Research Report

Impacts of Irrigation Management Transfer: A Review of the Evidence

Douglas L. Vermillion

International Irrigation Management Institute

Research Reports

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Research Report 11

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Douglas L. Vermillion

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

The author: Douglas L. Vermillion is a social scientist and management specialist at the International Irrigation Management Institute.

Vermillion, D. L. 1997. *Impacts of irrigation management transfer: A review of the evidence.* Research Report 11. Colombo, Sri Lanka: International Irrigation Management Institute.

/ irrigation management / irrigation systems / policy / privatization / case studies / performance evaluation / irrigated farming / economic aspects / financing / operation / environmental sustainability /

ISBN 92-9090-340-5
ISSN 1026-0862

Editor: Kingsley Kurukulasuriya; *Consultant Editor:* Steven Breth; *Artist:* D. C. Karunaratne; *Typesetter:* Kithsiri Jayakody; *Publications Manager:* Nimal A. Fernando.

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Summary

For the last two decades, an ever-increasing number of countries around the world have been turning over the management authority for irrigation systems from government agencies to farmer or other local, nongovernmental organizations. This phenomenon is generally referred to as management transfer or devolution.

Despite the widespread adoption of irrigation management transfer programs, little information is available internationally about its impacts. This report synthesizes the most significant evidence available to date about the impacts of management transfer programs on the financial viability of irrigation systems, the quality of irrigation operations and maintenance, the physical sustainability of irrigation infrastructure, agricultural and economic productivity, and the environment. Data from 29 studies of irrigation management transfer are summarized and evaluated.

More evidence is available in the literature on operational and financial performance; less evidence is available on effects of management transfer on maintenance and economic performance of irrigated agriculture. The literature shows a mixture of positive and negative results, while on balance most sources report positive results, especially in operations and finance, although the cost of irrigation to farmers often rises. Agricultural and economic performance tend not to change much with transfer. Management transfer often results in lower government expenditures for irrigation.

Although the literature on the subject is becoming extensive, no clear analytical paradigm has yet emerged. The literature is a disparate collection of definitions and methodologies from which it is difficult to deduce general conclusions or policy implications. Many writers show a bias in favor of transfer programs, apparently on philosophical grounds. More systematic research methods need to be applied with enough commonality to permit conclusions about impacts and to specify conditions under which transfer programs could be expected to succeed or not. The International Irrigation Management Institute and other organizations are engaged in this task.

The report recommends 12 principles that should guide future research on the impacts of this important reform. It concludes with an identification of key researchable propositions about the essential conditions that should prevail for management transfer programs to succeed:

- a clearly recognized and sustainable water right and water service
- infrastructure that is compatible with the water service and local management capacities
- well-specified management functions and assignment of authority
- effective accountability and incentives for management
- arrangements for viable and timely conflict resolution
- adequate resources that can be mobilized for irrigation management

It is hoped that this report will be useful for policy makers and planners, technical staff of donor agencies, and researchers who wish to determine whether to adopt transfer policies, how to structure transfer programs, what kind of outcomes to expect, and how to measure what those outcomes really are.

Impacts of Irrigation Management Transfer: A Review of the Evidence

Douglas L. Vermillion

Introduction

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

The logic often used to justify irrigation management transfer policies is as follows:

1. Government bureaucracies lack the incentives and responsiveness to optimize management performance. Farmers have a direct interest in enhancing and sustaining the quality and cost-efficiency of irrigation management. When given the authority and incentives to act collectively, farmers will act to contain the cost of water management while improving operational performance because it is in their direct interest to do so. However, where management transfer involves elimination or reduction of government subsidies, the cost of irrigation to farmers will increase.
2. When management transfer occurs in a supportive socio-technical context, improved quality and cost-efficiency of irrigation management will result. This will normally enhance the profitability of irrigated agriculture enough to offset the increased cost of irrigation to farmers.
3. Management transfer will also save money for the government as it divests itself of the responsibility to finance routine costs of operations and maintenance (O&M) of irrigation systems. The savings can be used either to reduce government expenditures in the irrigation subsector or to reallocate funds to other functions that cannot be handled or financed directly by the private sector.

Following this line of reasoning, we can consider management transfer to be successful if it saves the government money, improves the cost-efficiency of O&M, and maintains or increases the productivity of irrigated agriculture for farmers and urban consumers.

The Need for Evidence about a Global Phenomenon

Early efforts to transfer irrigation management from the government to farmer organizations occurred in the USA, France, Colombia, and Taiwan from the 1950s through the 1970s. Irrigation management transfer (IMT) became a national strategy in most developing countries only in the 1980s and 1990s. Chile, Peru, Mexico, Brazil, the Dominican Republic, Colombia, Haiti, Senegal, Mauritania, Niger, Zimbabwe, Tanzania, Sudan, Somalia, Madagascar, Turkey, Pakistan, India, Sri Lanka, Bangladesh, Lao PDR, Vietnam, China, Indonesia, and the Philippines are among the countries implementing national transfer programs. This process 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.

Given the extent to which management transfer is being implemented worldwide, it is remarkable how little information is available internationally about the results of transfer programs. It remains to be seen whether IMT can simultaneously save money for the government, bring about more cost-efficient management for the farmers, and achieve financial and infrastructural sustainability. Most reports about impacts are qualitative and hard to validate. Over a hundred papers were prepared for the International Conference on Irrigation Management Transfer, held in Wuhan, China in September 1994, but only 25 contained data on performance outcomes of management transfer. Most of those papers presented only data on performance after transfer, using at most, two or three performance measures. Four papers presented before-and-after comparisons; one paper presented a with-and-without comparison (Turral 1995). It is often difficult to distinguish the effects of management transfer from rehabilitation or changes in inputs or technology.

This report reviews the evidence emerging about the impacts of irrigation management transfer, with reference to performance criteria, measures used, and the strength of evidence. The literature includes the following categories of performance measures:

- financial performance
- quality of O&M
- agricultural and economic productivity
- environmental sustainability

Table 1 displays basic information on the main references in the literature. Most transfer units are subsections of irrigation systems that are managed by farmer organizations while the main system continues to be managed by a government agency. Transfer units range in size from 5-hectare pump schemes in Indonesia to the 14,000-hectare Paliganj Distributary Canal in Bihar, India. In several cases, entire schemes have been transferred to farmer organizations (usually federated). These range from 50-hectare schemes in Indonesia to the 230,000-hectare Columbia Basin Project in the USA (which was transferred to three districts serving an average area of 77,000 hectares).

In less-developed countries, most post-transfer organizations tend to be water users' associations that take over O&M responsibility directly, at relatively small scales (i.e., less than 1,000 hectares of service area). Although common in Asia and Africa, they often lack legal powers of rights-of-way, ability to enforce rules and

TABLE 1.
Irrigation management transfer studies: Units, levels, and functions transferred.

Study and country	Transfer unit	Size of transfer unit (ha)	New management[a]	Functions transferred[b] O&M	Functions transferred[b] Finance	Ownership of assets
Oorthuizen & Kloezen 1995–Philippines	Entire scheme	150–200	WUA	Partial	Partial	Govt.
Wijayaratna & Vermillion 1994–Philippines	Laterals and entire scheme	500–5,000	WUA	Partial	Partial	Govt.
Bagadion 1994–Philippines	Distributary canal	2,500	WUA	Partial	Partial	Govt.
Svendsen 1992–Philippines	Distributary canal	<5,000	WUA	Partial	Partial	Govt.
Johnson & Reiss 1993–Indonesia	Tube well	5–200	WUA	Partial	Full	Govt.
Nguyen & Luong 1994–Vietnam	Pump scheme	n.a.	Parastatal	Full	Full	Govt.
Johnson et al. 1995–China	Scheme	5,000	Irrigation district	Full	Full	Govt.
IIMI & BAU 1996–Bangladesh	Tube well	<100	WUA	Full	Full	Private
Rana et al. 1994–Nepal	Irrigation system	500–2,000	Agency/WUA	Partial	Partial	Govt.
Olin 1994–Nepal	Tube well	120	WUA	Full	Full	Govt.
Mishra & Molden 1996–Nepal	Entire scheme	8,700	WUA	Partial	Partial	Govt.
Kloezen 1996–Sri Lanka	Distributary canal	80–260	Agency/WUA	Partial	Partial	Govt.
Uphoff 1992–Sri Lanka	Field channels	50–150	WUA	Full	Partial	Govt.
Pant 1994–India	Tube well	84	Cooperative	Full	Partial	Govt.
Srivastava & Brewer 1994–India	Distributary canal	14,000	Intervillage committee	Partial	Partial	Govt.
Rao 1994–India	Minor canal	359–513	WUA	Partial	Partial	Govt.
Shah et al. 1994–India	Tube well	50–150	WUA	Partial	Partial	Govt.
Kalro & Naik 1995–India	Minor canal lift schemes	<400	WUA	Full & partial	Full & partial	Govt.
Azziz 1994–Egypt	Field channel	20–60	WUA	Full	Partial	Govt.
Samad & Dingle 1995–Sudan	Pump scheme	80–4,000	Private company/ WUA	Partial	Partial	Govt.
DSI, EDI, & IIMI 1996–Turkey	Scheme and subunits	50–34,000	Municipal govts.	Full	Full	Govt.
Maurya 1993; Musa 1994–Nigeria	Distributary canal	126–271	Agency/WUA	Partial	Partial	Govt.
Wester, During, & Oorthuizen 1995–Senegal	Lift schemes	20	WUA	Full	Full	Private
Yap-Salinas 1994–Dominican Rep.	Federated	5,240–9,240	WUA	Partial	Partial	Govt.
Vermillion & Garcés-Restrepo 1996–Colombia	Irrigation district	14,000	WUA/district	Partial	Full	Govt.
Garcés-Restrepo & Vermillion 1994–Colombia	Schemes	1,000–25,000	WUA/district	Full	Full	Govt.
Johnson 1996–Mexico	Blocks	5,000–30,000	WUA	Full	Full	Govt.
Svendsen & Vermillion 1994–Washington State, USA	Irrigation district	77,000	WUA/district	Full	Full	Govt.
Farley 1994–New Zealand	Schemes	2,000	Mutual company	Full	Full	Private

[a]WUA=Water users' associations.

[b]Full operation and maintenance responsibility is defined as complete control over O&M budgets and implementation, although subject to governmental regulations. Full financing is net of general agricultural subsidies and rehabilitation.

fee payments, and authority to make contracts.

At larger scales of transfer, such as in the USA, Mexico, Japan, and Taiwan, post-transfer governance entities tend to be farmer-elected boards of directors while management entities tend to be cadres of professional staff. These countries have stronger legal systems and local institutions that are more capable of handling management at larger scales of complexity than legal systems and organizations in less-affluent countries. Irrigation organizations in industrial countries are independent legal entities, such as semi-municipalities, mutual companies, and water districts.

