PROPERTY RIGHTS AND COLLECTIVE ACTION IN THE DEVOLUTION OF IRRIGATION SYSTEM MANAGEMENT

Douglas L. Vermillion[1]

INTRODUCTION

Water has been called the first resource. Without it, life could not exist. With it, not only life but health, prosperity and power can be obtained. And yet it is becoming increasingly scarce, polluted and politicized. In today's world of growing competition for this precious resource, it is becoming increasingly urgent that society and nations develop equitable property rights for water and enable local communities to manage water services. In developing countries about 70 percent of accessible fresh water is used for agriculture (FAO 1993).[2]

The purpose of this paper is to identify policy recommendations and research priorities which will lead to more effective efforts to devolve the management of irrigation systems from governments to water users associations. This paper focuses on the question, "What are the essential motivating factors which will invoke collective action among water users to ensure effective and sustainable management of irrigation systems after devolution?" We will see that the most important motivating factors are property rights, broadly defined, which provide security and incentives for farmers to invest in irrigation management. How devolution programs are structured and implemented can also shape farmer perceptions about related property rights, and hence, can have an important impact on collective action among water users.

In brief, our analysis is structured as follows. How irrigation management devolution programs are structured, or organized, will determine what kinds of property rights are given to water users. What property rights are held by water users will, in turn, determine to what extent farmers are willing to provide collective action for irrigation management. The quality of management will, in turn, affect how well irrigation systems perform and what outcomes they produce, such as financial viability, condition of infrastructure and agricultural productivity.

Before we go any further, a few definitions are needed. By property rights, we mean the claims, entitlements and related obligations among people regarding the use

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[1] Independent consultant for water policy and institutions.

[2] Water for agriculture also often includes water for aquaculture and drinking water for livestock. In industrialized countries industry uses about 40 percent of available fresh water, in less developed countries this figure is only about 10 percent.

and disposition of a scarce resource (see Furubotn and Pejovich 1972).[3] The leading theorists Furubotn and Pejovich (1972) and North (1990) both include goods and services as potential objects of property, or assets. Following Eggertsson, we include three types of rights, rights to use an asset, rights to obtain benefits from an asset and rights to alienate or sell an asset (1990). Property rights are primarily social conceptions, but in order to have force on human behavior, they must be enforceable through sanctions. Sanctions may involve modern legal codes, punishments imposed by users groups or other social pressures. Key obligations which may be attached to property rights are financing construction and maintenance of infrastructure, financing costs of service provision, and following rules regarding use or protection of the resource.

Applying these concepts to irrigation, we broadly consider irrigation infrastructure, water, land, funds owned by an irrigation organization, legal status of an irrigation organization, and a license or commission to provide an irrigation management service to all be potential types of property, to which rights and obligations may be attached.

Following Meinzen-Dick and Knox (1999), devolution is the transfer of rights and obligations over resources to resource users groups. For irrigation, this normally involves transfer of rights and responsibilities for irrigation system management from the government to local water users groups. Collective action is the coordinated behavior of groups toward a common interest or purpose.

IRRIGATION DEVELOPMENT, CURRENT TRENDS AND THE NEED FOR DEVOLUTION

The 1950s through 1970s was the *era of capital-intensive expansion of irrigation worldwide*. The need for rapid, large-scale development of infrastructure created large, powerful bureaucracies whose focus was on civil engineering. Irrigation development was synonymous with construction. Irrigation management was an after-thought. By the 1970s, construction costs were rising as the best locations for irrigation development were already used. At the same time rapid deterioration and poor management of irrigation schemes were widespread. The rate of growth in financing irrigation operations and maintenance (O&M) did not keep pace with the enormous growth in irrigated area.

The 1970s and 1980s could be characterized as the *era of irrigation improvement*, wherein the emphasis was increasingly on rehabilitation, introduction of new technologies and management techniques, training, introduction of irrigation service fees and farmer participation. But deterioration, under-financing and poor management

[3] Furubotn and Pejovich emphasize the social basis of property rights: "….property rights do not refer to relations between men and things but, rather, to the sanctioned behavioral relations among men that arise from the existence of things and pertain to their use." Property rights are "norms of behavior" which define "the position of each individual with respect to the utilization of scarce resources" (1972).

performance persisted. From the late 1980s until the present, a new paradigm of irrigation development has come to the forefront—the *era of reform*. It is now widely understood that irrigation systems will not be able to perform as needed without basic institutional reform, and this generally means devolution of some or all responsibility for irrigation management to water users associations.

Economic and social changes are advancing at an ever-accelerating rate. These also create increasing pressure to devolve management for irrigation systems to local users groups. *The central challenge facing irrigated agriculture today and in the foreseeable future is how to produce more food with less water*. With an increase of 90 million people per year, world population in 30 years is expected to exceed eight billion. In the coming 30 years approximately 80 percent of the additional food supply needed to serve the growing requirement will have to be produced on land served by irrigation. This is expected to result in a 650 percent increase in the demand for water over this time (Serageldin 1995). Furthermore, given the balance of economic and political power, industrialization and urbanization in developing countries will no doubt cause a reduction in the share of available fresh water which is allocated to agriculture. Except for rare inter-basin transfers of water or possible effects of long-term climate changes, the total supply of water in water basins is basically fixed (Seckler 1996). The inevitable result of this convergence of factors is increasing competition and pressure to use water more productively.

Largely driven by government fiscal shortages and a common inability to raise sufficient revenues from collection of water charges, an increasing number of governments around the world have adopted programs to devolve responsibility for irrigation management to water users associations (Johnson et al. 1995).[4] Consistent with general structural adjustment strategies, irrigation management transfer has been supported by the major international development banks (EDI 1996; Arriëns, et al. 1996).

It is expected that decentralization and devolution[5] of water resources management will increase water user participation in decision-making and investment and that this, in

[4] Irrigation management transfer (IMT) 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, Colombia and Taiwan in the 1950s, 1960s and 1970s. Management transfer became a national strategy in developing countries only in the 1980s and 1990s, with Chile, Peru, Mexico, Brazil, Dominican Republic, Colombia, 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 implementing national 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.

[5] Herein, *decentralization* refers to movement of management roles from higher or central levels to lower or local units within the same agency or ministry. *Devolution* refers to transfer of management

turn, will improve management incentives, accountability, agricultural and economic productivity and cost recovery (World Bank 1993). Devolution programs generally involve efforts to organize water users associations, train future managers, make essential repairs and formalize agreements between water users and the government.

Inasmuch as the reforms are normally motivated by financial pressures and driven by donor deadlines, devolution policies tend to be adopted before a clear strategy for implementation has been identified. There is a significant knowledge gap about actual results of irrigation management transfer—especially which strategies work and what are the necessary pre-requisites.

At the heart of the *theory of devolution* is the argument that local, common users of a resource, who are empowered as a group to take over management of the resource, have the incentive to manage more efficiently and sustainably than does a centrally-financed government agency.

Some are concerned that devolution programs are sometimes promoted in environments where these pre-requisites do not exist (World Bank 1993). Some may be introduced through policy and technical assistance. Some emerge only slowly in society. There is further concern that partial or incremental attempts at devolution may not be effective and may strengthen resistance to reform (Vermillion 1997a).

This paper focuses on the basic institutional elements which are included in devolution itself. Two questions are addressed. First, *What is the essential set of elements (rights, responsibilities and powers) which should be included in irrigation management devolution?* In other words: Is there a critical mass of elements that should be included in a devolution program so that it will result in an effective and sustainable result, and if so, what are these elements? The second question is, *What are the outcomes of devolution efforts which do and do not contain this essential set of elements?*

IRRIGATION MANAGEMENT GAPS AND INADEQUATE PROPERTY RIGHTS

Perhaps it would serve to clarify the conceptual and *real* relationship between property rights, collective action and irrigation management by considering a few examples which illustrate management gaps or dysfunctions which can arise when property rights are inadequate to meet management requirements.

In the early 1980's, in the Dumoga valley (a transmigration area in North Sulawesi, Indonesia), the author came upon a farmer placing large wooden logs in the upper reaches of the south main canal of the Dumoga Irrigation Project. The canal served

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roles from a government organization to a non-governmental or financially autonomous one, which is usually a local organization constituted by resource users.

more than 5,000 hectares of farmland. He did it to divert large extra flows into fields where only a few farmers were constructing new rice fields. When asked if this wasn't prohibited, he replied, "Yes, but we are closer to the wood." All the project officer did as he passed by on an inspection was to remove the logs and depart. After a short while the farmer restored the logs to its illegal position. Construction of the project was nearly completed, but rules and rights, together with enforcement mechanisms, were yet to be developed.

