan, farmers have taken full charge of the agricultural management of irrigation schemes. Key factors enabling them to do so were the presence of a strong local branch of the farmers' union and supportive political leadership. A third important factor is that the Dueim farmers are not settlers but were once freeholders of the land they now farm as tenants. They are currently campaigning for the return of ownership for their land. This is an example of the importance of property rights in supporting management turnover.

The Dueim system represents Sudan's first real step towards fully privatized, farmer-managed irrigated agriculture. It may prove a useful model in the country's continuing search for viable forms of farmer management.

Parastatal management

The future of parastatal management remains unclear. Downsizing was intended as a prelude to complete closure, so the agency has every incentive to succeed. Under the terms of the downsizing it was able to retain the more productive wheat schemes, giving it some advantage over the other management modes.

Following downsizing, the White Nile Agricultural Schemes Administration (WNASA) is expected to finance its own activities. This it attempts to do through the collection of an administrative fee from farmers. Revenue is also generated through the supply of inputs and from the purchase of wheat from farmers at prices well below those on the open market.

The agency has not altered its basic management system. As before, it supplies all inputs on credit, recovering these in kind after harvest. The pressure to become self-financing has, however, led it to adopt cost-recovery procedures that place farmers at a disadvantage. The proportion of the crop to be

retained by the agency is calculated according to prices at the time inputs are supplied. Given Sudan's high rate of inflation, the agency is able to make a substantial profit in this way.

Performance Results of Schemes Under Alternative Modes of Management

This section compares the performance of the three management modes in terms of: a) efficiency in the delivery of agricultural services, b) cost effectiveness of inputs and services, c) agricultural production technology and productivity levels, d) quality of irrigation services, e) productivity of irrigation water and d) relative water supply. In addition, an assessment is made of the impacts of the changes in production relationships on tenant incomes. The analysis is based on empirical evidence obtained from a sample of farmers in six selected schemes: two schemes (Rawda and Guli) under parastatal management, two schemes (Tawila and Umganeem) managed by a private company and two schemes (Salati and Almagam) managed by farmer organizations.¹⁰ Based on this analysis and drawing on evidence from another study¹¹, the final section examines whether under prevailing conditions, farmers have the financial capacity to take over the administration of the schemes.

Efficiency in the delivery of production inputs and services

Official expectation was that the delivery of support services would improve with transfer of management to the private sector and farmer organizations. This section compares efficiency in the provision of support services in turned over schemes with those under parastatal management on the basis of a "Service Delivery Performance Index". This index was computed from data obtained from a sample survey of 155 farmers in the six selected schemes, carried out during the wheat season of 1993-94. The index is derived from farmer perceptions about provision of support services. Appendix 2 gives the method of computation of the index. The results are presented in Annex Table 1.

Overall, the delivery of support services by the parastatal was considered by farmers to be superior to that of the private company and the farmer organization. This was primarily because the parastatal agency now concentrates its efforts on a limited number of schemes (38), whereas previously it had to service some 174 schemes. Also, at present, government regulations permit only wheat cultivation in the agency managed schemes, unlike earlier where cotton was grown in addition to wheat. The focus on a single crop enabled the agency to coordinate its services more effectively.

The delivery of support services in the farmer managed schemes ranked the lowest. The administration of the farmer managed schemes is still its formative stages. The organization functions with a skeleton staff, most of whom are on secondment from the White Nile Agricultural Schemes Administration. Another important reason for the poor delivery of support services is that with the withdrawal of state support, farmers have to rely on the inadequately developed private market where critical inputs are very often in short supply. This is particularly a problem in the White Nile area.

The performance of the private company in the provision of support services was mixed. Farmers in one of the schemes (Tawila) were satisfied with the services rendered by the company. In the other scheme managed by the company, farmers were disappointed with the services provided. According to the field staff of the company, management had restricted the level of investments in the latter scheme since its production potential was considered to be low.

Cost effectiveness in the provision of inputs and services

A key argument in support of transferring management for the schemes from state to non-governmental entities centers on the potential for more cost effectiveness of services. This argument is particularly

relevant to Sudan where, given the capital intensity of agricultural production in the publicly managed irrigation schemes, the availability of working capital rather than land or water is a major constraint for irrigated agriculture. Cost effectiveness in the provision of inputs and services is a significant indicator of management performance in this context.

Table 1 shows the average costs of inputs and services provided by the three entities which currently manage the White Nile pump schemes. The total cost of inputs and services in the farmer managed schemes were not significantly different from the parastatal managed schemes. Differences were in the cost of fertilizer and harvesting.

Table 1. Cost of inputs and services by management modes (US \$/ hectare) -1993/94 wheat crop

Cost Item	Parastatal Agency	Private Company	Farmer Organization
Production Inputs			
Seeds	\$ 22	\$ 22	\$ 21
Fertilizer	\$ 28	\$ 37	\$ 20
Agrochemical/Spraying	\$ 12	\$ 25	\$ 12
Sacks	\$ 3	\$ 3	\$ 3
Services			
Land Preparation	\$ 10	\$ 12	\$ 10
Desilting Irrigation Canals	\$ 2	\$ 2	\$ 1
Harvesting	\$ 10	\$ 16	\$ 14
Management Fee	\$ 2	\$ 3	\$ 2
Costs/Hectare	\$ 89	\$ 89	\$ 83

Exchange rate - 1 US\$ = 425 Sudanese Pounds (LS)

Source: Study survey and scheme administration records

In the farmer managed schemes, farmers curtailed the use of fertilizer. This was partly due to financial difficulties and also because of shortages of fertilizer in the open market. The farmer managed schemes had to rely on the private sector for harvesting, where the charges for hiring harvesters were higher than rates charged by state institutions. The parastatal agency supplied its own machinery to farmers at a lower rate. Farmer managed schemes economized on pest and disease control costs by opting for manual spraying instead of the customary aerial spraying. The agency contained the cost of pest and disease control by using the surplus agrochemicals from the previous season and by permitting farmers to resort to manual spraying.

The cost of inputs and services in the company managed schemes was higher than in the other management modes. The results of a survey carried out by the authors showed that the company levied a higher charge for fertilizer from its farmers than the parastatal agency for the same quantity. The company used its own machinery for land preparation and harvesting but, it had charged the farmers a higher than the rates levied by other private sector companies providing the same service. Although the company was expected to negotiate the costs of inputs and services in advance with the farmer leaders, field inquiries revealed that the farmers were unaware of the costs of inputs and services, even after the cultivation season.

Under the prevailing conditions in Sudan, transaction costs for acquiring inputs and services are substantial. Under state management, the parastatal agency absorbed the transaction costs. In the case of the schemes contracted to the private company, the transaction costs have apparently been transferred to farmer accounts. This is reflected in the higher charges for inputs and services provided by the company.

Field inquiries revealed that less powerful private companies which had earlier taken over the management of some White Nile pump schemes opted out due to the difficulty in obtaining production inputs and credit from state institutions.¹² In Sudan, where private markets are poorly developed and institutions are oriented to serve the public sector, it is unlikely that independent farmer groups could acquire inputs and services at affordable prices without the intervention of a formal management entity.

Agricultural technology

Agricultural production in the major irrigation schemes in Sudan has traditionally been capital intensive. All major operations, such as land preparation, seeding, pest and disease control measures, and harvesting are mechanized. Manual work is confined to thinning, irrigation and cotton picking. These activities are performed by farmers using family labor and supplemented when necessary with hired labor. The choice of crop variety, seeding rate, the quantity and the timing and rates of application of fertilizer and agrochemicals for major crops (i.e. cotton and wheat) are specified by government based on the recommendations of the Agricultural Research Corporation.

Table 2 gives the results of the survey carried out to ascertain the current crop production technology under the three management modes. There were no changes in production technology in the schemes under company management. The company financed the entire cultivation program. The major agricultural operations continued to be mechanized and the recommended amounts of fertilizer applied. The situation was the same in the parastatal schemes, except for some farmers opting for manual spraying of pesticides instead of aerial spraying. It was noteworthy that a majority of farmers (67%) in the private company managed schemes had not weeded their holdings.

There was a notable shift in production technology in the farmer managed schemes. Investigations carried out in two farmer managed schemes revealed that a substantial number of farmers did not follow the standard agricultural practices (Table 2). Fourteen percent of the farmers had not applied urea fertilizer and some 25 percent had used only half the recommended amount. More than 50 percent of the tenants had not applied any phosphate fertilizer and nearly half the farmers had not weeded their holdings.

Table 2. Crop production technology by management modes - Wheat Crop 1993/94

Activities	Number of Farmers Reporting (%)		
	Parastatal managed	Private company managed	Farmer Organization managed
<u>Fertilizer Application</u>			
Urea - No Application	-	2	15
- 50% of Recommendation	-	-	25
- Recommended Amount	100	98	61
Phosphate - No Application	-	2	56
- 50% of Recommendation	-	-	2
- Recommended Amount	100	98	43
<u>Method of Pest and Disease Control</u>			
None	-	-	4
Manual Spraying	51	52	96
Aerial Spraying	8	48	-
Manual/aerial	41	-	-
<u>Weed Control</u>			
None	16	67	42
Manual	84	33	58
Chemical	-	-	-
<u>Method of Harvesting</u>			
Manual	100	100	10
Combine Harvester	100	100	90

Source: Study survey data

Crop yields

Information on crop yields were obtained from records maintained by the scheme management. Table 3 gives the average wheat yields in the 1993/1994 season the transferred schemes and those under parastatal management. Yields realized in the parastatal schemes (893 kgs/ha.) were slightly higher than the average yield (476-714 kgs/ha) for the White Nile area. Similar yields were realized in the company managed schemes. Wheat yields in the farmer managed schemes (714 kgs/ha) were low and the variability in wheat yield from one scheme to another was high.

The low yields in the farmer managed schemes is apparently due to the fall in agronomic standards following the withdrawal of parastatal management. Also, the more productive schemes were either retained by the parastatal agency or were transferred to the private sector. The schemes which came under farmer management were the less favorable ones.

Table 3. Comparison of wheat yields under three management modes - 1993/94 cropping year

Scheme Management	Average yield per scheme (Kgs/ha.)
Parastatal agency (n = 26)	893 (cv = 50)*
Private company (n = 4)	833**
Farmer organization (n = 29)	714 (cv = 62)

* cv = coefficient of variation

** sample size too small to estimate cv

Source: Survey data and scheme management records

Quality of irrigation service

The recommended irrigation for wheat is eight waterings at 14 day intervals. Each irrigation is supposed to apply 950 cubic meters per hectare (IFAD, 1994). The crop water requirements for a hectare of wheat in the White Nile pump schemes is estimated to be 7600 m³.

The results of the sample survey carried out in six schemes under the three modes of management (Annex Table 2) revealed that the weighted average number of irrigation received by farmers were 5.38 in the farmer managed schemes, 6.21 and 6.42 in the parastatal and company managed schemes respectively. Only a small proportion of the farmers (30 % in parastatal and 35% in company managed schemes)¹³ received the scheduled eight irrigations. None of the farmers in the farmer managed schemes received the full requirement and a majority (54%) received only 4 or 5 irrigations.

Assuming crop water requirements for the White Nile area to be 7,600 m³/ha, the relative irrigation supply was estimated on the basis of the weighted average number of irrigations received by farmers. The results are presented in Table 4. Figures in the table suggest that in none of the schemes was this theoretical water supply sufficient to satisfy crop water requirements.

Table 4. Relative water supply in the three types of schemes

Scheme Management	Weighted Average Number of Irrigations	Quantity of Water Supplied (M³/ha)	Crop Water Requirements (M³/ha)	Relative Water Supply
Parastatal Agency	6.21	5910	7600	0.78
Private Company	6.42	6114	7600	0.80
Farmer Managed	5.38	5124	7600	0.67

The results of the farm survey revealed that only 25 percent of the farmers in the farmer managed schemes received irrigation water on the scheduled dates. Whereas, 52 percent of the farmers in the parastatal managed schemes, and 62 percent of the farmers in the company managed schemes reported receiving irrigation water on schedule.

Field inquiries suggest that the quality of irrigation service is superior in the private company managed schemes. The company had a vested interest in ensuring that the schemes it managed received its share of irrigation in order to safeguard its investments. The company had advanced capital for repairing pumps and the maintenance of irrigation canals and deducted the sum advanced from the water charges payable to the Ministry of Irrigation. In addition, the company made "incentive payments" to personnel to ensure that irrigation requirements were satisfied.

The quality of irrigation service in the farmer managed schemes was below desired levels. These schemes did not have an adequate number of field staff to supervise water distribution. Moreover, farmers were preoccupied arranging for credit and production inputs which were in short supply.

Productivity of land and water under the management modes

This section compares the performance of six selected schemes under the three management modes in terms of gross value of output per unit of land and irrigation water supplied. Data is from the wheat season of 1993-94.

Table 5 gives estimates of gross returns per unit of land and irrigation water in the six schemes. Total volume of water pumped in each scheme was estimated on the basis of the recorded number of hours the pump was operated during the growing season (December 1993-March 1994) and measured flow rates. Conveyance loss was set at 10 percent which is the standard used by the Hydraulic Research Station for the White Nile area.¹⁴

Table 5 indicates that there is no clear relationship between productivity of land and water and the management modes in the six schemes studied. The highest productivity levels were realized in one of the parastatal schemes (Guli). Yet, in the other scheme under parastatal management (Rawda), productivity levels were similar to the schemes under non-governmental management. The change in the mode of management of agricultural production in the White Nile schemes did not have a significant impact on productivity levels.

Table 5. Productivity of land and irrigation water in six selected schemes by management modes wheat crop, 1993/1994

Variable	Units	Parastatal Managed		Private Company		Farmer Organization	
		Rawda	Guli	Tawila	Umganee m	Salati*	Almagam
Command area	ha	221	524	-	215	218	353
Actual irrigated area	ha	171	505	170	200	76	340
Total yield from scheme	tons	153	529	152	142	54	312
Total Quantity of Water Pumped	000m ³	1256	2973	1797	1237	-	2003
Conveyance Losses (10%)	000m ³	127	297	178	124	-	200
Quantity of Water Delivered	000m ³	1129	2676	1619	1113	-	1803
Gross Product Value/ Scheme	mil. LS	10.7	37.0	10.6	10.0	3.8	21.8
Yield / Cropped Area	tons/ha	0.9	1.0	0.9	0.7	0.7	0.9
Standardized Gross Product Value/ha	\$/ha	132	154	132	105	105	132
Gross Product Value/m³ of water	\$/m³	0.020	0.029	0.014	0.019	-	0.025

*note: As data on the quantity of water pumped in Salati was unreliable the productivity of water was not estimated

1 US\$ = 425 LS

Profitability of irrigated agriculture

From the farmer's perspective the ultimate measure of success in farming is normally the profitability of the enterprise. Profitability of irrigated agriculture is measured in terms of net returns per hectare under the three modes of management. To minimize distortion in the value of output due to extreme values, the modal yield per hectare was used instead of the average. Output was valued at the prevailing market prices. Cost of inputs and services were the actual amount charged to farmer accounts by management. The cost of hired labor is the amount reported by farmers in the survey.

Table 6 gives the net returns per hectare for wheat under the three types of schemes. The highest net return was realized in the parastatal schemes (\$42/ha), followed by farmer managed schemes (\$18/ha). The net return in the company managed scheme was a modest \$7/ha. This was primarily due to the high cost of production according to the records maintained by the company.

Farmers' incomes

Two factors significantly affect farmers' earnings from irrigated agriculture in Sudan. First is the cost of credit. Second, the high taxation of agriculture. Methods of financing agricultural production changed

following state disengagement from the management of White Nile pump schemes. Farmers in the farmer managed schemes had to finance production from their own resources or obtain credit from the banks under the Islamic principles of banking. The method of financing in the company managed scheme was based on the principles of profit sharing or *musharaka*, which is another mode of financial transactions defined under *Sharia* or Islamic law. Under parastatal management, inputs and services were supplied by the agency and the cost was recovered in kind after harvest. Institutional financing is currently confined only to wheat and cotton. All other crops are excluded from institutional credit.

Farmer income was estimated from two farm models. The first one is based on the current modal yield under the respective management modes. The second model compares farmer income at a uniform yield level of 2,428 kgs/ha (600 kg/fedan) of wheat. The latter model reveals how differences in mode of financing affects farm incomes. Income estimates are made for the total farm (i.e. 5 ha holding consisting of three parcels of about 1.7 ha each). This is the predominant farm allotment in the White Nile pump schemes.

Table 6. Net returns per hectare for wheat crop by management modes, 1993-1994

	Units	Parastatal managed	Private Company managed	Farmer Organization managed
Yield/hectare	Kgs	893	833	714
Sale Price	\$/kg	0.165	0.165	0.165
Gross Returns	\$	147	137	118
Production Costs				
Seed	\$	22	22	22
Fertilizer	\$	28	37	20
Chemicals/Spraying	\$	12	25	12
Sacks**	\$	3	2.6	26
Land Preparation	\$	10	12.3	9.5
Desilting Irrigation Canals	\$	1.6	2	1.4
Harvesting	\$	10	16	14
Hired Labor	\$	5	2.2	6
Other Costs	\$	4	0	2
Administration Charges				
Harvesting Fee	\$	0	0	1.4
Land and Water	\$	8.4	8.4	8.4
Management Charges	\$	1.6	3	2
Total Costs	\$	105	130	100
Net Returns	\$	42	7	18

* modal yields

** bags for collecting/storing harvest

Exchange rate = 1US\$ = 425 LS.

Source: Survey data and scheme management records.

The cropping pattern is a three course rotation: wheat - sorghum -fallow. A majority of farms in all schemes cultivate the entire wheat parcel and grow sorghum on about half the extent. The remaining area is left fallow. Wheat is the principal irrigated crop. Sorghum is the staple food crop and is grown mainly under rainfed conditions with some supplementary irrigation. Annex Table 3 gives the cost and returns per hectare of sorghum in the White Nile pump schemes during 1994. Due to the unavailability of information on the costs and returns for sorghum in the schemes selected for study, figures given in Annex Table 3 were taken as the standard in the crop budget for all three management modes.

Income estimates also take into account the value of farm products consumed at home¹⁵ and the following taxes are levied: a) Zakat¹⁶; b) Uhur¹⁷; c) Gibana¹⁸; and d) crop tax¹⁹.

Farm incomes in farmer managed schemes

Under the Islamic banking system, the bank provides material inputs in kind under the *murabaha*²⁰ system and cash to pay for services as *salam* credit. The cash requirements and the value of each credit component is given in Annex Table 4. Although the loans are interest free, there is a "service charge" of 3 percent per month on the *murabaha* credit. The *salam* component entails the forward sale of the crop at prices determined prior to the growing season. The cash equivalents of servicing these loans are set out in Annex Table 5.

Details of the cash incomes of farmers in the farmer managed scheme are given in Annex Table 6. For Model 1, at the current yield levels, the farmer incurs a net loss of some \$130 (LS55,600) after loan repayment, tax obligations and allowing for on-farm consumption (Annex Table 6). In Model 2, which assumes a wheat yield of 1,428kgs/ha, the farmer realizes a net cash surplus of about \$25 (LS10,000) from the holding. It is noteworthy that taxes and cost of servicing loans represent a substantial drain on the farmers' potential cash earnings amounting to some 30 percent of the gross earnings from agriculture. This has far reaching implications on the financial sustainability of farmer management of agricultural production in the White Nile pump schemes.

Farm incomes in company managed schemes

Annex Table 7 sets out the total farm budget for the company managed schemes. As noted earlier the company finances the entire cultivation of the wheat crop and recovers the cost in kind after harvest. The profit is then divided on the basis of 54 percent to the tenant, 42 percent to the company and 4 percent is set aside for "social development." All taxes for the wheat crop are paid by the company. It is assumed that farmers pay only the Zakat tax on Sorghum. Under the terms of the contract farmers are required to surrender the entire wheat crop to the company. Therefore, the computation of the value of produce consumed is confined only to sorghum.

Estimates presented in Annex Table 7 show that farmers in the company managed schemes incur a cash deficit of \$34 at the current yield of 833 kgs/hectare of wheat. The deficit is substantially lower than in the farmer managed schemes as the company pays the taxes and other government dues. At the assumed wheat yield of 1,428 kg/ha the cash surplus of farmers in the company managed schemes is about twice the surplus realized in the farmer managed schemes.

The company's share of the profit amounts to \$5 from a 1.7 ha. wheat holding before taxation at the current yield level of 833 kgs/ha. This represents a return of about 2 percent on its investment²¹. At the production level of 1,428 kg/ha (model 2) the company realizes a pre-tax profit of about \$74 from a 1.7 ha. wheat holding. This gives a return of about 33% on its investment.

