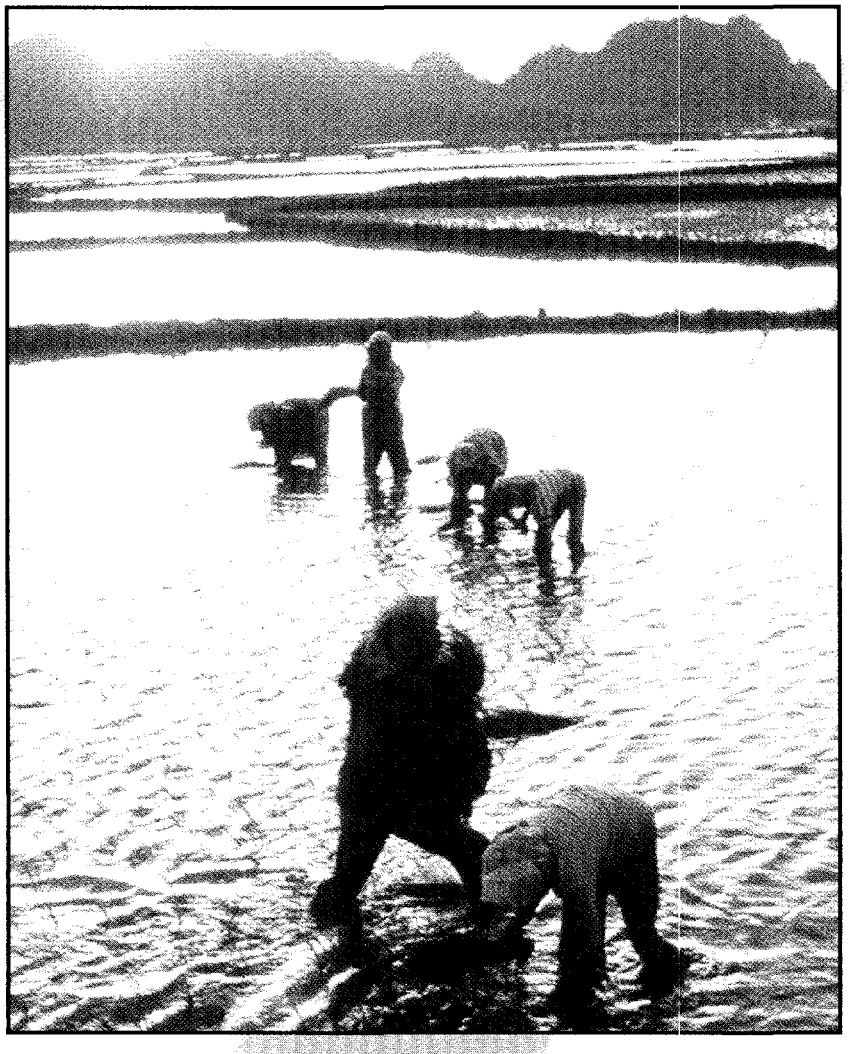
The World Bank and Irrigation



William I. Jones

OED

A World Bank Operations Evaluation Study

The World Bank and Irrigation

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Foreword

Irrigation, the largest recipient of public agricultural investment in the developing world, accounted for 7 percent ($20 billion) of World Bank lending from 1953–90. To determine the impact of this lending, OED undertook a comprehensive review of the Bank's experience with more than 200 irrigation projects. The review examines project results, traces shifts in policy, and explores trends in lending. Above all, it reviews effects on farmers, and suggests ways to improve on irrigation investments and promote sustainability.

More than two-thirds of Bank-financed irrigation projects have had satisfactory outcomes. The projects benefited some 16 million farm families directly, and served millions more indirectly. Perhaps the greatest benefit of irrigation has been its role in enhancing food security and in making food more affordable for all, most notably the poor.

Irrigation investments will continue to be needed, to meet the demands for food of an ever-growing population. Because fewer and fewer new sources of water are available, the emphasis of irrigation investments has shifted away from new facilities towards rehabilitating and upgrading existing ones. Water scarcity also calls for effective resource management and participatory institutional mechanisms.

The study proposes steps for improving Bank processes, including methods for better supervision and evaluation of investment projects; for addressing key issues in system design and sustainability, such as water scarcity and operations and maintenance; and for dealing with issues of drainage, resettlement, catchment degradation, and project design in the humid tropics.

Robert Picciotto
Director General
Operations Evaluation

Prefacio

El riego, el mayor receptor de inversiones agrícolas del sector público en el mundo en desarrollo, representó el 7 por ciento (US$20.000 millones) de los préstamos del Banco desde 1953 hasta 1990. Con el objeto de determinar las repercusiones de estas operaciones crediticias, el DEO llevó a cabo un estudio amplio de la experiencia del Banco en más de 200 proyectos de riego. En él se examinan los resultados de los proyectos, se investigan los cambios en las políticas pertinentes y se estudian las tendencias de los préstamos. Se analizan principalmente los efectos en los agricultores, y se proponen maneras de mejorar las inversiones en riego y de promover la sostenibilidad de los proyectos.

Más de dos terceras partes de los proyectos de riego financiados por el Banco han tenido resultados satisfactorios, y han beneficiado en forma directa a unos 16 millones de familias de agricultores y han atendido a millones más indirectamente. Tal vez el beneficio mayor del riego ha consistido en mejorar la seguridad alimentaria y en lograr que los alimentos estén más al alcance de todos, en especial de los pobres.

Se continuarán necesitando inversiones en riego para satisfacer las demandas de alimentos de una población en constante crecimiento. Debido a que cada vez son más escasas las nuevas fuentes de agua, se atribuye menos importancia en las inversiones en riego a las nuevas instalaciones para concentrarse en la rehabilitación y mejoramiento de las existentes. La escasez de agua requiere también una gestión eficaz de los recursos y mecanismos institucionales de participación.