About half of the cases listed in table 1 involve only partial transfer of control over irrigation O&M, especially for larger systems. Full transfer of management responsibility occurs more often when the unit of transfer is an entire small- or medium-scale scheme (i.e., <2,000 hectares), especially for lift irrigation. However, full transfer of management for medium- or large-scale schemes has occurred in various countries in the Americas and Europe and in Taiwan. Government subsidies often continue in more-developed countries as well as in less-developed countries (often due to the political clout of farmers). In South and Southeast Asia, governments tend to retain partial control over O&M plans and budgets and continue to provide partial financing for O&M. It is common in this region for medium- to large-scale irrigation systems to be jointly managed, either by dividing the canal hierarchy into separate spheres of management or by creating joint agency/farmer committees to take decisions about O&M (Merrey 1996).

About half the cases cited involved transfer of full responsibility for financing the recurring costs of irrigation. Rarely is ownership of irrigation infrastructure transferred to the new management authority. The only such cases in the cited studies are the sale of public deep tube wells in Bangladesh to farmer groups and individuals and the sale of small irrigation systems to irrigators' associations in New Zealand. The transfer program in Chile has also included transfer of ownership of irrigation facilities (Gazmuri 1994). For surface irrigation, particularly in the medium- and large-scale systems, governments retain responsibility for future rehabilitation and modernization. This policy may encourage farmers to defer maintenance. Also, particularly in Asia and Africa, neither post-transfer management entities nor individual farmers have clear or measurable water rights. This uncertainty may also inhibit farmers from investing more fully in the long-term maintenance and improvement of their irrigation systems.

Financial Performance

Aspects of financial performance of irrigation that are most related to management transfer are cost of irrigation to the government, cost of irrigation to farmers, levels of management staff (often the largest component of O&M costs), levels of water charges and collection rates, budget solvency, and revenue sources. Table 2 summarizes the key findings of the literature on impacts of transfer on the financial performance of irrigation.

TABLE 2.
Reported impacts of IMT on irrigation finance.

Study, country, irrigation type	Impacts
Oorthuizen & Kloezen 1995, Philippines, SI	Reduced cost to farmers; 75% drop in budget. Fee collection rates rose from 20% to 81%.
Wijayaratna & Vermillion 1994 Philippines, SI	Revenue from water charges increased from 24% in 1979 to 60% in 1990. Reduction in agency field staff. Diversification of revenue sources.
Bagadion 1994 Philippines, LI	Budget losses converted to surpluses. Fee collection rate rose from 27% to 60%.
Svendsen 1992 Philippines, SI, LI	Decrease in frequency of deficit budgets; increase in revenue from water charges and other income. 29% drop in the operating expenditures. Decline in staff from 13% to 75%. Government subsidy dropped from ₱25 million in 1976 to zero in 1982.
Johnson & Reiss 1993 Indonesia, LI	Cost of water pumped increased five to seven times.
Johnson et al. 1995 China, SI	Per hectare cost of water to farmer rose 2.5 times. Growing importance of sideline revenue enterprises after reform.
IIMI & BAU 1996 Bangladesh, LI	O&M costs remained similar after privatization, though loss of subsidies meant increased costs to farmers. Diesel deep tube wells not financially viable without subsidy.
Olin 1994 Nepal, LI	Cost of water decreased 40–50%.
Mishra & Molden 1996 Nepal, SI	Cash and labor value raised from farmers increased to US$6.77/ha, and 77% of farmers paid water charges.
Kloezen 1996 Sri Lanka, SI	Government subsidies for O&M continued. Farmer organizations invested mainly in input provisions and marketing, not in O&M. Annual government costs decreased 33%. Diversification of revenue sources.
Pant 1994 India, LI	50% reduction in the cost of water. Budget deficits converted to surplus.
Shah et al. 1994 India, LI	50% reduction in cost of water.
Kalro & Naik 1995 India, SI, LI	Increased costs and time required for farmers. Improved rate of recovery for water charges. No decline in government expenditures for O&M.
Azziz 1994 Egypt, SI	Dramatic decline in maintenance costs. Per hectare pumping costs declined from US$68–$79 to $45–$50 after rehabilitation and IMT.
DSI, EDI, & IIMI 1996 Turkey, SI, LI	Increase in average water fee collection rate from 38% to 72% in the first year after IMT.
Maurya 1993 Nigeria, SI	Water fee collection rates rose from 50% to 90% after IMT.
Yap-Salinas 1994 Dominican Republic, SI	Water fees increased 1,500% in 8 years. Fee collection rates increased from 12% to 80%.
Vermillion & Garcés-Restrepo 1996 Colombia, SI	44% average decline in total staff. Farmer emphasis on cost-cutting. No long-term major change in cost of irrigation. Cost of water relative to production fell 27%. Diversification of revenue sources, from 10% to 20% of revenue other than fees. Budget deficits converted to surpluses.
Garcés-Restrepo & Vermillion 1994 Colombia, SI, LI	Declining trend in fee levels. Reduction in staff by 38%. Shift from deficit to surplus budgets in all study cases.
Johnson 1996; Gorriz, Subramanian, & Simas 1995 Mexico, SI	45–180% increase in water charges. Increase in fee collection rates from 15%, originally, to 80% to 100%. Shortfall in financing declined nationally from US$66 million to $41 million annually. Local self-reliance increased from 43% to 78%.
Svendsen & Vermillion 1994 USA, SI	Decrease in government staff by 86%. Farmer emphasis on cost-cutting. Volumetric charges reduced by 16%. Diversification of revenue sources. Water charge was 80% of revenue before and 67% after IMT. Farmers raised capital replacement fund.
Farley 1994 New Zealand, SI	Farmer emphasis on cost-cutting. Average operational costs declined 66%. After IMT, water charges were a quarter to a half of the pre-IMT level.

Notes: SI = surface irrigation. LI = lift irrigation.

Cost to government

One of the main reasons governments promote transfer programs is to save money by reducing the cost burden of irrigation management (Johnson 1995). Therefore it is curious that there is little information on impacts on the government. Only four of the cited studies mentioned effects of transfer on costs of irrigation to the government. Three reported a decline in government expenditures, and one reported no change. Potentially, transfer could reduce government expenditures for O&M and allow reallocation of central revenues to construction or other costs within the irrigation or agriculture sector. Or transfer could lead to a reduction in the total budget for the sector. Much depends on size of budgets, financial policy, and political will.

In the Philippines, the move to make the National Irrigation Administration (NIA) financially autonomous and to turn over irrigation system management by 1990 gave the government annual savings of US$12/ha from cash and in-kind contributions in systems where transfer was partially or fully implemented (Bagadion and Korten 1991). Revenues from irrigation fees collected by water users' associations, which partially or fully took over irrigation management, constituted 24 percent of NIA's total revenue in 1979 and 60 percent by 1990 (Wijayaratna and Vermillion 1994). In the early stages of the transfer program in the Philippines, the government's expenditures for irrigation O&M fell from ₱25 million in 1976 to zero by 1982. Subsequently, however, limited subsidies were reintroduced (Svendsen 1992).

Kloezen (1996) shows that the rise of the participatory management policy in Sri Lanka lowered government irrigation O&M expenditures from approximately US$14.80/ha in 1985 to $6.50/ha in 1994. Pant (1994) indicates that in Uttar Pradesh, India, the transfer of a typical public tube well to farmer management reduced government subsidies to the tube well system from US$876 before IMT to $656 afterward, or by 25 percent. In the West Gandak scheme in Nepal, government expenditures for maintenance declined from US$6.65/ha to $4.06/ha after transfer (Mishra and Molden 1996).

The small-scale irrigation turnover program in Indonesia includes about 70 percent of all public irrigation systems and 21 percent of the total irrigation design area. By the time the program has been fully implemented, the government will annually save an estimated US$13.5 million in O&M costs (Vermillion and Johnson 1990). Vermillion (1989) calculated the budgetary effect of the planned policy of reallocating funds from small-scale systems to underfunded medium- and large-scale systems. In the Sumedang Section of the West Java Provincial Irrigation Service, which has numerous small-scale systems and only a few medium- or large-scale ones (i.e., over 500 hectares in service area), turnover would permit transfer of all O&M funds for small-scale to medium- or large-scale systems, which would allow an increase in O&M expenditures on the larger systems from a pre-turnover level of about US$10/ha to a post-turnover goal of $15/ha, to prevent deterioration of larger systems.

As a result of Mexico's large-scale management transfer program, annual government subsidies for irrigation O&M fell from US$40 million in 1989 to zero by 1993, at which time approximately 2.4 million hectares of service area had been transferred to farmer management (Johnson 1996). Gazmuri (1994) asserts that at a macro level in Chile, irrigation management transfer had a positive effect on redistribution of wealth from the wealthier (those who had water) to the poorer. After transfer, public funds previously spent on irrigation were diverted to poverty-alleviation programs. However, no data are available.

There is little evidence on the effect of management transfer policies on overall government spending in the water or agriculture sectors of developing countries. Most studies dealing with the issue only document government spending for O&M, especially at the scheme level. No attempts have been made to determine whether savings from decreased government spending for irrigation O&M are being diverted to new construction, rehabilitation, or other uses within the sector, or to other sectors, or used to permit an overall shrinking of government expenditures. There is a need for studies to examine sector-level impacts of transfer policies and test the proposition that transfer actually reduces the cost of irrigation to the government, particularly in the long term.

Cost to farmers

The literature suggests that where significant subsidies that existed before transfer are dropped, the cost of irrigation to farmers may rise substantially. Where there is little or no change in subsidies, transfer may lead to a decrease in irrigation costs to farmers. High-cost systems, such as pump irrigation, are especially likely to significantly increase the cost of water to farmers. Lift irrigation systems seem to be the most financially vulnerable after transfer. Two studies reported that tube wells were not financially viable after transfer without government subsidy (Johnson and Reiss 1993; IIMI and BAU 1996).

In Senegal, project reports indicate that after transfer of lift schemes supervision of pumps by farmer-hired staff improved, which reduced overpumping. Due to a loss of government subsidies, however, water charges rose 200 to 400 percent, despite a 50 percent decrease in the cost of electricity for pumping (Meinzen-Dick et al. 1997). More broadly, privatization of irrigated agriculture in the Senegal River valley (irrigated by river lift pump schemes) led to a 78 percent increase in the cost of rice production for farmers between 1980 and 1993 (in constant 1980 prices), due primarily to discontinuance of subsidies for credit, input provision, and irrigation. The price of rice (in 1980 dollars) rose by 65 percent during the period, from approximately US$0.11/kg in 1980 to $0.19/kg in 1993 (Wester, During, and Oorthuizen 1995; Meinzen-Dick et al. 1997).