In the early stage of the Small-scale Irrigation Turnover Program in Indonesia, in the late 1980's, project staff informed farmers in a small scheme located in a hilly area of West Sumatra that a certain, but undisclosed, amount of funds were available to make small repairs to their scheme before full management responsibility would be turned over to them. Farmers were invited to make a list of priorities for repairs. This was seen as a form of farmer participation. The farmers responded by generating a long wish list. High on the list was a curious request for the government to raise the masonry embankment along a 300-meter reach of the upper main canal by about 25 cms. When asked why they requested this, some farmer representatives answered that about 11 years before, the government had first installed the masonry embankment. By now the canal had accumulated about 20 cms of silt. They said that if the government raised the embankment another 25 cms they would probably not have to do any desiltation for another 11 years!

From our perspective on property rights and collective action, we would conclude that the free government assistance had created a sense of speculative dependency among farmers towards the government for the irrigation scheme. Government investment had served to create the impression that the irrigation structures belonged to the government and it was the responsibility of government to minimize the cost of irrigation to the farmers. Such assistance had discouraged farmers from taking collective action to maintain the canal.

A director of an irrigation agency in a developing country in Asia told this author about a problem he had observed. The government provides repeated assistance to irrigation schemes where the farmers are deferring maintenance and expecting the government to return and make repairs at the government's expense. Farmers in neighboring systems which are much better maintained by farmers see this pattern and eventually complain to the government and demand that it provide similar assistance to them. Procedures made it difficult for the agency to require matching investments from farmers and eager donors provided generous amount of aid to finance rehabilitation projects.

In the mid-1990s, the author visited a pilot site for management transfer in the state of Maharashtra, India. A minor canal command of approximately 200 ha had been transferred to farmer management. The farmers reported that their new water users association had doubled the irrigation water charge after transfer but that the total cost

of irrigation to farmers had actually declined. When asked how this could be, they answered that before transfer, each individual farmer had to pay a bribe each time he requested water. After transfer the association purchased water from the Irrigation Department at a bulk rate for each season. The association prevented payment of bribes.

The transfer had created a group property right to an agreed amount of water, receivable upon payment of a seasonal water charge. This single transaction improved equity and efficiency by replacing the multiple, informal transactions that went on previously.

In South Sumatra, Indonesia, the author observed a concrete water division box that had been installed at the location where a traditional notched-log proportioning weir had existed before. The box divided a tertiary canal into three quaternary channels. After construction, farmers re-directed the new channels back together just downstream from the new box and re-installed their traditional proportioning device. The device defined farmer conceptions about how local property rights to the water should be allocated. The new box confused them. Design engineers were oblivious to the traditional system of water rights within the scheme.

During the campaign for the Philippine Senate in the early 1990s, several candidates announced that, if elected, they would vote to abolish the national irrigation service fee. They said farmers were too poor and shouldn't have to pay the fee. This precipitated a large demonstration of farmers which converged on the capital and insisted, curiously, that the irrigation fee not be abolished. The protestors said that their payment of the fee was their only basis for demanding an acceptable irrigation service from the government. In their minds payment of the fee established their right to an acceptable service.

About thirty years ago a reservoir and large-scale irrigation system was built in northern Thailand, near Chiang Mai. A feeder canal conveyed water from the reservoir through the city of Chiang Mai to a farming area serving several thousand hectares. By the mid 1990s, Chiang Mai had grown into a city of over five million people. By then, factories, businesses and hotels were extracting water from the main canal and dumping heavily polluted water back into the canal. The government considered constructing a new feeder canal to take water from the reservoir (which was originally constructed solely for agriculture) to serve a new industrial park. All this has happened in a setting where farmers in the scheme have no water rights to protect their supplies from their resource-rich competitors.

These examples indicate the range of manifestations of property rights issues in the management of irrigation systems. While such issues may be treated as "technical" or "management" problems, considering the underlying property rights is often key to understanding and addressing the situation.

PROPERTY RIGHTS FOR IRRIGATION MANAGEMENT

Many people think that property rights are related only to physical resources. But our definitions above say that they can be related to services as well as goods. This implies that property rights may be vested in irrigation decision-making authority, service provision and financing, in addition to rights to water and irrigation infrastructure. We consider a organization to be a manifestation of "social capital", and hence a form of group property. Experience with irrigation management devolution indicates that rights over decision-making, service provision and financing are as important as are water rights and infrastructure use rights. Therefore, we summarize below the key types of property rights which can and normally should be vested in irrigation management organizations. We hypothesize that the more of these rights are devolved to viable water users associations, the more devolution is likely to succeed.

Property rights, which may be inherent in, or devolved to, water users associations (either fully or shared with the government) are the following:

Water right – The association and individual members have a right to a share of the water supply (of a useable quality) at the point of extraction from the resource base and at the level of individual users.

Right to determine crop and method of cultivation – Individual water users, sometimes constrained by group imperatives, have the right to select which crops they will plant and how they will cultivate them. This is essential if farmers are to have the potential to optimize productivity based on local knowledge.

Right to protect against land conversion – The association has the right to protect its irrigated land against conversion to non-agricultural or non-water use purposes, in the event that the majority of members oppose such conversion. Irrigated land is the main revenue base to finance the association, recover investment costs, and ensure sustainable livelihood for members.

Infrastructure use right – The association has the right to operate, repair, modify or eliminate structures. Without this right, the association is unable or unwilling to invest in long-term maintenance and repair and is likely to consider the infrastructure as the property of the government.

Right to mobilize and manage finances and other resources – The association has the power to impose service fees, establish sideline revenue activities, plan and implement budgets, require labor or other inputs from members, recruit and release staff and provide training.

In addition the following may be considered key organizational rights to devote to water users associations:

Right of organizational self-determination – The association has the right to determine its mission, scope of activities (whether single function or multiple function,

including businesses), basic by-laws, rules and sanctions and method for selecting and removing officers.

Right of membership in organization – All water users who are eligible for membership according to association by-laws have the right to be members of the association and receive its privileges, services and benefits--as long as they comply with its rules and obligations. This also implies the right to exclude non-members from the service provided by the association.

Right to select and supervise service provider – Where members of the association are unable or unwilling to directly implement the O&M service by themselves, the association may appoint third parties (such as contractors) to implement required services. The association has the right to set the terms of such contracts and supervise service providers.

Right to support services – Subject to government policies or agreed conditions, the association has the right of access to support services it needs in order to function properly. This may include access to credit, banking services, agricultural extension, technical advisory services, subsidies, conflict resolution support and other legal services, marketing assistance, training and so on.

CHARACTERISTICS OF RIGHTS

Not all rights related to irrigation management are the same. They vary in many respects, as will be indicated below. It should be emphasized that it is the details about specific characteristics of irrigation management rights that constitute the most substantive and important matters to be negotiated and resolved in devolution programs. Policy makers, planners and farmer leaders should be aware of these sometimes subtle but important characteristics. These are described briefly below.

Exclusivity – This is the extent to which non-members or non-right holders can be excluded from gaining access to the resource or benefits which are supposed to be only for members. If non-members are prevented from receiving water allocated to the association, we can say membership rights and benefits are exclusive. If the association cannot prevent encroachment on its water supply by non-members then the association's service is said to be non-exclusive. A water users association which cannot prevent non-members from using its services is in a very weak position to exact fees and other obligations from its members.

Transferability – Some rights can be transferred from an original holder to another person, either temporarily or permanently, according to the rules of an association and the terms agreed to in negotiations. This is a normal prerequisite for water markets. With regard to services, if a water users association requires help with managing an intake and main canal, it may only have the option to have the government irrigation agency provide this service. However, if it has the right to select who provides this

service, then the right to service provision is transferable between the government or another party.

Scale – Rights can be granted at one level or scale but not another. A water users association may hold a water right, but not individuals; or in the case of Chile, individuals, not associations, may hold water rights (Gazmuri 1994). Associations at the tertiary canal level may have rights to use, repair and modify irrigation infrastructure but federated associations at the secondary and main canal levels may lack such rights. It is important that it be clear at what scale or level rights are provided.

Duration – Rights to membership in a water users association may be permanent for land holders (as long as they meet membership obligations) and temporary for renters or sharecroppers. Water rights may change seasonally in response to changes in water supply conditions.

Recognition – Rights may be recognized by some stakeholders but not all. Traditional rights may be recognized and respected by local water users but not recognized by the government or water users from other systems or sectors. Increasingly, rights need to be recognized both internally and externally in order to be assured.