Se proponen en el estudio medidas para mejorar los procedimientos del Banco, entre ellos métodos para mejorar la supervisión y la evaluación de los proyectos de inversión; para abordar problemas fundamentales en el diseño y la sostenibilidad de los sistemas, como la escasez de agua y las operaciones y el mantenimiento, y para tratar problemas relativos a drenaje, reasentamiento, deterioro de las cuencas de captación y formulación de proyectos en las zonas tropicales húmedas.

Robert Picciotto
Director General
Departamento de Evaluación de Operaciones

Préface

L'irrigation, qui dans le monde en développement est le premier bénéficiaire des investissements publics dans l'agriculture, a reçu 7 pour cent (20 milliards de dollars) des prêts de la Banque mondiale entre 1953 et 1990. Pour déterminer l'impact de ces prêts, le Département de l'évaluation des opérations (OED) a entrepris de faire le point général des constatations qui se dégagent de plus de 200 projets d'irrigation financés par la Banque. L'étude examine les résultats des projets, retrace l'évolution de la politique de la Banque en matière d'irrigation et analyse les perspectives de prêt dans ce secteur. Surtout, elle passe en revue les effets de ces projets sur les agriculteurs et propose des moyens d'améliorer les investissements dans le secteur de l'irrigation et d'en promouvoir la durabilité.

Plus des deux tiers des projets d'irrigation financés par la Banque ont donné des résultats satisfaisants. Les projets ont profité à quelque 16 millions de foyers agricoles, directement, et à des millions d'autres, indirectement. Le principal intérêt de ces projets a peut-être été qu'ils ont contribué à renforcer la sécurité alimentaire et à rendre les denrées alimentaires plus abordables pour tous, plus particulièrement pour les pauvres.

Il faudra continuer à investir dans l'irrigation si l'on veut répondre aux besoins alimentaires d'une population en constante augmentation. Les nouvelles ressources en eau se faisant de plus en plus rares, les investissements dans l'irrigation ont cessé de porter sur la construction de nouveaux ouvrages pour favoriser la remise en état et l'amélioration de ceux qui existent déjà. La rareté de l'eau impose aussi de bien gérer les ressources et de promouvoir des mécanismes institutionnels de participation.

L'étude propose des solutions pour améliorer les procédures de la Banque, notamment des méthodes qui permettent de mieux superviser et évaluer les projets d'investissement; de se pencher sur des questions clés touchant la conception et la durabilité des systèmes, comme la rareté de l'eau et les aspects d'exploitation et d'entretien; et de trouver des solutions aux problèmes de drainage, de repeuplement, de dégradation des bassins versants et de conception des projets dans les zones tropicales humides.

Robert Picciotto
Directeur général
Evaluation des opérations

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While dozens of individuals helped shape this study, it is appropriate to single out a few for their significant contributions: Jeremy Berkoff, Sadiqul Bhuiyan, Robert Burns, Romana de los Reyes, William Easter, Harald Frederiksen, Gilbert Levine, Ruth Meinzen-Dick, Christopher Perry, Hervé Plusquellec, Christian Polti, David Seckler, and Thomas Wickham. Whatever the contribution of these and other individuals, the study is the responsibility of OED.

Abbreviations and acronyms

AGR	Agriculture
AMS	Administrative manual statement
ARIS	Annual review of implementation and supervision
ASTAG	Agricultural Division of Asia Technical Department
CGIAR	Consultative Group on International Agricultural Research
CPM	Central policy memorandum
CPN	Central policy note
DID	Drainage and Irrigation Department
EDI	Economic Development Institute
ERR	Economic rate of return
EIRR	Economic internal rate of return
EPDCS	Economic Analysis and Projections Department, Commodity Studies and Projections Division
FAO	Food and Agriculture Organization
FY	Fiscal year
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IER	Impact evaluation report
IFAD	International Fund for Agricultural Development
IIMI	International Irrigation Management Institute
IPC	Institute of Philippine Culture
IRR	Internal rate of return
M&E	Monitoring and evaluation
MTP	Management Turnover Program
NGO	Nongovernmental organization
NIA	National Irrigation Administration
NISIP	National Irrigation Systems Improvement Project
O&M	Operation and maintenance
OD	Operational directive
ODI	Overseas Development Institute
OED	Operations Evaluation Department
OMS	Operational manual statement

OPM	Operational policy memorandum
OPN	Operational policy note
PCR	Project completion report
SCARP	Salinity Control and Reclamation Project
SPN	Supervision
TADP	Tangail Agricultural Development Project
USSR	Former Union of Soviet Socialist Republics
WDR	World Development Report
WUA	Water users association

Executive Summary

Today, the global demand for agricultural produce—for food and fiber—is met. There is hunger, but that is because the hungry cannot translate their need into demand or civil disorder disrupts food flows. The prices of staple foods are near historic lows, and stockpiles are adequate. This is a situation that would be inconceivable without the last half-century's investments in irrigation.

Irrigation will continue to play a critical role in our ability to feed and clothe ourselves, not to mention its considerable role in creating jobs. As demand for agricultural products increases, driven by population growth and rising incomes, the preponderance of increased production will have to come from irrigated lands. Irrigation supplies plants with water, usually the most critical input to crop production. There are strong, positive interactions between irrigation and the other major sources of agricultural growth: fertilizer, improved seed, better husbandry, integrated pest management, and better integration into markets.

Irrigation is the largest recipient of public agricultural investment in the developing world. It is also a major recipient of public operating subsidies. Instances where irrigators pay even the operation and maintenance (O&M) costs of public systems are few.