Farm incomes in parastatal managed schemes

The budgeted incomes of farmers in the schemes provisionally retained under parastatal administration is given in Annex Table 8. Although at the present level of production the net cash benefit of farmers is negative, the deficit is less than in the schemes transferred to the private company or brought under farmer management. This is because of the lower cost of production and higher yields recorded in the parastatal schemes.

Hence, under the present system of institutional credit and the prevailing agricultural tax system in Sudan, farmers are financially better off under parastatal management than private sector management.

Is farmer management of irrigation schemes financially sustainable ?

The focus so far has been on the implications of state disengagement from the management of agricultural production in the White Nile pump schemes. At present the state retains the ownership of pumps and is in charge of their operation and maintenance. The Government of Sudan is contemplating the outright transfer of ownership and the operation and maintenance of the irrigation facilities to farmer organizations and private companies.²² A key question is whether farmers have the financial capacity to take charge of operation and maintenance of the irrigation facilities - given the prevailing high tax structure, the high cost of credit and the fact that the production and marketing of cotton and wheat (the dominant crops in the White Nile schemes) continue to be state regulated. A misjudgment of this issue will have far reaching consequences for the White Nile pump schemes in particular and the country's economy in general.

The prospects for farmer take over of irrigation facilities should be judged in terms of their ability to pay the fuel cost for operating the diesel pumps and operation and maintenance costs of other irrigation facilities. Based on information obtained from the White Nile Agricultural Scheme Administration, Narayanamurthy (1995) estimates that the cost of diesel consumed ranged from US cents 0.35 (LS1.49) to US cents 0.43 cents (LS1.85) per m³ for pumps with engine capacities of 85-406 HP. An estimate made by IFAD sets the figure at US cents 0.14/m³ (LS 0.6/m³). Narayanamurthy (ibid) estimated the fuel cost for supplying 8,579 m³ of water per hectare for the wheat crop at three cost rates - US cents 0.19, 0. 28 and 0.38/m³ (0.8, 1.2, 1.6 LS/m³ respectively).

Table 7 gives the estimated fuel cost for irrigating a hectare of wheat. Operation and maintenance costs excluding the cost of fuel are about \$31/ha (LS13,200). Total O&M cost/ha ranges from \$48 (LS20,200) to \$64 (LS26,300) for the different fuel cost rates specified (Table 7). It is evident from the net cash income estimates given in Annex Tables 6 to 8 that farmers would not be able to pay for the fuel leave alone bear other O&M costs at their current income levels. Unless there is a reduction in taxes and costs of production, and measures are taken to increase wheat yields, transferring O&M responsibilities will not be financially sustainable.

Table 7. Cost of supplying water and O&M charges - wheat crop

Costs	Fuel Cost Rates		
	US cents 0.19 (LS 0.8)	US cents 0. 28 (LS 1.2)	US cents 0. 36 (LS 1.6)
Fuel Costs f or Pumping 8570 m ³ /Hectare of Water	US \$ 17	US \$ 24	US \$ 31
O&M Charges/hectare (excluding fuel cost)	US \$ 31	US \$ 31	US \$ 31
Total Cost of Water Supply & O& M/ hectare	US \$ 48	US \$ 55	US \$ 62
Total Cost of Water Supply & O& M/ 1.7 ha parcel	US \$ 82	US \$ 94	US \$ 105

Source: Narayanamurthy [1995]

Exchange rate: 1 US\$ = 425 LS

This analysis has been only on the transferred schemes engaged in wheat production. It will be worthwhile analyzing the prospects for farmer take over of the White Nile pump schemes in the event of a shift to cotton cultivation or to other alternative crops.

Conclusion

The evidence presented in this chapter suggests that in Sudan, irrigation management transfer is premature. The country's economy is in disarray. Precariously low official reserves, hyperinflation, shortages of production inputs, spare parts and fuel, escalating costs of agricultural inputs and a crumbling infrastructure characterize the economy. Production of wheat and cotton continue to be regulated by the state. Production remains oriented towards a state dominated economy. Political patronage is a key factor in private sector participation in the irrigation management transfer program. As a result the pioneering attempt to privatize the White Nile pump schemes as been administratively chaotic.

Under these circumstances it is hardly surprising that, contrary to government's expectations, the private sector has been unenthusiastic about the privatization of the White Nile schemes. Four years after the reforms were initiated, only one company had taken over management of few schemes. 33 schemes are provisionally managed by farmer organizations and some 90 schemes have been abandoned.

High taxation and the high cost of borrowing impose a substantial financial burden on farmers. As the analysis shows, farmers growing wheat experience a negative cash balance at current levels of production, once tax obligations and debt service are met. Even if wheat yields double, the cash surplus from their farms is barely sufficient to pay the cost for fuel for operating the pumps, let alone financing other operation and management tasks.²³

The lesson which emerges from this study is that unplanned and abrupt withdrawal of state management can be counter-productive. Merely changing the ownership or the mode of management of an irrigation system does not necessarily result in improved performance. Far more important is the economic, political and the institutional environment within which it functions. To create a more dynamic irrigated agricultural sector, governments must be committed to comprehensive macro-economic and sectoral policy reforms aimed to provide the conditions necessary to foster competition, create market conditions, strengthen management capacities of farmers and prepare them in advance to face the new situation. Unless these conditions are satisfied, management reform per se may cause more harm than benefit.

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END NOTES

¹ Irrigation is not a "stand alone" activity. It requires a reliable and economical supply of inputs (fertilizer, seeds etc.) and services (egs: markets) to realize its full potential and induce investments in irrigation (Seckler, 1989).

² The term "support services" refers to the procurement and distribution of seeds, fertilizer, chemicals, machinery and equipment, and services such as land preparation, credit and marketing.

³ The functions of the Agricultural Corporations were to: i) specify the area allocated to various crops, ii) procure and supply agricultural inputs to farmers, iii) supply machinery and equipment and carry out tasks such as land preparation, aerial spraying,, harvesting, iv) determine planting dates, irrigation schedule and the dates of other cultivation practices, v) pay cash advances to farmers, vi) procurement of cotton and wheat produced and recover the cost of inputs and services rendered, and vii) recover land and water charges from farmers.

⁴ The area under cotton - the principal irrigated crop - declined from 331,795 hectares in 1981/82 to 281,526 hectares in 1989/90. Total cotton output dropped from 5.8 metric tons in 1983 to 2.3 metric tons in 1990. Yields of irrigated cotton, wheat, sorghum and groundnuts were only a quarter to a third of the potential yields (World Bank, 1990).

⁵ WNASA had an accumulated debt of about US\$ 2 million by 1990 (Records of Advisory Unit for Agricultural Corporations, Ministry of Agriculture). Many schemes under its management were dilapidated and under-performing for several years resulting in a high incidence of indebtedness amongst farmers.

⁶ Although recent estimates are unavailable, the indications are that it has substantially exceeded this figure during the last few years.

⁷ Total external debt was estimated at US\$ 16 billion in 1992, which was over US\$ 600 per capita (nearly twice the annual GDP).

⁸ IFAD (1993).

⁹ The leading edge of this economic regime is the Islamic banking system which was introduced with the establishment of the Faisal Islamic Bank in 1978. This system found political expression with certain influential religious groupings which gave them a greater political significance than its voting constituency would warrant (Duffield, 1990).

¹⁰ Appendix I gives a brief account of salient characteristics of the six schemes and outlines the sampling method for the farm survey.

¹¹ Narayanamurthy (1995).

¹² Two of the companies which had opted out were Green Valley Pastures Ltd and Zaituna, both located in Kosti.

¹³ See Annex Table 2 for method of deriving the weighted average.

¹⁴ Hydraulic Research Station, Wad Madani (personal communication).

¹⁵ According to a study done in a major White Nile province, per capita coarse grain consumption was estimated at 0.5 kg/day (information obtained from the IFAD project office in Kosti). The average household size is 6.1 persons/household (IFAD, *ibid*). On this basis the annual coarse grain requirement per household was estimated to be about 1,300 kg. Assuming that 80% of grain consumption is sorghum and 20% wheat, the consumption needs were set at 10 bags (1000 kgs) of sorghum and 3 bags (300 kgs.) of wheat. These amounts are accounted for in the budgets for each farm model.

¹⁶ Zakat is a religious tax levied on cereal crops only and equivalent to 2.5% of output on any production increases of 2000 kgs. The rate actually charged at present is 5%.

¹⁷ Uhur is a tax levied by the central government at the rate of 8% on the marketable surplus.

¹⁸ Gibana is a local government tax currently set at 40 and 60 Sudanese Pounds for sorghum and wheat, respectively.

¹⁹ A crop or profit tax is levied by the central government at the rate of 5%.

²⁰ The murabaha system is similar to the hire-purchase system. Material inputs are supplied by the Bank in kind and the farmers reimburse the cost to the Bank in kind after harvest.

²¹ Analysis of the current incomes in the company managed schemes was based on accounts maintained by the private company and supplemented by information obtained from farm surveys carried out for this study. Several farmers in the company managed schemes expressed their dissatisfaction about the records maintained by the company.

²² The transfer of irrigation facilities and ownership of land to farmers is a key component of the White Nile Agricultural Services Project currently being implemented with financial assistance from IFAD (IFAD, 1994).

²³ See Table 12

Field Study Locations

Field studies were carried out in six randomly selected schemes: two schemes (Rawda and Guli) managed by the parastatal agency, two schemes (Tawila and Umganeem) managed by a private company and two schemes (Salati and Almagam) managed by farmer organizations. The table below gives the salient characteristics of the six selected schemes.

Characteristics	Rawda	Guli	Tawila	Umganeem	Salati	Almagam
Management mode	Parastatal agency	Parastatal agency	Private company	Private company	Farmer Organization	Farmer Organization
Location (Province)	Ed Dueim	Kosti	Kosti	Kosti	Ed Dueim	Ed Dueim
Command Area (hectares)	221	524	-	215	218	353
Area Irrigated (hectares)	171	505	170	200	76	340
Average Size of holding (ha)	5	6.3	5	5	4	5
Cropping Pattern						
Summer Crop	Sorghum	Sorghum	Sorghum	Sorghum	Sorghum	Sorghum
Winter Crop	Wheat	Wheat	Wheat	Wheat	Wheat	Wheat

The Farmer Sample

In each of the six selected schemes, three field blocks (called a 'number': a 38 hectare block of land fed by a single water course called 'abu ishreen,' off -taking from a minor canal) were selected on the basis of the location of the 'abu ishreen at the head, middle and tail end of the minor canal. From each block a sample of nine farmers were selected: three farmers whose fields are fed by the field canal taking of from the head of the 'abu ishreen', three from a the middle and three from the tail end. Thus, the survey sample consisted of 162 farmers: 27 farmers from each scheme. Data obtained from seven farmers were excluded from the final analysis as the information was considered unreliable.

Appendix 2

Methodology for the computation of service delivery performance index

The computation of the Service Delivery Performance Index was based on the results of survey carried out among a sample of 155 tenants from six selected schemes: two schemes managed by the private sector, two schemes administered by the White Nile Agricultural Scheme Administration and two schemes managed by the Duqm Tenants' Management Organization.

The sample of tenants were each asked whether they were satisfied or dissatisfied with the following services provided by the management:

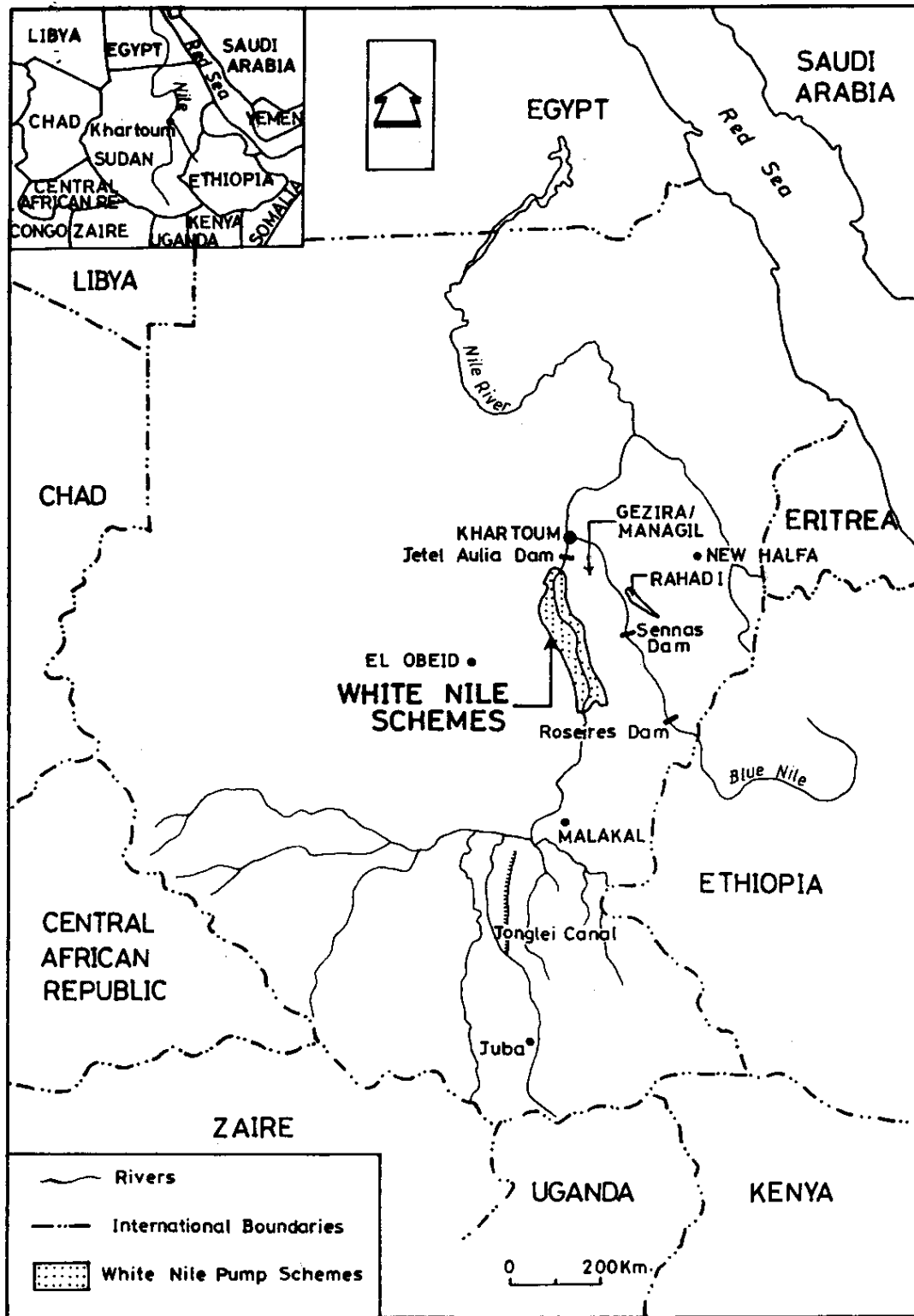
- i. Timeliness of land preparation
- ii. Quality of land preparation
- iii. Timeliness of seed supply
- iv. Timeliness of sowing
- v. Timeliness of fertilizer supply
- vi. Timeliness of pest and disease control.
- vii. Timely provision of machinery and equipment
- viii. Timeliness of harvesting the crop.

To compute the index, a score was assigned to each of the above services on the basis of the responses of the tenants interviewed. The criteria used was as follows:

- | | | |
|------|--|----------|
| i. | Seventy five percent or more of the tenants interviewed were satisfied with the service. | 4 points |
| ii | Fifty to seventy four percent of the tenants satisfied | 3 points |
| iii. | Twenty five to fifty percent of the tenants satisfied | 2 points |
| iv. | Ten to twenty five percent of the tenants satisfied | 1 point |
| v. | Less than ten percent of the tenants satisfied | 0 |

Based on the foregoing score the service delivery performance index can take a value from 0 to a maximum score of 32 (8x4)

Figure 1. Location of White Nile Pump Schemes



Annex Table 1. Service Delivery Performance By Management Modes in Six Schemes

Service	Parastatal Agency		Private Company		Farmer Organization	
	Rawda	Guli	Tawila	Umganeem	Salati	Almagam
Timeliness of land preparation	4	4	3	0	2	2
Quality of land preparation	4	4	3	3	4	4
Timeliness of seed supply	4	4	4	2	3	2
Timeliness of sowing	4	4	4	2	1	1
Timeliness of fertilizer supply	4	4	4	1	2	2
Timeliness of pest and disease control	4	4	4	2	4	4
Provision of machinery and equipment	4	4	4	3	1	1
Timeliness of harvest	1	4	4	3	3	1
TOTAL SCORE	29	32	30	16	20	17

Annex Table 2. Number of irrigations received by farmers in the three types of schemes, wheat crop 1993-94

Number of Irrigations	Number of Farmers Reporting (%)					Weighted Average*
	4	5	6	7	8	
Scheme management						
Parastatal agency	15	27	10	18	30	6.21
Private company	12	12	33	8	35	6.42
Farmer organization	20	37	28	15	0	5.38

$$\text{Weighted average} = \frac{\sum w X_{4-8}}{\sum w}$$

Where w = weighting factor corresponding to % of farmers receiving the respective number of irrigations. X = number of irrigations.

Source: Study survey data

Annex Table 3. Cost and returns per hectare for Sorghum, White Nile Area, 1993/94

	Units	Value
Sorghum yield	kgs/ha	1200
Price of sorghum	\$/kg	0.05
Gross revenue	\$/ha	60
Production costs		
Seed	\$	0.5
Fertilizer	\$	15
Sacks	\$	2.4
Land preparation	\$	2.2
Desilting irrigation canals	\$	1.5
Harvesting	\$	6
Hired labor	\$	10
Administration charges		
Land and water	\$	7
Management charges	\$	2
Total costs	\$	47
Net revenue	\$	13

Exchange rate : 1 US\$ = 425 LS

Source: Department of Agricultural Economics and Statistics, Khartoum

Annex Table 4. Cash requirements and credit type for a 1.7 ha parcel of wheat in farmer managed schemes, 1993/94 season

Cost Item	Costs/Parcel (\$)	Credit Type	
		Murabaha (\$)	Salam (\$)
Seeds	36	36	
Fertilizer	34	34	
Chemicals	20	20	
Sacks	4	4	
Land preparation	16		16
Desilting irrigation canals	2.4		2.4
Harvesting	24		24
Hired labor	9.5		9.5
Other costs	3		3
Administrative charges			
Harvesting fee	2.4		
Land and water	14		
Management charges	3		
TOTAL	168	94	55

Exchange rate: 1 US\$ 425 LS

Annex Table 5. Cost of institutional credit, farmer managed schemes [wheat crop 1993-1994]

		Loan Type		Cost of Debt
		Murabaha	Salam	Service
1	Total value of loan (\$)	94	55	
2	Service charge on Murabaha loan (\$)	17		17
3	Wheat equivalent of Salam loan valued at Salam price (kgs)		658	
4	Equivalent value of Salam loan at market prices (\$)		107	
5	Less Price adjustment on Salam loan (\$)		36	
6	Cash equivalent of Salam loan repayment (\$)		71	
7	Cost of debt service- Salam loan (\$)		16	16
8	Total cost of debt service (\$)			33

*Units of measurement in parenthesis. Exchange rate: 1 US\$ = 425 LS

Notes on computation of cost of debt service

The notes given below relate to the corresponding row number in the table.