After turnover of pump schemes to farmer groups in Indonesia, water charges to farmers increased fivefold to sevenfold, because government subsidies were lowered (Johnson and Reiss 1993).

In India, where the cost of electricity for pump irrigation is heavily subsidized, Pant (1994) notes that a consequence of turnover of a public tube well to farmer management in Uttar Pradesh was more efficient pump use, which brought about a reduction in water costs from US$2.70/ha to $1.20/ha in *kharif* (summer season) and from $6.20 to $3.20/ha for *rabi* (winter season). The number of irrigations increased from two to three. However, since data were only available for 2 years, it was impossible to confirm a trend In Gujarat, in a post-transfer comparison of tube well system performance for 30 sample wells, Shah et al. (1994) report that, after turnover of public tube wells, irrigated area increased 30 to 400 percent in sample systems, and the price of water fell by 40 to 50 percent.

In a before-and-after comparison in a 180-hectare block of a medium-size system in Southern Luzon, the Philippines, Oorthuizen and Kloezen (1995) found that the average total annual expenditures for

O&M were US$31,196 during the 4-year period before transfer and $7,696 (in 1982 dollars) during the 4 years following transfer—a 75 percent reduction. Studies in the USA (Svendsen and Vermillion 1994), Colombia (Vermillion and Garcés-Restrepo 1994), and the Philippines (Lauraya and Sala 1994) report an engineers' concern that the tendency for farmers to push cost-cutting to the extreme after IMT may accelerate system deterioration.

Reforms leading to local financial and managerial self-reliance in the Bayi and Nanyao irrigation districts in Hebei, China, resulted in increases in annual surface water costs (in 1991 dollars) in Bayi from US$13/ha in 1984 to $36/ha in 1992 and in Nanyao from $24/ha in 1984 to $60/ha in 1992 (Johnson, Svendsen, and Zhang 1994).

From a sample study of six irrigation districts in Mexico, Gorriz, Subramanian, and Simas (1995) report an immediate and consistent nominal increase in water fees after transfer of between 45 percent and 180 percent (ranging from US$2.25 to $7.79/1,000 m^3) in 1994. Fees also increased modestly in real terms relative to the cost of production (Johnson 1996).

Transfer of the Coello and Saldaña systems in Colombia was accompanied by a significant reduction in government subsidies. The area-based water fee (in constant 1988 dollars) rose from US$1.50/ha in 1967 to $8.68/ha at transfer in 1976 and then declined to $5.54/ha in 1993. Conversely, the volumetric water fee was declining before IMT (from $22/100 m^3 in 1967 to $13/100 m^3 at transfer in 1976), but reversed to a modest rising trend afterward, reaching $16/100 m^3 in 1993. The overall cost of water rose somewhat after transfer as a result of a policy to raise the proportion of the charges that are based on the volume of use. From a broader perspective, the total cost of water relative to the cost of rice production, 4.4 percent in the 1950s, was low anyway, and it fell still further after transfer—to 3.3 percent in Coello in 1993 and to 3.1 percent in Saldaña (Vermillion and Garcés-Restrepo 1996).

Comparative post-transfer evidence about reduced costs of irrigation as a result of transfer also comes from New Zealand where the government privatized 49 irrigation schemes in the early 1990s through the outright sale of the districts. Of these, 47 were sold to farmer groups. Farley (1994) reports that water charges on privatized schemes are one-half to one-quarter the costs on government "pre-privatized" schemes, even though government schemes still retained subsidies for O&M costs while privatized schemes paid the full cost of operations. This is attributed to privatized schemes cutting operational costs by 66 percent, on average, reducing overhead costs, and designing simpler repair and maintenance work. In the Hawea system, annual water charges were US$24/ha before privatization and $10/ha afterward. The Greenstreet system was privatized in 1990, and by 1994 it had an annual water fee of $2.10/ha and cash reserves of $3.30/ha, compared with average water fees exceeding $7.00/ha and average debt loads of $30/ha for government schemes in the same region. The Bannockburn system, privatized in 1990, had an annual water charge of $10.80/ha with no debts, while government schemes in the same region had water charges ranging from US$25 to US$47/ha with large debts.

In the USA, farmers in the Columbia Basin Project were already paying close to the full cost of O&M before the transfer (except for subsidized electricity for pumping water out of the Columbia Basin, which continued after transfer). In this case, IMT also prompted a reversal in trends in water charges, beginning with a rising trend followed by a downward trend after transfer. Water charges rose from US$159/ha in 1961 to an annual average of $198/ha in 1969–73 and then gradually fell (in real terms) to $122/ha by 1989, constituting an average decline in assessment rates of 22 percent and a decline of 16 percent in volumetric charges (from $83/ha-m to $70/ha-m) between the pre- and post-transfer periods (Svendsen and Vermillion 1994).

The studies were divided in reporting changes in cost of irrigation to farmers. Eight studies reported reduced costs, seven reported increased costs, with changes occurring in both directions in surface and lift irrigation schemes. Eight studies noted a decline in the overall cost of irrigation; only one reported an increase. Costs to farmers are most likely to increase in lift irrigation schemes or in other schemes where government subsidies are removed (such as in Indonesia, Bangladesh, and Senegal). However, increased costs of irrigation to farmers may be offset by an even more rapidly rising value of production (as was reported in studies on IMT in Colombia and the USA).

There is a tendency for studies to rely either on data about costs of irrigation to the government or costs of irrigation to farmers, without combining the two to derive the total cost of irrigation. Both are needed to get a complete picture on financial impacts of management transfer.

Management staff

In countries where transfer is intended to reduce government expenditure, reports generally indicate that irrigation agency staff size diminished following transfer, either at system or administrative levels. This decline is often gradual however, as governments wait for staff to retire. In the Philippines, the number of employees of the NIA at regional and system levels throughout the country was reduced, and the service area per staff member improved from 38.5 ha/staff in 1976 to 100 ha/staff by 1985 as a result of management transfer. Oorthuizen and Kloezen (1995) report that turnover of a system in Southern Luzon led to a decrease in agency staff from 24 in 1982 to only 6 in 1987, or a change in average service area per staff member from 75 ha/staff in 1982 to 300 ha/staff in 1987. Consequently annual operating expenses dropped 60%. Similar declines in government staff and operating expenses were reported by Svendsen (1992) in a sample of transferred systems. The decline in NIA staff was part of a policy under which positions were not filled after staff retired. The requirement that NIA become self-financing motivated the agency to reduce costs. It is not clear from these reports how many new management staff members, sponsored by the farmer organizations, may have been hired to replace former agency staff members.

In the Columbia Basin Project in the USA, there were 612 Bureau of Reclamation staff members in 1969, the year of transfer. By 1985 only 83 remained. Staff declines were even steeper in the Irrigation and Land Management Division where staff numbers dropped from 297 in 1969 to only 22 in 1985 (Svendsen and Vermillion 1994). Staff members were either rehired by the districts, transferred to other systems, or retired. Again, data are not available on how the pre-transfer numbers of agency staff members compared with the post-transfer numbers of non-agency staff members.

Studies on transfer in Mexico and Colombia have reported data on total staff (agency or farmer-sponsored) before and after transfer. In Mexico, Johnson (1996) reported total irrigation system staff fell slightly after transfer but government staff dropped from 7,742 before transfer to 4,450 by 1993. In Colombia, the 10 irrigation systems transferred to farmer management between 1990 and 1994 had an average decline of 44 percent staff, which produced an average increase in area served per district-level staff of 211 percent. Coello and Saldaña, which were transferred in 1976, together had 300 district staff members in 1975 and 189 staff members in 1993. In 1975, an average of 62 ha/staff were served, whereas in 1993, 147 ha/staff were served (Garcés-Restrepo and Vermillion 1994).

Five of the cited studies reported reductions in the number of staff after transfer (three of which apparently referred only to numbers of agency staff). None reported increases. This is because, in most cases, transfer programs are part of a government policy to reduce spending in the irrigation subsector. However, some studies that rely only on government data about staffing may overlook the hiring of staff by farmer organizations. The failure to include data on both agency and farmer organization staff can give an exaggerated impression of declines in the total irrigation management staff.

Generally, farmer-sponsored organizations are unwilling to hire or retain "excess" staff members, which governments in developing countries often do. When the government policy is to reduce or eliminate irrigation management staff when carrying out transfer programs, the government usually relocates staff members into systems that are not being transferred (as in Indonesia and Sri Lanka), does not fill posts when staff members retire (as in the Philippines), encourages farmer associations to hire former agency staff members after transfer (as in Colombia), transfers staff members into non-O&M activities, such as construction of new systems (as in Turkey), or revises the agency's overall mandate, such as in the USA where the Bureau of Reclamation shifted into environmental regulation after the end of the construction era.

Fee collection rates

Evidence on impacts of transfer on fee collection rates is generally based on post-transfer data or simple before-and-after comparisons. I am not aware of any time-series trend analyses or with-and-without comparative samples. In the Philippines, Bagadion (1994) reports the average annual irrigation fee collection rates in the Libmanan-Cabusao pump irrigation system to have been 27 percent for 1982–88 and 60 percent for the post-transfer period 1990–92. In another study in a NIA system in southern Luzon, fee collection increased from 20 percent before transfer to 81 percent in 1989, after transfer (Oorthuizen and Kloezen 1995). Mishra and Molden (1996) also report a substantial rise in collection rates and overall labor and cash raised by farmers after transfer in Nepal.

In the On-Farm Water Management Project in the Dominican Republic, despite a 1,500 percent increase in water fees between 1985 and 1993 as a result of management transfer, fee collection rates rose from 12 percent before IMT to 80 percent afterward, reportedly due to significant improvements in the reliability of water delivery (Yap-Salinas 1994; Hanrahan 1990). In Mexico, water fee collection rates rose from only 15 percent before transfer to 80 to 100 percent afterward. Collection rates are generally 60 to 70 percent during the first transitional year and above 80 percent by the second year (Gorriz, Subramanian, and Simas 1995, 32). This high rate results largely from the districts' requirement that farmers pay fees before water is delivered (Johnson 1996).

In China, total water fee collection throughout the country increased from

US$51 million in 1984, when reforms were just starting, to $415 million in 1992 (in 1994 dollars), partly because collection rates increased from 30 percent in 1984 to 70 percent in 1991. 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 percent before IMT in 1989 to more than 90 percent in 1990 after farmers became involved for the first time in collecting the fee. Following the approach of NIA in the Philippines, farmer organizations in the Kano project are granted rebates for 10 to 15 percent of fees collected if the total collection rate exceeds 80 percent (Maurya 1993). Aside from the common rise in fee collection rates, what these cases of transfer have in common is that farmer organizations became involved in collecting the fees, they received incentives for collecting over a certain rate, and they gained more voice in determining how the fees were to be spent.