Seven percent of World Bank lending has been for irrigation. From 1950 through 1993, this amounted to $31 billion in constant US dollars. Overall, the Bank supported 614 projects with irrigation components during that period, including 365 where more than half of project expenditures went to irrigation. More than one hundred irrigation projects are at various stages of implementation and have not yet been evaluated. A sizeable number of projects formally classified as rural credit, electrification, or area development have also supported irrigation.

This study focuses on 208 Bank-funded irrigation projects that have been evaluated. Evaluation consists of project completion reports, audits, and impact evaluations. Where assessments differ, this study gives preference to impact evaluations over audits, and audits over project completion reports. Analysis takes account of the sometimes uneven quality of the data set. The study also examines the Bank's 614 irrigation-related projects approved through 1993, the 100 ongoing projects, and non-Bank studies which shed light on some questions not illuminated by evaluation.

The study chiefly addresses two questions. What has the Bank's irrigation policy been? And what have been the returns (in the broadest sense of the term) on irrigation investments? The answers should be useful for improving such investments. They lead to *findings* on what has or has not worked, and about how the Bank's irrigation policies have evolved.

Recommendations for changes in policy on Bank-supported irrigation investments are made.

Bank policy and lending

Asia has received 69 percent of Bank lending for irrigation. (This is not a concentration, since 85 percent of the developing world's irrigated area is in Asia.) *More than half of all lending has gone to humid tropical Asia,* where irrigation systems are used chiefly to grow rice. India, with 26 percent of irrigation borrowing, is easily the largest client. The Asian projects have, on average, been bigger in total cost, in loan size, in area irrigated, in output, and in the attention their problems have attracted.

The other 31 percent of Bank lending for irrigation has been split between Africa, the Americas, and Europe. While investments in Africa have been widely distributed, one finds them primarily in arid and semi-arid North Africa and the Sahel, and in Madagascar. The average African project is relatively small and complex; hence Africa has accounted for 30 percent of the projects but only 12 percent of the lending. Bank irrigation investment in the Americas (13 percent) has fluctuated over time, the 1980s being the low point. While there are some rice irrigation projects in humid areas, such as those in Colombia and Guyana, more are found in arid areas of the Pacific coast. Lending to Europe (5 percent) was concentrated in the 1970s and early 1980s, particularly in Romania; it has since ceased.

Bank lending for irrigation has declined since peaking in the mid to late 1970s and early 1980s. Massive world and Bank investment in irrigation began in the 1960s in response to food crises, high agricultural prices, and neo-Malthusian anxieties. The subsequent positive response of world agriculture has led to low crop prices, less sense of urgency about agricultural problems, and falling irrigation investments. There is some danger that this situation will lead to complacency, to inadequate levels of irrigation investment, and to subsequent crises for the world's poorest and most dependent people.

In the 1950s the Bank approved, on average, one irrigation project a year; in the 1960s, four per year; in the 1970s and in the 1980s, 26; and so far in the 1990s, 15. Average irrigation lending per year (in 1991 US dollars) was $37 million in the 1950s, $343 million in the 1960s, $1,120 million in the 1970s, $1,273 million in the 1980s, and $1,032 million so far in the 1990s.

Until the 1970s there was little ambiguity about whether projects were irrigation projects or not, but in 1973 the Bank began to fund many more projects described as "rural development" and containing an irrigation component. Also in the 1970s and early 1980s, after adjustment for inflation, the average irrigation project got smaller. Since then, average project size has expanded. There has been a marked shift from financing of specific irrigation schemes to subsectoral loans.

Bank irrigation lending has been directed chiefly toward growing more grain. For more than half of irrigation projects, grain was the sole output; for more than 90 percent, the predominant one. Most often, that grain was rice, the sole output of more than one-third of the projects and the predominant one in 60 percent. The main nongrain outputs were cotton, sugarcane, and fruits and vegetables.

The most basic distinction between irrigation projects in terms of their design and environment is between rice and nonrice projects. Rice projects are concentrated in East and Southeast Asia, Bangladesh, and eastern India, in areas where annual rainfall averages 2,000 mm. Most nonrice projects are in West Asia (including Pakistan and parts of India), North Africa, the west coast of the Americas, and Europe.

Average annual rainfall at evaluated irrigation projects in West Asia and North Africa is less than 400 mm.

This concentration of Bank irrigation lending on rice in humid tropical areas differs from the distribution of the developing world's irrigated area, only about one-third of which is in the humid tropics.

The benefits of most irrigation investment have reached the poor. The median farm size of beneficiaries per project is two hectares. The average project served 76,000 farm families, ranging from an average of 172,000 in India to 5,000 in sub-Saharan Africa. But these were not the only direct beneficiaries. Because irrigation increases farming intensity, it greatly increases labor demand. Some of the additional labor is provided by farm-operating families, and some by hired labor. Lack of data makes quantification impossible, but millions found opportunities to work as a result of these projects.

Most Bank-financed irrigation projects are not built from scratch. While it is not always possible to distinguish among rehabilitation, extension, upgrading, and new construction, *less than half of the evaluated projects were clearly new construction.* About one-fifth were clearly rehabilitation. The rest were some combination of these.

Bank financing covers only a part of borrowers' irrigation investment programs. One indicator of this is the *low incidence of Bank financing of dams.* Less than one-fourth of the evaluated projects involved any dam financing, and very few of those were large dams.

After resettlement and large dams, drainage is the element of irrigation on which the Bank is the most criticized. *Poor drainage has negative ecological consequences.* But *drainage has been an explicit element of more projects than any other physical feature; it is prominent in legal covenants* too.

Irrigation outcomes

Evaluations have rated 67 percent of irrigation projects satisfactory overall. When projects are weighted by size of area served, 84 percent of irrigation is rated satisfactory. This is better than the average for all Bank-supported agricultural projects (65 percent unweighted) but worse than the figure for all Bank projects (76 percent). More than 80 percent of irrigation projects supported by Bank loans approved before 1976 were rated satisfactory, as were almost 80 percent of those approved since 1981. In 1976 through 1981, average ratings were lower. This might be related to the increased complexity and smaller size of irrigation projects approved during that period. As with other kinds of projects, sub-Saharan irrigation projects were less likely than others to be rated satisfactory.