1. As specified in Annex Table 4
2. Estimated at the current rate of 3% per month for 6 months.
3. Total value of Salam Loan [\$ 55]: Salam price of wheat \$ 0.082/Kg. 4. Wheat equivalent of salam loan [658 kg.] x market price [\$ 0.16/kg.]5. Adjusted value as per salam loan repayment estimates. 6. Row 4 - Row 5 7. Row 6 - Value of salam loan in Row 1

Annex Table 6 Total farm budget - 5 hectare(twelve fedan) holding - farmer organization managed scheme

	Units	MODEL 1*	MODEL 2**
1. Cropping pattern			
Wheat	Hectare	1.7	4
Sorghum	Hectare	.8	2
Fallow	Hectare	2.5	4
2. Total production			
Wheat	kgs	1214	2428
Sorghum	kgs	950	950
3. Gross value of production			
Wheat	\$	194	388
Sorghum	\$	50	950
4. Loan receipt		149	149
5. Total cash inflow	\$	393	587
6. Cost of production and administration			
Production costs	\$	179	179
Administrative charges	\$	26	26
7. Taxes:			
Zakat	\$	12.2	22
Uhur	\$	12	28
Gibana	\$	9.5	22
Crop tax	\$	5	9
8. Total outflow		244	287
9. Net benefit before loan repayment		149	304
10. Loan repayment			
Value of loan		149	149
Debt service		35	35
Total loan repayment		183	183
11. Net benefit after taxation and loan repayment		-34	121
12. Less Value of home consumed production		-96	-96.
13. Net cash benefit		-130	25

* Model 1 = Existing cropping pattern and modal yield
Exchange rate: 1US\$ = 425 LS

** Model 2 = Assumed yield of 1428 kg/ha

Notes: Notes given below relate to the corresponding row number in the table

- Based on the current three course rotation
- From Table 6 for wheat and Annex Table 3 for sorghum
- Total production x market price [Wheat = \$ 0.16/kg. Sorghum = \$0 .05 /kg]
- Loan facilities only for wheat = from Annex Table 4
- Production and administrative costs for wheat [Table 6] and Sorghum [Annex Table 3]
- Taxes computed as follows: a. Zakat = 5% of gross value of production; b. Uhur = 8% levy on marketable surplus. Marketable surplus = total production - Quantity retained for home consumption.; Model 1 takes marketable surplus as wheat = 900 kgs [9 bags], sorghum = 0; Model 2: marketable surplus of wheat = 9 bags, sorghum = 10 bags; c. Gibana = local tax on marketable surplus at the current rate of \$ 1.05/bag (100 kg) of wheat and sorghum; d. Crop tax = 2% on the gross value of production

Annex Table 7. Total farm budget - 5 hectare (twelve fedan) Holding - Company Managed Scheme

	Units	MODEL 1*	MODEL 2**
1 Cropping pattern			
Wheat	Ha	1.7	1.7
Sorghum	Ha	0.8	0.8
Fallow	Ha	2.5	2.5
2 Wheat crop			
Total production	kgs	1416	2428
Gross value of production	\$	231	395
Production costs	\$	200	200
Administrative charges	\$	19	19
Total costs	\$	219	219
Net Returns per parcel of wheat	\$	12	176
3 Tenants share of profits from wheat (54%)	\$	6	95
4 Sorghum			
Total production	kgs	950	950
Gross value of production	\$	47	47
Production costs	\$	31	31
Administrative charges	\$	7	7
Total cost	\$	38	38
Net returns from sorghum	\$	9	9
5 Net income before taxes and home consumed Production	\$	15	104
6 Taxes			
Zakat	\$	2.3	2.3
7 Less value home consumed production	\$	-47	-47
8 Net cash benefit	\$	-34	55

*Model 1 = Existing cropping pattern and modal yield
Exchange rate : 1 US\$ = 425 LS

** Model 2 = Assumed yield of 1428/ha

Notes: Notes given below relates to the corresponding row number in the table:

1. Based on the current three course rotation
2. Wheat yields from Table 6 for Model 1. Model 2 yields based on author's survey results.
Total production x market price of wheat [\$ 0.16/kg]; Production and Administrative Costs from Table 6.
3. Farmer share = 54% of profit as state in the Tenancy Contract .
4. Sorghum yield, costs and returns from Annex Table 3
5. Farmer's share of profit from wheat [row 3] net returns from sorghum.
6. It is assumed that the tenant pays the 5% Zakat tax on sorghum. All taxes on the wheat are paid by the company in accordance with the tenancy contract.
7. Only the consumption requirements for sorghum are accounted for. The farmer surrenders the wheat crop to the company.

Annex Table 8 Total farm budget - 5 hectare (twelve fedan) Holding - Parastatal Managed Scheme

	Units	MODEL 1*	MODEL 2**
1 Cropping pattern			
Wheat	Ha	1.7	1.7
Sorghum	Ha	0.8	0.8
Fallow	Ha	2.5	2.5
2 Total production			
Wheat	Kgs	1518	2428
Sorghum	Kgs	950	950
3 Gross value of production			
Wheat	\$	247	395
Sorghum	\$	47	47
4 Loan receipt	\$	159	159
5 Total cash inflow	\$	453	601
6 Cost of production			
Production costs	\$	159	22
Administrative charges	\$	17	28
7 Taxes:			
Zakat	\$	15	22
Uhur	\$	16	28
Gibana	\$	13	22
Crop Tax	\$	6	9
8 Total outflow	\$	225	257
9 Net benefit before loan repayment	\$	228	345
10 Total loan repayment	\$	159	159
11 Net benefit after taxation and loan repayment	\$	69	185
12 Less value of home consumed production	\$	-96	-96
13 Net cash benefit	\$	-27	89

* Model 1 = Existing Cropping Pattern and modal Yield

Model 2 = Assumed yield of 1428/hectare

Exchange rate : 1 US\$ = 425 LS

Notes: Notes given below relate to the corresponding number in the table.

1. Based on the current three course rotation.
2. From Table 6 for wheat and Annex Table 3 for Sorghum
3. Total production x market price [Wheat = \$ 0.16 /kg., Sorghum = \$ 0.05 /kg]
4. Loan facilities only for the production cost of wheat-loan repaid in kind after harvest at the prevailing market price.
6. Production and administrative cost for wheat [Table 6] and Sorghum [AnnexTable 3]
7. Taxes computed as for Annex Table 6
10. Value of production loan repaid in kind.
11. See text.

CHAPTER 3

Information Exchange Activities

3.1 Short report series on locally-managed irrigation

The purpose of the Short Report Series is to disseminate concise information on locally-managed irrigation and irrigation management transfer or turnover experiences world-wide to a broad range of people--policy makers, planners, researchers, donors and officials in both public and non-governmental organizations--who are concerned with the irrigation sectors of primarily developing countries. IIMI's intention is not to promote irrigation management transfer per se, but to enhance the knowledge base available to decision makers and advisors as they face questions of policy adoption and strategies for implementation. The purpose of the Series is to disseminate widely in a concise format information and ideas about locally-managed irrigation and management turnover around the world. Locally-managed irrigation can be of many types, such as traditional farmer-constructed diversion or tank schemes, indigenous and often new lift irrigation, government-constructed but farmer-managed irrigation systems and systems where management is or has been transferred from an outside agency to a local user organization.

In 1994 IIMI produced and disseminated through its Farmer Managed Irrigation Systems Network mailing list six papers in the Short Report Series, as follows:

Farley, Peter J. 1994.

Privatization of Irrigation Schemes in New Zealand. No. 2.

Gazmuri S., Renato. 1994.

Chilean Water Policy. No. 3.

Wijayaratne, C.M. and Douglas L. Vermillion. 1994.

Irrigation Management Turnover in the Philippines: Strategy of the National Irrigation Administration. No. 4.

Vermillion, Douglas L. and Carlos Garces-Restrepo. 1994.

Irrigation Management Transfer in Colombia: A Pilot Experiment and its Consequences. No. 5.

Nagata, Keijuro. 1994.

Land Improvement Districts in Japan. No. 6.

Srivastava, L.P. and Jeffrey D. Brewer. 1994.

Irrigation Management Transfer at Paliganj, Bihar, India. No. 7.

Through correspondence with authors and technical editing several additional pending Short Reports were under preparation during 1994. These include papers on tubewell management transfer in Bangladesh, privatization of irrigated agriculture in Sudan, participatory management in Sri Lanka, management transfer in the Columbia Basin, USA, irrigation sector privatization in the Senegal River valley, small-scale irrigation turnover in Madagascar and privatization of lift irrigation on the White Nile, Sudan.

3.2 International conference on irrigation management transfer

IIMI's Local Management Program sponsored the International Conference on Irrigation Management Transfer which was held in Wuhan, P.R. China September 20 through 24, 1994. The Conference was attended by 220 participants from 28 countries. Main donors for this major event were the Ford Foundation, CIDA, FAO, BMZ, IDRC, Oxfam, Australian Catholic Relief Services and the Mekong Secretariat. To sponsor the Conference, IIMI collaborated with Wuhan University of Hydraulic and Electrical Engineering (which made all arrangements for housing, food, use of facilities, field trips, certain sessions and

presentations), Wuhan University (which provided the Conference hall and rooms), Hubei Association of Science and Technology (which arranged visas and domestic transportation), Hubei Association of Hydraulic Engineering (which arranged field trips), Hubei Province Ministry of Water Resources and National Ministry of Water Resources (which gave approval and guidance for the Conference).

Objective The overall objective of the Conference was to enhance policy making, planning and implementation of irrigation management transfer programs world-wide through the exchange of information and experiences about irrigation management transfer between a large number of professionals from many countries.

Brief Description of Activities During 1994 IIMI staff attached to the PSM Program, as well as staff of IIMI's Travel and Information Offices, were very busy in the planning and implementation of the Conference, which included arranging international and domestic travel, visas, organizing sessions, field trips, technical review and selection of papers submitted, preparation of three volumes of Conference papers, preparation and delivery of Conference papers and addresses, selection of participants, editing of papers and preparation of publication of the selected proceedings.

Outputs A set of three volumes of all papers has been produced and distributed to all participants, donors and others. A selected proceedings publication will be produced as an edited book within six months. Two or three papers will be produced under the Short Report Series.

Significant Findings The Conference demonstrated the strong interest many countries world-wide have in irrigation management transfer. Many issues and findings emerged about necessary pre-conditions for enabling management transfer to succeed, the process of implementing management transfer, agency re-orientation, financing and how to make locally-managed irrigation sustainable after transfer. The following is a list of key issues and recommendations raised by participants at the Conference.

- 1) Lack of clear water rights, weak or non-legal status of farmer organizations and ill-defined separation of roles between the irrigation agency and farmer organizations are common conditions which seriously weaken the capacity of turnover programs to result in viable locally-managed irrigation.
- 2) Five vital management elements must be in place for irrigation management transfer to result in sustainable locally-managed irrigation. These elements are:
 - sustainable and recognized water right,
 - functional infrastructure which is compatible with the water right and local management capacity,
 - clearly defined management responsibility and authority,
 - supportive management accountability and incentives and
 - adequate resources.
- 3) Management transfer which is partial or involves incomplete control by farmers leads to unstable management characterized by limited cost efficiency and staff accountability. Turnover is often partial, with agency staff continuing to exercise partial control over water distribution or budgets after turnover. This leads to a poor response by farmers and unsatisfactory results. This can create a false impression of failure which can reinforce resistance to turnover policies.

- 4) Turnover should be treated as an evolving program rather than as a short-term project with rigid quotas for turning over set numbers of systems per year.
- 5) There is a frequent lack of strategic planning to reorient agencies and plan pro-actively for staff disposition prior to the implementation of turnover. This compounds agency resistance to turnover programs.
- 6) There is a frequent lack of clarity about who is responsible for rehabilitation after turnover. This creates an atmosphere of speculation and a tendency among farmer organizations to defer maintenance.
- 7) Effective farmer organizing requires genuine negotiation.
- 8) Establishing motivating conditions for farmer organizations to take over irrigation management is more important than investing in efforts to motivate and train farmers.
- 9) Farmers do not always prefer to take over ownership of irrigation systems. Often they fear that this would create liabilities, new taxes or require them to fully finance the future costs of rehabilitation.
- 10) Farmers do not always want complete withdrawal of the agency from dealings with their irrigation system. Farmers often want continuing agency assistance for technical guidance, rehabilitation, dispute resolution, financial audits and subsidies.
- 11) Abuse of authority by factions after turnover is seen by less powerful farmers as a risk which is associated with management turnover. They may therefore seek continued agency involvement in auditing, regulating and helping to mediate conflicts.
- 12) Rehabilitation is often done before turnover without meaningful farmer participation and investment. This can discourage farmers from taking over responsibility for the irrigation system after turnover. In contrast, farmer participation and investment in system improvements prior to turnover can be an effective means of preparing farmers to take over long-term responsibility for irrigation systems.
- 13) The common joint management arrangement of turning over management responsibility to farmers organizations for tertiary and distributory canals and having agencies retain management responsibility for main system canals often appears to result in unstable, confusing, unaccountable and ineffective management of medium and large scale irrigation systems.
- 14) Farmer organizations often evolve into multi-functional organizations, going beyond irrigation O&M to sideline enterprises, provision of agricultural credit and inputs and marketing. This has happened spontaneously in China, the Philippines, Sri Lanka, Colombia and the USA after management transfer. This is seen by some as a threat to a needed focus on the irrigation function and by others as necessary to increase farmer incentives to support group action.
- 15) After turnover, farmer organizations often seek secondary revenue sources to cross subsidize water charges in order to replace earlier government subsidize with private sector ones, to keep the cost of water from rising too high after turnover.

- 16) Farmers tend to place a strong emphasis on reducing costs after turnover. This can threaten the physical sustainability of irrigation systems, especially where it is not clear who is responsible for rehabilitation after turnover.
- 17) Farmer organizations seem to rarely raise capital replacement funds after turnover. This can be a cause for concern about the long-term physical sustainability of irrigation systems after management is turned over to farmers, especially if it is questionable that governments will be able to afford to finance rehabilitation in the future.
- 18) Irrigation systems which were originally designed to be managed by trained engineers or technicians so as to maximize water user efficiency and flexibility of operation is often incompatible with the management capacities of farmers.
- 19) Management transfer commonly involves increased cost to farmers for irrigated agriculture, especially where farmers were not paying for the full cost of irrigation before turnover. This can be a disincentive for farmers to take over management of irrigation systems.
- 20) Strong high-level political support and support among farmers for management turnover is essential if agency resistance to turnover is to be overcome. It may not be advisable for policy makers to have resistant irrigation agencies implement turnover programs. Consideration should be given to having neutral organizations, such as NGOs or companies, implement turnover programs.
- 21) In several countries governments are establishing performance assessment units concurrently with the implementation of turnover programs, with an aim of assessing the performance of systems after turnover. Agencies show little interest in assessing the performance of agency-managed systems.

CHAPTER 4

Impacts Of Irrigation Management Turnover: A Review Of Evidence To Date¹

Douglas Vermillion²

Abstract

Despite the widespread adoption of irrigation management turnover programs, little information is available internationally about impacts of turnover. This paper synthesizes the most significant evidence available to date about the impacts of turnover programs on performance of irrigation operations and maintenance, financial viability, agricultural and economic productivity, government resources and the environment. More data is available in the literature on operational and financial performance, while little data is available on effects of turnover on maintenance and economic performance of irrigated agriculture.

The literature shows a mixture of positive and negative results, while on balance most sources report positive results, especially in operations and finance, although the cost of irrigation to farmers often rises. Agricultural and economic performance tend not to change much with turnover. Turnover often results in reduction in expenditures for irrigation by the government

Introduction

Among the guiding principles of the Earth Summit held in Rio de Janeiro in 1992 were the recommendations that water should be treated as an economic good (with a right attached to it), that water management should be decentralized and that farmers and other stakeholders should play a more important role in the management of natural resources, including water (Keating, 1993). Increasingly, local management solutions are being sought for global problems of food and resource problems (Ostrom, 1990). Irrigation management turnover (or transfer) has become a widespread strategy in more than 25 countries in Asia, Africa and Latin America, where governments are reducing their roles in irrigation management while farmer groups or the private sector are taking them over (Vermillion, 1992). Most often governments pursue irrigation turnover programs in order to reduce their expenditures on irrigation, improve productivity, and stabilize deterioration of irrigation systems (Vermillion, 1994).

The string of logic often used to justify turnover policies is as follows:

Government bureaucracies tend to lack the incentives and responsiveness to optimize management performance. Farmers have a direct interest in enhancing and sustaining the quality and cost efficiency of irrigation management. When given the authority and right incentives to act collectively, farmers will tend to optimize and economize water management because it is in their direct interest to do so. However, where management transfer includes a decline in government subsidy to irrigated agriculture, it will involve an increase in the cost to farmers of irrigated agriculture.

When management transfer occurs in a supportive socio-technical context, it will result in improved quality and cost-efficiency of irrigation management. This (it is assumed) will normally enhance the profitability of irrigated agriculture enough to more than offset the increased costs to farmers of irrigation management.

Management transfer will also save money for the government, as it divests itself of the responsibility to finance routine costs of operations and maintenance of irrigation systems. The savings can then be used either to reduce government expenditures in the irrigation subsector or to reallocate funds to other functions which can not be handled or financed directly by the private sector.

Following this line of reasoning, we can consider “successful” management turnover as that which saves the government money, improves the cost effectiveness of O&M while improving, or at least not weakening, the productivity of irrigated agriculture.

Irrigation management turnover is occurring in many countries in Asia, Africa, the Americas and the Pacific. Early efforts to transfer management from government to farmer organizations occurred in the USA, France and Taiwan in the 1950s, 1960s and 1970s. IMT, or turnover, became a national strategy in developing countries only in the 1980s and 1990s, with Chile, Peru, Mexico, Brazil, Dominican Republic, Haiti, Senegal, Mauritania, Niger, Zimbabwe, Tanzania, Sudan, Somalia, Madagascar, Turkey, Pakistan, India, Sri Lanka, Bangladesh, Lao, Vietnam, China, Indonesia and the Philippines and other countries adopting transfer programs. This has been referred to as “turnover” in Indonesia and the Philippines, “management transfer” in Mexico and Turkey, “privatization” in Bangladesh, “disengagement” in Senegal, “post responsibility system” in China, “participatory management” in India and Sri Lanka, “commercialization” in Nigeria and “self management” in Niger.

Emerging evidence about impacts

Given the extent to which management turnover is being implemented world wide, it is remarkable how little information is available internationally about the results of turnover programs. Whether or not management turnover can simultaneously save money for the government, result in more cost effective management for the farmers and achieve financial and infrastructural sustainability remains to be seen. Most reports about impacts are qualitative and hard to validate. Over 100 papers were prepared for the International Conference on Irrigation Management Transfer, held in Wuhan, China in September 1994. Of these, only 25 contained any data on performance outcomes of management transfer. Most papers presented post-facto data only, using at most, two or three performance measures. Four papers presented before and after comparison; one paper presented a with and without comparison (Turrall, 1995). It is often difficult to distinguish the effects of management transfer from rehabilitation or changes in inputs or technology.

We will provide an overview of the kind of evidence which is emerging about the impacts of irrigation turnover, with reference to performance criteria, measures used, and the strength of evidence. The literature includes the following categories of performance measures:

- O&M performance,
- financing,
- agricultural and economic productivity,
- government resources, and
- the environment.

Evidence in the literature comes in four basic types, listed from the weakest and most frequent type to the strongest and most infrequent type:

- qualitative reports of stakeholders,

- post facto assessment of single cases,
- with and without comparisons, and
- before and after comparisons.

Table 1 displays basic information on the main references in the literature listed below. Most transfer units are sub-sections of irrigation systems which are managed by farmer organizations while the main system continues to be managed by a government agency. These range in size widely from 5 ha pump schemes in Indonesia to the 14,000 ha Paliganj Distributary Canal in Bihar, India. In several cases entire schemes are transferred to farmer organizations (usually federated). These range from small scale 50 ha schemes in Indonesia to the 230,000 ha Columbia Basin Project in the USA (which was transferred to three districts serving an average area of 77,000 ha). Most post-transfer organizations are farmer associations. At larger scales of transfer, such as in the USA, China, or Colombia, post-transfer governance entities tend to be farmer-elected boards of directors while management entities tend to be professional district management staff. The majority of cases cited in the literature involve a transfer of only partial control over irrigation system management functions. Most studies are post facto, with the second most common type being short-term before and after comparisons.

Table 1. Functions, levels and organizations in literature on irrigation transfer

Author	Country	Transfer Unit	Size of Tr. Unit	New Management Entity	Functions Transferred
1. Kloezen, 1996	Sri Lanka	Distributary C.	80-260 ha.	Joint agency/WUA	Partial
2. Uphoff, 1992	Sri Lanka	Field Channels	50-150 ha.	Farmer Associations	Partial
3. Pant, 1994	India	Tubewell Area	84 ha.	Farmer Cooperative	Full
4. Srivastava & Brewer, 1994	India	Distributary C.	14,000 ha.	Village Irr. Comm.	Partial
5. Rao, 1994	India	Minor Canal	359-513 ha.	Farmer Org. Comm.	Partial
6. Shah, 1994	India	Tubewell	50-150 ha.	Farmer Organization	Full
7. Rana, et. al., 1994	Nepal	Irrigation Syst.	500-2000 ha.	Joint Agency & WUA	Partial
8. Olin, 1994	Nepal	Tubewell Area	120 ha.	WUA	Full
9. Mishra & Molden, 1996	Nepal	Entire Scheme	8,700 ha.	WUA	Full
10. Oorthuizen & Kloezen, 1995	Philippines	Entire Scheme	150-200 ha.	WUA	Partial
11. Wijayaratne, et. al., 1994	Philippines	Laterals and Entire Scheme	500-5000 ha.	WUA	Partial/Full
12. Bagadion, 1994	Philippines	Distributary C.	2,500 ha.	Federated WUA	Partial
13. Johnson & Reiss, 1993	Indonesia	Tubewell Area	5 -200 ha.	WUA	Full
14. Nguyen, et. al., 1994	Vietnam	Pump Scheme	ND	Parastatal	Partial
15. Johnson et al., 1995	China	Entire Scheme	5,000 ha.	Irrigation District	Partial
16. Maurya; Musa, 1993	Nigeria	Distributary C.	126-271 ha.	Joint Agency & WUA	Partial
17. Samad, 1995	Sudan	Entire Pump Scheme	80-4000 ha.	Pvt. Co.; Tenant Org.	Partial
18. Wester, 1995	Senegal	River Lift	20 ha.	Farmer Group	Full
19. Azziz, 1994	Egypt	Turnout	20-60 ha.	WUA	Partial
20. Yap-Salinas, 1994	Dominican Republic	Federated	5240 - 9240 ha.	WUA	Full
21. Vermillion & Garces, 1996	Colombia	Irrigation Dist.	14,000 ha.	Irr. District Staff	Partial
22. Johnson, 1996	Mexico	Block	5,000 - 30,000 ha.	WUA	Full
23. Svendsen & Vermillion, 1994	USA	Irrigation Dist.	77,000 ha.	Irr. District Staff	Partial
24. Farley, 1994	New Zealand	Block	2000 ha.	Mutual Irrigation Co.	Full

Table 2 summarizes the extent to which different types of performance data are included in the literature reviewed herein. The most common performance indicators are those about operations, which included 21 of the 24 sources reviewed. Surprisingly little data is contained in the literature on economic impacts of transfer. This is an important deficiency since perhaps the most pertinent concern about management transfer is whether or not incremental benefits to farmers outweigh costs. Also, most sources make no attempts to identify and measure performance indicators which are important to farmers and other stakeholders. We believe it is important to include farmers perspectives in assessments of impacts of management turnover to farmer organizations.