Assurance – Assurance is a related but broader concept than recognition. Although a right may be valid and legal, assurance that it will be honored or protected may depend upon many things, including political will, dispute resolution arrangements, and availability of sanctions. It is one thing to establish formal rights (to water, use of infrastructure, control of financing, etc.) but it is another matter to assure realization of such rights. Devolution programs should provide both establishment and assurance of rights devolved, through necessary political support, campaigns, financing mechanisms, and other means to assure rights are respected.

Comprehensiveness – We have stated above that there is a basic set of rights which belong to, or should belong to, irrigation management. It is rare that devolution programs transfer all or nearly all of this set of rights to water users associations, including full recognition and assurance. This is a primary concern in this paper—what difference does it make if many or only a few of this set of rights are devolved to water users associations? How does this difference affect the viability, sustainability and performance of local irrigation management after devolution? Because of the diverse nature of irrigation systems worldwide, generic answers to these questions are difficult to obtain. Nevertheless, we make an attempt in the following sections of this paper.

STRUCTURING DEVOLUTION TO PROMOTE COLLECTIVE ACTION

The term *collective action* creates images of farmer groups repairing canals or rotating water. However, as with property rights, our analysis requires a much broader concept of collective action. We consider action to be both decision-making and the

behavior invoked by it. It is collective because it represents the *shared interests* of a defined group of resource users. Drawing partly from Ostrom (1990), we see that there are three basic types of collective decisions or actions.

The first is *constitutional actions*. This involves the design and establishment of the group or association, wherein its mission and basic structure of authority and decision-making are determined and adopted. The second type of collective action is about *collective choice*. This is the development of rules and sanctions for operations and maintenance of the irrigation system, financing costs of irrigation, settlement of disputes, and modernization and improvement of the system. The third type is *operational actions*, which are the specific decisions and actions in the course of implementing operations, maintenance, financing, dispute resolution, and modernization and improvement of the irrigation system. These three levels are hierarchical: constitutional actions set the conditions and limits within which collective choices occur; collective choices set the limits within which operational actions occur.

We will now demonstrate a practical consequence of these concepts. Devolution programs are often limited to small-scale systems or minor canal commands within large-scale systems because officials object to devolving management responsibilities to farmers for main system infrastructure and large service areas. They reason that farmers lack the necessary technical skills to operate and maintain larger and more complex structures.

However, it is easier to accept that farmers are capable of collectively defining the kind of service they want and forming an organization to ensure that the service gets provided. These two functions are, in essence, the two highest forms of collective action--constitutional and collective choice. If these two functions of self-determination for irrigation service are devolved, then--in terms of the shared interest of water users--it may not matter which party actually delivers the main system O&M service (which requires higher technical skills), as long as the shared interests are fulfilled. Lack of technical skills is not a good reason to oppose devolution, if the association has the capacity to define the service desired and then select and commission the technical expertise to deliver it.

The key challenge for devolution programs is to create an enabling environment wherein communities of water users can structure their organizations, establish rules and policies, and implement them in a way which ensures the local productivity and sustainability of irrigation systems.

The following is a list of key enabling factors which are hypothesized to be conducive to the emergence and development of desired collective action in water users associations. The list is distilled from literature on the subject and interactions with numerous practitioners in international meetings and fieldwork.

- Irrigation makes a significant improvement in productivity and profitability of irrigated agriculture, compared with rainfed agriculture [implies existence of water rights and right of crop choice].
- Irrigated agriculture is an important component of farm family livelihoods.
- Most farmers are either landowners or cultivators with multi-year leasehold status.
- A generally-accepted system of land and water rights exists or can be expected to exist by the time irrigation management transfer, or devolution, is implemented [implies water rights, land conversion protection and right of crop choice].
- Social divisions are not serious enough to prevent communication and joint decision-making among farmers.
- Social traditions support group organization for irrigated agriculture, existence of producer cooperatives and other rural organizations [implies right of organizational self-determination].
- Farmers are dissatisfied with the current irrigation management service by the government and believe that improvements in the quality of irrigation management could significantly increase the productivity and profitability of irrigated agriculture [implies right of crop/cultivation choice, right to use infrastructure, right to support services].
- Farmers believe that these improvements can be realized through the association's control over the management of water services [implies right to use infrastructure, right of organizational self-determination, right of membership, right to select service providers].
- Farmers believe that their association can reduce or contain increases in the cost of irrigation to farmers [implies right of organizational self-determination, right to manage finances, right to select service provider].
- Farmers generally perceive that their private benefits of devolution outweigh their costs and that the benefit/cost ratio of devolution is roughly equal among farmers [implies right of organizational self-determination, right to manage finances].
- It is technically feasible to implement the water service with existing infrastructure or after pending improvements are made [implies right to use infrastructure, right to support services].

Many of the above enabling factors imply the existence of various property rights. Although many of these factors may seem obvious to some, it should be emphasized *that most irrigation management devolution programs do not take such factors into*

account in the planning process. Schemes that are lacking in many of the above factors may require more intensive external support to develop viable water users associations. Both effective devolution of implied organizational rights and external support to local organizations are needed.

It is not possible to state universally what are the necessary pre-conditions for development of water users' associations. Some factors might be essential in one place but not in another. In one place, some factors may be so important that they compensate for the absence of others. However, we hypothesize that the more enabling factors that exist in a location, the greater is the likelihood that viable water users' associations will develop and collective action will emerge.

RESULTS OF COMPREHENSIVE, PARTIAL AND MINIMAL DEVOLUTION OF PROPERTY RIGHTS

We will now examine comparative evidence of the results of irrigation management devolution. We compare devolution programs which we characterize as relatively comprehensive, partial and minimal in their devolution of the basic set of property rights for irrigation management, identified above. Impacts on the performance of irrigation financing, operations, maintenance and productivity are considered (Vermillion 1997b). For each type, we provide summary information from different experiences and then include more detailed information on a case study.[6]

COMPREHENSIVE DEVOLUTION

Comparative Evidence

Comprehensive devolution means transfer of all or most of the basic set of property rights listed above. Not many devolution programs in developing countries have done this. Examples of relatively comprehensive irrigation management devolution include the USA, France, Spain, Japan, Mexico[7], Chile and China.[8]

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 (Johnson 1996). From a sample study of six irrigation districts in

[6] The author wishes to acknowledge the substantial inputs of M. Svendsen, C. Garcés-Restrepo, and M. Samad, the co-authors of the case studies on the USA, Colombia, and Sri Lanka, respectively.

[7] Mexico's devolution program was preceeded by passing of a national water law which established water rights and legal status of water user associations and federations. Associations have infrastructure use rights, crop choice, service for pay, local financial control and right of self-determination.

[8] Contrary to the perceptions of some outsiders, China generally provides long-term land use rights to farmers, water rights, infrastructure use rights, crop choice, service for pay, local financial control and legal status and right of self determination for farmer associations.

Mexico, Gorriz, et al. (1995) report an immediate and consistent nominal 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 in real terms relative to the cost of production (Johnson 1996).

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. Farmer-sponsored organizations generally are not willing to hire or retain "excess" staff, as governments often do in developing countries.

In Mexico, water fee collection rates rose from only 15% before transfer to 80% to 100% afterwards. Collection rates are generally 60 to 70% during the first transitional year and above 80% by the second year (Gorriz et al. 1995). This high rate is largely due to the requirement by districts that farmers pay fees before water is delivered (Johnson 1996). In the large-scale transfer of 3.3 million ha served by large-scale irrigation systems in Mexico, the shortfall in meeting irrigation district costs 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.

Reports of experiences in Mexico (Johnson 1996; Gorriz et al. 1995); Colombia (Vermillion and Garcés-Restrepo 1996); and the United States (Svendsen and Vermillion 1994) indicate farmer perceptions that O&M staff have become more responsive to farmers after turnover. It is reported that maintenance work was more responsive to farmers' priorities after turnover in Chile (Meinzen-Dick et al. 1994).

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. (Johnson 1996).

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). 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). This was partly due to an increase in collection rates from 30% in 1984 to 70% in 1991 (Turner and Nickum 1997).

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 nine 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, many of whom were family members of irrigation management staff who were employed by the district to work in the "diversified management division". By 1994, 30% of the Bayi district revenue was from its sideline enterprises (Vermillion, et al. 1994).

Long-term time series data on irrigation efficiencies before and after management devolution are available from case studies in the medium scale Nanyao and Bayi irrigation districts in the north China plain (Johnson et al. 1995). 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. This trend was part of a larger policy to reduce water consumption per ha and cannot be attributed only to the reforms, which occurred in the mid 1980s. However, it is apparent that the reforms did not reverse the trend. It is likely that the more active involvement of farmers and village governments in irrigation management helped facilitate the decline in water consumption per ha.

Annual discharge into the Nanyao 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.