At appraisal, the economic rate of return on irrigation investments was expected to average 22 percent. The average evaluation rate of return[1] was 15 percent. These are unweighted averages. When projects are weighted by size of area served, the appraisal-expected rate of return was 29 percent; the evaluation rate of return, 25 percent.

Therefore, the overall impact of Bank-financed irrigation projects has been relatively good. Given the social and technical complexity of irrigation, this record is a credit to borrowers and to the Bank. But it is also clear that there is ample room for improvement, both in the one-third of the projects rated unsatisfactory, and in the two-thirds rated satisfactory.

Of the six most important factors that enter economic-returns calculations, the factors that most significantly affect the outcome of irrigation projects are the size of the irrigated area, output price, crop yield, and unit cost. Variations in implementation (whether overall time or delay) had no effect on economic returns.

During most of the 1970s and 1980s there were substantial declines in the international *prices* of irrigation's principal farm products: rice, other grains, cotton, and sugar. The prices of these commodities may well remain low. Ironically, these declines, which have significantly lowered evaluation rates of return for irrigation, have probably been caused in part by irrigation investments, especially in the case of rice. But lower food and fiber prices have been an immense benefit to the poor.

Project size, as measured by area served, has a significant correlation with economic return. Using evaluation estimates, the correlation factors between size and economic return were 0.28 for all projects, 0.32 for gravity projects, and 0.34 for pump projects. The correlation holds when results are controlled for sub-Saharan Africa, where irrigation projects are much smaller than average and results have been notably disappointing. These coefficients, surprisingly high for a single factor in such a complex social phenomenon as irrigation, suggest the existence of economies of scale.

The 1991 *World Development Report* (WDR) argued that *economic distortions* have a large and negative impact on project outcome. Neither the 1991 WDR nor this study was able to quantify the internal price distortions and internal market imperfections that have the greatest impact on irrigation projects. Of the distortions tested, exchange-rate distortions had a greater negative effect than interest-rate distortions; foreign-trade distortions, however, *improved* the economic performance of irrigation projects. Presumably, foreign trade distortions stemmed from government actions to protect farmers from low international prices, especially for rice. Such protection does not affect economic return directly. Evidently, given higher financial returns, farmers unleashed more of their human capital and achieved better economic results.

One premise of this study was that *water scarcity* would be shown to have affected performance—that is, that farmers and their governments in arid zones would make greater efforts to make irrigation work well and thus achieve better results than those in humid areas, where there is enough water for rainfed cropping. This premise was not confirmed. There is no statistically significant relationship. In fact, groundwater projects do slightly *better* in wet areas than in dry ones, probably because their water, supplementing rainfall, has a higher unit value.

The results of surface irrigation projects, in contrast, show no relationship to rainfall. Rehabilitation, extension, and upgrading of surface projects tended to occur in wetter zones. Higher sunk costs and an established irrigation tradition should lead to higher returns for these projects than the returns on all-new projects, which tended to be in drier areas.

Groundwater irrigation projects are somewhat smaller than surface projects on average, and have somewhat lower costs per unit area. Nevertheless, evaluation estimates of economic return are 21 percent higher for groundwater projects than for surface projects. Irrigators' groups are about twice as likely to work satisfactorily.

Bank processes

In the Bank's irrigation *sector work,* for the sample analyzed, little attention has been paid to environmental planning, specifically to *water allocation* and *natural resource planning,* but the situation is improving. Sector report coverage of specific areas of environmental impact has been poor and is still quite weak. This is true for *drainage,* and especially so for *aquifer management* and the various dimensions of *catchment management:* deforestation, overgrazing, inappropriate farming, soil degradation, erosion, and silting.

Sector work coverage is better for three of the four problem areas selected. Coverage of *land issues* is broad but none too thorough. Coverage

of *the O&M-water charges-participation constellation* too is broad. Coverage of *management and organization* is broad but generally superficial. It concentrates on government institutions, occasionally touching on their relations with irrigators' organizations but almost never focusing on the irrigators' organizations themselves. There was no coverage of *gender issues.*

A number of the most recent irrigation sector reports, including those on India and the Philippines, get top marks for breadth and depth of coverage.

While it was not possible to assess quality at entry as a whole, irrigation project outcomes were sensitive to certain aspects of *preparation* and to *appraisal.* Evaluators have found that quality of design and planning has been even more critical to project success than adequacy of final design.

Irrigation projects got a 12 percent higher level of supervision per year than the average Bank project. Since irrigation is at the high end of the spectrum in project complexity, that is not surprising. Regionally, Europe stands out for its low level of supervision input, 33 percent below the Bank norm and 40 percent below the irrigation average; South Asia stands out for its high level, 56 percent above the Bank norm and 39 percent above the irrigation average. Four major irrigation borrowers have resident Bank agricultural staff. Two borrowers have had exceptionally high irrigation supervision levels, 53 and 55 percent above the irrigation average; two have had low levels, 30 and 10 percent below the irrigation average. The high supervision figures may indicate an implementation culture, and the low ones a lending culture.

Implementation—a borrower process

The average *implementation delay* for irrigation projects, 1.7 years, was only slightly above the average for all projects. In addition to the usual factors like shortages of borrower's funds, *land acquisition* and *construction* problems are prominent causes of delays in irrigation project implementation. While implementation averages a 30 percent time delay, 16 percent of the works, on average, do not get built even in that longer period. That is equivalent to a delay of 55 percent per unit of project built.