Table 2. Performance measures included in literature on impacts of irrigation management transfer

Author	Country	Operational	Financial	Agricultural	Maintenance	Economic
1. Kloezen, 1996 (SI)**	Sri Lanka	Yes	Yes	Yes		Yes
2. Uphoff, 1992 (SI)	Sri Lanka	Yes		Yes		
3. Pant, 1994 (LI)	India	Yes	Yes	Yes	Yes	
4. Srivastava & Brewer, 1994 (SI)	India	Yes		Yes	Yes	
5. Shah, 1994 (LI)	India		Yes			
6. Rao, 1994 (SI)	India	Yes				
7. Olin, 1994 (LI)	Nepal	Yes	Yes			
8. Rana et al., 1994 (SI)	Nepal	Yes			Yes	
9. Mishra & Molden, 1996 (SI)	Nepal	Yes	Yes	Yes		Yes
10. Oorthuizen & Kloezen, 1995 (SI)	Philippines	Yes	Yes		Yes	
11. Wijyaratne and Vermillion, 1994 (SI)	Philippines	Yes	Yes	Yes		
12. Bagadion, 1994 (LI)	Philippines					
13. Johnson and Reiss, 1993 (LI)	Indonesia	Yes	Yes		Yes	
14. Nguyen et al., 1994 (LI)	Vietnam	Yes		Yes		
15. Johnson et al., 1995 (SI)	China	Yes	Yes	Yes		Yes
16. Maurya; Musa, 1993 (SI)	Nigeria	Yes	Yes	Yes	Yes	
17. Samad, 1995 (LI)	Sudan	Yes		Yes		Yes
18. Wester, 1995 (LI)	Senegal	Yes		Yes	Yes	Yes
19. Azziz, 1994 (SI)	Egypt	Yes	Yes	Yes		Yes
20. Yap-Salinas, 1994 (SI)	Dominican Republic	Yes	Yes			
21. Vermillion and Garces, 1996 (SI)	Colombia	Yes	Yes	Yes	Yes	Yes
22. Johnson, 1996 (SI)	Mexico	Yes	Yes	Yes		Yes
23. Svendsen and Vermillion. 1994 (SI)	USA	Yes		Yes	Yes	Yes
24. Farley, 1994 (SI)	New Zealand		Yes			

** SI = surface irrigation; LI = lift irrigation.

O&M performance

Much of the literature which supports management turnover asserts that it enhances O&M practices. The most common kind of evidence employed is qualitative statements by project officers, farmers, researchers and rapid appraisal visitors, often based on chance encounters or group interviews with farmers. Project studies in the Philippines, Sri Lanka, Nepal, and India have reported farmer satisfaction with improved water delivery service and equity after turnover (Meinzen-Dick, et al., 1994a; Uphoff, 1992). Table 3 below summarizes key findings of literature on the results of turnover on the performance of irrigation operations and maintenance. Reports of turnover experiences in Mexico (Goriz, et al. 1994); Colombia (Vermillion & Garces-Restrepo, 1994); and the United States (Svendsen & Vermillion, 1994) indicate farmer perceptions that O&M staff have become more responsive to farmers after turnover. Maintenance is reported to be more responsive to farmers' priorities after turnover in Chile (Meinzen-Dick, et al., 1994b, p. 77). However, assessments of farmer perceptions through participatory appraisal and group interview methods may not be a strong way to make generalizations or assess "external validity"; their value is more in eliciting farmer performance criteria and examining local dynamics (Gosselink & Hoerberichts, n.d.; Pretty, 1995).

Information on post facto change is common. Oorthuizen and Kloezen (1995) report on a case of turnover in Southern Luzon, Philippines where financial autonomy prompted farmers to take cost-cutting measures which negatively effected water distribution and maintenance, as reported by farmers and agency officials. Svendsen and Vermillion (1994) note a similar tendency of farmer boards in the Columbia Basin, USA, to cut costs to the point of infringing upon O&M performance.

In a survey of farmer perceptions about turnover, a study of two systems turned over to farmer management in central Colombia in 1976, Vermillion and Garces-Restrepo (1996) obtained survey data from 93 farmers sampled from upper and lower reaches of the Coello and Saldaña irrigation systems. In Coello system—where relative water supply (Levine, 1982) is normally approximately 1.4 and a variety of crops is planted—45% of farmers interviewed said water delivery was "always enough," 32% said it was "enough most of the time." Forty percent judged that management in general had "improved" after turnover, 53% said it had "not changed much." In Saldaña (where relative water supply is in the order of 1.75 and only rice is planted), 59% said water delivery was "always enough" and 31% said it was "enough most of the time." Forty-five percent felt management had "improved," 35% said it had "not changed much," but 25% said it had "worsened." Although farmers were asked to compare the situation before and after turnover, their perceptions were obtained post-facto, 19 years after turnover, which constitutes a rather weak and possibly unbalanced before/after comparison.

Contrary to the common notion that farmers generally want to take over complete control, only 29% of farmers in Coello and Saldaña districts wanted the irrigation agency (INAT) to withdraw completely; 48% wanted the agency to remain partially involved in management (mainly to protect against abuses by powerful farmers and help settle disputes); and 21% preferred that the agency should take over management again.

Before and after timeline data on annual irrigation supply per ha in Coello shows a long-term declining trend from 1,300 mm in 1975 (the year before turnover) to 400 mm in 1991. The decline in irrigation supply per ha is partly due to expansion of area and decline in river flows at the source. Under these circumstances, it is notable that management was able to keep farmers relatively satisfied with water adequacy after turnover. Vermillion and Garces-Restrepo (1996) report current water use efficiencies to be 73% in Coello and 57% in Saldaña.

In a pilot turnover project in the Kano River Irrigation Project in Nigeria, newly organized farmers changed water distribution schedules to discontinue night-time irrigation and improve head/tail equity. This led to an

additional 12% of water volume reaching middle and tail reaches of distributary canals within the season the changes were introduced (Musa, 1994). On the basis of post-facto farmer interviews and observations of water distribution, Kloezen (forthcoming) reports that turnover of distributary canals to farmer organizations in Sri Lanka did not change water distribution practices at the field channel level, partly because agency staff were still involved in management, canals had been recently rehabilitated and were in good condition, water was abundant and the attention of the farmer organizations was more on agricultural production than irrigation.

Comparisons of performance between systems with versus without turnover is rare in the literature. Most present either post-facto or before and after data. In a post-facto design about turnover of a medium size pump scheme along the Red River in Vietnam, Nguyen, et al. (1994) reports an increase in irrigation efficiency from 50% to 81% and a decrease in water consumption per ha from 8,000 m³ to 5,120 m³ (a 36% drop) over a four-year period after turnover. In another post-facto report, water delivery efficiency in the Azua system in the Dominican Republic increased between 25% and 30% after management transfer under the On Farm Water Management Project (NESPAC, 1994).

Before and after comparisons are stronger than post-facto data because they help rule out the possibility of trends having begun before turnover and continuing into the post-facto period. These tend to be simple, short-term comparisons however, without enough of a time line to confirm a pattern interrupt at the time of turnover. In a simple before and after comparison, Pant (1994) reports that the turnover of a public tubewell in Uttar Pradesh, India increased water and electricity use efficiencies by reducing average pumping time per irrigation from 42.4 and 39.3 hours per ha in kharif season for two years before turnover to 13.4 and 22.8 hours per ha in kharif season during the first two years after turnover (1992-94). Azziz (1994) reports a dramatic and consistent reduction in average irrigation time after management transfer in a sample of mesqa's small storage/shallow lift pump turnouts in Egypt from an average of 15-17.5 hours per ha before turnover to 5 to 7.5 hours per ha. However, no comparisons with non-Mesqa or non-turned over turnout groups is given, so it is not clear whether similar improvements occurred in other areas over time as well.

Regarding impacts on equity, Rao (1994) compares water delivered per ha between three minor commands in the Sreeramsagar Project in Andhra Pradesh, India. In one year after management transfer he recorded an improvement in equity between the three blocks from 2,186 m³/ha, 4,387 m³/ha and 12,065 m³/ha before transfer to 7,416 m³/ha, 7,307 m³/ha and 10,329 m³/ha respectively, afterwards. However, this was in a system where total irrigation supply exceeds gross demand by more than 200%.

Turnover of the 12,000 ha Paliganj Distributary Canal in the Sone Command in Bihar, India to a federated farmers' organization in 1989 resulted in a new rotational arrangement in the dry season, policing of breaches and new use of farmer canal repair parties. The impact on equity of water distribution was reported in a simple, short-term before and after comparison. Before turnover in 1988, 16.7% of water entering the distributary reached gate 10, which was two-thirds of the distance to the tail end of the canal. By 1990, after farmers had taken over O&M for the canal, 21.2% of water entering the canal reached gate 10 and for the first time in known history, water reached to tail end of the canal (Vermillion, 1992). Before turnover, 30.7% of the canal command area which is located in the tail end received an average of 10 to 12% of total canal water. During 3 years after turnover, 18% of canal water reached the tail area (Srivastava & Brewer, 1994).

Long-term time series data on irrigation efficiencies before and after management devolution or turnover is available from case studies in the medium scale Nanyao and Bayi irrigation districts in the north China plain (Vermillion, et al., forthcoming). In Nanyao district, the rise in annual cost of irrigation water from US\$ 4.68 per ha in 1972 to US\$ 31.84 per ha in 1993 (in 1991 dollars) helped bring about a decline in water duty

from 11,000 m³ per ha in 1973 to only 4,500 m³ per in 1993. Seen alone, this trend appears to continue unaffected by the reforms which occurred in the mid 1980s.

However, annual discharge into the system increased from 28 million m³ in 1972 to about 60 million m³ in 1982 (at the collapse of the commune system) and then steadily declined thereafter to 20 million m³ in 1993. The same peak and decline trend occurred in the Bayi system, where total annual discharge (from surface and groundwater) went from 6 million m³ in 1972 to 34 million m³ in 1980, then declining to 17 million m³ in 1993. The average annual number of surface irrigations decreased from 3 in 1973 to 2 in 1992 in Nanyao and from 6 in 1973 to 4 in 1992 in Bayi--after peaking in 1982 in both systems. Introduction of the "pay for service" system at main canal, village and farmer levels undoubtedly influenced the decline in water diverted and delivered per ha after reforms in the mid 1980s.

Two studies which employ extended before and after comparisons report constant or slight temporary drops in irrigation performance for 2 to 5 years after transfer. In a study of the large-scale Columbia Basin Project in the USA, Svendsen & Vermillion (1994) report a relatively constant overall irrigation efficiency (system-wide PET/aggregate net supply) of about .46 to .48 after turnover in 1969. Conveyance efficiency dropped slightly at turnover from .70 to .65 in 2 years and then rose to pre-turnover levels for several years until a long-term decline to .62 by 1989 (attributed to deterioration due to the cost containment policy of the farmer board). Total system irrigation supply per ha. rose substantially for two years after turnover and then dropped 10% over 15 years, from a high point of .77 hectare-meters in 1971. The rise in total irrigation supply per acre after turnover occurred despite declining water delivery per acre at farm turnouts during the same time (due to rising use of sprinklers and shift to lower water consuming crops)--indicating a temporary lapse in main system management. Over the long-term since turnover, farmers generally reported no change in the quality or timeliness of irrigation delivery.

Garces-Restrepo & Vermillion (1994) report a three-year leveling off of long-term increases in irrigated area at the time of management transfer in the Coello district, which they attribute to temporary inefficiencies during adjustment to new management.

In their study of the Columbia Basin Project, Svendsen and Vermillion (1994) developed an equity index for comparing relative water supply between three branches in the system, each managed by a different farmer irrigation district. The study showed no change in equity for 6 years after turnover, followed by a steady decline, possibly due to system deterioration brought on by cost cutting measures. The index was 1.15 (i.e., 15% difference between branches with the highest and lowest RWS) for the period 1969-75 and then declined to 1.03-1.10 in the latter 1970's and early 1980's.

Regarding system maintenance, studies on lift irrigation in Senegal (Wester, et al., 1995) and Indonesia (Johnson and Reiss, 1993) report an acceleration in deterioration of pump set equipment for lift irrigation after turnover of equipment and networks to management by farmer organizations. In Indonesia this was attributed to lack of local knowledge, skills and spare parts. In Senegal, farmers continued to maintain the network while pump set equipment deteriorated, indicating a constraint in skills rather than farmer motivation. While the Indonesia study substantiated the finding with data on pump operating hours and ratios of irrigated versus design area, the Senegal study relied only on reports of breakdowns.

In a post-facto case study of a system in the Terai of Nepal, Rana, et al. (1994) report that irrigation discharge increased four fold after substantial turnover-related de-silting and repair work was conducted by farmers. Without comparisons with other systems which did not have physical repair work or which did not have turnover, it is impossible to distinguish the effect of physical repair versus turnover. The study by Mishra and Molden (1996) on the West Gandak scheme in Nepal found that inflow increased from 2.2 cumecs to 7.9 cumecs after turnover, relative to a design capacity of 8.5 cumecs. However, this result is

primarily explained by the effects of a major de-siltation which was part of the turnover program. Without a long-term comparison before and after transfer, it is difficult to know whether similar levels of discharge might have been achieved before turnover. In the Bhairawa-Lumbini groundwater irrigation project in Nepal, it is reported that farmers became cost conscious after turnover and reduced waste of water, resulting in a 50% drop in water consumption per ha even at the same time the price of water was reduced by 40 to 50% (Olin, 1994).

In a study in Colombia, Vermillion and Garces-Restrepo (1996) conducted a detailed post-facto maintenance survey of the Coello and Saldaña irrigation systems in 1994. The study found that 68% of all irrigation structures (for conveyance and division) in Coello were fully functional and 30% were partially functional. In Saldaña, 48% of all structures were fully functional and 44% were partially functional. In Coello, 80% of farmers interviewed in a stratified random sample stated that maintenance of irrigation structures was the same after turnover as before; 15% said it was better afterwards. In Saldaña, 70% said it was the same; 10% said it was better. The post-facto study design, provides evidence that satisfactory performance can be sustained after transfer, but it does not show whether performance levels rose or fell as a result of transfer.

The study by Svendsen and Vermillion (ibid) relied on secondary data about maintenance from technical audits conducted every two years by the US Bureau of Reclamation.³ For the 222,582 ha. Colombia Basin Project, between 1973-77 there were only 5 "category 2" recommendations by auditors which stated "important preventative maintenance needed". By the period 1980-84 there were 20 such recommendations. During the entire post-transfer period, no "category 1" recommendations were received ("urgent remedial maintenance required"). This suggests that cost cutting measures may be compromising the quality of maintenance over time, while still holding the line against breakdowns.

Most evidence on impacts on the performance of irrigation O&M is based on either qualitative reports or post-facto data for normally only 3 to 5 years. However, what limited data exists to date mostly indicates either positive or no effects on O&M performance, with the exception of some evidence that a temporary downturn in performance sometimes occurs immediately after turnover.

Table 3. Reported performance impacts on operations and maintenance

Author/Country	Operations	Maintenance
1. Kloezen/Sri Lanka, 1996 (SI)**	Quality of water distribution did not change.	
2. Uphoff/Sri Lanka, 1992 (SI)	Improved equity of water distribution.	Maintenance activity and investment increased.
3. Pant/India, 1994 (LI)	Reduced average irrigation time.	Maintenance work increased.
4. Srivastava & Brewer/India, 1994 (SI)	Improved equity. 27% more water to tail end; 20% increase in irrigated area in dry season.	More maintenance activity.
5. Rao/India, 1994 (SI)	Improved equity of water distribution.	
6. Rana et al./Nepal, 1994 (SI)	Irrigation discharge increased four fold.	
7. Olin/Nepal, 1994 (LI)	50% drop in water consumption.	
8. Mishra & Molden, 1996/ Nepal (SI)	Inflow increased from 2.2 to 7.9 cumecs (26% to 93% of design capacity)	
9. Oorthuizen & Kloezen/Philippines, 1995 (SI)	Water distribution became less equitable.	Maintenance worsened.
10. Wijayarathne and Vermillion/Philippines, 1994 (SI)	Improved water distribution equity; expansion of dry season irrigated area.	
11. Johnson and Reiss/Indonesia, 1993 (LI)		Deterioration of pump sets accelerated.
12. Nguyen et al./Vietnam, 1994 (LI)	Irrigation efficiency improved 31%. Water consumption per ha. dropped 36%. Area irrigated increased 71%.	
13. Johnson and Vermillion/China, 1995 (SI)	Reduction in water duty from 11,000 m ³ to 4,500 m ³	
14. Maurya; Musa/Nigeria, 1993 (SI)	Improved equity. 12% more water reached middle and tail reaches.	Increased maintenance activity.
15. Samad/Sudan, 1995 (LI)	Average number irrigations higher in government than farmer managed schemes. Timeliness and water adequacy worse in schemes turned over.	
16. Wester/Senegal, 1995 (LI)	Expansion of areas irrigated.	Deterioration of pumpsets accelerated.
17. Azziz/Egypt, 1994 (SI)	Reduced average irrigation time; better water adequacy.	
18. Johnson, Mexico, 1996 (SI)	No change in water delivered per ha. in case study	
19. Yap-Salinas/Dominican Republic, 1994 (SI)	Delivery efficiency improved 25-30%	
20. Vermillion and Garcés/Colombia, 1996 (SI)	More responsive operations. Water adequacy satisfactory. 40% to 45% farmers say operations improved. Temporary inefficiencies after turnover.	Good maintenance; 92% to 98% of state quality of maintenance has stayed same.
21. Svendsen and Vermillion/USA, 1994 (SI)	More responsive operations. Efficiency did not change. Equity worsened slightly.	Good but slight declining trend detected.

** SI = surface irrigation; LI = lift irrigation.

Irrigation finance

The five aspects of irrigation financing most related to management turnover are: staff, O&M costs and fees, fee collection rates, revenue sources and budget solvency. Table 4 below summarizes the key findings of the literature on the impacts of turnover on the financial performance of irrigation systems and organizations.

Staff In countries where transfer is aimed at reducing the size of government, reports generally indicate a reduction in numbers of irrigation agency staff follow transfer, either at system or administrative levels. This is often a gradual process however, while governments wait for staff to retire. In the Philippines, staff of the National Irrigation Administration, at regional and system levels throughout the country, decreased from 2.6 staff per 100 ha service area 1976 to 1 staff per 100 ha by 1985 as a result of management transfer. Oorthuizen & Kloezen (1995) report that turnover of a system in Southern Luzon led to a decrease in staff from 24 in 1982 to only 6 in 1987, or a drop from a service area of approximately 75 ha. per staff in 1982 to 300 ha. per staff in 1987. This led to a 60% reduction in annual operating expenses.

In the Columbia Basin Project in the USA, there were 612 US Bureau of Reclamation (USBR) staff in 1969--the year of transfer. By 1985 only 83 USBR staff remained. Staff declines were even steeper in the Irrigation and Land Management Division, dropping from 297 in 1969 to only 22 in 1985 (Svendsen & Vermillion, *ibid*). Staff were either re-hired by the districts, transferred to other systems, or retired.