In summary, 10 studies reported significant increases in water fee collection rates, none reported decreases. Increases were generally substantial, from the 10 to 30 percent range to the 80 to 100 percent range. Increases in collection rates were reported to have been facilitated because farmers were more satisfied with the irrigation service and because the post-transfer farmer organization was better able to collect fees from farmers (often with the intervention of village authorities).

Budget solvency

Financial solvency after transfer depends on the level of subsidy that is removed as well as on the capacity of the post-transfer managing organization to cut costs and raise additional revenue. Six of the studies reported a shift from deficit to surplus budget balances for irrigation systems after management transfer; none reported a trend toward more deficits. This is partly because post-transfer management entities lack sufficient reserve funds to operate at a deficit in any year.

In their study in southern Luzon, the Philippines, Oorthuizen and Kloezen (1995) report that the system's annual budget deficit declined from an average of US$19,178 during 1982–85 to $554 during 1986–89, the first 4 years after transfer. This improvement largely occurred because farmers cut annual expenditures by 25 percent and increased fee collection from 20 percent to over 80 percent. Pant (1994) reported annual losses of US$876 before transfer of a public tube well in Uttar Pradesh, India, that changed to consistent surpluses after transfer. Bagadion (1994) reported that the Libmanan-Cabusao pump irrigation system in the Philippines was able to convert an annual average loss of US$42,218 for 1981–89 into an annual average surplus of $42,880 after transfer, during 1990–92.

In the transfer of 3.3 million hectares served by large irrigation systems in Mexico, the annual national shortfall in meeting irrigation district costs fell from US$66 million in 1989 to $41 million in 1993, when transfer was 80 percent completed. The share of total irrigation system O&M costs, which are financed by farmers or other local sources (as opposed to government funds), rose from 43 percent in 1989 to 78 percent in 1993. These figures, however, should be compared with data on the total cost of irrigation management, both to the government and to the farmers. The absence of district reserve funds, a fixed base fee, and government subsidies means that the districts will be financially vulnerable in the event of drought (when there is no water to sell) or when major repairs or rehabilitation are needed (Johnson 1996).

Prior to transfer in 1976, Coello and Saldaña districts, Colombia, had budget deficits in most years. During the 16 years after transfer, Coello had a balanced or surplus budget, whereas Saldaña (which had higher costs because of a substantial amount of necessary dredging and desilting) had deficits during 8 of the years (Vermillion and Garcés-Restrepo 1996). Garcés-Restrepo and Vermillion (1994) report that all irrigation districts transferred to farmer organizations in Colombia between 1990 and 1994 had budget deficits for 2 to 4 years before transfer and had surpluses during the first 2 to 4 years measured afterward. Decreases in expenditures (mainly due to staff layoffs) and increases in revenue (primarily from increases in water charges) accounted for the improved financial conditions.

In summary, the most typical financial impacts of management transfer are lower overall costs of irrigation (including decreased government spending for irrigation O&M), an increase in the cost of irrigation to farmers (especially in lift schemes), and higher rates of collection of charges from farmers. Not surprisingly, the financial viability of post-transfer organizations is more apparent in areas where agricultural and economic productivity of irrigated agriculture is high (such as in the USA, Mexico, Chile, and Colombia). The most problematic financial situations appear to be where the cost of irrigation to farmers is already relatively high (such as in lift schemes in India, Bangladesh, and Indonesia) and where either the government is dropping a subsidy or where the profitability of agriculture is not high. The literature provides almost no data with a time frame long enough to assess the financial sustainability of management after transfer. This is a major issue, particularly since few post-transfer management organizations raise a capital replacement fund, and policies about who will be responsible for future rehabilitation and modernization are normally quite unclear.

Diversity of revenue sources

Five of the cited studies reported a tendency to diversify revenue sources after management transfer. Usually this occurs where the post-transfer organization has full responsibility for financing the costs of irrigation and where farmers exert pressure to keep water fees as low as possible (as in Colombia, China, and the USA). In these cases, diversified revenue collection is a strategy to cross-subsidize irrigation costs after government subsidies have been discontinued. Revenue diversification also occurs where post-transfer organizations expand their mandate beyond O&M and into the economic productivity of irrigated agriculture, as was reported in the Philippines (Wijayaratna 1993) and Sri Lanka.

In the Coello system in Colombia, irrigation district revenue from sources other than water charges increased from 10 percent of revenue in 1983 to 20 percent by 1992 (Vermillion and Garcés-Restrepo 1994). In the 5,000-hectare Kaudulla scheme in Sri Lanka, farmer organizations took over management of distributary canals in 1992 and quickly federated to the main system level, diversifying revenue sources including collection of membership, seasonal, and shareholder fees; provision of fertilizers and agro-chemicals; rice marketing; tractor rental; and interest from small loans. Within 2 years the organization had raised US$8,335 from profits on input sales totaling $200,000, with a net profit rate of 4 percent.[1] Through group rice marketing, the organization also obtained a selling price of

[1]However, the 4 percent net profit rate is overshadowed by an agricultural credit interest rate of 9 percent and an annual rate of inflation of approximately 11 percent.

approximately $0.01/kg above the market rate (Kloezen 1996).

The reforms in China during the 1980s promoted the 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 percent 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 employed by the district to work in the "diversified management division." By 1994, 30 percent of the Bayi district revenue was from its sideline enterprises (Vermillion et al. 1994).

Following management transfer, irrigation districts in the Columbia Basin Project, USA, 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 percent of revenue. It declined to 67 percent of revenue by 1989 as the districts developed seven mini-hydropower stations and engaged in water selling contracts and other income-generating activities.

Quality of Operations and Maintenance

Much of the literature supporting management transfer asserts that it improves the quality of O&M of irrigation systems. The most common kind of evidence employed is qualitative statements by project officers, farmers, researchers, and rapid appraisal visitors, often based on chance encounters or group interviews with farmers. Project studies in the Philippines, Sri Lanka, Nepal, and India have reported farmer satisfaction with improved water delivery service and equity after IMT (Meinzen-Dick, Manzardo, and Reidinger 1995; Uphoff 1992).

Table 3 summarizes key findings of literature on the results of IMT on the performance of irrigation O&M. Seven studies reported that equity of water distribution improved after transfer; one study on the Philippines reported that it became worse (Oorthuizen and Kloezen 1995). Seven studies reported an increase in service area after transfer. In Turkey, the average service area expanded 20 to 40 percent only 1 year after transfer (DSI, EDI, and IIMI 1996). Three studies reported lower water consumption per hectare (two of the studies were on lift schemes, in Vietnam and Nepal). Four studies reported improvements in water adequacy after transfer. Two reported a worsening situation in water distribution after transfer in lift schemes in Sudan and Bangladesh, due to the failure of the farmer's organizations to develop and function properly (Samad and Dingle 1995; IIMI and BAU 1996).

Reports of experiences in Mexico (Gorriz, Subramanian, and Simas 1995), Colombia (Vermillion and Garcés-Restrepo 1994), and the USA (Svendsen and Vermillion 1994) indicate farmer perceptions that O&M staff have become more responsive to farmers after turnover. Maintenance is reported to be more responsive to farmers' priorities after turnover in Chile (Meinzen-

TABLE 3.
Reported impacts of irrigation management transfer on O&M.

Study, country, type of irrigation	Operations	Maintenance
Oorthuizen & Kloezen 1995 Philippines, SI	Water distribution became less equitable.	Worsened.
Wijayaratna & Vermillion 1994 Philippines, SI	Improved water distribution equity; expansion of dry-season irrigated area.	n.a.
Bagadion 1994, Philippines, LI	No increasing trend in service area.	n.a.
Svendsen 1992 Philippines, SI, LI	Equity of water distribution improved and 7% expansion of benefited area in the dry season.	n.a.
Johnson & Reiss 1993 Indonesia, LI	n.a.	Deterioration of pump sets accelerated.
Nguyen & Luong 1994 Vietnam, LI	Water consumption per hectare dropped 36%. Area irrigated increased 71%.	n.a.
Johnson et al. 1995, China, SI	Reduction in water duty from 11,000 m^3 to 4,500 m^3.	n.a.
IIMI & BAU 1996 Bangladesh, LI	Declining numbers of farmers reporting adequate and timely water delivery.	Higher breakdown rates in smaller pumps; spare parts and repair easier.
Olin 1994, Nepal, LI	Drop in water consumption by 50%.	n.a.
Rana et al. 1994, Nepal, SI	Irrigation discharge increased fourfold.	n.a.
Mishra & Molden 1996 Nepal, SI	Inflow increased from 2.2 m^3/s to 7.9 m^3/s (26%–93% of design capacity)	n.a.
Kloezen 1996, Sri Lanka, SI	Quality of water distribution did not change.	n.a.
Uphoff 1992 Sri Lanka, SI	Improved equity of water distribution.	Maintenance activity and investment increased.
Pant 1994, India, LI	Reduced average irrigation time.	Maintenance work increased.
Srivastava & Brewer 1994 India, SI	Improved equity; 27% more water to tail end; 20% increase in irrigated area in the dry season.	More maintenance activity.
Rao 1994, India, SI	Improved equity of water distribution.	n.a.
Kalro & Naik 1995 India, SI, LI	Adequacy and reliability of water distribution improved, as reported qualitatively.	n.a.
Azziz 1994, Egypt, SI	Reduced irrigation time; better water adequacy.	n.a.
Samad & Dingle 1995 Sudan, LI	Timeliness and water adequacy worse in schemes turned over.	n.a.
DSI, EDI, & IIMI 1996, Turkey, SI, LI	In first year, area served increased 20–40%.	n.a.
Wester, During, & Oorthuizen 1995 Senegal, LI	Expansion of areas irrigated.	Deterioration of pump sets accelerated.
Maurya 1993; Musa 1994 Nigeria, SI	Improved equity; 12% more water reached middle and tail reaches.	Increased maintenance activity.
Yap-Salinas 1994 Dominican Republic, SI	Delivery efficiency improved 25–30%.	n.a.
Vermillion & Garcés-Restrepo 1996, Colombia, SI	More responsive operations. Water adequacy satisfactory. 40–45% of farmers say operations improved. Temporary inefficiencies after IMT. Expansion of area irrigated.	Good maintenance; 92–98% of farmers report quality of maintenance has not changed.
Johnson 1996, Mexico, SI	No change in water delivered per hectare or in area irrigated.	n.a.
Svendsen & Vermillion 1994 USA, SI	More responsive operations. Efficiency did not change. Equity improved slightly.	Good but slight declining trend detected.

Notes: SI = surface irrigation. LI = lift irrigation. n.a.= not available.