Unit costs per hectare are a useful implementation indicator. The average unit cost for all irrigation projects is $4,800. Projects rated unsatisfactory have unit costs that are 3.5 times higher than those rated satisfactory. Not surprisingly, new construction projects are costlier than rehabilitation. Gravity schemes are costlier than pump schemes,[2] and rice schemes are costlier than nonrice schemes. These produce major regional differences. For instance, the unit costs of the average sub-Saharan African scheme were 13.3 times the South Asia average. Calculating "adjusted" unit costs that take account of scheduled works not actually built shows that implementation problems were concentrated in the Americas, East Asia, and sub-Saharan Africa, in rehabilitation projects, in paddy projects, in gravity schemes, and, not surprisingly, in projects rated unsatisfactory.

Key issues in system design and sustainability

From the many themes raised by Operations Evaluation Department (OED) audits and impact evaluations of irrigation projects, two were selected for extensive discussion because of their importance: operation and maintenance (O&M), and surface system design in the humid tropics.

Operation and maintenance. The evaluations reveal pervasive problems in operation and maintenance, in cost recovery, and with users' groups. Of the three, O&M is the most

important because it affects benefits directly. Irrigators' groups may be worthwhile in themselves simply because they give members a sense of ownership, while cost recovery is a matter of transfers between governments and irrigators, which may affect incentives to irrigate efficiently. Part of the Bank's enthusiasm for irrigation cost recovery stems from the presumed link between cost recovery and better operation and maintenance.

The study confirms earlier findings by OED that there is normally no link between higher water charges and better operation and maintenance. Revenue from water charges generally goes to the general treasury and is not earmarked for O&M. Studies by the Asian Development Bank, Ford Foundation, Institute for Philippine Culture, International Irrigation Management Institute, and the Philippine National Irrigation Administration suggest that financial autonomy results in major improvements in quality and cost effectiveness. Financial autonomy often takes the form of turning operation and maintenance over to irrigators, but there are other arrangements as well. When financial autonomy prevails and irrigators pay O&M costs and arrange O&M themselves, O&M improves.

The Bank has promoted irrigators' groups and turnover of systems to them in a variety of ways, but disappointment has been more common than success. Success requires more than covenants in which borrowers agree to set up users' groups. Empirical studies have identified the conditions that lead irrigators to create users' groups that endure.

Irrigation system design. Evaluations report pervasive problems with irrigation system design, particularly in the humid tropics where drainage and flood control are major problems. In most cases, these projects started with rice systems based on slow, continuous water delivery, and sought to convert them to more-reticulated systems with higher delivery capacities, often designed for on-off operation, and supposed to be capable of water delivery on demand (or close to it) for a variety of crops. Several audits suggest that these more-reticulated systems, although suited to drier regions, are inappropriate in the humid tropics.

These more-reticulated systems in the humid tropics especially have problems of farmer vandalism of structures and water hogging by head-end irrigators. These actions have serious consequences for tail-enders and for society at large.

Suggested solutions fall into two categories. One is to make such systems operate better by improving water conveyance and regulating structures, and improving communications to make possible irrigation on demand.

The other proposed solution is to achieve operational effectiveness and reliability by reducing system flexibility. A lower level of irrigation service (though higher than most irrigators now get), by assuring delivery according to a rigid schedule, obliges farmers to conform their cropping to the water delivery schedule. That involves some sacrifice of agronomic and economic optimality. Sometimes such solutions involve installation of pumps and the cost of pumping. Importantly, they reduce system operators' discretion, and thus their opportunities for collusion with privileged irrigators. By imposing water scarcity, such systems provide incentives for water saving.

Recommendations

Half or more of the Bank's current lending for irrigation is not for construction of new systems but for extensions, rehabilitations, and upgrades of existing systems. As time passes, farmers in more parts of the world face increasing competition for water. The cost of

developing new irrigation sites is rising too, the most economically attractive ones having been developed already. Moreover, the prices of food and fiber that irrigation helps produce and that justify irrigation are at historic lows and may stay there. Under these circumstances, it is appropriate that emphasis continue to shift away from new sites, but not to simply rehabilitating existing projects to old standards. Irrigation systems serve a changing environment and need to be constantly redesigned. *Upgrading* requires intensive application of engineering and social solutions to improve existing irrigation, thus lowering unit costs, conserving water, and improving service to people.

When investors, the Bank included, assess irrigation projects, benefits and costs from provision of household and industrial water and of its public health, catchment improvement, and dam safety effects should be counted.

Large irrigation projects are more likely to succeed than smaller ones—most likely, because there are engineering economies of scale, because larger projects attract better managers, and because borrowers are more disposed to take the actions necessary to assure that larger, more visible projects succeed. There is no justification for a bias against large projects.

A common argument against more beneficiary participation in project design and implementation is that it causes delay. If the finding of this study—that implementation delays do not prejudice the results of irrigation projects—is confirmed, then there is less reason to worry about implementation delays and more scope for participation. In any event, lack of participation often reduces benefits and disrupts implementation schedules.

Irrigation is more likely to succeed in countries with lower levels of certain kinds of economic distortions. This fact should be considered in investment decisions.

Construction quality and land acquisition are major implementation problems. Bank irrigation supervision should focus on them.

There is rarely any link between irrigation water charges and O&M. There are valid efficiency and equity reasons for raising water charges, but improving O&M is not one of them. Bank directives should reflect this fact.

The most promising way to improve O&M is to make irrigators responsible for their own O&M and to provide them technical support.

Whether irrigators contract for O&M with irrigation departments or with private entities or do it themselves, they need to be organized. The conditions that foster group organization and functioning are known. They should be fostered in Bank-supported projects.

Where water conservation is called for and there is little likelihood that water charges will be raised enough to achieve it, the Bank and its borrowers should seek other ways to foster more efficient water use, including irrigation systems designed to impose water scarcity by rationing supply.