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-1980s. Annual grain yield per unit of water (100 m3) in Nanyao was 66 kg in 1973, 70 kg in 1982 and 135 kg in 1992. Similarly in Bayi, yields per 100 m3 increased from 28 kg in 1973 to 65 kg in 1982 to 150 kg in 1992. Data on the impacts of devolution over such a long time period is rare and suggests that transfer had a positive effect on yield returns to water, given the parallel upturn in trend in both systems at the time of transfer.

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 1990s. 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.

Only a few studies refer to impacts of management transfer on the environment. 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 et al. 1994).

Case Study: Comprehensive Devolution in the USA

Nature of devolution – The Columbia Basin Project (CBP) is a large multi-purpose, reservoir-based project located on the Columbia River in the state of Washington in the USA. The irrigated area is about 230,000 hectares, which is divided into three districts. 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. Today, each farmer-controlled district consists of 2,000 to 2,500 landowners and is controlled by a five- to seven-person board elected from among the water users. Seventy-four percent of all landholders have less than 160 acres of irrigated land in the project. Districts purchase water from the US Bureau of Reclamation and then resell it to their members.

For over five years the districts negotiated with the Bureau over water and cost allocation and which works should be reserved by the Bureau, managed jointly between districts, and transferred to individual districts. After coming to agreement in 1969, the Bureau transferred management of the system to three farmer-governed irrigation districts (Svendsen and Vermillion 1994). Farmers generally favored the transfer of management. Their primary interests were in obtaining more local control over water allocation, water fee structures, O&M expenditures, and drainage ways and in minimizing water charges. The Bureau's main interest was in shedding responsibility for delivering water to individual farms and handling special water sales. It preferred to focus mainly on construction and regulation of water and land use at the basin level. The farmers did not like the "red tape" of government management and the Bureau didn't want the "headaches" of dealing with thousands of individual farmers.

Control over the dam and intake was retained by the government, since the headworks involved a massive hydro-electric power generation facility. Full responsibility for managing the main and subsidiary canal network was transferred to the three districts (see Table 1).[9] This also included responsibility to fully finance the cost of O&M and develop a capital replacement fund to pay for all future costs of rehabilitation. Farmers pay a 30% surcharge over the routine O&M fee to build up this fund.

The districts have the status of semi-municipal corporations, legally constituted by the state government for the purpose of irrigation and drainage. They have rights of eminent domain but are generally exempt from liabilities for damages to property caused by the irrigation and drainage system. They are tax-exempt, not-for-profit entities constituted by the water users. A formal water right is granted to each district by a concession from the state government. The right is divided into basic allotments for water users, measured in volume of water per unit of land per season. The districts have the powers to make their own rules and sanctions (subject to environmental policy and general regulatory constraints), plan and implement O&M, set budgets and water charges, hire and fire staff and apply very strong sanctions. Since transfer the districts have seized and resold more than 20 farms because of failure of owners to pay the water charge. Water is not delivered if water charge payments are in arrears. The districts can raise sideline revenue to help contain inflation of water charges. This includes the right to sell excess water to users outside the district. The districts agreed that the Bureau should retain ownership of system infrastructure, because they wanted to avoid liabilities attached to ownership.

Interestingly, the Bureau has the right to take over management of the system again if the districts should seriously fall behind in their agreed repayment schedule for construction or fail to properly maintain the system. The Bureau conducts technical and financial audits every three years to ascertain whether the districts are maintaining agreed performance standards. The districts are obligated to comply with recommendations for essential and important preventive maintenance.

[9] This is with the exception of a few structures which serve all three districts.

Table 1: Key characteristics of devolution in USA, Colombia and Sri Lanka

Elements	**Columbia Basin, USA**	**RUT, Colombia**	**Hakwatuna Oya, Sri Lanka**
Water right vested in legally-recognized WUA	Water right & strong legal status	No water right, limited powers	No water right, weak status
Legally binding service agreement	Between govt & WUA, users approve O&M plan	Informal, board defines service to users	Informal, govt not legally bound
Balance between management responsibility & authority	Balanced. Full authority for management responsibilities	More responsibility than authority, govt oversight	More responsibility than authority, close govt supervision
Integrated management for financing, O&M, conflict resolution	Integrated and independent in all 3	Not fully integrated due to partial dependence on govt in all 3	Not integrated. due to strong dependence on govt in all 3
Balance between incentives & type of accountability required in farmer organization	Strong mgt control through sanctions and personnel incentives	Only partial control over staff, labor laws restrict incentives	No, ID still deploys staff, WUAs have no hired staff & rely on volunteerism

Management transfer in the Columbia Basin contains all of the five elements of devolution which are hypothesized to be essential to produce viable local management of water.

The process of devolution was relatively complete. It included elimination of direct government subsidies, removal of government staff, negotiated agreements about improvements of scheme infrastructure, and a clear understanding that farmers would be responsible to finance all future rehabilitation and modernization (see table below).

Table 2: Devolution process in USA, Colombia and Sri Lanka

Transfer activities	**Columbia Basin USA**	**RUT, Colombia**	**Hakwatuna Oya, Sri Lanka**
Water user associations created	Yes	Yes	Yes
Train farmer representatives	Yes	Yes	Yes
Train management staff	Yes	Yes	Yes
Revise O&M procedures	No	No	Partial
Revise water charges	No	Yes	No
Reduce government financing	Eliminated*	Substantial	Moderate
Remove government staff	Yes	Yes	No
Main system improvements	No	Yes	No
Subsidiary system improvements	Yes	No	Yes
Farmers prioritized improvements	Yes	No	No
Farmers invested in improvements	Yes	No	Minor
Responsibility for future rehabilitation transferred	Yes	No	No

*Indirect subsidies to farmers continued, such as low charges for pumping water.

Performance results. In the Columbia Basin Project, before transfer farmers were already paying close to the full cost of O&M (except for subsidized cost of electricity for pumping water out of the Columbia Basin, which continued after transfer). Under pressure from farmers to contain costs, the boards reversed a pre-transfer upward trend in water charges. Water charges declined in real terms from $80 per acre in 1969-70 (the time of transfer) to $49.42 per acre by 1989 (in 1989 USD; Svendsen and Vermillion 1994).

In the Columbia Basin Project there were 612 US Bureau of Reclamation (USBR) staff in 1969—the year of transfer. By 1985 only 83 USBR staff remained and were assigned only for functions at the intake and main system levels which were not transferred to the districts. USBR staff in the Irrigation and Land Management Division of the Project dropped from 297 in 1969 to only 22 in 1985. Government staff previously assigned to the districts were either re-hired by the districts, transferred to other systems, or retired.

Following transfer, the irrigation districts have diversified their revenue sources in an effort by farmer-elected board members to keep water charges as low as possible. Before transfer in 1976, the water charge was 80% of revenue. This fell to 67% of

revenue by 1989 as the districts developed seven mini-hydropower stations and engaged in water selling contracts and other income generating activities.

In short, the government used the transfer to discontinue subsidies and remove its own staff from the districts. The districts responded by significant reductions in costs and water charges. They also minimized financial risk through revenue diversification and ensured sustainability of infrastructure by raising a capital replacement fund (which was required by the transfer agreement).

In the Columbia Basin, USA, the farmer-elected board has continuously exerted pressure on district staff to contain costs of management. It was reported that district managers all believed that the cost containment policy was gradually compromising the long-term sustainability of infrastructure. As required in the transfer agreement, after transfer the USBR conducted technical audits every two years.[10] Between 1973-77, there were only five cases found by auditors where important preventative maintenance was recommended. By the period 1980-84, there were 20 such recommendations. During the entire post-transfer period however, auditors never reported any cases where urgent remedial maintenance was required. This suggests that cost-cutting measures may be compromising the quality of maintenance over time, while still holding the line against significant disrepair.

In the Columbia Basin, management transfer has apparently had little or no effect on the quality of irrigation service received by farmers. There was a gradual shift to higher value, less water intensive crops after management transfer, but this was primarily the result of changing market prices and a shift from furrow and basin to sprinkler irrigation. The reduction in water costs after transfer had the effect of increasing average farm incomes by about 15% over what they would have been without the reduction. It is estimated that this could increase net income by about $1,600 per year on a typical 65-hectare farm. The value of agricultural production in the Columbia Basin increased from approximately US $ 182 per irrigated ha at the time of transfer in 1969 to about $283 in 1989 (in 1989 USD; Svendsen and Vermillion 1994).

PARTIAL DEVOLUTION

Comparative Evidence

In India, where the cost of electricity for pump irrigation is heavily subsidized, Pant (1994) 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

[10] 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.

per ha for the rabi (winter) season. The number of irrigation applications increased from two to three. Annual losses of US $876 before transfer of a public tubewell in Uttar Pradesh changed to consistent surpluses after transfer. The turnover of the public tubewell 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).