Johnson (1996) reported a slight reduction in total irrigation system staff after transfer in Mexico but a substantial reduction of government staff from 7,742 before transfer to 4,450 by 1993. In Colombia the 10 irrigation systems transferred to farmer management between 1990 and 1994 had an average decline in the number of staff of 43.7%, which produced an average increase in area served per district-level staff by 211%. In Coello and Saldaña, which were transferred in 1976, there were 300 total district staff in 1975 and 189 staff in 1993. In 1975, an average of 62 ha was served per staff, whereas in 1993, 147 ha was served per staff (Garces-Restrepo & Vermillion, 1994).

O&M costs and fees The literature to date suggests that where significant subsidies exist before transfer and are dropped afterwards that transfer can result in significant increases in the cost of irrigation to farmers. Where there is little or no change in subsidies, transfer may lead to a decrease in irrigation costs for farmers. High cost systems, such as pump irrigation, are especially susceptible to significant increases in the cost of water to farmers. Lift irrigation systems seem to have the most problems with financial viability after transfer (Johnson & Reiss, 1993).

In Senegal, project reports indicate that irrigation turnover improved supervision of pump management and reduced over pumping, leading to an average increase in water charges of 200 to 400%, due to loss of government subsidies--despite a decrease in the cost of electricity for pumping by about 50% (Meinzen-Dick, 1994b). More broadly, privatization of irrigated agriculture in the Senegal River (irrigated by river lift pump schemes) valley led to a 78% increase in the cost of rice production for farmers between 1980 and 1993 (in constant 1980 prices), due primarily to discontinuance of subsidies for credit, input provision and irrigation. The price of rice rose by 65% during the same time period, from approximately \$.11 per hg. in 1980 to \$.19 per kg. in 1993 (in 1980 dollars; Wester, et al., 1995; Meinzen-Dick, 1994b).

Turnover of pump schemes to farmer groups in Indonesia caused 5 to 7 fold increases in the level of water charges to farmers, due to a reduction in government subsidies (Johnson and Reiss, 1993). In India, where the cost of electricity for pump irrigation is heavily subsidized, Pant (1995) notes that turnover of a public tubewell to farmer management in Uttar Pradesh led to more efficient pump use which brought about a reduction in water costs from US \$2.70 to \$1.20 per ha in kharif (summer) season and a reduction from US

\$6.20 to \$3.20 per ha for the rabi (winter) season. The number of irrigations increased from 2 to 3. However, since data was only available for 2 years, it was impossible to confirm a trend. In a post-facto comparison of tubewell system performance for 30 sample tubewells, Shah, et al. (1994) report that turnover of public tubewells in Gujarat caused an increase in irrigated area between 30 and 400% in sample systems and a reduction in the price of water by 40 to 50.

In a before and after comparison case study in a 180-ha block of a medium-size system in Southern Luzon, Philippines, Oorthuizen and Kloezen (1995) found that average total annual expenditures for O&M were \$ 31,196 during the four-year period before turnover and were only \$ 7,696 per year (in 1982 dollars) on the average during the four years following turnover--a 75% reduction in budget. Studies in the US (Svensen & Vermillion, 1994), Colombia (Vermillion & Garces-Restrepo, 1994) and the Philippines (Lauraya & Sala, 1994) report a concern by engineers that the tendency for farmers to push cost cutting to the extreme after turnover may accelerate deterioration.

Reforms toward local financial and managerial self-reliance in the Bayi and Nanyao irrigation districts in Hebei, China led to increases in surface water costs from \$ 13 ha/yr in 1984 to \$ 36/ha/yr in 1992 in Bayi and from \$ 24 ha/yr in 1984 to \$ 60 ha/yr in 1992 in Nanyao (in 1991 dollars; Johnson, et al., 1994).

From a sample study of six irrigation districts in Mexico, Gorriz, et. al. (1995) report a consistent increase in water fees after transfer of between 45% and 180%, at a range of \$ 2.25 to \$ 7.79 per 1000m³ in 1994. Fees also increased modestly relative to the cost of production but remained in the moderate range of 3% to 8% (Johnson, 1996).

Transfer of the Coello and Saldaña systems in Colombia was accompanied by significant reduction in government subsidies. The area-based water fee rose from \$ 1.50 per ha. in 1967 to \$ 8.68 per ha. at transfer in 1976 and then declined to US\$ 5.54 per ha. in 1993 (all in constant 1988 dollars). Conversely, the volumetric water fee was on a downward trend before turnover (from \$.22/100m³ in 1967 to \$.13/100m³ at turnover in 1976), which reversed to a modest rising trend afterwards--reaching \$.16/100m³ in 1993. The overall cost of water rose modestly after transfer with a policy to raise the proportion of the cost of water which is charged volumetrically. From a broader perspective, the total cost of water relative to the cost of rice production is low anyway and fell still further from before to after transfer, from an already relatively low 4.4% in the 1950's to 3.3% in Coello and 3.1% in Saldaña in 1993 (Vermillion & Garces-Restrepo, 1996).

Comparative post-facto evidence about reduced costs of irrigation as a result of transfer also comes from New Zealand where the government privatized 49 irrigation schemes through outright sale of the districts in the early 1990's. Forty-seven were sold to farmer groups. Farley (1994) reports that water charges on privatized schemes are 2 to 4 times lower than on government "pre-privatized" schemes, despite the fact that government schemes still retained subsidies for O&M costs while privatized schemes paid the full cost of operations. This is attributed to privatized schemes on the average cutting operational costs by 66%, reducing overhead costs and designing simpler repair and maintenance work. In the Hawea system, annual water charges were US \$23.90 per ha before privatization and US \$10 per ha afterwards. The Greenstreet system was privatized in 1990 and by 1994 had an annual water fee of US\$ 2.10 per ha and cash reserves of US \$3.30 per ha, compared with average water fees exceeding US \$7.00/ha and average debt loads of US \$30 per ha for government schemes in the same region. The Bannockburn system, privatized in 1990, had an annual water charge of US \$10.80 per ha with no debts, while government schemes in the same region had water charges ranging from US \$25 to \$47 per ha with large debts.

In the Columbia Basin Project farmers were already paying close to the full cost of O&M before turnover (except for subsidized electricity for pumping water out of the Columbia Basin, which continued after

transfer). In this case turnover also prompted a reversal in trends in water charges, beginning with a rising trend followed by a downward trend after transfer. Water charges rose from \$ 64.44 per acre in 1961 to an annual average of \$ 80.33 per acre in 1969-73 and then gradually fell (in real terms) to \$ 49.42 per acre by 1989, constituting an average decline in assessment rates of 21.9% and a decline of 15.9% in volumetric charges (from \$.83 to \$.70 per hectare-meter water) between pre- and post-turnover periods (Svendson & Vermillion, *ibid*).

Collection rates Evidence on impacts of transfer on fee collection rates is generally in the form of post-facto or simple before and after comparisons. We are not aware of any time series trend analyses or with and without comparative samples. Bagadion (1994) reports average irrigation fee collection rates in the Libmanan-Cabusao pump irrigation system in the Philippines to have been an annual average of 27% for the period 1982-88 and 60% for the post-turnover period 1990-92. In another study in a system in southern Luzon, Philippines, fee collection increased from 20% under the National Irrigation Administration before turnover to 81% in 1989, after turnover (Oorthuizen & Kloezen, 1995). Mishra and Molden (1996) also report in Nepal a substantial rise in collection rates and overall labor and cash raised by farmers after turnover.

In the On Farm Water Management Project in the Dominican Republic, fee collection rates rose from 12% before turnover to 80% afterwards, reportedly due to significant improvements in the reliability of water delivery--despite the fact that water fees increased by 1,500% between 1985 and 1993 as a result of management transfer (Yap-Salinas, 1994; Hanrahan, et al, 1990). In Mexico, water fee collection rates rose from only 15% before transfer to 80% to 100% afterwards. Cost recovery is reported to be virtually 100% in all systems which have been transferred to farmer organizations for at least one year. Collection rates are generally 60 to 70% during the first transitional year and 100% by the second year (Gorriz, et al., 1995, p. 32). This high rate is largely due to the requirement by districts that farmers pay fees before water is delivered (Johnson, 1996).

In China, total water fee collection throughout the country increased from US\$ 50.70 million in 1984, when reforms were just starting, to \$ 415.12 million in 1992 (in 1994 dollars), partly due to an increase in collection rates from 30% in 1984 to 70% in 1991 (Turner and Nickum, 1994). In conjunction with organizing farmers and turning over management responsibility in the Kano River Irrigation Project in northern Nigeria, water fee collection rates rose from only 50% before turnover in 1989 to more than 90% in 1990 after farmers became involved for the first time in collecting the fee. Following the approach of NIA in the Philippines, farmer organizations are granted rebates for 10 to 15% of fees collected if the total collection rate exceeds 80% (Maurya, 1993). Aside from the common rise in fee collection rates, what the above cases of turnover have in common is that farmer organizations became involved in collecting the fees, received bonus incentives for collecting above a certain rate, and gained more voice in determining how the fees were spent.

Diversity of revenue sources Another common tendency after transfer is for farmer organizations to begin to diversify their sources of revenue beyond water charges and management functions beyond irrigation O&M. This has been so in cases of turnover in the Philippines (Wijayaratra, 1993), Sri Lanka, Colombia, China, and the USA. In the Coello system in Colombia, irrigation district revenue from sources other than water charges increased from 10% of revenue in 1983 to 20% by 1992 (Vermillion & Garces-Restrepo, 1994). In the 5,000 ha Kaudulla scheme in Sri Lanka, farmer organizations took over management of distributary canals in 1992 and quickly federated to the main system level, diversifying revenue sources, including collection of membership, seasonal and shareholder fees, provision of fertilizers and agro-chemicals, paddy marketing, tractor rental, and interest from small loans. Within two years the organization had raised US \$8,335 from profits on input sales valuing \$200,000, with a net profit rate of 4%.⁴ Through

group rice marketing the organization also obtained a selling price of approximately one US cent more per kg. than the market rate (Kloezen, forthcoming).

The reforms in China during the 1980's promoted formation of sideline enterprises to cross-subsidize local government budgets after the demise of line agency funding from central government sources (Gitomer, 1994). Today, sideline enterprises are a common source of financing for irrigation districts. For example, the Bayi district in Hebei province developed 9 sideline enterprises between 1984 and 1992 after it became financially autonomous. The enterprises produced approximately US \$60,000 in profits during this period, of which 65% was allocated to the district for water management costs and the rest went to salaries and bonuses of enterprise workers, most of whom were family members of irrigation district staff. By 1994, 30% of the Bayi district revenue was from its sideline enterprises (Vermillion, et al., 1994).

As a result of pressures from farmers, irrigation district boards in the Columbia Basin Project have promoted diversification of revenue sources after transfer in an effort to keep water charges as low as possible. Before transfer in 1976, the water charge was 80% of revenue. It fell to 67% of revenue by 1989 as the districts developed 7 mini-hydropower stations and engaged in water selling contracts and other income generating activities.

Budget solvency Financial solvency after turnover depends partly on the level of subsidy which is removed as well as the potential of the post-transfer managing organization to cut costs and raise additional revenue. In their case study in southern Luzon, Philippines, Oorthuizen and Kloezen (1995) report that within 4 years the system's budget deficit declined from an annual average during 1982-85 of US\$ 19,178 to an average of \$ 553.57 during 1986-89, the first four years after turnover. This largely occurred because farmers cut annual expenditures by one fourth and increased fee collection from 20% to above 80% (as mentioned above). Pant (ibid) reported annual losses of US \$876 before transfer of a public tubewell in Uttar Pradesh changed to consistent surpluses after turnover. Bagadion (1994) reported that the Libmanan-Cabusao pump system, Philippines, was able to convert annual average losses of US 42,218, for the period 1981-89, into an annual average surplus of \$42,880 after turnover, during 1990-92.

In the large-scale transfer of 3.3 million ha. served by large-scale irrigation systems in Mexico, the shortfall in meeting required levels of financing irrigation fell from an annual national deficit of \$ 66 million in 1989 to \$ 41 million in 1993, when transfer was 80% completed. Local self reliance in financing irrigation O&M rose from 43% in 1989 to 78% in 1993, at the national level. However, the absence of district reserve funds, a fixed base fee and government subsidies means that the districts are extremely financially vulnerable in the event of drought (when there is no water to sell) or when major repairs or rehabilitation will be needed in the future (Johnson, 1996).

Coello and Saldaña districts, Colombia, had budget deficits in most years prior to turnover in 1976. During 16 years after turnover Coello had a balanced or surplus budget, whereas Saldaña (which had higher costs due to a substantial amount of necessary dredging and de-silting) had deficits during 8 of the 16 post-turnover years measured (Vermillion & Garces-Restrepo, forthcoming). Garces-Restrepo and Vermillion (1994) report that all irrigation districts transferred to farmer organizations in Colombia between 1990 and 1994 had budget deficits for 2 to 4 years before transfer and had surpluses during the first 2 to 4 years measured afterwards. This was due to both decreases in expenditures (mainly due to staff lay offs) and increases in revenue (primarily from increases in water charges).

Data on the effect of turnover programs on government subsidies to irrigation systems is lacking in the literature. This is needed in order to assess the extent of real financial autonomy after transfer and to interpret changes in cost of water. Also, there is almost no data provided in the literature with a long enough time frame to assess financial sustainability of management after turnover.

Table 4. Reported performance impacts on irrigation finance

Author/Country	
1. Kloezen/Sri Lanka, 1996 (SI)**	Government subsidies for O&M continued after turnover. Farmer organizations invested mainly in input provisions and marketing, not O&M. Annual government costs decreased 33%.
2. Pant/India, 1994 (LI)	50% reduction in cost of water. Budget deficits converted to surplus.
3. Shah/India, 1994 (LI)	50% reduction in cost of water.
4. Olin/Nepal, 1994 (LI)	Cost of water decreased 40% to 50%.
5. Mishra & Molden/Nepal, 1996 (SI)	Cash and labor value raised from farmers increased to \$6.77/ha. 7% of farmers paid water charges.
6. Oorthuizen & Kloezen/Philippines, 1995 (SI)	Reduced cost to farmers. 75% drop in budget. Fee collection rates rose from 20% to 81%.
7. Wijayarathne and Vermillion/Philippines, 1994 (SI)	Revenue from water charges increased from 24% in 1979 to 60% in 1990. Reduction in agency field staff.
8. Bagadion/Philippines, 1994 (LI)	Budget losses converted to surpluses. Fee collection rate rose from 27% to 60%.
9. Johnson and Reiss/Indonesia, 1993 (LI)	Cost of water pumped increased 5-7 times.
10. Johnson and Vermillion/China, 1995 (SI)	Cost of water to farmer per ha. rose 2.5 times. Growing importance of sideline revenue enterprises after reform.
11. Maurya/Nigeria, 1993 (SI)	Water fee collection rates rose from 50% to 90% after turnover.
12. Azziz/Egypt, 1994 (SI)	Dramatic decline in maintenance costs. Per ha. pumping costs declined from \$ 68 - \$ 79 to \$ 45 - \$ 50 after rehabilitation and turnover.
13. Yap-Salinas/Dominican Republic, 1994 (SI)	Water fees increased 1,500% in 8 years. Fee collection rates increased from 12% to 80%.
14. Vermillion and Garces/Colombia, 1996 (SI)	44% average decline in total staff. Farmer emphasis on cost cutting. No long term major change in cost of irrigation. Cost of water relative to production fell 27%. Diversification of revenue sources, from 10% to 20% of revenue other than fees. Budget deficits converted to surpluses.
15. Johnson, 1996 and Gorris, et al., 1995/Mexico (SI)	Increase in water charges between 45% and 180%. Increase in fee collection rates from 15% to 80%-100%. Shortfall in financing declined nationally from \$66 to \$41 million annually. Local self reliance increased from 43% to 78%.
16. Svendsen and Vermillion/USA, 1994 (SI)	86% decrease in government staff. Farmer emphasis on cost cutting. Volumetric charges reduced 16%. Diversification of revenue sources. Water charge was 80% of revenue before and 67%, after turnover.
17. Farley/New Zealand, 1994 (SI)	Farmer emphasis on cost cutting. Average operational costs declined 66%. After turnover, water charges was 1/4 to 1/2 of the pre-turnover level.

** SI = surface irrigation; LI = lift irrigation

Agricultural and economic productivity

The relationship between management transfer, agricultural productivity and economic output is less direct than the relationship between transfer and O&M performance or financial viability. Of the 25 papers presented at the International Conference on Irrigation Management Transfer in Wuhan, China in 1994 which contained data on performance, only 14 reported increases in cropping intensity (of up to 97% in Andra Pradesh) and 10 reported increases in crop yields (Turrall, 1995). Most reported improvements in both performance measures, although the studies provide no control comparisons to enable exclusion of other causes of improvements. The most common agricultural productivity measures referred to in the literature on management transfer are area cultivated, cropping intensity and yield. The most common

economic measures referred to are gross value of output, net farm income per hectare, economic returns to irrigation. Less data is available on economic than agricultural productivity. Table 5 below summarizes the key findings of the literature of the impacts of turnover on the agricultural and economic productivity of irrigation systems.

Research in Mexico has shown no significant increase in area irrigated, cropping intensity or yields before and after management transfer (Johnson, 1996). Gross economic returns have remained similar or have declined after transfer, being in the range of \$ 1,500 to \$ 1,900 per ha. (Ibid).

The Dominican Republic's On Farmer Water Management Project reported yield increases of 40%. But it is not possible from the data to distinguish the effects of transfer from other factors, such as improved irrigation infrastructure and cultivation practices (Sagardoy, 1994). In the Coello and Saldaña systems in Colombia, net income rose from US \$124.32 per ha in 1984 to \$153.15 per ha in 1994 (in 1988 peso equivalents), with net income varying dramatically during the period, however. Economic return to irrigation was US \$12 per 100m³ in the Coello system in 1993 (with water use efficiency of 73%) and \$11 per 100m³ in Saldaña in 1993 (with water use efficiency of 57%). However, no data on economic productivity before transfer was available. While this type of evidence supports the view that farmer organizations can sustain relatively high levels of productivity after transfer, it does not confirm that the levels were primarily achieved or sustained because of management transfer.

In a comparison of two localities in the Senegal River Valley, researchers found that in the Doue Region of the Senegal River Valley, privatization of irrigated agriculture support services was accompanied by a decline in cropping intensities but an expansion in irrigated area, from 620 ha in 1985 to 1,070 ha by 1991. Farmers shifted to growing more of their crops only in the wet season, partly due to rapidly rising input prices and greater complexities of dry season irrigation after management transfer. Similarly, in the Ile a Morphil in the Senegal River, privatization led to a near doubling of irrigated area between 1985 and 1993 and an increase in cropping intensity from 86% during 1985-88 to 93% during 1990-93 (Wester, et al., 1995).

In a case study of a pilot turnover project in the Kano River Irrigation Project in Northern Nigeria, researchers found that organizing farmers to take over management of distributary canals led to 12% increases in water volume reaching middle and tail ends of pilot canals, which resulted in an 80% increase in dry season cropped area. Turnover was introduced to the system largely because of lack of government funds for irrigation O&M and the consequent rapid deterioration of the system due to lack of maintenance. In the 1992/93 season following turnover, 70% of distributary canals and 60% of field channel lengths were cleaned by farmer groups. As a result 10% more wheat and 8% more maize was grown in the dry season than in previous years. However, absence of data for multiple years prevents us from generalizing about trends in productivity and the sustainability of farmer investments in maintenance (Maurya, 1993; Musa, 1994).

Samad and Dingle (1995) compared the performance of six pump schemes along the White Nile in Sudan which were managed by three types of organizations: farmer groups (which had recently taken over management), the White Nile Agricultural Corporation (a parastatal), and a contracting private holding company. Wheat yields per unit of water delivered were 11 kgs/100 m³ in schemes managed by farmers and by the private company. They were 17 kgs/100 m³ in schemes managed by the parastatal. This difference was attributed to better access to agricultural inputs by the parastatal.

Gross margin/100m³ of water delivered for the 1993/94 wheat crop was \$0.34/100m³ in the turned over schemes, \$1.09/100m³ in the parastatal schemes, and only \$0.09/100m³ in schemes managed by the private company. Average net farm income was \$17.68/ha in the turned over scheme, \$42.26/ha in the parastatal

scheme, and only \$6.90/ha in the scheme managed by the private company. The differences were attributed to higher cost of inputs and difficulty of obtaining timely inputs for the private sector entities. 1993/94 was the first year after transfer and the farmers and private company had little, if any, experience in management before this time.