Dick et al. 1997). However, assessments of farmer perceptions through participatory appraisal and group interview methods may not be reliable for making generalizations or assessing "external validity;" their value is more in eliciting farmer performance criteria and examining local dynamics (Gosselink and Strosser 1996; Pretty 1995).

Post-transfer reporting of change is common. Oorthuizen and Kloezen (1995) report on a case of IMT in Southern Luzon, the Philippines, where financial autonomy prompted farmers to take cost-cutting measures that negatively affected water distribution and maintenance, as reported by farmers and agency officials. Svendsen and Vermillion (1994) for the USA and Vermillion and Garcés-Restrepo (1996) for Colombia report a similar tendency of farmer-elected boards of directors to cut costs to the point of compromising O&M performance.

Operations

In a study of two systems turned over to farmer management in central Colombia in 1976, Vermillion and Garcés-Restrepo (1996) obtained survey data from 93 farmers sampled from the upper and lower reaches of the Coello and Saldaña irrigation systems. In the Coello system, where relative water supply was reported to be approximately 1.4 (Levine 1982) and a variety of crops is planted, 45 percent of farmers interviewed said water delivery was "always enough" while 32 percent said it was "enough most of the time." Forty percent judged that management in general had "improved" after IMT; 53 percent said it had "not changed much." In Saldaña (where relative water supply is in the order of 1.8 and only rice is planted), 59 percent said water delivery was "always enough" and 31 percent said it was "enough most of the time." Forty-five percent stated management had "improved," 35 percent said it had "not changed much," but 25 percent said it had "worsened." Farmers were asked to compare the pre-transfer and post-transfer situations and their perceptions obtained 19 years after transfer constitute a rather weak and possibly unbalanced before-and-after comparison

Contrary to the common notion that farmers generally want complete control, only 29 percent of farmers in the Coello and Saldaña districts wanted INAT (National Institute of Land Development), the irrigation agency, to withdraw completely; 48 percent wanted the agency to remain partially involved in management (mainly to protect against abuses by powerful farmers and to help settle disputes); and 21 percent preferred the agency to resume management.

Before-and-after time-line data on annual irrigation supply in Coello show a long-term declining trend from 1,300 mm/ha in 1975 (the year before transfer) to 400 mm/ha in 1991. The smaller irrigation supply per hectare is due to expanded area and declining river flows at the source. Under these circumstances, it is notable that management was able to keep farmers relatively satisfied with water adequacy after the transfer. Vermillion and Garcés-Restrepo (1996) report current water use efficiencies to be 73 percent in Coello and 57 percent in Saldaña.

In a pilot IMT project in the Kano River Irrigation Project in Nigeria, newly organized farmers changed water distribution schedules to discontinue nighttime irrigation and improve head/tail equity. This increased the volume of water reaching middle and tail reaches of distributary canals by 12 percent within the season the changes were introduced (Musa 1994). On the basis of post-transfer farmer interviews and observations of water distribution, Kloezen (1996) reports that turnover of distributary canals to farmer organizations in Sri Lanka did not change water distribution practices at the field-channel level, because agency staff were still involved in management, canals had been recently rehabilitated and were in good condition, water was abundant, and the attention of the farmer organizations was more on agricultural production than on irrigation.

Comparisons of performance between systems with-IMT versus without-IMT are rare in the literature. Most present either post-transfer or before-and-after data. Nguyen and Luong (1994) conducted a post-transfer study on the effects of management transfer of a medium-size pump scheme along the Red River in Vietnam. They report that irrigation efficiency (i.e., ratio of water delivered to diverted) increased from 50 percent to 81 percent and water consumption decreased from 8,000 m^3/ha to 5,120 m^3/ha (a 36% drop) over a 4-year period after IMT. In another post-transfer report, irrigation efficiency in the Azua system in the Dominican Republic increased 25 to 30 percent after management transfer under the On-Farm Water Management Project (NESPAK 1994).

Before-and-after comparisons are more reliable than post-transfer data because they help rule out the possibility of trends having begun before IMT and continuing into the post-transfer period. These tend to be simple, short-term comparisons. They lack a time line long enough to confirm the existence of an interrupted pattern at the time of transfer. In a simple before-and-after comparison, Pant (1994) reports that the turnover of a public tube well in Uttar Pradesh, India, increased water and electricity use efficiencies by reducing the average duration of pumping time per irrigation in the kharif season from 42.4 and 39.3 hr/ha in the 2 years before turnover to 13.4 and 22.8 hr/ha in the first 2 years after turnover (1993–94). In Egypt, Azziz (1994) reports a dramatic and consistent reduction in average irrigation time after management transfer in a sample of *mesqa*s (small storage/shallow-lift pump turnouts) from an average of 15.0 to 17.5 hr/ha before IMT to 5.0 to 7.5 hr/ha after IMT. However, no comparison with non-mesqa or nontransferred turnout groups is given, so it is not clear whether similar improvements occurred in other areas over time as well.

Regarding impacts on equity, Rao (1994) compares water delivery in three minor commands in the Sreeramsagar project in Andhra Pradesh, India, which irrigated maize, turmeric, and groundnut. One year after management transfer, he recorded an improvement in equity among the three blocks. The blocks received 2,186 m^3/ha, 4,387 m^3/ha, and 12,065 m^3/ha before transfer as compared with 7,416 m^3/ha, 7,307 m^3/ha, and 10,329 m^3/ha, respectively, after transfer. However, this was in a system where total irrigation supply exceeded gross demand by more than 200 percent.

Transfer of management for the 12,000-hectare Paliganj Distributary Canal in the Sone Command in Bihar, India, to a federated farmer organization in 1989 resulted in a new rotational arrangement in the dry season, policing of breaches, and the 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. In 1988, 17 percent 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 of the canal, 21 percent of water entering the canal reached gate 10 and for the first time on record, water reached the tail end of the canal (Vermillion 1992). Before transfer, 31 percent of the canal command area located in the tail end received an average of 10 to 12 percent of the total canal water. During 3 years after the transfer, 18 percent of the available canal water reached the tail area (Srivastava and Brewer 1994).

Long-term time series data on irrigation efficiencies before and after management devolution, or IMT, 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/ha in 1972 to $31.84/ha in 1993 (in 1991 dollars) helped bring about a decline in water duty from 11,000 m^3/ha in 1973 to only 4,500 m^3/ha in 1993. This trend was part of a larger policy to reduce water consumption per hectare and cannot be attributed only to the reforms, which occurred in the mid-1980s. But it is likely that the more active involvement of farmers and village governments in irrigation management helped facilitate the decline in water consumption per hectare.

The annual discharge into the Nanyao system increased from 28 million cubic meters in 1972 to about 60 million cubic meters in 1982 (when the commune system collapsed) and then steadily declined to 20 million cubic meters in 1993. The same peak and decline trend occurred in the Bayi system, where total annual discharge (from surface water and groundwater) rose from 6 million cubic meters in 1972 to 34 million cubic meters in 1980, then fell to 17 million cubic meters in 1993. The average annual number of surface irrigations in Nanyao decreased from three in 1973 to two in 1992 and in Bayi from six in 1973 to four in 1992—after peaking in 1982 in both systems. The introduction of the pay-for-service system at main canal, village, and farmer levels undoubtedly influenced the decline in water diverted and delivered per hectare after reforms in the mid-1980s.

Two studies that employ extended before-and-after comparisons report constant or small temporary drops in irrigation performance for 2 to 5 years after transfer. In a study of the large-scale Columbia Basin Project in the USA, Svendsen and Vermillion (1994) report a relatively constant overall irrigation efficiency (system-wide potential evapotranspiration divided by aggregate net supply) of about 0.46 to 0.48 after IMT in 1969. Conveyance efficiency dropped immediately at transfer from 0.70 to 0.65 and continued to decline to 0.62 by 1989 (attributed to deterioration stemming from the cost-containment policy of the farmer board). Total system irrigation supply per hectare rose substantially for 2 years after transfer and then dropped 10 percent over 15 years, from a high point of 0.77 ha-m/ha in 1971. The rise in total irrigation supply per hectare after transfer occurred despite declining water delivery per hectare at farm turnouts during the same time (as a result of greater use of sprinklers and a shift to crops that consume less water), indicating a temporary lapse in main system management. Over the long term since transfer, farmers generally reported no change in the quality or timeliness of irrigation delivery.

In Colombia, Garcés-Restrepo and Vermillion (1994) report a 3-year leveling off of long-term increases in irrigated area at the time of management transfer in the Coello district, which was then followed by further increases. They attribute this to temporary inefficiencies during adjustment to new management.

In their study of the Columbia Basin Project, Svendsen and Vermillion (1994) developed an equity index for comparing relative water supply between three branches in the system, each managed by a different farmer irrigation district. The study showed no change in equity for 6 years after the transfer, followed by a gradual improvement. The index was 1.15 (i.e., a 15% difference between branches with the highest and lowest relative water supply) for 1969–75. The index then declined to 1.03 to 1.10 in the late 1970s and early 1980s (i.e., equity had improved).

In a post-transfer case study of a system in the terai of Nepal, Rana et al. (1994) report that irrigation discharge increased fourfold after substantial transfer-related desilting and repair work was done by farmers. Without comparisons with other systems that did not have physical repair work or that did not have IMT, it is impossible to distinguish between the effects of physical repairs and the effects of management transfer. Mishra and Molden (1996) found that on the West Gandak scheme in Nepal inflow increased from 2.2 m^3/s to 7.9 m^3/s after transfer, relative to a design capacity of 8.5 m^3/s. However, improvement is primarily explained by the effects of a major desiltation, which was part of the transfer program. Without a long-term comparison before and after transfer, it is difficult to know whether similar levels of discharge might have been achieved before the transfer. In the Bhairawa-Lumbini groundwater irrigation project in Nepal, it is reported that farmers became cost-conscious after the transfer and reduced waste of water, resulting in a 50 percent drop in water consumption per hectare even though the price of water was reduced by 40 to 50 percent at the same time (Olin 1994).

Maintenance

Regarding system maintenance, studies on lift irrigation in Indonesia and Senegal report an acceleration in deterioration of pump set equipment for lift irrigation after turnover of equipment and networks to management by farmer organizations. In Indonesia, this was attributed to lack of local knowledge, skills, and spare parts (Johnson and Reiss 1993). 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 (Wester, During, and Oorthuizen 1995). Although the Indonesia study substantiated the finding with data on pump operating hours and ratios of irrigated versus design area, the Senegal study relied only on reports of breakdowns.