Pant's study also 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 transfer) and 59.5 ha during 1992-94 (after transfer). Cropping intensities were an average of 143% during two years before transfer and 162% afterwards. Yields for wheat, rice and sugarcane increased about 10%, indicating that farmers preferred to intensify rather than extensify production after transfer.

In a post-facto comparison of tubewell system performance for 30 sample tubewells, Shah, et al. (1994) reported 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%.

Transfer of management for 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 transfer 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 the tail end of the canal (Vermillion 1992). Before transfer, 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 the transfer, 18% of available canal water reached the tail area (Srivastava and Brewer 1994). In Paliganj Canal, management improvements due to transfer led to an increase in irrigated area in the dry season from 3,613 ha in 1990 before transfer to 4,350 ha after transfer in both 1992 and 1993.

In a before and after comparison case study in a 180-ha block of a medium-size irrigation 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 transfer and were only $7,696 per year (in 1982 dollars) on average during the four years following transfer—a 75% reduction in budget. 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.

Turnover of the system in Southern Luzon led to a decrease in agency staff from 24 in 1982 to only 6 in 1987, or a reduction in average service area per staff of approximately 75 ha in 1982 to 300 ha per staff in 1987. This led to a 60% reduction in annual operating expenses. Similar declines in government staff and operating expenses were reported by Svendsen (1992) in a sample of transferred systems. The decline in staff of the National Irrigation Administration (NIA) in the Philippines was part of a policy of attrition to not replace staff after retirements. The requirement that NIA had to become self-financing, motivated the agency to reduce costs where possible.

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-transfer period 1990-92. Bagadion also 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 transfer, during 1990-92.

The study by Oorthuizen and Kloezen found that fee collection increased from 20% before transfer to 81% after transfer, in 1989 (Oorthuizen and Kloezen 1995). Within four 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 transfer. This largely occurred because farmers cut annual expenditures by one fourth and increased fee collection from 20% to above 80% (as mentioned above).

In a paper on transfer 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. The Banurbur system irrigated 486 ha in the dry season before transfer and 750 ha afterwards. The increase continued for several years. The Maramag system irrigated 524 ha in the dry season before transfer and 719 ha afterwards. The MNOH system in Bicol added an additional 390 ha to wet season irrigation after transfer and a third crop was planted in several blocks for the first time.

Case Study: Partial Devolution in Colombia

Nature of devolution – In Colombia, the initiative for irrigation management devolution came from the water users themselves, who in 1976 successfully lobbied the government to take over management of the Coello and Saldaña districts in central Colombia (Plusquellec 1989). These first transfers were only partial in that they did not include WUA control over budgets, O&M plans or personnel. The government irrigation agency, HIMAT, retained a strong supervisory role in these areas.

The initial transfers were considered successful (Vermillion and Garcés 1996), and by the end of the economic recession of the 1980s, the government adopted a national devolution policy as part of its overall strategy of economic liberalization and political

decentralization.[11] Between 1990 and 1997, 17 irrigation districts were transferred under the national program.

The Roldanillo-La Union-Toro, or RUT, irrigation district is located in the prosperous Cauca valley, and serves 9,700 ha. It was built between 1958 and 1971. Water is pumped from the Cauca river through three pumping stations, for both irrigation and drainage. The district has predominantly smallholdings, with 75% of holdings being less than five ha. The main crops are cotton, grapes, fruit trees and sugarcane. Water is delivered on demand. Since it is pumped twice, from the river into the canals and from the canals onto fields, it constitutes a major cost to farmers.

RUT was the first district to be transferred under the national program, in January 1990. As part of the government's overall policy to eliminate subsidies to the agricultural sector, the government discontinued its subsidy to the scheme. Before transfer the subsidy was approximately 60 to 80% of total costs. Since the scheme had been rehabilitated before transfer, no arrangements were made for further repairs as part of the transfer process. After transfer farmers began to realize that they had seriously under-estimated how much pumping costs would be without a subsidy. They have since pressured the government to provide a temporary subsidy of approximately US $800,000 for energy costs. Several staff remained with the district after transfer and no training was provided as part of the transfer process.

As is the case elsewhere in Colombia, in RUT there is no water right or concession vested in the district or individual farmers. Water is allocated administratively by the government. The WUA consists of a general assembly of members and an elected board of directors. WUA members are all owners of farmland within the command area. A general assembly of members meets at least once a year to re-elect board members and approve policies.

Under the transfer, the WUA takes over management of the entire irrigation network, including the intake. From the time of transfer until 1995-96, the government had to approve O&M plans and budgets, changes in irrigation fees and reductions in staff (the latter of which was resisted by the government). The district can establish rules and apply sanctions against members. The maximum sanction applied has been fines against members for infractions. More severe penalties apparently require involvement of the government. The WUA has the right to make contracts with third parties and raise supplemental revenue aside from water charges. WUAs are still prohibited from making profits (Table 1).

Under the transfer process the irrigation agency, HIMAT (or INAT as it was renamed after 1994)[12] facilitates the formation of water users associations. This

[11] The strategy included removal of agricultural price supports, input subsidies and trade barriers.

includes preparation of a constitution, formulation of by-laws and designation of basic rules and sanctions. Farmers elect representatives to a Board of Directors. This is followed by preparation and signing of a concessional contract agreement between INAT and the WUA. Whether or not the transfer process includes training, rehabilitation, or changes in O&M plans, fees or personnel depends, on a case-by-case basis, on the interests of the WUA and INAT and agreements reached between them during pre-transfer negotiations (Table 2).

Recognizing the problems inherent in this partial "delegation of administration", and needing to induce greater farmer investment in future expansion efforts, the government passed the Land Development Law No. 41 in 1993. The new law declared that thereafter full control over irrigation district finances, O&M procedures and personnel would be vested in the water users associations. This was an enlargement of devolution but it still did not include designation of a water right, clear responsibility and authority for financing maintenance and rehabilitation and ownership of scheme infrastructure.

Performance results – In RUT district in Colombia, farmers supported management transfer, expecting that it would improve management efficiency and contain costs. After transfer the WUA immediately began to reduce staff (although this was resisted and limited by the government). It also replaced ditchtenders inherited from the agency with new ones hired by the district board. Operations were decentralized into zones. The district began making structural repairs at its own expense, reportedly in more pragmatic and cost efficient ways than had been done by public agencies before transfer. The district also began to diversify its revenue sources and hired lawyers to collect overdue fees. These actions were intended to improve accountability and competence of staff, management efficiency and the financial solvency of the district.

In the first five years after transfer, government expenditures were eliminated entirely. The total cost of irrigation in RUT is relatively high, largely due to the two-stage pumping of water from the river. Under pressure from farmers, the board initially reduced the O&M budget even as the government withdrew its subsidy. Expenditures on O&M were decreased from US $163/ha in 1989 to $95/ha by 1995 (in 1995 USD). This was achieved largely through substantial decreases in the amount of water pumped per ha[13] as well as lower spending for maintenance. Despite these stringency measures the cost of irrigation as a percentage of gross value of output rose from 2.1% in 1989 to 3.5% by 1994. This was largely due to declines in the economic value of output, caused by drops in crop prices.

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[12] In 1994, responsibility for meteorology was removed from the agency and its name was changed to the National Institute for Land Development (INAT) to reflect its narrower focus on development of irrigation, drainage and flood control facilities.

[13] The Relative Irrigation Supply (supply/requirement) fell from 2.0 in 1989 to 1.1 by 1995.

Over time actual farmer payments of water charges declined from $83 before transfer to $65 per ha by 1995. This was mainly due to a declining fee collection rate, from above 90% to less than 70% by 1995. By 1995, only 70% of RUT's budget was mobilized from fees. In an effort to balance finances, the board was then pressured to both increase the water charge and reduce the O&M budget. These efforts were insufficient and due to concerns about pump station maintenance and lobbying from farmers, by 1995 the government again began subsidizing routine O&M costs in the district.

In brief, after transfer the WUA board responded to farmer demands to reduce the cost of irrigation. However, this resulted in under-financed maintenance. It is likely that this was partly related to an expectation that the government would resume its subsidies and eventually sponsor rehabilitation in the future.

There is reason to doubt the sustainability of infrastructure maintenance after devolution in Colombia. In the RUT scheme in Colombia, an inspection of the canal network in 1996 revealed that approximately 17% of the main and secondary canal lengths and 18% of control structures were defective. However, it is estimated that it would require an increase of only two percent in the O&M budget to repair all defects in the network within three years. Five years of budget cutting after transfer raised concern by the government about apparent under-financing for maintenance. Local financial sustainability of scheme infrastructure is in doubt with the advent of resumption of government subsidies.