Azziz (1994) reports comparative post-facto data that the transfer of mesqas in Egypt led to an increase in average annual farm income of US \$300 per hectare. Pant's study of transfer of a public tubewell in Uttar Pradesh, India documented a decrease in irrigated area but increases in cropping intensity and yields after the transfer. The average irrigated area in rabi (winter) season was 103 ha during 1990-92 (before turnover) and 59.5 ha during 1992-94 (after turnover). Cropping intensities were an average of 143% during two years before turnover and 162% afterwards. Yields for wheat, rice and sugarcane increased about 10%, indicating that farmers preferred to intensify rather than extensify production after turnover. Because of a limited study time period (2 years before and 2 years after) it is impossible to generalize about trends. In the case of turnover in the Paliganj Canal in Bihar, India, management improvements due to turnover (mentioned above) led to an increase in irrigated area in the dry season from 3,613 ha in 1990 before turnover to 4,350 ha after turnover in both 1992 and 1993 (Srivastava & Brewer, 1994).

Uphoff reports the results of management transfer in the Gal Oya system in Sri Lanka as improved equity of water distribution between head and tail areas, improved maintenance, increased cropping intensity and higher yields. However, the study does not present system-wide quantitative data about these results and only refers to agricultural productivity changes in a partial, anecdotal way. Attendance of farmers at meetings is characterized as a good in itself (Uphoff, 1992).

In a paper on turnover in several systems in the Philippines, Wijayaratna and Vermillion (1994) report on improvements in water distribution, expansion of irrigated area, and increases in cropping intensities in all study sites. The Banurbur system irrigated 486 ha in the dry season before turnover and 750 ha after turnover. The increase continued for several years. The Maramag system irrigated 524 ha in the dry season before turnover and 719 ha afterwards. The MNOH system in Bicol added an additional 390 ha to wet season irrigation after turnover and a third crop was planted in several blocks for the first time. Again, the data has a short time line and incomplete coverage of key agricultural performance data.

In Vietnam, four years after the turnover of a medium scale river lift pump system in the Red River delta, area irrigated increased from 934 ha to 1600 ha., while leading to an increased cropping intensity from 170% to 250% after turnover. (Nguyen, et al., 1994). Management turnover of the West Gandak scheme in Nepal led to yield increases for rice from 2.2 to 3.4 tons per ha. and for wheat from 1.6 to 2.4 tons per ha. This was apparently due to a combination of de-siltation and management changes related to turnover. Incremental economic benefits as a result of turnover were estimated to be \$ 193 per ha. per year or \$ 182 per ha. per year after accounting for an increase in O&M costs to farmers (Mishra and Molden, 1996).

Johnson, et al. (1994) report that annual grain yield (wheat and maize) per unit of water in two systems in the north China plain increased steadily between 1973 and 1992 and the rate of increase accelerated after the reforms in the mid 1980's. Annual grain yield (kg) per unit of water (100 m³) in Nanyao was 66 kgs/100m³ in 1973, 70 kgs/100m³ in 1982 and 135 kgs/100 m³ in 1992. Similarly in Bayi, yields increased from 28 kgs/100m³ in 1973 to 65 kgs/100m³ in 1982 to 150 kgs/100m³. Turnover impact data over such a long time period is rare and suggests that turnover had a positive effect on yield returns to water, given the parallel upturn in trend in both systems at the time of turnover. However, measures of input use rates or other factors were not documented.

Table 5. Reported performance impacts on agricultural and economic productivity

Author/Country	Agricultural	Economic
1. Kloezen/Sri Lanka, 1996 (SI)**	Cropping intensities increased from 138% to 200%.	Gross value of output between \$ 944 and \$ 1,136 per ha. per year after turnover.
2. Pant/India, 1994 (LI)	Increase in cropping intensity from 143% to 162%. Yields increased 10%.	
3. Srivastava & Brewer/India, 1994 (SI)	20% increase in area irrigated in dry season.	
4. Mishra & Molden/Nepal, 1996 (SI)	Rice yields increased from 2.2 to 3.4 t/ha. Wheat yields increased from 1.6 to 2.4 t/ha.	
5. Wijayarathne and Vermillion/Philippines, 1994 (SI)	Increases in cropping intensity and area irrigated.	
6. Nguyen et al./Vietnam, 1994 (LI)	Cropping intensity increased from 170% to 250%. 14% increase in area cropped. Yield increased 13%.	Incremental benefits per ha. per year increased by \$ 193 or by \$ 182, net of increased O&M cost.
7. Johnson and Vermillion/China, 1995 (SI)	Grain yields increased modestly.	Cases of both increase and decrease in net income.
8. Maurya; Musa/Nigeria, 1993 (SI)	80% increase in dry season cropped area.	
9. Samad/Sudan, 1995 (LI)	High yields per 100m ³ water in parastatal vs. turned over schemes (17 kgs. vs. 11 kgs.)	Gross margin 3 times higher in parastatal than turned over schemes. Productivity of land and water higher in parastatal than turned over schemes.
10. Wester/Senegal, 1995 (LI)	Increase in irrigated area by 72%, with cropping intensity rising and falling in different locations.	Cost of irrigated rice production increased 78%.
11. Azziz/Egypt, 1994 (SI)	Increase in main crop yields 10% - 16%.	Increase in farm incomes by \$ 60 per ha.
12. Johnson/Mexico, 1995 (SI)	No change in area irrigated, cropping intensity or yields.	Gross economic returns have remained same or declined (\$ 1500 - \$ 1900 after turnover)
13. Vermillion and Garces/Colombia, 1996 (SI)	Rice yields of 6.5 tons, sustained after turnover. Irrigated and crop area continued to expand after turnover.	Net farm income rose 23%. Economic return to irrigation was \$ 11 - \$ 12 per 100 m ³ water. Gross value of output increased 400%, 1983-1991.
14. Svendsen and Vermillion/USA, 1994 (SI)	Shift to less water intensive crops.	Average farm incomes rose approximately 15% due to reduction in water cost.

** SI = surface irrigation; LI - lift irrigation.

Svendsen and Vermillion (1994) report that the reduction in per area water costs after transfer enhanced average annual profitability of irrigated farming by about 15% of average family incomes, assuming real net income remained the same in the 1980's as in 1978. They note that this would increase the gross margin on a typical 65 hectare farm by about \$1,600 per year. In general, the literature to date most often reports positive impacts of management transfer on agricultural and economic productivity.

Government resources

One of the main reasons governments promote transfer programs is to reduce the cost burden of irrigation management on the government. Therefore it is curious that there is not very much information available on impacts of transfer on the government. Potentially, transfer could reduce government expenditures for

O&M and allow reallocation of central revenues to construction or other costs within the irrigation or agricultural sector. Or it could cause a total reduction in budget for the sector itself. Much depends on size of budgets, financial policy and political will.

The move to make the National Irrigation Administration (NIA) in the Philippines financially autonomous and to turn over irrigation system management by 1990 produced an annual savings to the Philippine Government of US \$12 per ha from cash and in-kind contributions in systems where transfer was partially or fully implemented (Bagadion & Korten, 1991). Revenues from irrigation fees collected by water users associations which partially or fully took over irrigation management constituted 24% of NIA's total revenue in 1979 but 60% by 1990 (Wijayaratra & Vermillion, 1994). Kloezen (1996) shows that the rise of "participatory management" policy in Sri Lanka supported a reduction in irrigation O&M expenditures by the government from approximately \$ 14.80 per ha in 1985 to \$ 6.50 per ha in 1994. Pant (1994) showed that the transfer of a typical public tubewell to farmer management in Uttar Pradesh, India reduced government subsidies to the tubewell system from US \$876 before turnover to \$656 afterwards, or a reduction of 25%. In the case of the turnover of the West Gandak scheme in Nepal, government expenditures for maintenance declined from \$ 6.65/ha. to \$ 4.06/ha. after turnover (Mishra and Molden, 1996).

The small scale irrigation turnover program in Indonesia includes about 70% of all public irrigation systems and 21% of the total irrigation design area. It has been estimated that by the time the program has been fully implemented it will save the government approximately US \$13.5 million in annual O&M costs (Johnson, 1995). Vermillion (1989) calculated the budgetary effect the policy would have at the district level assuming a policy of reallocating funds from small scale systems to underfunded medium large scale systems. In the Sumedang Section of the West Java Provincial Irrigation Service, which has numerous small scale systems and only a few medium or large scale ones (i.e., over 500 ha in service area), turnover would permit transfer of all O&M funds for small scale systems to medium or large systems, which would allow an increase in O&M expenditures on the larger systems from a pre-turnover level of about US \$10 per ha to a post-turnover goal of \$15 per ha, to prevent deterioration of larger systems.

As a result of Mexico's large scale management transfer program, annual government subsidies for irrigation O&M fell from \$ 40 million in 1989 to zero by 1993, at which time approximately 2.4 million ha. of service area had been transferred to farmer management. Gazmuri (1994) asserts that at a macro level in Chile, irrigation management transfer had a positive effect on redistribution of wealth from the wealthier (those who had water) to the poorer. After transfer, public funds previously spent on irrigation were diverted to poverty alleviation programs. However, no data is provided.

The environment

Only a few studies refer to impacts of turnover on the environment; these are mostly qualitative. In Chile, water users associations, which took over control of irrigation systems, reportedly became empowered by transfer and the 1981 Water Law Code and successfully pressured paper factories to invest in pollution reducing equipment, at the threat of cutting off water to industrial users (Meinzen-Dick, 1994b, p. 81).

Yap-Salinas (1994) reports that irrigation transfer in the Dominican Republic, through establishment of local organizations to regulate land and water use, has halted and reversed land degradation and loss of soil, which in turn has reduced health risks associated with water logging due to poor drainage previously. However, due to lack of comparative data it is difficult to know how much of this was due to installation of new drainage facilities versus the institutional reform.

In Senegal it is reported that irrigation management transfer has increased water logging and salinization due to poor management practices by new and inexperienced managers hired by farmer associations (Agsieve, 1994). Because of the short time frame reported, it is difficult to assess whether this is a long term problem or only a learning adjustment.

Impacts of transfer reported in the literature to date are mostly positive. This may be partly a result of a bias in sites selected or the possibility that many authors are promoters of the reforms. Evidence about impacts includes changes in O&M practices and performance, financial strategy and viability, agricultural and economic productivity, and limited reports about effects on government finances and the environment. The weakest areas to be documented, which are of potential importance, are effects on government subsidies, maintenance of irrigation infrastructure, and the cost of irrigation to farmers (relative to changes in economic productivity). Another weakness in the evidence is that most reports only mention two or three indicators of performance, so it is impossible to judge tradeoffs between key performance measures, such as changes in finance versus maintenance.

Future priorities

In our view the following are the three main priorities for research and development about irrigation management transfer.

Priority 1: Systematic assessment of impacts More systematic research is needed on the impacts of management transfer. Each study should include a balanced set of performance indicators which includes quality of operations and maintenance, financial viability, agricultural productivity, economic impacts, and impacts on government resources and the environment. The International Irrigation Management Institute is currently developing and field testing a methodological guide for impact assessment of irrigation management transfer, which will soon be disseminated to researchers and professionals involved in management transfer around the world.

Priority 2: Research on essential conditions Research to date and reports from practitioners in international meetings favor the notion that certain pre-requisites are needed before countries can expect to achieve success with turnover programs (Vermillion, 1994). The most common are:

- A clearly recognized and sustainable water right,
- Appropriate infrastructure relative to local management capacities,
- Clear designation of responsibility and authority for essential management functions,
- Effective accountability and incentive mechanisms, and
- Adequate resources (financial, human) for sustainable irrigation management

The components which tend to be most commonly lacking in many Asian countries are: clear water rights, clearly designated lines of authority between farmers and agencies, and effective accountability and incentive systems. Research is needed on what common characteristics occur in more successful cases of management transfer. Such characteristics include institutional arrangements of transfer, the socio-economic context, the agro-technical context, and support services for irrigated agriculture. Action research is needed which includes all five of the above hypothesized essential elements in locations where they do not yet normally occur.

Priority 3: Action research on turnover at a larger scale For several years the water user association has been promoted as both a governing and a management body for irrigation systems. Community organizers have helped WUA's to develop constitutions and by-laws, select leaders, approve plans and budgets and

apply sanctions. WUA's then directly manage operations, maintenance and finances. This model is not well suited for management at higher levels of larger scale systems or in more complex environments because all functions are integrated into the same body, which causes an overload at larger scales of management. Accountability between farmers and leaders, especially in finances, is often weak and WUA's generally do not have professional staff. This has led many to conclude that transfer can only occur at small scales of management.

And yet, the problems of poor performance, high costs to government and deterioration are equally, if not more, severe in large scale irrigation. Action research is needed on experiments to turnover medium or large scale irrigation systems to financially self-reliant local organizations. In an experiment to improve accountability and professionalism in local organizations, we suggest testing a tripartite organizational model where the governance entity (general assembly of farmers and elected board of directors) forms and supervises a professional management entity (recruited technicians or a contracted company). In turn, a separate body (perhaps a parastatal) performs independent financial and technical audits of management. Research is also needed to determine under what conditions turnover of management of the water source can and should be attempted.

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END NOTES

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³ The US Bureau of Reclamation regional offices conducted technical audits of systems after transfer. These involved on site inspection of all physical structures and examination of finances and management practices. Maintenance assessments were rated according to degree of urgency of need for repairs.

⁴ The 4% net profit rate is overshadowed by an agricultural credit interest rate of 9% and an annual rate of inflation of approximately 11%..

CHAPTER 5

Irrigation Management Transfer: Conditions for Success

The primary functions related to irrigation management may be summarized as follows:

- Legalizing water use for irrigation,
- Commissioning organizations to own irrigation property, to regulate water for irrigation, to provide resources for irrigation and to produce the irrigation service,
- Providing resources for the service,
- Producing the service,
- Owning irrigation assets, and
- Regulating and auditing.

The first two functions are inherently governmental. The other functions could be handled either by government or the private sector. The "private sector" can be either community or resource user groups, individuals, or companies. In light of our definition and the above list of functions, management transfer, then, would generally mean the turning over of part or all of the responsibility and authority to manage the functions of providing resources for the service, producing the service, owning irrigation assets and/or regulating and auditing irrigation management.

From a hydrological perspective, management transfer can mean the contraction of government management upstream—that is away from tertiary or distributary levels of irrigation systems, back to managing only the main system. Farmer groups or other private sector entities then take over management functions for sub-systems, in which case we can say that the system is jointly managed by both a government agency at the main system level and farmer groups at lower hydraulic levels of the system. Or transfer can include responsibility for the intake and entire irrigation and drainage network.

The most common reasons governments choose to pursue transfer are as follows:

- Lack of government funds to pay for the recurring costs of irrigation,
- Inability of governments to collect irrigation service fees from farmers,
- Poor management performance by government agencies, and
- Assumptions that farmers have the capability to manage irrigation effectively.

We will now briefly review some of the key lessons which are gradually emerging about necessary pre-conditions for transfer, the transfer process, supportive arrangements after transfer, and options for alternative management models after transfer.

Pre-conditions for viable irrigation management transfer

Comparative results from IIMI's case studies and other reports on transfer programs indicate that a clear water right at both system and user levels, with a compatible water distribution arrangement, exists in each of the cases of more successful transfer (Svendsen and Vermillion, 1994a; Vermillion, Wang, et al., 1994; Vermillion and Garces-Restrepo, 1994). Where these do not exist it may be difficult to form farmer groups

to manage irrigation collectively, as is pointed out by Kloezen, (1994); Woodhouse and Ndiaye, (1990); and Vermillion, (1994b). Where farmer organizations lack full legal and political recognition to make all decisions necessary to manage the irrigation system they appear to have difficulty achieving cost efficiency, raising adequate revenue, applying sanctions and entering into contractual relationships with third parties (Garces-Restrepo and Vermillion, 1994). Also, farmer organizations normally should have full control over raising and spending of revenues, hiring and firing of staff, applying sanctions and entering into contractual relationships.

Comparative research on farmer managed irrigation suggests that farmers are only willing to invest in maintenance or system management when benefits obtained (in water deliveries or agricultural production) are proportionately related to farmer investments in the system (Ostrom, 1992). In other words, the benefits of self management (such as cost efficiency, more responsive and reliable service, productivity and sustainability) will outweigh additional costs (in time or expense). The value of farmer investments in irrigation exceeds the opportunity costs (Ostrom, 1994). Farmer organizations should be seen as beneficial to the large majority of farmers in the area served by the organization. Farmers should have a clear basis for assuming that management transfer will enhance the profitability of irrigated agriculture for them. Factional divisions or extreme socio-economic differences can prevent emergence of effective collective action for management takeover (Wade, 1988). Investment by farmers in construction or in operations and maintenance, either through labor, payment of a fee or other means encourages a sense of ownership and serious concern about the performance and sustainability of irrigation among farmers (Lam, 1994). Skills required to manage irrigation systems should be made available among farmers or be recruitable by farmers.

An important issue still to be resolved is what is the or optimal size for farmer organizations which are taking responsibility for irrigation management. Related to this is the question of federation of farmer organizations and whether medium or large scale irrigation systems should be managed by multi-tier farmer organizations or by joint agency/farmer management (Merrey, 1994; Ostrom, 1992). There are some indications that irrigation district or company management models may be better suited than farmer organizations to managing larger scale or more complex irrigation systems (Svendsen and Vermillion, 1994; Maass and Anderson, 1986).

In short, research to date indicates that transfer will be acceptable to farmers' organizations and result in sustainable local management only where the following arrangements are in place:

- transfer is cost-beneficial to the majority of farmers,
- social divisions are not serious enough to disrupt communication and decision-making between farmers,
- clear and sustainable water rights are vested in the managing entity,
- the transfer policy clearly designates responsibility and authority and supportive accountability and incentive mechanisms at the operational level—including clear designation of responsibility for long-term maintenance and rehabilitation,
- irrigation system infrastructure is appropriate for local management capacities, and
- adequate human, financial and information resources are available to support local management.

Management transfer process

In a few cases, management transfer has already been implemented comprehensively, including all or most irrigation systems in the country, such as in Chile. In most cases management transfer is in the early stages of development, either in policy formulation, pilot adoption or under limited implementation (limited to small scale systems or terminal units of large systems). Governments implement such reforms because of an inability to finance irrigation management from central funds, donor pressures, inability to recover costs of irrigation from farmers, poor management of public irrigation, and the often untested assumption that farmer or private sector management will be better than management in the public sector.

Research to date has shown that strong support from high levels of the government for transfer should be directed towards the irrigation agency, otherwise bureaucratic resistance can interfere with transfer, especially at operational levels (Srivastava and Brewer, 1994; Vermillion and Garces-Restrepo, 1994). Irrigation or water resources agencies pressured to rapidly implement structural adjustment policies such as management transfer or outright privatization of irrigation systems tend to focus on rehabilitation and organizing farmers to the exclusion of comprehensive strategic planning about the reorientation of the irrigation agency itself and disposition of staff displaced by transfer. This appears to compound the problem of bureaucratic resistance (Samad and Dingle, 1994; Kloezen, 1994; Vermillion and Johnson, 1990). Pilot testing and action research are used in some countries in the early stages of transfer programs, but often more as a means for training staff to implement transfer rather than as an experimental, comparative means to develop a replicable transfer strategy (Vermillion, 1989a).

As demonstrated in the Philippines, the use of trained farmer organizers can be an efficient and effective approach which is practical to adopt on a large scale (Bautista, et al., 1994). This may be more effective and more cost efficient than attempts to organize farmers with government agency staff (Bagadion, 1994; Helmi and Vermillion, 1990). Transfer programs in as diverse settings as Indonesia and Colombia show that negotiations between the government and farmer organization representatives are needed at each stage of the transition process in order to resolve various issues of management responsibility, rehabilitation, financing, etc. (Bruns and Sudar, 1994). NGO's oriented toward dealing with organizational matters are often used to assist farmer organizations to develop their own locally-appropriate by-laws, accounting systems, proposals for system infrastructure improvement and management plans (Bruns and Sudar, *ibid*; Mott MacDonald, 1993). It may be necessary at this stage to set up an accounting system which involves financial and technical audits by a neutral and authoritative external body. This may help to create confidence among farmers and prevent abuses (Vermillion and Garces-Restrepo, 1994; Svendsen and Vermillion, 1994a).

System design and technology, originally installed for management by agencies and technical people may, need to be revised to be compatible with local management capacities and water rights (Vermillion, 1994c; Diemer and Slabbers, 1992). Government-sponsored rehabilitation prior to transfer without farmer participation or investment tends to amplify farmer dependency on the government and obstruct achievement of objectives of transfer programs (Vermillion, 1989a; Vermillion, 1989b). Where clarity is lacking about the terms and conditions for future rehabilitation and system improvements, especially regarding financing obligations, farmers are unlikely to raise a capital replacement fund (Garces-Restrepo and Vermillion, 1994a). Where there is a clear policy that farmers must finance rehabilitation it appears more likely that they will raise a capital replacement fund once they know that they are responsible for the long-term sustainability of the system (Svendsen and Vermillion, 1994a). Where organizational and

management skills are lacking, an emphasis on training farmers and management staff may be essential to introduce viable local management (Wijayaratra and Vermillion, 1994; Plusquellec, 1989). Where agency field operations staff are transferred to new farmer associations there may be less need for training (Svendsen and Vermillion, 1994b). Governments, donors, consultants and NGOs need to balance their emphasis on local capacity-building with the need to achieve targets within strict deadlines.