The design problems of large surface-irrigation schemes in the humid tropics are acknowledged. Whether the solution lies in simpler, less-reticulated systems that integrate gravity-feed and pumping or in more sophisticated and flexible systems, design questions and pump options deserve more critical attention and pilot testing prior to large-scale applications.

Irrigation-related health initiatives have been so successful that the Bank should consider expanding them, as part of irrigation projects or independently.

Where there is a potential synergy between irrigation and catchment improvement, Bank-supported projects should exploit it.

Defective or insufficient drainage is the biggest single source of environmental problems stemming from irrigation. The Bank should continue to stress the value of drainage and to finance drainage where demand exists. Because drainage problems frequently stem from weak demand and collective action dilemmas, the Bank should sponsor experimentation to master cooperative approaches to drainage investment.

The Bank should continue to apply its involuntary resettlement policy, and should assist borrowers in dealing with the social dimensions of irrigation investment, the goal being to achieve equity for both oustees and the society at large.

Notes

1. Still partly an estimate in most cases because full development has still not been attained for most irrigation projects at the time of evaluation.

2. The pump irrigation category covers a variety of types, most commonly pumped groundwater for local distribution, but also pumped river or other water to a major supply system or pumped local distribution from canals. Unfortunately, evaluations did not permit segregation into these subcategories, which would have proved instructive.

Resumen

En la actualidad, está satisfecha la demanda mundial de productos agrícolas, es decir, alimentos y fibras. Existe el hambre, pero ello se debe a que los que padecen hambre no están en condiciones de convertir sus necesidades en demanda o a que los disturbios populares producen perturbaciones en las corrientes de alimentos. Los precios de los alimentos básicos registran niveles bajos casi sin precedentes y las reservas son adecuadas. Esta situación sería inconcebible si no se hubieran efectuado inversiones en riego en los últimos 50 años.

El riego continuará teniendo una función esencial en lo que respecta a nuestra capacidad para alimentarnos y vestirnos, para no mencionar su importancia decisiva en la creación de empleo. A medida que aumenta la demanda de productos agrícolas —impulsada por el crecimiento demográfico y de los ingresos— la mayor parte del aumento de la producción tendrá que provenir de tierras regadas. El riego proporciona agua a las plantas, y es a menudo el insumo más fundamental en la producción de cultivos. Hay interacciones importantes y positivas entre el riego y las otras fuentes principales de crecimiento del sector agrícola: fertilizantes, mejores semillas, mejor cría de ganado, lucha integrada contra las plagas y mejor integración en los mercados.

En el mundo en desarrollo, el riego es el mayor receptor de inversiones agrícolas del sector público y también de subsidios fiscales de operación. Son pocos los ejemplos en que los beneficiarios del riego pagan incluso los costos de funcionamiento y mantenimiento de los sistemas públicos.

El 7 por ciento de los préstamos del Banco Mundial se ha utilizado para financiar operaciones de riego. Desde 1950 hasta 1993, estos préstamos ascendieron a $31.000 millones en dólares constantes de los Estados Unidos. En total, el Banco apoyó 614 proyectos con componentes de riego en ese período, entre ellos 365 en los que más de la mitad de los gastos del proyecto se destinó al riego. Más de 100 proyectos se encuentran actualmente en diversas etapas de ejecución y aún no se han evaluado. Un número considerable de proyectos clasificados oficialmente como de crédito rural, electrificación o desarrollo subregional han apoyado también el riego.

Este estudio se centra en 208 proyectos de riego financiados por el Banco que han sido evaluados. La evaluación comprende los informes de terminación, las auditorías y los informes de evaluación de las repercusiones del proyecto. En los casos en que hay diferencias en las evaluaciones, en este estudio se da preferencia a la evaluación de las repercusiones sobre las auditorías, y a éstas sobre los informes de terminación. Los análisis toman en cuenta la calidad a veces desigual del conjunto de datos. También

se examinan los 614 proyectos del Banco relacionados con el riego aprobados hasta 1993, los 100 en marcha y los estudios efectuados fuera del Banco que arrojan luz sobre algunas cuestiones que no tratan las evaluaciones.

El estudio se ocupa principalmente de dos interrogantes. ¿Cúal ha sido la política del Banco en materia de riego? y ¿cuáles han sido los rendimientos (en el sentido más amplio de la palabra) de las inversiones en riego? Las respuestas deberían contribuir a mejorar dichas inversiones. Llevan a *conclusiones* acerca de los éxitos y los fracasos y a la manera cómo han evolucionado las políticas del Banco en esta materia, y se formulan *recomendaciones* con respecto a cambios en la política de inversiones en riego financiadas por el Banco.

Políticas y préstamos del Banco

Asia ha recibido un 69 por ciento de los préstamos del Banco destinados a riego. (Esto no constituye una concentración del financiamiento, toda vez que el 85 por ciento de la superficie regada del mundo en desarrollo está en Asia.) *Más de la mitad de todos los préstamos se ha destinado a las zonas tropicales húmedas de Asia,* donde los sistemas de riego se utilizan de preferencia en el cultivo del *arroz.* India, que ha recibido el 26 por ciento de los préstamos para riego, es sobradamente el cliente principal. Como promedio, los proyectos de Asia han sido de mayor envergadura en cuanto al costo total, la magnitud del préstamo, la superficie regada, la producción y la atención que han atraído sus problemas.