In RUT in Colombia a significant improvement in cropping intensity occurred at the time of transfer and afterward. Intensity rose from 110% to 160-170% after transfer. Gross value of output (GVO) per unit of land did not change after transfer but the value of output per unit of water improved significantly. This is primarily due to a reduction in the amount of water pumped per hectare, as the district attempted to reduce management costs after transfer.

MINIMAL DEVOLUTION

Comparative Evidence

In Senegal, project reports indicate that transfer of lift schemes brought about improved supervision of pumps by farmer hired staff and led to a reduction in over-pumping. Due to a loss of government subsidies, however, water charges rose by 200 to 400%--despite a decrease in the cost of electricity for pumping by about 50% (Meinzen-Dick et al. 1994).

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 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 shortage of skills, spare parts and cash rather than lack of 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. Accelerated deterioration of infrastructure is most often reported in pump irrigation schemes, where government subsidies are withdrawn (such as in Senegal, Bangladesh and Indonesia).

The study in Senegal by Wester, et al. (1995) reported declines in cropping intensity, partly due to lack of skills and parts for pump management as well as other problems with credit and marketing related to structural reforms. 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 Senegal, it is reported that irrigation management transfer has increased waterlogging 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.

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 in the turned over schemes, $1.09 in the parastatal schemes, and only $0.09 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.

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 management transfer in 1989 to more than 90% in 1990 after farmers became involved for the first time in collecting the fee. Resembling 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).

In the Kano River Irrigation Project, newly organized farmers changed water distribution schedules to discontinue nighttime 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, which resulted in an 80% increase in dry season cropped area (Musa 1994). The study reported an increase in maintenance investment and activity after transfer and an increase in cultivated area, which was attributed to better operations.

Management transfer was introduced to the system largely because of lack of government funds for irrigation O&M, the consequent rapid deterioration of the system due to lack of maintenance and the new policy mandating financial autonomy for the river basin authorities and large scale irrigation systems. In the 1992/93 season following the transfer, 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).

Case Study: Minimal Devolution in Sri Lanka

Nature of devolution – In Sri Lanka, irrigation schemes above 80 ha in service area were the government's responsibility until the 1980s. In 1988, the government of Sri Lanka adopted the participatory irrigation management policy, which called for transfer of operation and maintenance of minor irrigation schemes and distributary canals of medium and major schemes to farmer organizations. This program sought to decrease recurrent expenditures by the government, improve operations and maintenance and improve the productivity of irrigation schemes through self-reliant farmer organizations (Abeywickrema 1986; Brewer 1994).

The devolution of responsibilities did not include transfer of control by farmer organizations over O&M plans or budgets, water charges or staff to farmer organizations (see Table 1). Farmer organizations must obtain approval from the Irrigation Department before making special repairs other than weeding or desilting. All major and medium scale irrigation schemes are the property of the government. The government has absolute rights over water and much of the land in the schemes which are in resettlement areas legally belongs to the government. Water is allocated administratively, whether farmers pay the nominal fee or not. The great majority do not.

The Agrarian Services Act of 1991 gives the Commissioner of Agrarian Services considerable regulatory control over farmer organizations. This includes regulating elections, auditing accounts, approving business transactions and prohibiting expansion of mandates of farmer organizations (Samad and Vermillion 1998). The 1994 amendments to the Irrigation Ordinance of 1968 authorizes farmer organizations to plan and implement operations and maintenance in distributary canals and formulate rules and sanctions related thereto. However, these plans and rules still require approval of the Irrigation Department.

The Hakwatuna Oya scheme is located in the center of Sri Lanka in the intermediate zone between the wet and dry parts of the island. Hakwatuna Oya is an ancient reservoir irrigation scheme which was rehabilitated in the 1960s. The scheme has high conveyance losses and experiences serious water shortages in the tail end during dry season. The irrigated area is about 2,400 hectares. Most farm sizes are between .5 and 2 hectares. A majority of farmers are landowners.

The reform process includes formation of informal field channel groups of about 15 to 20 farmers. Each group nominates a representative to the distributary canal organization, or DCO, which is the farmer organization registered with the Department of Agrarian Services (Table 2). In some schemes, DCOs are federated to the level of the entire scheme, but this ultimate body is not recognized as a legal entity. The transfer generally includes some rehabilitation of distributary networks, which may or may not be done with farmer participation. Government field operations staff generally remains assigned to the schemes after transfer and function under supervision of the Irrigation Department. The government continues to provide partial funds for maintenance and assume responsibility for future rehabilitation. Government subsidies for maintenance are generally channeled through DCO organizations as service contracts.

Discussions with farmer leaders in Hakwatuna Oya indicated that no significant changes in operational procedures had been made and that decisions about planting dates and irrigation scheduling are still taken in pre-season meetings attended by farmer representatives and officials of the irrigation and agriculture departments. Decisions are still made jointly, between farmers and the government, much as before transfer. In summary, this has been a minimalist approach toward devolution, with the emphasis being on transfer of responsibility rather than authority.

Performance results. In the Hakwatuna Oya scheme in Sri Lanka, despite the turnover of the distributary and field channel networks to farmer organizations, there were no significant changes in operation and maintenance or in deployment of Irrigation Department staff. There were 12 agency personnel before transfer, in 1989, and 11 in 1996. However, farmer leaders interviewed agreed that the establishment of farmer organizations improved communication between farmers and the irrigation department and that agency staff were more responsive than before.

There has been a pronounced decline in government expenditure for O&M beginning well before transfer and continuing thereafter. Average annual expenditure on O&M by the government before transfer was US$ 6.5/ha, compared to US$ 3/ha during the first five years after transfer. The reform itself did not cause the decline in government expenditure but was part of the overall strategy of reducing government investment in irrigation.

Irrigation water has traditionally been supplied free of charge to farmers in Sri Lanka. Previous attempts to levy a fee from farmers have failed. The government expected that management turnover would facilitate cost recovery by involving farmer organizations in collecting charges from farmers. The 1994 amendments to the Irrigation Ordinance of 1969 vests authority with farmer organizations to recover irrigation costs from farmers, including the right to levy a fee for the service. However, in general, cost recovery in transferred schemes remains very minimal and the cost of irrigation to farmers has remained about the same before and after transfer.

The cost of irrigation is far lower in Sri Lanka than in the other two cases. However, the modest nature of the reform in Hakwatuna Oya has not resulted in any significant changes in total cost of O&M or cost of irrigation to farmers. The government has reduced its level of spending but continues to subsidize routine maintenance and has not changed its policy about financing future rehabilitation.

In Hakwatuna Oya in Sri Lanka, government expenditure for maintenance remained about the same before and after transfer. Farmers slightly increased their investment in maintenance after transfer to the level of $2.50 per ha (much of it in the form of labor). This is double the level of government spending on maintenance, which has continued after transfer. An inspection of scheme infrastructure found about 15% of main and distributary canals and five percent of control structures to be defective. It was estimated that it would take an increase in the annual budget of 375% to handle routine maintenance and eliminate the backlog of disrepair within three years. This raises serious concern about the capacity of farmers to ensure the financial and physical sustainability of scheme infrastructure.

The study by Samad and Vermillion (1998) in Sri Lanka found no detectable change in irrigated area, crop patterns, cropping intensity (169%) or yields (3-3.6 t/ha for padi) as a result of the transfer of management of distributary canals to farmers. The transfer neither improved nor interfered with agricultural productivity. Economic productivity, measured in GVO per unit of land, declined somewhat after transfer, from US $800-1,000 in 1985-90 to US $600-800 in 1991-95 (in 1995 US dollars), but this is primarily related to changes in the price of rice rather than changes in irrigation management, which were nominal.

COMPARISON OF THE THREE CASES

There appears to be a tendency for irrigation management devolution programs to lead to reduced costs for irrigation management for the government and increased costs to farmers. More comprehensive programs tend to improve fee collection rates and financial viability of irrigation system O&M. Impacts on O&M and agricultural productivity are variable. They also tend to result in efforts to reduce the costs of irrigation and create additional sources of revenue.

When governments have a policy to reduce or eliminate staff along with transfer programs, this is done most often by relocating staff into systems which are not being transferred (as in Indonesia and Sri Lanka), not rehiring staff when they retire (as in the Philippines), having former agency staff be rehired by the farmer association after transfer (as in Colombia), transferring staff into non-O&M activities, such as construction of new systems (as in Turkey) and having the agency revise its overall mandate, such as with the US Bureau of Reclamation in the USA going into environmental regulation after the construction era in the USA. Less comprehensive devolution programs tend to not solve the problem of deterioration of infrastructure.