In summary, the irrigation transfer process supports emergence of locally sustainable irrigation only where:

- The transfer program has high-level political commitment,
- Before implementation, the government clearly designates alternative roles and staff placements for the irrigation agency after transfer,
- Farmer organizations should be developed before transfer and involve supportive traditional institutions and experienced farmers,
- By-laws, conflict resolution arrangements, accounting systems and O&M plans are developed during the transfer process.
- Where needed, rehabilitation should be done only if involving farmers in decision-making and investment.

Post-transfer arrangements

After transfer, a qualified entity, such as the irrigation agency, may be needed to provide technical guidance to farmer management organizations to help protect the integrity of irrigation structures and protect against unwanted externalities such as environmental damage (Garces-Restrepo and Vermillion, 1994b). This could be done as a periodic technical audit (Svendsen and Vermillion, 1994a). A periodic financial audit of farmer organization accounts by a neutral entity recognized by the government can help prevent abuses and provide legitimacy to the organization in the eyes of the farmers. Where the government retains a role in providing future assistance to farmer managed irrigation organizations for rehabilitation or system improvement, governments can encourage responsible irrigation management and local raising of a capital replacement fund by linking performance assessment from the technical and financial audits to conditions for receiving future government assistance (Svendsen and Vermillion, *ibid*).

The long-term sustainability of local organizations depends largely on their ability to adapt to changing conditions and the need to become profitable enterprises. Support services will be widely needed for farmer-based irrigation management organizations to help them make the transition from narrow O&M organizations to a more integrated business-oriented production organization. Support services will likely be needed the most to enhance profitability of farming through bulk purchase of agricultural inputs, timely resolution of technical problems with irrigation system operations and maintenance, credit and financing, legal assistance, dispute resolution, provision of business-oriented information and product processing and marketing (IIMI, 1987). As competition for water increases, as management for irrigation systems is devolved to local organizations and as water-related environmental problems spread in many parts of the world, higher-level organizations are urgently needed at the level of the resource base (river basins, watersheds, aquifers) to manage, regulate and protect the sustainable productivity of water and land resources. Interest is growing in develop federated community user or common property groups to take over the functions of planning, allocating and enforcing resource use at watershed or aquifer levels (Vermillion, *forthcoming*).

Dispute resolution arrangements should be available to local organizations managing irrigation systems. Farmer organizations at the irrigation system or federated levels should have the capability to settle most kinds of water-related disputes in an expeditious, objective and authoritative manner.

Interest is also growing in establishing the institutional parameters within which water markets can work effectively and fairly. Regarding financing, as government subsidies to irrigated agriculture decline, new local management organizations will often find it necessary to replace old subsidies with new forms of secondary revenue such as water sales and sideline businesses to keep irrigation systems financially viable (Vermillion, et al. 1994; Johnson, et al., 1994; Svendsen and Vermillion, 1994a). Secondary revenue generation may also create stronger incentives for farmers to support their organizations.

Appropriate local management models

Research and development practice in irrigation management in developing countries to date is producing a steadily growing body of evidence to support four important propositions about the prospects for irrigation reform in developing countries.

- 1) Public sector irrigation management is generally characterized by poor management performance, financial insolvency and physical deterioration. This is true for both small and large scale irrigation systems in developing countries;
- 2) There is a limit to the size and amount of federation which water users associations can handle and be effective. They seem to be best suited to managing small scale irrigation systems;
- 3) There are signs that the widely promoted model of joint management of medium and large scale irrigation systems by centrally funded agencies and water users associations is unstable and ineffective;
- 4) It is apparent that new alternative models for managing medium and large scale irrigation in developing countries are urgently needed to reverse serious deterioration and inefficiencies. Two alternative models which appear to be more viable and effective than agency or joint management approaches are: 1) "irrigation districts" governed by farmer-elected boards and managed by specialized staff and 2) mutual or contract "irrigation management companies."

If the above propositions are true, we see the need for an evolutionary shift toward three basic alternative management models as governments in developing countries decrease their role in direct management of irrigation systems. If given adequate strategic support, these management models may be expected to evolve, over the future approximately as follows:

- 1) Direct management of small scale irrigation systems by farmer organizations,
- 2) Management for medium scale or medium complexity irrigation systems by irrigation districts which are governed and supervised by farmer-elected boards and have specialized staff for management, and

- 3) Management for large scale or more complex irrigation systems by irrigation companies which are either owned or contracted by a federated farmers' organization and governed (but not supervised) by a farmer-elected board.

Research to date tentatively indicates that irrigation management transfer will have more effective management and performance outcomes where the level of professionalization, specialization and accountability of the managing entity matches the level of complexity imposed by the scale and management intensity of the management environment.

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CHAPTER 6

Analytical Framework for Irrigation Management Reform

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Abstract

This paper provides a framework which specifies the key components of irrigation management and indicates how they are inter-related. Considerations of management reform should include an analysis of four basic dimensions of irrigation management:

- *the water service,*
- *hydraulic technology,*
- *management functions, and*
- *organizations.*

The analysis should start from a precise definition of the water service which is required and then proceed to specify the nature of technology and management which is best suited to achieving an acceptable standard of performance in the water service. Analysis should be made of:

- *gaps between the existing and required service and*
- *gaps between the required service and the compatibility of existing technology and management.*

The analysis will largely determine whether or not reforms are actually required and, if so, how extensive and basic they should be.

Introduction

Developing countries, donor agencies and others are attempting to reform irrigation systems to provide financial sustainability and improve performance. While there have been various experiments with reform (several done by IIMI) there has been less systematic analysis of management systems and their performance. There is a need to pool internationally lessons learned about management reforms and provide guidance on the options, implications and basic modalities of strategic reform.

IIMI has developed and applied a comparative methodology for assessing the effects on irrigation performance of pilot experiments or reforms such as management turnover. IIMI has conducted research on irrigation management turnover for several years in such countries as Indonesia, the Philippines, Sri Lanka, India, China, Colombia, Mexico and Pakistan. IIMI proposes herein an analytical framework to examine irrigation management reform and provide practical guidance to professionals faced with the challenge of working through reform. This paper is a step in that direction.

This paper relates primarily to medium and large scale gravity irrigation systems (i.e., above 1,000 ha in service area). We will not discuss the important topics of pump and pressurized systems and the conjunctive use of water in irrigation. There are four basic dimensions for analyzing irrigation management alternatives:

- The water service,
- Hydraulic technology,
- Management functions, and
- Organizations

First dimension: The water service

The first dimension of this framework is the primary service which irrigation management provides, which is water delivery and drainage. The water service may include regulation of the water source, acquisition of water at the source, conveyance, distribution through the canal network and division points, application of water on fields, drainage and flood control. Measurement of water is an important aspect of water delivery.

For irrigation, the water service is primarily defined by the amount (or proportion) of water to be delivered to specified places at specified periods (or sequences) of time. These expectations are normally embodied in a water right, which may be defined at different levels, from the farmer up to the water source.

The three major challenges for managing water service for irrigation are:

- How to allocate water between watercourses and farmers and ensure that allocation rules are implemented?,
- How to manage variability in water supply, surpluses and scarcity consistent with the allocation rules and minimize negative environmental consequences?, and
- How to minimize negative environmental consequences.

The water service requires actions to be taken at one level which provide an agreed service to another level. The service delivered normally cuts across interfaces between each of the basic hydraulic levels.

In gravity flow systems, both discharge and water levels must be controlled to satisfy hydrologic parameters. The frequency and duration of water flows may also be controlled, depending on system technology. Control may be fixed or flexible and manual or automatic. The four basic variables relative to water delivery which are controlled in irrigation systems are:

- water discharge (Q),
- water level (H),
- duration of flow (T), and
- frequency of flows (F).

These variables define two basic types of water delivery management systems, each of which delivers a service differently within and between given levels of an irrigation system. These are:

- continuous flow systems (supply or demand based) and
- rotational systems (fixed or variable).

Continuous flow demand based systems target water deliveries according to requests or requirements for water. Continuous flow systems provide given proportions of uninterrupted water flow to the main canal

and possibly distributary canals. Rotational systems deliver water in turns to different sub-units of the system, either in time or frequency of flow, or both. Table 1 presents a basic typology of water delivery systems which are known to exist in the world. This is an adaptation of typologies by Replogle, et. al. (1983) and Maass and Anderson (1986).

Table 1. *Water delivery systems for irrigation*

No.	Delivery System	Variables Controlled	Remarks
1.	Continuous on demand	Q,F,T controlled as per requests.	Continuous flow in main and possibly distributary canals. Water delivered to fields on request basis. Technology and cost requirements high.
2.	Continuous modified or arranged demand	Basic allotments for Q or F are given with option for requesting additional Q,F, or T, subject to supply constraint	Continuous flow in main canal. Used in more water abundant environments or where sophisticated information and control facilities are available.
3.	Continuous regulated flow, supply based	Regulated Q flowing uninterruptedly to a given level, throughout the system.	Continuous flow in main and distributary canals. In paddy systems in Southeast Asia and South India.
4.	Continuous variable flow, supply based	Variable Q. T,F not relevant.	Continuous flow to distributary level, terminal delivery adjusted to relative crop requirements.
5.	Fixed rotation	F, T and Q (in theory) fixed down to watercourse level	Found in warabandi areas of North West India and Pakistan.
6.	Semi fixed rotation	Fixed T and F, fluctuating Q. Generally, rotating between watercourses in distributary	Wheat and maize irrigation in China; used under scarcity for rice systems in Southeast Asia.
7.	Variable rotation	Constrained Q and F, variable T	One cusec canal design in Sri Lanka; used at distributary and tertiary level during land preparation in Asian countries.

Second dimension: Hydraulic technology

Each of the above delivery systems varies in the sophistication of hydraulic technology required to manipulate water flow according to the service required and in the level of management intensity required to measure water and manipulate the hydraulic technology. Hydraulic technology constrains the type of delivery system which is feasible. Structures can determine whether or not it is feasible to have upstream or downstream control, flexible versus fixed distribution, manual versus automatic gate adjustment, and so on. It would be difficult or impossible, to introduce rotational irrigation in a system with no cross-regulating structures.

Water resource systems can be divided into six hydraulic levels, as follows:

- the water source,

- the main system (including the intake and main canals),
- the distributary system (including distributary and minor canals),
- the watercourse (including tertiary and field channels),
- farmers' fields, and
- the drainage system.

In an irrigation system the conveyance and distribution system consists of a network of channels or pipes with structures to regulate, control and measure water flows. Management of gravity irrigation systems involves use of hydraulic technology from the level of the intake to the drainage system. Although drainage systems are often a distinct network below the level of water application on fields, management of drainage is generally incorporated in the management of structures from the main system to farmers' fields. Irrigation management functions occur within each level and at the interfaces between them. The four key interfaces for irrigation system management then, are:

- interface between the water source and the main system,
- interface between the main system and the distributary subsystem,
- interface between the distributary and watercourse subsystems,
- interface between the watercourse and farmers' fields.

Typical technologies at the interface between the water source and the main system are dams, diversions and lift structures. Cross regulators, offtake structures and proportional dividers are typically found at the interface between the main, distributary and watercourse levels. Sliding gates, pipe outlets, syphons or simple cuts in channel bunds may be found at the interface between the water course and farmers' fields.

With the two dimensions of the water service and hydraulic technology we can analyze what management functions need to occur at different levels of an irrigation system. Careful definition of the service and management functions required helps determine what types of irrigation organizations will be most appropriate.

Third dimension: Management functions

The role of management is to provide the primary service of water delivery and drainage through the performance of all necessary management functions related to the service. The five basic management functions of irrigation management are:

- capture of the water resource,
- operation of structures,
- maintenance of structures,
- dispute resolution, and
- resource mobilization.

Each of these can be broken down into specific activities which can be defined in terms of human actions, use of resources, performance standards, information requirements, and decision criteria.

Capture the water resource is the function of acquiring water from its condition outside of an irrigation system and bringing it into the system for use in delivering water for agriculture.

Operation of irrigation structures includes control and measurement of water from the intake to farmers' fields through the use and manipulation of hydraulic technology. The nature of the water service and technology determines the requirements for gate operations, water measurement and information management which are needed to implement the service.

Maintenance involves the allocation of scarce funds, labor, and equipment to the repair, cleaning, desilting, lubricating, protection and beautification of irrigation system infrastructure and property. The nature and level of maintenance required is largely determined by a comparison between the service required and the ability of hydraulic structures to provide it.

Dispute resolution is the settling or containment of conflicts among water users, management staff and other users outside the irrigation system who are effecting or are effected by it. Unresolved conflicts can severely disrupt water distribution, maintenance and resource mobilization. But disputes can be difficult to settle in systems where water rights or management responsibilities are not clearly specified. High performing and sustainable irrigation systems have effective dispute resolution arrangements which can be handled rapidly and locally. These come in various types, such as special water courts in Spain, judicial systems in the USA and Japan, and traditional village or water organization bodies in Indonesia. Planners often fail to incorporate effective dispute resolution arrangements into management reform in the irrigation sector.

Resource mobilization includes the acquisition, allocation, expenditure of, and accounting for, funds, labor, equipment and other resources used in irrigation management. It may also include mobilization of skills through training. The level of resources required is largely determined by the sophistication and intensity of hydraulic technology and human resources which are required to provide the irrigation service. Whether the resources are mobilized from the farmers, government subsidies, or sideline income is determined largely by political dialogue at policy and system levels.

Most reforms in irrigation management in recent years have been prompted by a failure to mobilize sufficient resources to cover the costs of management. The rapid expansion of irrigated area from the 1950's up to the 1980's created an ever increasing demand for funds to pay for routine O&M. Over time governments became less and less capable of financing recurring costs and O&M budgets declining on a per hectare basis in many developing countries. Often, governments resort to management turnover only after failing to mobilize sufficient funds from the central treasury or collect adequate water charges from farmers.

A common sequence is for planning or finance department to reduce subsidies to irrigation agencies. The agency may react by first attempting to raise more fees from farmers. Additional pressures can lead to turnover of management which, in effect, transfers responsibility for resource mobilization to farmers. A key issue for management turnover is whether the additional cost to farmers for irrigation will be offset by improved economic productivity.

Fourth dimension: Organizations

In the foregoing we have seen how hydraulic technology and a defined water service can require widely different levels of management intensity, in terms of resources, information and control.

There are two basic roles which irrigation organizations play: governance and management. It is important to realize that the two are different and may involve two separate organizations. Governance of an irrigation system includes establishing the charter of authority for the management organization,

developing by-laws and rules for use of the irrigation system, developing water rights, selecting organization leaders, setting and regulating basic policy, commissioning services, and resolving conflicts which can not be settling by established management procedures.

Organizations differ in their capacity to provide management services at different levels of management intensity and accountability. This capacity is determined primarily by the organization's basis of authority, mode of financing and incentives for members to achieve performance standards.

There are eight basic types of organizations which are used for managing medium to large scale irrigation systems in the world. These are:

- government agency,
- public utility,
- local government,
- farmer association,
- irrigation district,
- mutual shareholding company,
- private company, and
- contractor.

Government agencies which manage irrigation systems generally are mostly or entirely financed by central revenues and regulated by standard civil service codes and budgeting procedures. They may exist at the central or provincial levels and normally have jurisdiction over many systems. They may be line departments or more integrated agencies.

Public utilities are generally fully or mostly financially autonomous and have mandates from government to provide a monopoly water supply service within a given jurisdiction, such as a region or river basin. Utilities are regulated by commissions or boards of directors which generally consist of government officials from line departments and local governments, users and other stakeholders. Examples are the National Irrigation Administration in the Philippines (only partly autonomous) and the Bonneville Power Corporation in the USA. Revenues are obtained mainly from sale of water.

Local governments such as villages or townships sometimes manage irrigation systems. This is often the case with small scale irrigation systems or watercourses of larger systems where viable local organizational alternatives to villages and towns do not exist. Examples are found in Turkey (where the government is often turning over management of irrigation systems to village governments; Cagil, 1995). In China villages and townships are often responsible for developing and managing distributary and watercourse levels of medium and large scale irrigation systems. Village governments in India (panchayat) and Indonesia (desa) are often responsible for irrigation management within village boundaries. The main revenue source tends to be land taxes.

Farmer associations In countries like Indonesia and Nepal traditional farmer associations are federated to manage medium scale irrigation systems (i.e., above 1,000 ha). The Chattis Muja system in Nepal (Yoder, 1994) and Balinese subak in Indonesia are examples. Farmers directly manage the systems themselves and with staff selected by farmers. The system is self-financing, although it may occasionally receive assistance from the government.

Irrigation district The irrigation district model of the USA, Spain, Mexico, Colombia and Taiwan is a common model for management of medium to large scale irrigation systems. The district is considered

as a "semi-municipality" or a kind of function-specific local public organization, which allows certain privileges and immunities not available to other private sector organizations. The members are water users who elect a board of directors. Typically, the board of directors recruits a general manager and professional staff assigned full time to manage the system. They are employees of the district. The board supervises the general manager and provides overall policy guidance. The general manager supervises other staff. Districts are financed primarily by water charges and possibly some sideline revenues.

Mutual company A mutual irrigation company is a limited liability corporation established through stock shares in the irrigation system which are owned by water users. Generally, share prices are based on a valuation of the assets of the irrigation system and a division among members. In a mutual company shares are normally sold only to farmer water users. As with the district model, farmers elect a board of directors which has oversight for company management. The board selects a general manager who in turn recruits professional management staff. Main revenue sources are water charges, but as a company, the management has the freedom to raise sideline revenues to "cross-subsidize" the cost of irrigation in the private sector. It can also raise profits and enter into joint ventures with other organizations, private or public. This model usually exists in irrigation systems in the USA which had been developed largely through farmer or private sector financing. China is currently adopting the mutual company shareholding model in pilot areas in Shandong and Hunan provinces, even though in China "ownership" formally means long-term leasehold status.

Private company In the case of plantation agriculture or large farms managed by private companies, irrigation systems are sometimes managed by the private company which manages agricultural production in the irrigated area.

Contractor Irrigation management by contracting organizations is done when the governing organization enters into a contract with a third party firm for a limited period of time to manage an irrigation system. In China, village governments provide franchise contracts to local "professional irrigation management teams" to take over management of deep tubewells for profit. In Hunan province "water auctions" are held by water conservancy bureaus or irrigation districts for open competitive bidding for 1 to 3 year contracts to manage O&M for medium and large scale irrigation systems. The contractor is paid by the entity which commissions its services.

An organization may have jurisdiction for the entire irrigation system or only for certain levels. A single system may be managed by a combination of organizations, such as is the case with so-called "jointly managed" irrigation systems, where a government agency manages the main and distributary levels and farmer associations manage the tertiary or watercourse levels.

Joint management (between government and farmer associations) is the approach followed in countries like India, Sri Lanka and Indonesia, where a government agency and farmer organizations are responsible for management at different levels and important managerial decisions, such as regarding cropping patterns or rotational irrigation, are, in principle, made jointly between government officials and farmer representatives (Chambers, 1988). In medium to large scale systems in Sri Lanka, "joint management committees" meet at distributary and main system levels to make key management decisions. Also, in Mexico in large irrigation systems the government commonly manages the intake and main canal while water users associations manage distributary and watercourse canals. Representatives from both sides constitute a "hydrologic committee" to ensure proper coordination between the interface between main and distributary canals.

Another variant of joint management is when an agency focuses on managing the main and, possibly distributary, system and farmer organizations manage the terminal or watercourse level. Instead of joint decision-making about important management decisions, a dual management system functions where the agency delivers an agreed service to the point of organizational interface with farmer groups. Both organizations operate at separate levels relatively independently.

An example of dual management is the north China plain, where irrigation “districts” (similar to public utilities) have agreements to deliver specified amounts of water down to turnouts from the main or distributary canals. Water management, maintenance and crop patterns below the turnout points are strictly the responsibility of the users or villages (with the qualification of there being crop quotas in some places). Otherwise, the agency and farmer organizations are managed relatively independently of one another.

Organizations and hydraulic levels

To simplify, we can collapse our types of organizations into three: a central authority, an intermediate organization and a farmer group. A central authority is a governmental or quasi-governmental organization (such as an agency or utility) whose jurisdiction is an administrative area which includes several irrigation systems. An intermediate organization exists between a central government authority and a primary group of farmers. By a farmer group, we mean relatively small and informal groups which function mainly through direct interpersonal interactions, of generally less than about 50 farmers. A larger water users association which functions above the level of a single interpersonal group is considered herein as an intermediate organization.