In their study in Colombia, Vermillion and Garcés-Restrepo (1996) conducted a detailed post-transfer maintenance survey of the Coello and Saldaña irrigation systems in 1994. They found that 68 percent of all irrigation structures for conveyance and distribution in Coello were fully functional and 30 percent were partially functional. In Saldaña, 48 percent of all structures were fully functional and 44 percent were partially functional. In Coello, 80 percent of farmers interviewed in a stratified random sample stated that maintenance of irrigation structures was the same after IMT as before; 15 percent said it was better afterward. In Saldaña, 70 percent said it was the same; 10 percent said it was better. The post-transfer study design provides evidence that satisfactory performance can be sustained for at least 25 years after transfer, but it does not show whether performance levels rose or fell as a result of transfer.

For their study of the 230,000-hectare Columbia Basin Project, USA, Svendsen and Vermillion (1994) relied on secondary data about maintenance from technical audits conducted every 2 years by the Bureau of Reclamation.[2] Between 1973 and 1977, there were only five “category 2” recommenda-

[2]The Bureau of Reclamation regional offices conducted technical audits of systems after transfer. These audits involved on-site inspection of all physical structures and the examination of finances and management practices. Maintenance assessments were rated according to the degree of urgency of the need for repairs.

tions by auditors, which stated “important preventative maintenance needed.” By 1980–84 there were 20 such recommendations. During the entire post-transfer period, no “category 1” recommendations (“urgent remedial maintenance required”) were received. This suggests that cost-cutting measures may be compromising the quality of maintenance over time, while still holding the line against breakdowns.

In short, five of the cited studies reported that after transfer of management the irrigation structures deteriorated and one study reported that their condition remained the same (Vermillion and Garcés-Restrepo 1996). Four studies (in India, Sri Lanka, and Nigeria) reported an increase in maintenance investment and activity after transfer. None of these were among the studies that reported deterioration in the condition of structures. Accelerated deterioration of infrastructure is most often reported in pump irrigation schemes, where government subsidies are withdrawn (such as in Senegal, Bangladesh, and Indonesia). Favorable maintenance conditions are reported in locations where the economic value of irrigated agriculture is relatively high (such as in the USA and Colombia).

Most evidence on impacts on the performance of irrigation O&M is based on either qualitative reports or post-transfer data for only 3 to 5 years. The limited data that exist mostly indicate either positive or no effects on O&M performance, though there is some evidence that a temporary downturn in performance sometimes occurs immediately after IMT. Post-transfer reductions in the amount of water delivered per hectare are almost entirely seen either in lift schemes or where water is charged volumetrically.

There is another problem embedded in several of the attempts to attribute improvements in operational performance to management transfer. In many countries (such as the Philippines, Nepal, Sri Lanka, and Indonesia) transfer programs include physical rehabilitation or repair of irrigation infrastructure. In such cases, improvements in operational performance may be more the result of physical improvements than of management reform. Studies by Wijayaratna and Vermillion (1994) on the Philippines and by Mishra and Molden (1996) on Nepal both report improvements in operational performance where transfer and rehabilitation occurred together. In such cases, research designs should include comparisons with systems that have been transferred but not rehabilitated or systems that have been rehabilitated but not transferred.

Agricultural and Economic Productivity

The relationship between management transfer and agricultural and economic productivity is less direct than the relationship between transfer and O&M performance or financial viability. Of the 25 papers presented at the International Conference on Irrigation Management Transfer in Wuhan, China, in 1994 that contained data on performance, only 14 reported increases in cropping intensity (of up to 97% in Andhra Pradesh) and 10 reported increases in crop yields (Turral 1995). Most reported improvements in both performance measures, although the studies provide no control comparisons to enable exclusion of other causes of the observed improvements. The most common agricultural productivity measures mentioned in the literature on management transfer are area cultivated, cropping intensity, and yield. The most common economic measures mentioned are gross value of output, net farm income per hectare, and economic returns to irrigation. Less data are available on economic productivity than on agricultural productivity.

Table 4 summarizes the key findings in the literature on impacts of management transfer on agricultural and economic productivity of irrigation systems. Seven studies reported increases in cropping intensity, which are generally attributed to more responsive irrigation operations after transfer. One study in Senegal (Wester, During, and Oorthuizen 1995) reported declines in cropping intensity, due to lack of management skills, shortages of parts for pumps, and to other problems with credit and marketing related to structural reforms. Results for crop yields were mixed: seven studies reporting increases in yields and six reporting the same or lower yields after transfer.

Three studies reported increases in cultivated area (Vietnam, Nigeria, and Colombia); these increases were attributed to better operations. Three reported more crop diversification (India, Colombia, USA), which was attributed in part to more flexible water distribution practices and efforts to conserve water delivered per hectare.

Regarding economic productivity, improvements in gross value of output or net farm income after transfer were reported in China (some locations), Egypt, Colombia, and USA while there were two reports of declines, in Sudan and China. Economic returns to irrigation were reported to have declined in some places in China and Mexico. 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 US$1,500 to $1,900/ha (Johnson 1996).

The Dominican Republic's On-Farm Water Management Project reported yield increases of 40 percent. But it is not possible from the data to distinguish the effects of transfer from other factors, such as improved irrigation infrastructure and cultivation practices (Sagardoy 1994). In the Coello and Saldaña systems in Colombia, net income rose from US$124/ha in 1984 to $153/ha in 1994 (in 1988 peso equivalents), with net income varying dramatically during the period, however. Economic return to irrigation was $12/100 m^3 in the Coello system in 1993 (with an irrigation efficiency of 73%, i.e., water delivered/diverted) and $11/100 m^3 in Saldaña in 1993 (with an irrigation efficiency of 57%). However, no data on economic productivity before transfer were available. While this type of evidence supports the view that farmer organizations can sustain relatively high levels of productivity after transfer, it does not confirm that the levels were primarily achieved or sustained because of management transfer.

In a comparison of two localities in the Senegal River Valley, researchers found that in the Doue Region, privatization of irrigated agriculture support services was accompanied not only by a decline in cropping intensities but by an expansion in irrigated area, from 620 hectares in 1985 to 1,070 hectares by 1991. Farmers shifted to growing more of their crops only in the wet season, partly due to rapidly rising input prices and the greater complexity of dry season irrigation after management transfer. Similarly, in the Ile à Morphil region, privatization led to a near doubling of irrigated area between 1985 and 1993 and an increase in cropping intensity from 86 percent during 1985–88 to 93 percent during 1990–93 (Wester, During, and Oorthuizen 1995).

TABLE 4.
Reported impacts of irrigation management transfer on agricultural and economic productivity.

Study, country, type of irrigation	Agricultural productivity	Economic productivity
Wijayaratna & Vermillion 1994, Philippines, SI	Increases in cropping intensity.	n.a.
Svendsen 1992 Philippines, SI, LI	Rice yields increased by 4% to 4 t/ha in both wet and dry seasons.[a]	n.a.
Nguyen & Luong 1994 Vietnam, LI	Cropping intensity increased from 170% to 250%. 14% increase in area cropped. Yield increased 13%.	Annual incremental benefits increased by US$193/ha or by $182/ha net of increased O&M cost.
Johnson et al. 1995 China, SI	Grain yields increased modestly.	Cases of both increase and decrease in net income.
IIMI & BAU 1996 Bangladesh, LI	Slight increase in cropping intensities. Mixed results for yields.	Small farmers (<1 ha) becoming a growing share of pump owners and of expanding irrigated area (58% to 63%, 1989–94).
Mishra & Molden 1996 Nepal, SI	Rice yields increased from 2.2 t/ha to 3.4 t/ha. Wheat yields increased from 1.6 t/ha to 2.4 t/ha.	n.a.
Kloezen 1996 Sri Lanka, SI	Cropping intensities increased from 138% to 200%.	Gross annual value of output between US$944/ha and $1,136/ha after IMT.
Pant 1994 India, LI	Cropping intensity increased from 143% to 162%. Yields increased 10%.	n.a.
Kalro & Naik 1995 India, SI, LI	Increases in cropping intensities and crop diversification. No change in yields.	n.a.
Azziz 1994 Egypt, SI	10–16% increase in main crop yields.	Increase in farm incomes by US$60/ha
Samad & Dingle 1995 Sudan, LI	High yields per unit of water in parastatal schemes (17 kg/100 m^3) versus turned-over schemes (11 kg/100 m^3).	Gross margin three times higher in parastatal than in turned-over schemes. Productivity of land and water higher in parastatal than in turned-over schemes.
Maurya 1993; Musa 1994 Nigeria, SI	Increase in dry-season cropped area by 80%.	n.a.
Wester, During, & Oorthuizen 1995, Senegal, LI	Cropping intensity rising and falling in different locations.	Cost of irrigated rice production increased 78%.
Vermillion & Garcés-Restrepo 1996, Colombia, SI, LI	Rice yields of 6.5 t/ha, sustained after IMT. Cultivated area continued to expand. More crop diversification.	Net farm income rose 23%. Economic return to irrigation was US$11–$12/100 m^3 water. Gross value of output increased 400%, 1983–91.
Garcés-Restrepo & Vermillion 1994, Colombia, SI, LI	n.a.	Cost of water relative to cost of rice production increased from 2.0% to 2.4%.
Johnson 1996 Mexico, SI	No change in cropping intensity or yields.	Annual economic returns (US$1,500–$1,900/ha) remained same or declined.
Svendsen & Vermillion 1994 USA, SI	Shift to less water-intensive crops but more due to changing water application technology and markets.	Average farm incomes rose 15% due to reduction in water cost.

[a]Adjusted for diffences in nitrogen fertilizer use and rainfall.

Notes: SI= surface irrigation. LI = lift irrigation. n.a.= not available.

As noted earlier, transfer of management of distributary canals in the Kano River Irrigation Project in Nigeria, resulted in a significant improvement in water distribution to tail-end areas and an overall improvement in cropping intensity. IMT was introduced to the system largely because of lack of government funds for irrigation O&M, which led to a rapid deterioration of the system, due to lack of maintenance, and a new policy mandating financial autonomy for the river basin authorities and large irrigation systems. In the 1992/93 season, following the transfer, 70 percent of distributary canals and 60 percent of field-channel lengths were cleaned by farmer groups. As a result, 10 percent more wheat and 8 percent more maize were grown in the dry season compared with previous years. However, the absence of data for multiple years prevents us from generalizing about trends in productivity and the sustainability of farmer investments in maintenance (Maurya 1993; Musa 1994).

Samad and Dingle (1995) compared the performance of six pump schemes along the White Nile in Sudan that 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 kg/100 m^3 in schemes managed by farmers and by the private company and 17 kg/100 m^3 in schemes managed by the parastatal. This difference was attributed to the parastatal's better access to agricultural inputs.