One might argue that the different outcomes of these cases are more the result of differences in levels of economic development than devolution strategies. A larger comparative analysis would be needed to test this, but there is some reason to discount this argument anyway. In 1989, the annual gross value of output (GVO) per hectare was approximately US $3,100 in the Columbia Basin, USA, US $954 in RUT in Colombia and $1,540 in Hakwatuna Oya in Sri Lanka (all in 1995 USD). However, the cost of irrigation (COI) is much higher in the USA than in Columbia and Sri Lanka and COI is much higher in Colombia than in Sri Lanka.

Figure 1 (p.194) shows the annual COI as a percentage of GVO for the year of transfer and five years thereafter, in each of the three cases. This indicates a key concern of farmers, which is: *Does the ratio between the benefits and costs of irrigation improve after devolution?* In this analysis, COI relative to GVO is positively rather than inversely related to level of economic development. Despite the high percentage of COI to GVO in the Colombia Basin (6.5-8.5%), it was the only case which experienced a significant decline in the ratio. COI as a percentage of GVO did not change significantly in the other two cases, although GVO rose slightly during five years after transfer in Colombia and declined in Sri Lanka.

CONCLUSION

The comparison of relatively comprehensive, partial and minimal devolution of property rights suggests that more comprehensive devolution does tend to result in better performance results and fewer negative outcomes than less comprehensive approaches. But one rather surprising finding is that most cases of devolution, even less

comprehensive ones, produced positive results in several ways. We conclude that irrigation management devolution has the potential to enhance the performance and sustainability of irrigation systems and that this potential is increased when more property rights and enabling factors exist in the context within which devolution occurs.

SEVEN CHARACTERISTICS OF MORE EFFECTIVE DEVOLUTION

The above experiences with irrigation management devolution suggest the following seven characteristics which tend to be a part of more successful devolution programs. International experience with irrigation management devolution suggests that policy makers and planners should pay special attention to incorporating these characteristics into management transfer programs.

An essential bundle of rights should be transferred. These include a water right, infrastructure use right, right of organizational self-determination, right of crop choice, right to manage financing and the right to select the water service provider.

There should be a clear redefinition of the role of government. The former irrigation management agency should reorient itself into a provider of support services, such as technical advisory service and extension, management assistance for large intakes and main canals, dispute resolution, and financial assistance through conditional subsidies.

Devolution programs should introduce new mechanisms of accountability. Examples are socio-technical and financial audits, subsidies requiring matching local investment, fee payment for service provided, service monitoring and so on.

The type of organization taking over management should fit the complexity and intensity of management required. For more complex situations and larger service areas, planners need to find alternatives to the ubiquitous water users association, originally developed for small schemes and tertiary sub-systems. These include semi-municipal irrigation districts, mutual companies, federations of water users associations and contracting of services to professional irrigation management firms. An additional source of complexity, which is rising in importance, is the growing diversification of uses of water within irrigation systems, such as for domestic needs, small-scale industry, fisheries, care of livestock, etc. This has implications for membership and structure of local water management organizations.

Subsidies should be structured so as to encourage local investment in irrigation management. The promise of fully subsidized rehabilitation in the future should be replaced with awareness that joint investment will be required. Subsidies for O&M costs should be linked to amounts of local investment and collection of service fees. Confirming property rights over infrastructure can provide an additional incentive for investment.

Support services should be available on an on-demand basis. Supply-driven programs only generate dependency on the government. To maintain a local sense of ownership and self-determination, water users associations should be able to request support services as needed and not be pressured into participation in government programs. Associations should have the right to select service providers.

Water users associations should have productive linkages with the external environment. Water users associations need to be able to integrate their organizations with the external environment, such as for water basin management, agricultural extension networking and expanding the range of productive activities from only cultivation to input provision, crop processing, marketing, etc.

PRIORITIES FOR RESEARCH

Irrigation management devolution is a widespread phenomenon occurring in many settings and being implemented with variable strategies. Research is needed which will provide evidence about what kinds of strategies work best in what settings, what additional enabling conditions help and what are the impacts of different devolution strategies. The following are eight priority research topics which this author believes are important for enhancing irrigation devolution programs worldwide.

1. *Organizational fit*. What organizational models work best in medium and large scale irrigation systems, in water demand-driven versus supply-driven settings and in settings with strong versus weak local institutions?

2. *Locally-appropriate mechanisms of accountability.* What new organizational, legal and financial mechanisms are needed to achieve that which has not been achieved in the past—namely, accountability of farmer leaders to farmers, government agencies to water users associations, and service providers to water users associations?

3. *Restructuring old patterns of irrigation investment*. How can government subsidies for the cost of O&M and rehabilitation and modernization be restructured so as to break loose from the old problems of co-dependency and encourage sustained local investment?

4. *Identification of needed support services and modalities*. What kinds of external support services are needed by water users associations after devolution? What are the most efficient and effective ways of providing these services? How can water users be enabled to take the initiative in seeking out and selecting support service providers?

5. *Linking up to sustainable water basin management*. Water users associations are increasingly under threat of competition for water from more powerful interests, such as hydro-power, urban water supply and industry. How should water users associations be organizationally related to water basin management so as to enable them to have an effective voice and protect their interests.

6. *Performance assessment*. Does devolution really lead to improvements in irrigation system performance? What are the points of weakness that need to be supported or corrected? What strategies lead to better results? How should farmers be involved in performance assessment?

7. *Changes in irrigation design and procedure*. What kinds of changes should be made in the design of irrigation structures or in O&M procedures as a result of management devolution? Sometimes schemes with elaborate, highly-flexible control and measurement structures are not suitable for schemes managed by farmer groups. What kinds of simplification are needed?

8. *Participation of water users*. To what extent should water users be involved in the formulation and implementation of management devolution programs?

The key challenge for both researchers and policy makers for management devolution programs is to identify what kinds of property rights should be devolved to users in order to create an enabling environment wherein communities of water users will have the motivation and capacity to act collectively to establish strong organizations, formulate rules and policies and implement them in ways which ensure the local productivity and sustainability of irrigation systems.

REFERENCES

Abeywickrema, N. 1986. Government policy in participatory irrigation management. In *Participatory management in Sri Lanka's irrigation schemes*. Colombo, Sri Lanka: International Irrigation Management Institute.

Asgive. 1994. Rice and salinity in the Sahel. *Agsieve* 6(6). Kutztown, Pennsylvania: Rodale Institute.

Arriëns, W.L., J. Bird, J. Berkoff, and P. Mosley. 1996. Overview of issues and recommendations, Volume 1 in *Towards effective water policy in the Asian and Pacific region*. Proceedings of the Regional Consultation Workshop, Manila, Philippines 10-14 May. Manila: Asian Development Bank.

Bagadion, B.U. 1994. *Joint management of the Libmanan-Cabusao pump irrigation system between farmers and the National Irrigation Administration in the Philippines*. Paper presented at the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September.

Brewer, J.D. 1994. The participatory irrigation system management policy. *Economic Review* 20 (6): 4–9.

EDI (Economic Development Institute of the World Bank). 1996. *Handbook on participatory irrigation management*. Washington D.C.: World Bank.

FAO (Food and Agriculture Organization of the United Nations). 1993. Water policies and agriculture. In *The state of food and agriculture*. Rome: FAO.

Eggertsson, T. 1990. *Economic behavior and institutions*. Cambridge: Cambridge University Press.

Farley, P.J. 1994. Privatization of irrigation schemes in New Zealand. In *Short Report Series on Locally Managed Irrigation* 2. Colombo, Sri Lanka: International Irrigation Management Institute.

Furubotn, E.G. and S. Pejovich. 1972. Property rights and economic theory: A survey of recent literature. *Journal of Economic Literature* 10(4):1137–1162.

Gazmuri, R. 1994. Chilean water policy. In *Short Report Series on Locally Managed Irrigation* 5. Colombo, Sri Lanka: International Irrigation Management Institute.

Gitomer, C.S. 1994. Price regulation in the reform of irrigation management in rural China. Presented at the Political Economy Workshop of the Joint Committee on

Near and Middle Eastern Studies of the Social Sciences Research Council, Berkeley, California, February 10-13.

Gorriz, C., A. Subramanian, and J. Simas. 1995. Irrigation management transfer in Mexico: Process and progress. Paper presented at the International Seminar on Participatory Irrigation Management, Mexico, February 3-15.

Johnson, S.H., III. 1996. Irrigation management transfer in Mexico: Moving toward sustainability. Prepared for Internal Program Review, Colombo, Sri Lanka: International Irrigation Management Institute, April 1-2.