The following matrix (Table 2) compares these three types of organizations with the three hydraulic levels identified above and displays nine organizational configurations known to exist for medium to large scale irrigation systems.

The first configuration in Table 2 is found in state managed irrigation schemes in Africa, such as the Gezira or Rahad schemes in Sudan (before recent changes in the last two years). In these schemes water is managed down to the watercourse level by government. Even cultivation has been state managed in pump schemes along the White Nile.

Table 2. Hydraulic Levels and Organizations in Irrigation Systems

	Main System*	Distributary Subsystem	Watercourse Level	Example
1.	CA	CA	CA	Parastatal in Sudan
2.	CA	CA	IO	Schemes in Indonesia with formal WUAs
3.	CA	CA	FG	Schemes in India with small informal groups below outlet
4.	CA	IO	IO	Columbia Basin, USA and Mexico
5.	CA	IO	FG	Large districts in China and Philippines
6.	IO	IO	IO	Irrigation districts in USA and Latin America
7.	IO	IO	FG	Medium irrigation districts in China, Federated FMIS in Nepal
8.	IO	FG	FG	Small farmer managed schemes with formal management
9.	FG	FG	FG	Small farmer managed schemes with informal management

* For simplicity, main system includes management of the intake at the water source and the main canal. In some cases, the intake and main canal could each be managed by different organizations. CA = central authority; IO = intermediate organization; FG = small, informal farmer group. It is not possible to include all the permutations which exist. In some cases there could be more than one central authority or intermediate organization managing sub-levels of the three basic levels above. Also, for simplicity, Table 2 only includes three basic levels. However, in larger systems with numerous layers, it is possible that more than three organizations are involved in managing the entire system.²

An example of the second configuration is found in "jointly managed" irrigation schemes where a formal water users association exists at the watercourse level, such as in medium to large systems in Indonesia, the Philippines and India. Type 3 only differs from type 2 in the smaller size and less formal nature of farmer groups at the watercourse level.

Type 4 has a central authority at the main system level and formal intermediate organizations at distributary and watercourse levels. An example is the large scale Colombia Basin Project in the USA where the government US Bureau of Reclamation manages the diversion and main canal and irrigation districts manage the distributary and watercourse levels and deliver water directly to farm turnouts. This also occurs in large scale irrigation districts in China where a government bureau manages the main system, an autonomous irrigation district manages the distributary system (IO1) and a formal village irrigation management group manages the watercourse (IO2).

Type 5 has three separate organizations, one at each level. An example is in irrigation schemes in China where a government agency (water conservancy bureau) manages the main system, an irrigation district manages the distributary system, and farmers informally distribute water at the watercourse level. This also occurs in the Philippines where the National Irrigation Administration manages the main system, a formal water users association manages the distributary subsystem and an informal group of farmers manages the watercourse.

Type 6 has an intermediate organization managing at all three levels. This is common in the USA and Latin America where irrigation districts manage entire irrigation schemes, from the main system to the watercourses.

Type 7 is found in China where medium scale irrigation districts manage main and distributary levels while small, informal farmer groups manage the watercourse. Another example is federated farmer managed irrigation systems in Indonesia and Nepal, where formal organizations exist at the main and distributary levels but not at the watercourse level. Type 8 is a slight variation of 7, which is found in smaller schemes where a formal farmer organization manages at the main system level but distributary and watercourse levels are handled only by informal, interpersonal interactions.

Type 9 is found normally only in very small irrigation systems, generally less than 150 hectares in service area, where informal farmer groups manage the entire system.

Organizational configurations for medium to large irrigation systems

We will now apply this matrix to the question, "Which of the above organizational configurations are likely to be most appropriate for medium to large scale irrigation systems in developing countries where governments are attempting to turn over irrigation management to non-governmental, intermediate organizations?" We answer with the following working hypotheses which are based on general observations.

After the financial stresses and structural adjustments in developing countries over the last 15 years, type 1 is practically extinct. It is too costly and is generally poorly managed. Type 2 is still very common in many developing countries, especially in Asia, but is generally under financed, has poor accountability between government and farmers, is under performing and is in need of reform. Type 3 has the same problems as type 2, except that informal groups are probably in an even weaker position relative to the central authority.

The problem with type 5 is that informal farmer groups are likely to be increasingly ineffective in an emerging environment of greater competition over water and a rising need for accountability over water use and financing. The same could be said for types 7 through 9. Increasingly, formal intermediate organizations will be needed at both distributary and watercourse levels, in medium and large scale irrigation systems.

This leaves types 4 and 6 as the best candidates for experimental adoption of new management configurations. Type 4 is most likely to be appropriate for large scale irrigation schemes where a central authority must still maintain control over the main system. There could either be a single federated intermediate organization managing distributary and watercourse levels or there could be two separate organizations at these two levels. This would depend in part on the relative independence or integration of water control and financing at the interface between the distributary and watercourse levels.

Type 6 will be appropriate where one or more intermediate organizations can manage the entire system without a central government authority. Again, the nature of the water service and financial interface between the three levels will largely determine whether two or three organizations will be needed overall. We hypothesize that generally a single organization will be less effective in managing an entire large scale irrigation system because it lacks the inter-organizational "creative conflict" often needed to achieve accountability among stakeholders of irrigation systems (see the discussion below).

The challenge of accountability

People who have a direct interest in the performance of irrigation systems can be referred to as "stakeholders". Core stakeholders in irrigation systems include farmers, farm laborers, and irrigation management personnel. More broadly, they include providers of agricultural inputs and support services, buyers and processors of agricultural products, other users of land and water who are connected to the irrigation system, and less directly, to urban consumers of agricultural products.

How accountability between core stakeholders (i.e., management staff and farmers) is to be achieved is perhaps the greatest challenge for irrigation organizations (Merrey, 1995). The degree of accountability of organizations to provide agreed services and resources is partly determined by how services and resources are exchanged at the interfaces between hydraulic levels and organizations.

Accountability of staff within organizations can be achieved in various ways, such as through financing methods, personnel policies, incentives, contractual agreements, terms of compensation, bonuses, awards and sanctions. Centrally-funded government agencies often have the weakest degree of staff accountability. Staff are supported by civil service codes which make it impossible to release staff. Salary rises are given solely on the basis of longevity in the agency. Bonuses and penalties based on job performance are generally not permitted under civil service codes. At the other extreme organizations in the private sector are often free to hire and fire staff, employ staff on renewable contracts, and incorporate into contracts incentives, bonuses and penalties linked to job performance.

The ability of an organization to impose accountability of staff depends partly on these internal mechanisms, but also—probably more importantly—on forces external to the organization which make the organization itself, as a single entity, need to achieve agreed performance standards. One of the verities of modern economics and organizational theory, most often forgotten in state-sponsored development strategies, is:

Unless the basic welfare of an organization depends on its achievement of agreed performance standards, it will not have the political will to impose effective internal mechanisms for accountability.

There are five basic strategies for achieving organizational accountability:

- internal governance arrangements,
- central regulation,
- competition,
- inter-dependence between organizations,
- common property arrangements.

Internal governance arrangements This is the oversight, supervision and monitoring of management procedures and practices by a unit appointed by the main governing body of the irrigation organization. An example is a board of directors elected by a water users association which appoints persons to review annual O&M plans, budgets and management performance, where management is implemented by professional management staff.

Regulation Organizations are made to be accountable by rules and sanctions imposed by a central authority which exists above the level of management. Regulation is most relevant for sensitive legal, political or security matters or where natural monopolies exist, such as for the military. Governments

sometimes sponsor technical and financial audits of irrigation management organizations to see that the public interest is being served. Governments often over apply central regulation in cases where it is ineffective, expensive and where they lack the capacity to enforce regulations. Examples of this are government regulations against aquifer draw down and the use of forest guards to prevent deforestation or elimination of "protected" species of wildlife.

Competition Where natural or contrived monopolies do not exist, where there is a reasonably equal playing field for competition and where temporary inefficiencies would not have disastrous effects--competition between service providers has historically proven to be an effective way to improve services and promote efficiency over time. Many people assume that irrigation systems are natural monopolies which can only have one service provider per system. In fact, competition can be introduced into irrigation systems through contracting different services to different organizations (such as operations, maintenance, fee collection, etc.). A contractor for one service who wants to obtain contracts for other services or for the same service in other irrigation systems, must optimize cost-effectiveness in order to compete for additional contracts. Contracting with service providers can also introduce competition in a given irrigation system over time.

Inter-dependence between organizations Inter-dependence between organizations can be created where different organizations manage different hydrologic levels of an irrigation system. This most often occurs in the form of a service being provided in one direction across an interface (such as water delivery) and resources flowing in the opposite direction (such as payment for water delivery). Inter-dependence implies a rough balance of power--that one organization cannot dominate the other. Inter-dependence can create an energizing tension or "creative conflict" between organizations which makes them accountable to a common objective.

Another way inter-dependence can be created is through separating into two organizations, or at least two distinct bodies, responsibility for governance versus management. The water users association model conventionally fuses governance and management into the same organization. This makes accountability of leaders to members and leaders to performance standards difficult to achieve, especially where associations exceed 50 members. Farmers may wish to "participate" in some governance functions (such as selecting representatives or approving basic policies or annual plans) but they often lack the time and interest to be directly involved in various management functions. Furthermore, medium to large scale irrigation systems require a higher degree of management intensity and professionalism than is typically obtained through a water users association where the farmers directly handle both governance and management.

In medium to large scale irrigation districts in the USA, Mexico and Colombia, a general assembly of farmers elects a board of directors and approves basic policies, annual plans and water fees. The board of directors recruits and supervises professional staff to perform management functions. Management staff are accountable to the board for their performance. The board can hire, fire and provide bonuses or penalties relative to staff performance. Members of the board are accountable to the general body of water users. In theory, they can be relieved of their positions or extended by the general membership.

Performance audits can also be used to create inter-dependencies between organizations. Sometimes an additional organization is involved in providing independent technical and financial audits. Certain subsidies or benefits may be linked to outcomes of audits. In the USA, the Bureau of Reclamation retains the right to take over again management of irrigation districts which have been found by audits to be seriously lacking in financial or O&M performance standards (Svensen & Vermillion, 1994).

Eligibility requirements for future rehabilitation assistance could be linked to favorable results from maintenance audits.

In the Mohini Distributary Canal of the Kakrapar Irrigation System in Gujarat, India, water is "sold" on a seasonal volumetric basis by the Irrigation Department to the Mohini Water Distribution Cooperative Society. The Department depends on the Society for revenue and the society depends on the Department for its water supply (Datye & Patil, 1987).

Another example is the Bachawa Reservoir Irrigation District in Hubei Province, China. The irrigation district (a financially autonomous local public utility) delivers water to the village level. It collects the volumetric water charges from the village irrigation management groups, but must give a certain percentage of it to the county water conservancy bureau. The bureau collects the fixed area water charge and must give a certain percentage of it to the irrigation district. The district provides data and information to the bureau and the bureau provides technical assistance and liaison services with the government to the irrigation district. The two-way requirement for resource flows and services between the bureau and the district engenders accountability for flow of services between the two organizations. (Intl. Conference, 1994)

Common property arrangements When local users of a resource organize to create property rights and restrictions for use of a resource, this is called a common property organization. People have done this for centuries to manage irrigation systems, forests, communal farm land, pastures and fishing waters (Ostrom, 1990). These are generally local, relatively small-scale organizations which develop their own systems of rights, rules and sanctions which may work effectively through social pressures and local arrangements for conflict resolution. (By definition then, a water user association in a large-scale irrigation system which does not have a water right is not a common property organization.) Traditional farmer managed irrigation systems appear to have valuable lessons for how contemporary management reforms can take advantage of organizing principles at the distributary and water course levels of irrigation systems (Yoder and Thurston, 1990; Horst, 1984).

Organizational choice

Herein we will briefly identify some common basic organizational requirements which appear to be present where irrigation is managed successfully and sustainably. Aside from specific features of particular irrigation organizations, there are some general characteristics which appear to be present in well functioning irrigation systems (or more broadly, in water resource management systems). We hypothesize that, generally, a successful and sustainable irrigation organization (or configuration of organizations) generally has most of the following trenchant organizational characteristics. It:

- is a self-financing utility,
- is governed substantially by the water users,
- has carefully defined and measurable water service objectives which are compatible with a recognized water right,
- has ownership of irrigation assets,
- has rights of eminent domain,
- has power to quickly enforce rules and collection of revenue,
- has transparent administration, operations and performance,
- sets and uses service charges according to strict accounting practices,
- cooperates with an independent body which provides oversight.³

The extent to which the above powers are contained in a single organization, and whether that organization is a public or private entity, a district or a mutual company, or a cooperative association, will largely be determined by factors which are situation specific. We hypothesize that the following are the key criteria for determining the specific type of organizations which will be required and feasible in order to embody the above set of essential organizational characteristics:

- the "maturity" of a country's institutions,
- government policy toward water resources management,
- the complexity and political sensitivity of the water service,
- the sophistication and organizational traditions of water users, and
- the degree of corruption and effectiveness of measures to contain it (Fredericksen, 1996)

Institutional maturity refers to the effectiveness of the legal/judicial system, the degree of liberalization, redundancy and competition among organizations, and the degree of socio-political recognition for institutions. Government policies about resource use and conservation constrain the set of organizational choices available, through setting boundaries for managerial control and use rights. The level of complexity, scale of management and political sensitivity of the water service determines to a large extent whether the organization can be in the public or private sector and whether externalities and liabilities can be managed internally by a single organization or by a network of organizations. Degree of literacy, availability of information, and cultural orientations toward political participation and local organizing shape how governance and accountability arrangements must be structured in a given context. And not least of all, the degree of corruption and how it can be contained will effect how financial control (often the bane of water users associations) must be achieved. Where the above "trenchant organizational characteristics" are not found, but where policy makers want to introduce them, strong, high-level commitment will be required to bring about such reforms.

Strategic questions for institutional reform

Questions of, "Whether to adopt a transfer policy?" and if so, "How to formulate the policy and program?" are strategic problems of high orders of complexity, especially in developing countries with large numbers of small farmers, scattered irrigation systems and constrained financial and information resources. Where management transfer is being planned or implemented it may involve changes in: 1) management roles and procedures; 2) lines of authority and responsibility; 3) financing; 4) water rights; 5) infrastructure; and 6) ownership of infrastructure.

Comprehensive strategic change methods generally the following components:

- 1) Emerging policy objectives,
- 2) Performance gaps,
- 3) Assumptions about the policy and management environment,
- 4) Reform options and issues,
- 5) Participation of stakeholders, and
- 6) An information system.

Strategic change generally addresses the following kinds of questions.

1) What is the potential scope for reform under consideration?

Policy makers and planners in irrigation ministries who are faced with internal and external pressures for change make initial assumptions about the basic level and nature of reforms that are to be considered. Will the scope for reform be limited to only operational procedures, or more broadly, to include organizational restructuring (at the sector or agency level) or changes in financing, or more broadly still—to potentially include a change in mission? Initial designation of the potential scope of reform provides the basis for determining how the strategic planning process should be organized.

2) How should the planning process be organized?

Through discussions at the senior management level the desired outcomes, general time frame for planning, participants involved, activities and resources for planning are estimated. Expectations are communicated to all levels and agencies involved.

3) What is the set of feasible options for reform?

Within the broad parameters defined in step 1 above, there may be a range of options for reform that needs to be identified and each one assessed in terms of its feasibility. Options for restructuring an irrigation agency may include such changes as divisional realignments, decentralization, changes in sources of financing, downsizing and transfer of management roles and authority.

4) To what extent do performance gaps justify reform?

The first step in strategic planning is to assess three kinds of performance gaps which may have prompted considering reform in the first place:

- i. the gap between current performance and existing targets,
- ii. the gap between current and potential performance, and
- iii. the gap between current performance and a level of performance which will be needed in the future.

For the purposes of the strategic review, senior management decide which kinds of performance criteria matter most, such as cost of irrigation to the agency, financial viability, operational performance, maintenance of infrastructure, etc. Management also identify which of the above types of performance gaps is most important for the purpose of the strategic review. For the important one, an assessment is made about the extent and implications of the gap. This provides the basis for addressing the range of options for reform.

5) What kind of reforms should be adopted and at what levels?

Once the range of feasible options has been identified, they should be compared according to important criteria (such as, likelihood the option will fill the performance gap, resource requirements, time required, etc.). Analysis of performance gaps could determine that changes in management procedures alone can fill the gaps, so that more substantial changes are not needed.

Serious gaps in financing and O&M performance by the agency could suggest that more basic reform is needed, such as transfer. Decisions would then need to be made about what management roles would be turned over, what size of systems would be turned over, what levels of canals would be turned over in large systems and what type of organizations should take over management (farmer organizations, districts with professional management staff, contract companies, etc.)

Multiple reforms may be required at different levels. For example, a decision to turn over management of irrigation systems to farmer organizations may require changes at different levels, such as changes in water rights, in agency mandate and financing, rehabilitation of systems, need for new agricultural support services arrangements and so on.

6) What kinds of information and experimentation are needed?

Considerations about reform options and processes are greatly enhanced by information and participation of stakeholders who are involved in the reforms. The level of need for accuracy, generalizability, and rapidity of information will determine what kinds of information, data collection methods and experiments may be needed to identify appropriate options and processes. For transfer planning, information needed may include such things water rights, functional condition of irrigation structures, nature of farmer organizations, profit and so on.

7) What kind of change process is needed?

Once the type of reform is identified, planners and stakeholders can formulate a plan for implementation, always keeping in mind how to make the transition process become a learning and reorientation experience for those involved. It should prepare participants, from the agency and farming community, for the new roles invoked by the reforms. A comparison should be made between the current context and what technologies, skills and management functions are envisioned for the future. For management transfer, this may include considerations about the need for legal changes, institutional organizing, inputs from NGOs, negotiations between farmers and the agency, infrastructure improvements, training, development of support services and so on.

8) What kind of governance and management entity is needed to take over the roles being turned over?

Water users associations are commonly promoted as single purpose organizations. The function of these organizations is to manage and possibly finance irrigation for their area of jurisdiction. Another model is the multi-purpose farmer organization, which also has responsibility for providing agricultural services in addition to irrigation management. For larger or more complex irrigation environments more sophisticated organizations may be required, such as irrigation districts, mutual or contract companies and stock shareholding arrangements. Criteria for deciding among these options should be identified and considered one of the most important being the structure of incentives for local collective action.

9) What kinds of resources and time schedule are needed to implement the reforms?

Defined broadly, resources for implementing reform include financing, political power, technology, personnel, skills and expertise and time.

10) What kinds of techniques are needed to support the change process?

There is a large number of techniques and tools which may be employed to support institutional change in the irrigation sector. These can be employed in the policy formulation, planning, pilot experimentation and general implementation stages. For example, policy formulation and planning may be supported by such methods as working groups, policy review workshops, SWOT analysis, analysis of responsibility matrices, financial analysis, stakeholder analysis, and analysis of benefit/cost streams. Pilot experimentation may include such techniques as institutional organizing, farmer-to-farmer training, participatory rural appraisal, and self assessment of performance. General implementation may involve monitoring and evaluation, review workshops and rapid appraisals.

11) What adjustments in the reform need to be made, after implementation has begun?

If the institutional change is organized as a learning process, then information and response arrangements will enable adjustments to be made on the basis of further experience and analysis during each of the stages of policy formulation, planning, pilot experimentation and general implementation.

Questions of whether or not to adopt an irrigation transfer strategy? What should the strategy look like? How should it be implemented, are complex questions which need to be decided uniquely in each country, and in the details, in each irrigation system. An effective process of decision-making and change will likely require the participation of all the key stakeholders involved, including high level officials, field operations staff and farmers. It will require formulation of a common vision of a new future, both for the farming community and for the government.

Summary

This paper has specified the key components of irrigation management and indicates how they are inter-related. Considerations of management reform should include an analysis of the four basic dimensions of irrigation management:

- the water service,
- hydraulic technology,
- management functions, and
- organizations.

The analysis should start from a precise definition of the water service which is required and then proceed to specify the nature of technology and management which is best suited to achieving an acceptable standard of performance. Analysis should be made of gaps between the existing and the required service and gaps between the required service and existing technology and management. Effective analysis of change will determine whether or not reforms are actually required and, if so, how extensive and basic they should be.

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END NOTES

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² In Mexico, in the first phase of management CA at the main system and IO at the distributary sub system. In the second phase the CA is at the water source and a federation of IOs is at the main system level. No FG exist at the watercourse level.

³ These were adapted from a personal communication to the author by Harald Fredericksen, February 25, 1996.