The gross margin for the 1993/94 wheat crop was US$0.34/100 m^3 in the turned-over schemes, $1.09/100 m^3 in the parastatal schemes, and only $0.09/100 m^3 in schemes managed by the private company. Average net farm income was US$18/ha in the turned over schemes, $42/ha in the parastatal schemes, and $7/ha in the schemes managed by the private company. This was the first year after transfer and the farmers and the private company had little, if any, experience in management before then. The private entities paid more for inputs and had difficulties in obtaining inputs on time.

Azziz (1994) reports comparative post-transfer data that the transfer of mesqas in Egypt led to a US$300/ha increase in average annual farm income. Pant's (1994) study of transfer of a public tube well in Uttar Pradesh, India, documented a decrease in irrigated area but increases in cropping intensity and yields after the transfer. The average irrigated area in rabi was 103 hectares during 1990–92 (before transfer) and 60 hectares during 1993–94 (after transfer). Cropping intensities averaged 143 percent during the 2 years before transfer and 162 percent afterward. Yields for wheat, rice, and sugarcane increased about 10 percent, indicating that after transfer farmers preferred to intensify production on the existing area rather than expanding the area irrigated. Because of a limited study period (2 years before and 2 years after), it is impossible to generalize about trends. In the Paliganj Canal in Bihar, India, as a result of management improvements after transfer (mentioned above), irrigated area in the dry season increased from 3,613 hectares in 1990, before transfer, to 4,350 hectares after transfer in both 1992 and 1993 (Srivastava and Brewer 1994).

Uphoff (1992) reports the results of management transfer in the Gal Oya system in Sri Lanka as improved equity of water distribution between head and tail areas, improved maintenance, increased cropping intensity, and higher yields. However, the study does not present system-wide quantitative data about these results and only refers to agricultural productivity changes in a partial, anecdotal way. Attendance of farmers at meetings is characterized as a good in itself .

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 in all study sites. The Banurbur system irrigated 486 hectares in the dry season before transfer and 750 hectares afterward. The increase continued for several years. The Maramag system irrigated 524 hectares in the dry season before transfer and 719 hectares afterward. The Mahaba-Nasisi-Ogsong-Hibiga (MNOH) system in Bicol added 390 hectares to wet season irrigation after transfer, and a third crop was planted in several blocks for the first time. However, the data cover a short period, do not include information on water supply, and provide incomplete information on agricultural performance.

In Vietnam, 4 years after the transfer of a medium-scale river lift pump system in the Red River delta, Nguyen and Luong (1994) report that area irrigated increased to 1,600 hectares, from 934 hectares before transfer, leading to a cropping intensity of 250 percent, compared with 170 percent before transfer. Management transfer of the West Gandak scheme in Nepal led to yield increases for rice from 2.2 to 3.4 t/ha and for wheat from 1.6 to 2.4 t/ha. These gains apparently resulted from a combination of desiltation and management changes related to transfer. Annual incremental economic benefits as a result of transfer were estimated to be US$193/ha, or $182/ha after accounting for an increase in O&M costs to farmers (Mishra and Molden 1996).

Johnson, Svendsen, and Zhang (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 in Nanyao was 66 kg/100 m^3 in 1973, 70 kg/100 m^3 in 1982, and 135 kg/100 m^3 in 1992. Similarly, in Bayi, yields increased from 28 kg/100 m^3 in 1973 to 65 kg/100 m^3 in 1982 and to 150 kg/100 m^3 in 1992. Data on IMT impacts over such a long period are rare and suggest 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. However, rates of input use or other factors were not documented.

In the Columbia Basin, USA, Svendsen and Vermillion (1994) report that the reduction in water costs per unit area after transfer enhanced average annual profitability of irrigated farming by about 15 percent of average family incomes, assuming that real net income remained the same in the 1980s as in 1978. They note that this would increase the gross margin on a typical 65-hectare farm by about US$1,600/yr. In general, the literature most often reports positive changes in agricultural and economic productivity after transfer, although it is likely that such changes often occur primarily because of factors other than irrigation management transfer.

A common problem is that most studies that report marginal changes in agricultural productivity do not attempt to control for intervening variables such as changes in rainfall or fertilizer application rates. Cropping intensities and yields have tended to rise gradually in many countries due to a variety of factors. Similarly, economic productivity is affected by broad economic changes beyond management transfer, including changes in prices, subsidies, and markets. To attribute changes in agricultural or economic productivity at least partly to management transfer, it will be necessary for researchers to incorporate potential intervening variables into their analysis and for the base of comparative information to expand.

Environmental Sustainability

Only a few studies refer to impacts of management transfer on the environment; these are mostly qualitative. In Chile, water users' associations, which took over control of irrigation systems, reportedly became empowered by transfer and the 1981 Water Law Code, and they successfully pressured paper factories to invest in pollution-reducing equipment, by threatening to cut off water to industrial users (Meinzen-Dick et al. 1997).

On a field trip to Colombia in 1996, I learned of efforts by farmers in the transferred districts of Saldaña and Recio to organize collective efforts to prevent further deforestation in the water catchment areas above their irrigation districts. Farmers complained that deforestation over the previous 10 to 15 years had dramatically increased the silt load in the water diverted into their schemes and had also caused a steady decline in the stream flow at the diversion weirs.

Yap-Salinas (1994) reports that irrigation transfer in the Dominican Republic, through the establishment of local organizations to regulate land and water use, has halted and reversed land degradation and loss of soil, which in turn has reduced health risks previously associated with waterlogging from poor drainage. However, in the absence of comparative data it is difficult to assess the relative contributions of installation of new drainage facilities and institutional reform.

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. Because of the short time covered, it is difficult to assess whether this is a long-term problem or only a learning adjustment.

I am not aware of any other studies that attempt to attribute environmental impacts to irrigation management transfer. This may be because irrigation management transfer is a relatively recent phenomenon and environmental impacts normally take several years to become apparent and measurable.

There are numerous ways in which the management of irrigation and drainage could be modified to achieve emerging environmental objectives such as reduction in rates of soil erosion, salinity, waterlogging, pollution, and extraction of the resource base (i.e., aquifers and water basins). These changes may require regulation of management practices at the farm, scheme, and water basin levels. Given the rising competition for water and degradation of water and land resources, there is a need for impact studies to include environmental measures, especially where regulatory arrangements for resource management are weak. In the future, networks of farmer-managed irrigation systems will likely need to take responsibility for local regulation of water basins. An example is proposals to organize farmer tube-well groups into a federated aquifer group to regulate against depletion of shallow aquifers in hard rock areas in South Asia (Moench 1996). Where needed, transfer programs should develop institutional frameworks and prepare post-transfer organizations to take up such responsibilities.

Quality of Research

Evidence of impacts in the literature comes in four basic types, listed generally from the weakest to the strongest methods:

- qualitative reports of stakeholders
- post-transfer assessment of single cases
- with-and-without comparisons
- before-and-after comparisons

Table 5 summarizes the extent to which different performance measures are included in the literature reviewed here. The most common performance indicators are those about operations, which were included in 25 of the 29 sources reviewed. Twenty-one of the sources included data on financial performance, and 18 studies reported on agricultural performance. Only 12 studies reported on economic performance after transfer. This is a significant deficiency since perhaps the most pertinent concern about management transfer is whether incremental benefits to farmers outweigh costs. The relatively few studies reporting on maintenance after transfer partly reflects the brief periods they cover. This shortcoming makes it difficult to answer questions about the long-term physical sustainability of irrigation systems after transfer.

Table 6 displays data on basic types of data collection methods used in the impact assessment studies. The table indicates two common tendencies: (1) considerable reliance on secondary data collected from agency offices (26 of the 29 studies) and (2) a surprisingly frequent tendency to elicit and report the perspectives of people having a stake in the outcome of management transfer (including farmers, agency staff, and post-transfer management staff). However, the ability of most of these studies to generalize about the prevalence of certain perspectives is limited by a lack of systematic sampling, which was done in only nine studies. Only eight of the studies made independent measurements of water distribution operations. In some studies, the heavy reliance on secondary data, most often from the implementing agency itself, may lead to overestimation of performance levels, particularly before transfer, thus leading to underestimation of any positive changes after transfer. Since one of the frequent concerns about management transfer is that it will accelerate the rate of deterioration of infrastructure, it is unfortunate that only five of the studies involved direct and independent inspection of irrigation infrastructure.

Table 7 summarizes information on key analytical methods used in the impact studies. The most common analytical design used is comparison of performance before and after transfer, which was done in 24 of the 29 studies cited. Given the great diversity in conditions between irrigation schemes, and the practical difficulties of obtaining large samples of schemes (for with-and-without IMT comparisons), before-and-after comparisons are a practical and compelling approach. However, only 12 of the 24 studies that did before-and-after comparisons had data for more than 4 years. To detect trends it is probably necessary to have at least 6 years of performance data (3 years before and 3 years after IMT). A 10-year time frame is a more desirable standard. Only three of the studies cited made comparisons between schemes that had and had not been transferred. None of them included enough schemes for statistical comparison. Five of the studies used statistical tests, others used only descriptive statistics.

Taken together, the literature on irrigation management transfer does not yet allow analysts to draw strong conclusions

TABLE 5.
Performance measures included in studies on impacts of irrigation management transfer.

Study and country	Operational	Financial	Agricultural	Economic	Maintenance
Oorthuizen & Kloezen 1995—Philippines	"	"			"
Wijayaratna & Vermillion 1994–Philippines	"	"	"		
Bagadion 1994–Philippines	"	"			
Svendsen 1992–Philippines	"	"	"		
Johnson & Reiss 1993–Indonesia	"	"			"
Nguyen & Luong 1994–Vietnam	"		"		
Johnson et al. 1995–China	"	"	"	"	
IIMI & BAU 1996–Bangladesh	"	"	"	"	"
Olin 1994–Nepal	"	"			
Rana et al. 1994–Nepal	"				"
Mishra & Molden 1996–Nepal	"	"	"	"	
Kloezen 1996–Sri Lanka	"	"	"	"	
Uphoff 1992–Sri Lanka	"		"		
Pant 1994–India	"	"	"		"
Srivastava & Brewer 1994–India	"		"		"
Rao 1994–India	"				
Shah et al. 1994–India		"			
Kalro & Naik 1995–India		"	"		
Azziz 1994–Egypt	"	"	"	"	
Samad & Dingle 1995–Sudan	"		"	"	
DSI, EDI, & IIMI 1996–Turkey		"		"	
Maurya 1993; Musa 1994–Nigeria	"	"	"		
Wester, During, & Oorthuizen 1995–Senegal	"		"	"	"
Yap-Salinas 1994–Dominican Republic	"	"			
Vermillion & Garcés-Restrepo 1996–Colombia	"	"	"	"	"
Garcés-Restrepo & Vermillion 1994–Colombia	"	"		"	
Johnson 1996–Mexico	"	"	"	"	
Svendsen & Vermillion 1994–USA	"		"	"	"
Farley 1994–New Zealand		"			
Total	25	21	18	12	9

TABLE 6.