Johnson, S.H., III, D. Vermillion, M. Svendsen, W. Xinyuan, Z. Xiying, and M. Xuesen. 1995. Institutional management and performance changes in two irrigation districts: Case study from Hebei province. Selected Papers from the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September. Rome: IIMI and FAO.

Johnson, S.H., III, M. Svendsen, and X. Zhang. 1994. Performance impacts of transfer. Paper presented at the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September.

Johnson, S.H., III and P. Reiss. 1993. Can farmers afford to use the wells after turnover? A study of pump irrigation turnover in Indonesia. In *Short Report Series on Irrigation Management Transfer* 1. Colombo, Sri Lanka: International Irrigation Management Institute.

Maurya, P.R. 1993. Partial turnover of management of Nigerian large scale irrigation projects to farmers: Constraints and solutions. *Proceedings of ICID-Fifteenth Congress* (Q,45-R. 4), The Hague, pp. 51-65.

Meinzen-Dick, R. and A. Knox. 1999. Collective action, property rights, and devolution of natural resource management: *A conceptual framework*. Paper presented at the Workshop on Devolution of Natural Resource Management, Puerto Azul, Philippines, 21-25 June.

Meinzen-Dick, R.; M. Mendoza; L. Sadoulet; G. Abiad-Shields and A. Subramanian. 1997. Sustainable water user associations: Lessons from a literature review. In *User organizations for sustainable water services,* ed. A. Subramanian, N. Vijay Jagannathan, and R.S. Meinzen-Dick pPp 7-87 in .(eds). . World Bank Technical Paper Number 354. Washington, DC: World Bank.

Musa, Inuwa K. 1994. Irrigation management transfer in Nigeria: A case of financial sustainability for operation, maintenance and management. Paper presented at

the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September.

North, Douglass C. 1990. *Institutions, institutional change and economic performance.* Cambridge: Cambridge University Press.

Oorthuizen, Joost and Wim H. Kloezen. 1995. The other side of the coin: A case study on the impact of financial autonomy on irrigation management performance in the Philippines. *Irrigation and Drainage Systems*, 9:15-37.

Ostrom, Elinor. 1990. *Governing the commons: The evolution of institutions for collective action*. Cambridge, UK: Cambridge University Press.

Pant, Niranjan. 1994. The turnover of public tubewells in Uttar Pradesh: A case study of a successful cooperative society. Paper presented at the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September.

Plusquellec, Herve. 1989. Two irrigation systems in Colombia: Their performance and transfer of management to user's associations. *Policy, Planning and Research Working Paper Series* No. 264. Washington, D.C.: World Bank.

Samad, M. and M.A. Dingle. 1995. Privatization and turnover of irrigation schemes in Sudan: A case study of the White Nile pump schemes. Draft Final Report. Colombo, Sri Lanka: International Irrigation Management Institute.

Samad, Madar and Douglas L. Vermillion. 1998. Assessment of participatory management of irrigation schemes in Sri Lanka: Partial reforms and partial benefits. IIMI Draft Research Report. Colombo, Sri Lanka: International Irrigation Management Institute.

Seckler, David. 1996. The new era of water resources management: From "dry" to "wet" water savings. *Research Report* 1. Colombo, Sri Lanka: International Irrigation Management Institute.

Serageldin, Ismail. 1995. Toward sustainable management of water resources. *Directions in Development Series*. Washington, D.C.: The World Bank.

Shah, Tushaar, Vishwa Ballabh, Kusum Dobrial, and Jayesh Talati. 1994.Turnover of state tubewells to farmer cooperatives: assessment of Gujarat's experience, India. Paper presented at the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September.

Srivastava, L.P. and Jeffrey D. Brewer. 1994. Irrigation management transfer at Paliganj Canal, Bihar, India. *Short Report Series on Locally Managed Irrigation*, Number 7. Colombo, Sri Lanka: International Irrigation Management Institute.

Svendsen, Mark. 1992. Assessing effects of policy change on Philippine irrigation performance. *Working Papers on Irrigation Performance*, Number 2. Washington, DC: International Food Policy Research Institute.

Svendsen, Mark and Douglas Vermillion. 1994. *Irrigation management transfer in the Columbia Basin: Lessons and international implications*. Colombo, Sri Lanka: International Irrigation Management Institute.

Turner, Jennifer L. and James E. Nickum. 1997. Trickle down decentralization of water resources administration and financing in post-Mao China. In Marcus Moench, ed. A monograph on legal approaches to groundwater management.

Vermillion Douglas L. 1992. Irrigation management turnover: Structural adjustment or strategic evolution? *IIMI Review* 6 (2): 3-12.

Vermillion, Douglas L. 1997a. Impacts of irrigation management transfer: A review of the evidence. *IIMI Research Report* No. 11. Colombo, Sri Lanka: International Irrigation Management Institute.

Vermillion, Douglas L. 1997b. Management devolution and the sustainability of irrigation: Results of comprehensive versus partial strategies. Paper presented at the FAO/World Bank Technical Consultation on Decentralization and Rural Development, 16-18 December, Rome.

Vermillion, Douglas L. and Carlos Garcés-Restrepo. 1996. Results of irrigation management in two irrigation districts in Colombia. *IIMI Research Paper* No. 4. Colombo, Sri Lanka: International Irrigation Management Institute.

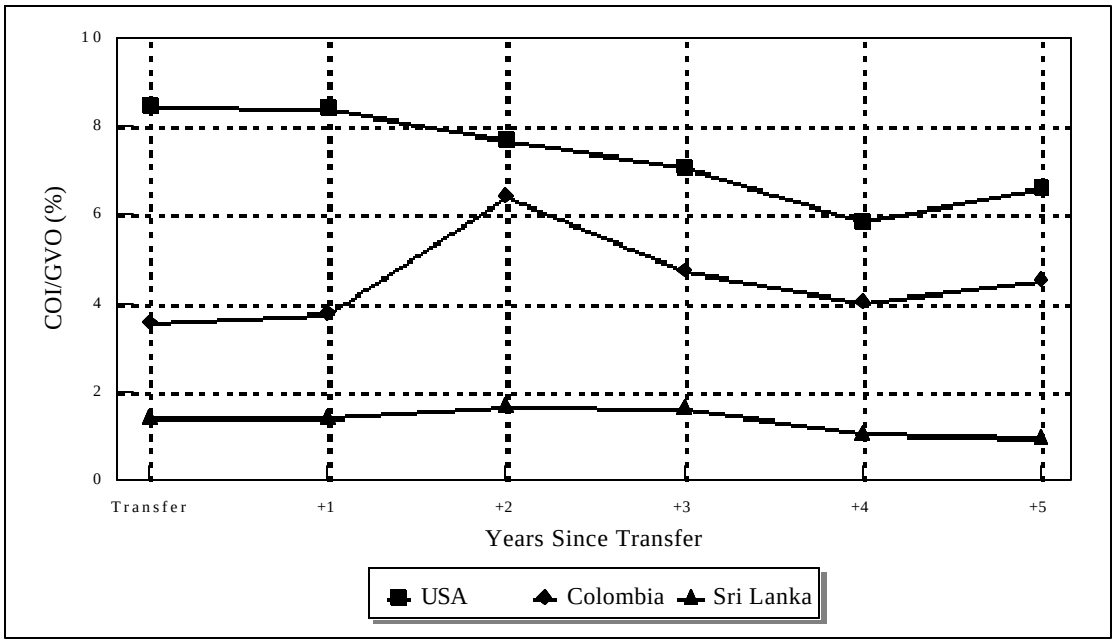
Vermillion, Douglas, Wang Xinyuan, Zhang Xiying and Mao Xuesen. 1994. Institutional reform in two irrigation districts in North China: A case study from Hebei province. Paper presented at the International Conference on Irrigation Management Transfer, Wuhan, China, 20-24 September.

Wester, Philippus, Arjen During and Joost Oorthuizen. 1995. Locally managed irrigation in the Senegal River Valley in the aftermath of state disengagement. *Short Report Series on Locally Managed Irrigation*, Number 9. Colombo, Sri Lanka: International Irrigation Management Institute.

Wijayaratna, C.M. and Douglas L. Vermillion. 1994. Irrigation management turnover in the Philippines: Strategy of the National Irrigation Administration. *Short Report Series on Locally Managed Irrigation*, Number 4. Colombo, Sri Lanka: International Irrigation Management Institute.

World Bank. 1993. *Water resources management. A World Bank Policy Paper*. Washington, D.C.: World Bank.

Figure 1: Cost of irrigation as percentage of gross value of output



* Schemes: Columbia Basin in USA, RUT in Colombia, and Hakwatuna Oya in Sri Lanka

** All figures calculated in constant US dollars.