El 31 por ciento restante de los préstamos del Banco para riego se divide entre los países de Africa, las Américas y Europa. Si bien las inversiones en Africa se han distribuido en forma amplia, se encuentran fundamentalmente en las regiones áridas y semiáridas del norte de Africa y el Sahel, y en Madagascar. El término medio de los proyectos en Africa es relativamente pequeño y complejo y a ello se debe que a este continente le corresponda el 30 por ciento de los proyectos, pero sólo el 12 por ciento del financiamiento. Las inversiones en riego del Banco en las Américas (13 por ciento) han variado en el transcurso del tiempo, registrándose el nivel más bajo en el decenio de 1980. Aunque hay algunos proyectos de riego de arrozales en las zonas húmedas —como en Colombia y Guyana— los hay más en las regiones áridas de la costa del Pacífico. En los años setenta y principios de los ochenta, se otorgaron muchos préstamos en Europa (5 por ciento), sobre todo en Rumania, pero desde entonces no se han concedido más.

Los préstamos para riego del Banco han disminuido desde que llegaron a su nivel máximo a mediados y fines del decenio de 1970 y comienzos del de 1980. Las inversiones en riego en gran escala del Banco y otras instituciones en todo el mundo comenzaron en los años sesenta con el fin de aliviar las crisis de alimentos y los elevados precios de los productos agrícolas, y calmar las ansiedades neo-maltusianas. Posteriormente, la reacción positiva de la agricultura mundial dio lugar a precios bajos de los cultivos, menos urgencia para tratar los problemas del sector agrícola y disminución de las inversiones en riego. Existe el peligro de que esta situación conduzca a un falso sentido de seguridad, a niveles insuficientes de inversiones en riego y a posteriores crisis que podrían afectar a los segmentos más pobres y más dependientes de la población mundial.

En los años cincuenta el Banco aprobó como promedio un proyecto de riego al año; en el decenio de 1960, cuatro al año; en los setenta y ochenta, 26, y en el actual decenio, 15. El préstamo medio para riego al año (en dólares de los Estados Unidos de 1991) ascendió a $37 millones en los años cincuenta, $343 millones en los sesenta, $1.120 millones en los setenta, $1.273 millones en los ochenta y $1.032 millones en lo que va corrido del presente decenio.

Hasta el decenio de 1970 no había muchas ambigüedades acerca de si los proyectos eran de riego o no, pero en 1973 el Banco empezó a financiar muchos más proyectos de "desarrollo rural" que incluían un componente de riego. Además, en el decenio de 1970 y principios del de 1980, una vez hechos los ajustes por concepto de inflación, disminuyó la magnitud media de los proyectos de riego. Pero desde entonces ha aumentado y se ha producido un desplazamiento marcado del financiamiento de planes de riego específicos a préstamos subsectoriales.

El financiamiento del Banco para riego se ha destinado principalmente al cultivo de más cereales. En el caso de más de la mitad de los proyectos de riego, los cereales constituían el único producto y, en más del 90 por ciento, el predominante. Con mayor frecuencia, el arroz era el único producto en más de una tercera parte de los proyectos y el principal en el 60 por ciento. Los principales productos distintos de los cereales eran el algodón, la caña de azúcar y las frutas y verduras.

La diferencia más fundamental entre los proyectos de riego en cuanto a su diseño y ubicación *está entre los destinados al cultivo del arroz y a los productos distintos del arroz.* Los primeros se concentran en Asia oriental y sudoriental, Bangladesh y la India oriental, en zonas donde el promedio de precipitaciones anuales alcanza los 2.000 mm. La mayor parte de los otros proyectos se encuentran en Asia occidental (Pakistán y partes de la India), norte de Africa, la costa occidental de las Américas y Europa. En Asia occidental y el norte de Africa, la precipitación media anual de los proyectos de riego evaluados asciende a menos de 400 mm.

Esta concentración de préstamos del Banco destinados al riego para el cultivo de arroz en zonas tropicales húmedas es distinta a la distribución de la superficie regada del mundo en desarrollo, donde alrededor de una tercera parte está en los trópicos húmedos.

Los pobres se han beneficiado de la mayoría de las inversiones en riego. El tamaño medio de las explotaciones agrícolas de los beneficiarios por proyecto es de dos hectáreas. El proyecto típico atendió a 76.000 familias de agricultores, que van desde un promedio de 172.000 en la India, a 5.000 en Africa al sur del Sahara. Pero estos no fueron los únicos beneficiarios directos. Toda vez que el riego aumenta la intensidad de cultivo, eleva considerablemente la demanda de mano de obra. Una parte de la mano de obra adicional la proporcionan las familias que dirigen las explotaciones, y otra parte la mano de obra contratada. No es posible cuantificar debido a la falta de datos, pero millones de personas encontraron oportunidades para trabajar como resultado de estos proyectos.

La mayoría de los proyectos de riego financiados por el Banco no parten de cero. Si bien no siempre es posible distinguir entre rehabilitación, ampliación, mejoramiento y nuevas construcciones, *menos de la mitad de los proyectos evaluados eran sin lugar a dudas proyectos de nuevas construcciones.* Cerca de una quinta parte eran evidentemente proyectos de rehabilitación, y el resto una combinación de ambas cosas.

El financiamiento del Banco abarca sólo una parte de los programas de inversión en riego de los prestatarios. La baja incidencia de financiamiento de represas por el Banco así lo demuestra. Menos de una cuarta parte de los proyectos evaluados comprendía financiamiento para represas, y en muy pocos casos éstas eran de gran escala.

Después del reasentamiento y la construcción de grandes represas, el drenaje es el elemento del riego por el que más críticas recibe el Banco. *El drenaje deficiente tiene consecuencias ecológicas negativas.* Sin embargo, *el drenaje ha sido un elemento explícito de un mayor número de proyectos que cualquier otro componente físico,* y también *figura en forma destacada en los convenios legales.*

Resultados del riego

En las evaluaciones se ha clasificado como en general satisfactorio a un 67 por ciento de los proyectos de riego. En los casos en que los proyectos se ponderan según la extensión de la superficie atendida, el 84 por ciento del riego se estima satisfactorio. Esto es mejor que el promedio de todos los proyectos de agricultura financiados por el Banco (65 por ciento no ponderados), pero peor que el porcentaje correspondiente a todos los proyectos del Banco (76 por ciento). Más del 80 por ciento de los proyectos de riego apoyados por préstamos del Banco aprobados antes de 1976 se consideró satisfactorio, al igual que casi el 80 por ciento de los aprobados desde 1981. Entre 1976 y 1981, las clasificaciones fueron más bajas como promedio, lo que podría atribuirse a la mayor complejidad y menor dimensión de los proyectos de riego aprobados en ese período. A semejanza de otros tipos de proyectos, los de riego en Africa al sur del Sahara tenían menos probabilidades que otros de clasificarse como satisfactorios.