Key data collection methods used in studies on impacts of irrigation management transfer.

Study and country	Secondary data from agency	Farmer interviews	Systematic sampling	Stakeholder perspectives	Direct measurement of operations	Direct inspection of structures
Oorthuizen & Kloezen 1995–Philippines	"	"	"	"		
Wijayaratna & Vermillion 1994–Philippines	"			"		
Bagadion 1994–Philippines	"			"		
Svendsen 1992–Philippines	"					
Johnson & Reiss 1993–Indonesia	"			"		"
Nguyen & Luong 1994–Vietnam	"					
Johnson et al. 1995–China	"			"		
IIMI & BAU 1996–Bangladesh	"	"	"	"	"	
Rana et al. 1994–Nepal	"	"		"	"	
Olin 1994–Nepal		"	"	"	"	
Mishra & Molden 1996–Nepal	"			"		
Kloezen 1996–Sri Lanka	"	"	"	"	"	
Uphoff 1992–Sri Lanka		"		"		
Pant 1994–India	"			"		
Srivastava & Brewer 1994–India	"	"		"	"	"
Rao 1994–India	"	"		"		
Shah et al. 1994–India	"	"		"	"	"
Kalro & Naik 1995–India	"	"	"			
Azziz 1994–Egypt	"	"	"	"		
Samad & Dingle 1995–Sudan	"	"	"	"	"	
DSI, EDI, & IIMI 1996–Turkey	"					
Maurya 1993; Musa 1994–Nigeria	"			"		
Wester, During, & Oorthuizen 1995–Senegal	"	"	"	"		"
Yap-Salinas 1994–Dominican Republic				"		
Vermillion & Garcés-Restrepo 1996–Colombia	"	"	"	"	"	"
Garcés-Restrepo & Vermillion 1994–Colombia	"	"		"		
Johnson 1996–Mexico	"					
Svendsen & Vermillion 1994–USA	"			"		
Farley 1994–New Zealand	"			"		
Total	26	15	9	24	8	5

TABLE 7.
Key analytical methods used in studies of irrigation management transfer.

Study and country	Compare performance before and after IMT	Compare performance with and without IMT	Performance measured in more than two transferred units	Time series analysis[a]	Statistical tests used
Oorthuizen & Kloezen 1995–Philippines	"			"	
Wijayaratna & Vermillion 1994–Philippines	"		"		
Bagadion 1994–Philippines	"			"	
Svendsen 1992–Philippines	"		"	"	"
Johnson & Reiss 1993–Indonesia			"		"
Nguyen & Luong 1994–Vietnam	"		"		
Johnson et al. 1995–China	"			"	
IIMI & BAU 1996–Bangladesh		"	"		"
Rana et al. 1994–Nepal	"		"		
Olin 1994–Nepal	"				
Mishra & Molden 1996–Nepal	"				
Kloezen 1996–Sri Lanka	"			"	
Uphoff 1992–Sri Lanka	"				
Pant 1994–India	"			"	
Srivastava & Brewer 1994–India	"				
Rao 1994–India	"				
Shah et al. 1994–India	"			"	
Kalro & Naik 1995–India			"		
Azziz 1994–Egypt	"		"		
Samad & Dingle 1995–Sudan		"	"		"
DSI, EDI, & IIMI 1996–Turkey	"		"		
Maurya 1993; Musa 1994–Nigeria	"		"		
Wester, During, & Oorthuizen 1995–Senegal	"		"	"	
Yap-Salinas 1994–Dominican Republic	"				
Vermillion & Garcés-Restrepo 1996–Colombia	"			"	
Garcés-Restrepo & Vermillion 1994–Colombia	"		"	"	
Johnson 1996–Mexico	"		"	"	
Svendsen & Vermillion 1994–USA	"			"	"
Farley 1994–New Zealand		"	"		
Total	24	3	15	12	5

[a]Defined as including data on at least five consecutive time periods.

about cross-national trends in impacts, either positive or negative. This is partly because of the highly varied nature of transfer programs and irrigation contexts and the many factors that can affect the performance of irrigated agriculture. It is also due to the lack of rigorous research methods used, as noted above.

Conclusions

Evidence about impacts

Impacts of transfer reported in the literature are mostly positive. This may be partly a result of a bias in sites selected or the possibility that many authors are promoters of the reforms. The most often reported positive impacts of transfer programs are reduction in the cost of irrigation to farmers and to the government, enhanced financial self-reliance of irrigation schemes, expansion of service areas, reduction in the amount of water delivered per hectare, and increases in cropping intensity and yields. The most frequently reported negative results of transfer programs are increased costs to farmers, failing financial viability of lift schemes, and deteriorating infrastructure. Reported impacts on government resource allocation, total costs of irrigation, and environmental stability are relatively rare in the literature.

Quality of research methods

As noted above, much of the so-called evidence about impacts is based upon qualitative reports, without before-and-after or with-and-without comparisons, without independent measurements with quantitative data, without systematic sampling of farmers, with short time frames, and with a failure to distinguish possible alternative causes of the observed "impacts" of transfer. Another weakness in the evidence is that most reports mention only two or three indicators of performance, so it is impossible to assess tradeoffs between key performance measures, such as changes in short-term financial performance versus long-term maintenance.

Irrigation management transfer programs are probably more often adopted because of government funding constraints than because of validated expectations about enhanced performance. Transfer programs are sometimes promoted for philosophical reasons. Considering the potential far-reaching effects of this reform on the livelihood of farmers and the sustainable productivity of irrigation systems, it is vital that much more rigorous and compelling research methods to assess its real impacts be adopted and that the results be assessed comparatively.

It should be pointed out, however, that while some performance indicators are relatively easy to measure and analyze (such as financial performance), others are moderately difficult (such as O&M performance). It is very difficult to make a compelling analysis that can convincingly attribute changes in agricultural and economic productivity to management transfer because there are so many potential determinants of change in these measures. It may take several years after management transfer to establish that an irrigation system is environmentally sustainable and to determine the extent to which transfer has influenced the outcome. Nevertheless, since management transfer can potentially have a major impact on the performance of irrigated agriculture in developing countries, it is important that researchers rise to the challenge of making more careful assessments of its impacts.

Recommended improvements in research methods

To overcome the shortcomings of studies to date, the following principles should guide future research on the impacts of irrigation management transfer.

1. Wherever possible, studies should include a balanced core set of performance indicators, including financial performance, quality of O&M, agricultural productivity, economic impacts, and impacts on the environment.
2. Future studies should avoid excessive dependence on data collected from secondary sources, such as agency offices. Where such data are used, corresponding measures should be sampled independently (through farmer interviews or remote sensing, for example) to validate the data.
3. To enable generalization, farmers should be selected through systematic random sampling, normally stratified according to location of fields relative to irrigation headworks.
4. More extensive use should be made of before-and-after interrupted time series research designs, which include data for at least 3 to 5 years before and 3 to 5 years after the occurrence of transfer, to more firmly establish the timing of impacts of transfer.
5. The preponderance of single case studies limits analysts' ability to generalize about impacts. Given the difficulty of conducting detailed time-series analyses in a large number of schemes, case studies should be complemented by surveys of 20 to 30 randomly selected schemes where a smaller amount of data is collected on core performance measures.
6. For assessments of financial impacts, both costs to the farmers and to the government should be measured, as well as changes in the total cost of irrigation.
7. Where transfer programs include improvements in irrigation infrastructure, research studies should include with-and-without comparisons with control for the contending effects of physical improvements and management reform.
8. Given the importance of documenting the physical sustainability of irrigation systems after transfer, impact studies should include direct observations of the physical condition and functionality of irrigation infrastructure.
9. Assessments of agricultural impacts, such as crop yields, should also measure potential alternative causes of changes in yields, such as changes in fertilizer application rates, rainfall patterns, and technology or cultivation practices. Statistical methods such as analysis of variance and multiple regression should be used to assess the relative importance of different causal factors of changes in agricultural productivity.
10. Assessments of economic productivity should compare changes in cost of irrigation to farmers with changes in the value of agricultural output.

11. Assessments of economic impacts should also measure changes in potential alternative determinants of economic productivity, such as prices of inputs and crops, market conditions, and subsidies. As with the assessment of agricultural productivity, statistical methods such as analysis of variance and multiple regression should be used to attempt to assess the relative importance of different causal factors of changes in economic productivity.

12. Changes in agricultural or economic productivity should be more clearly linked to transfer by documenting the nature and timing of effects of transfer on changes in policies and procedures for O&M and financing, and then relating O&M performance outcomes to agricultural productivity.

IIMI is currently developing and field-testing a methodological guide for impact assessment of irrigation management transfer, which will soon be disseminated to researchers and professionals involved in management transfer around the world (Vermillion et al. 1996).

Key issues for future research

Research to date and reports from practitioners in international meetings favor the notion that certain prerequisites are needed before countries can expect to achieve success with management transfer programs. The most common are

- a clearly recognized and sustainable water right and water service
- infrastructure that is compatible with the water service and local management capacities
- well-specified management functions and assignment of authority
- effective accountability and incentives for management
- arrangements for viable and timely conflict resolution
- adequate resources that can be mobilized for irrigation management

The components most commonly lacking in Asian countries tend to be clear water rights, clearly designated lines of authority between farmers and agencies, and effective accountability and incentive systems. Research is needed on what common characteristics occur in more successful cases of management transfer. Such characteristics include institutional arrangements of transfer, compatibility of socioeconomic contexts for collective action, maturity of supporting local institutions (especially for resource allocation and conflict resolution), and support services for irrigated agriculture. Action research is needed that includes all six of the above hypothesized essential elements in locations where they do not yet occur.

For several years, water users' associations have been promoted as both a governing and a management body for irrigation systems. Community organizers have helped water users' associations to develop constitutions and bylaws, select leaders, approve plans and budgets, and apply sanctions. Water users' associations then directly manage operations, maintenance, and finances. This model is probably not well suited for management at higher levels of larger systems or in more complex management environments. Accountability between farmers and leaders, especially in finances, is often weak, and water users' associations generally do not have professional staff. As a result, many conclude that transfer can only occur at small scales of management. Action research is needed on alternative nongovernmental management models that are expected to be more capable of managing medium-scale or large irrigation systems, such as irrigation districts or mutual companies. In all cases, researchers should apply compelling analytical methods to document the impacts of reform.

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INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE
P O Box 2075 Colombo, Sri Lanka
Tel (94-1) 867404 • Fax (94-1) 866854 • E-mail IIMI@cgnet.com
Internet Home Page http:/ /www.cgiar.org
ISBN: 92-9090-340-5

ISSN: 1026-0862