En la evaluación inicial, se preveía que la tasa de rendimiento económico de las inversiones en riego alcanzaría un promedio de 22 por ciento. En la evaluación final el promedio[1] fue de 15 por ciento. Estos son promedios no ponderados. Cuando los proyectos se ponderan por la superficie regada, la tasa prevista en la evaluación inicial fue de 29 por ciento, y en la evaluación final, 25 por ciento.

Por consiguiente, las repercusiones generales de los proyectos de riego financiados por el Banco han sido relativamente satisfactorias. Considerando la complejidad técnica y social del riego, este historial es motivo de orgullo para los prestatarios y el Banco. Pero también es evidente que hay muchas posibilidades de mejoramiento, tanto en el tercio de los proyectos estimados insatisfactorios como en los dos tercios considerados satisfactorios.

De los seis factores más importantes incluidos en los cálculos de rendimiento económico, los que más influyen en los resultados de los proyectos de riego son el tamaño de la superficie regada, el precio de los productos, la producción de los cultivos y el costo unitario. Las variaciones en la ejecución (ya sea tiempo o atraso en general) no influyeron en el rendimiento económico.

Durante gran parte de los decenios de 1970 y 1980 se registraron disminuciones apreciables de los *precios* internacionales de los principales productos agrícolas relacionados con el riego: arroz, otros cereales, algodón y azúcar. Es posible que los precios de estos productos se mantengan en un nivel bajo. Lo irónico es que estas disminuciones, que han tenido el efecto de reducir considerablemente las tasas de rendimiento del riego en las evaluaciones finales, se han debido probablemente en parte a las inversiones en riego, sobre todo en el caso del arroz. Sin embargo, los precios más bajos de los alimentos y las fibras han reportado inmensos beneficios a los pobres.

Hay una importante correlación entre *el tamaño del proyecto*, medido por la superficie atendida, y el rendimiento económico. Mediante la utilización de estimaciones en la evaluación, los factores de correlación entre dimensión y rendimiento económico fueron de 0,28 para todos los proyectos, 0,32 para los proyectos de riego por gravedad y 0,34 para los proyectos de bombas. La correlación es válida cuando los resultados se ajustan para Africa al sur del Sahara, donde los proyectos de riego son mucho más pequeños que el promedio y los resultados han sido desalentadores. Estos coeficientes, sorprendentemente elevados tratándose de un solo factor en un fenómeno social tan complejo como el riego, indican la existencia de economías de escala.

En el *Informe sobre el Desarrollo Mundial 1991* se sostenía que las *distorsiones económicas* tienen

efectos considerables y negativos en los resultados de los proyectos. Ni en dicho Informe ni tampoco en este estudio fue posible cuantificar las distorsiones de precios internos ni las imperfecciones del mercado interno que repercuten más en los proyectos de riego. Entre las distorsiones estudiadas, las cambiarias tenían un efecto negativo mayor que las de las tasas de interés; sin embargo, las distorsiones del comercio exterior *mejoraron* el desempeño económico de los proyectos de riego. Al parecer, éstas surgían de las medidas adoptadas por los gobiernos para proteger a los agricultores de los bajos precios internacionales, en especial del arroz. Tal protección no afecta en forma directa el rendimiento económico. Es evidente que en vista de un rendimiento financiero más alto, los agricultores liberaban más capital humano y lograban mejores resultados económicos.

Una premisa de este estudio era demostrar que la *escasez de agua* había influido en el desempeño —es decir, que agricultores y gobiernos en zonas áridas se esforzaban más para que el riego tuviera éxito y, en consecuencia, lograban mejores resultados que los obtenidos en las zonas húmedas, donde hay agua suficiente para los cultivos de secano. Esta premisa no fue validada. Desde el punto de vista estadístico no hay una relación importante. De hecho, los proyectos de aguas freáticas tienen *algo más* de éxito en las zonas húmedas que en las secas, lo que probablemente se deba a que el agua, que sirve de complemento a las precipitaciones, tiene un valor unitario más elevado.

A diferencia de lo anterior, los resultados de los proyectos de riego de superficie no indican una relación con las precipitaciones. La rehabilitación, la ampliación y el mejoramiento de estos proyectos tendía a ocurrir en zonas más húmedas. Los costos no recuperables más elevados y una arraigada tradición de riego deben producir rendimientos más altos en estos proyectos que en los totalmente nuevos, que tendían a estar en zonas más secas.

En promedio, los proyectos de *aguas freáticas* son algo más pequeños que los de superficie, y sus costos unitarios son un poco más bajos. Sin embargo, en las evaluaciones se calcularon tasas de rendimiento económico de 21 por ciento más altas para los proyectos de aguas freáticas que para los de riego de superficie. Hay el doble de probabilidades de que los grupos de beneficiarios del primer grupo trabajen en forma satisfactoria.

Procedimientos del Banco

En los *estudios del sector* de riego del Banco, en lo que respecta a la muestra analizada, se ha prestado poca atención a la planificación ambiental, concretamente a la *asignación de recursos hídricos y la planificación de recursos naturales*, pero la situación está mejorando. La cobertura de los informes sectoriales de determinadas esferas del impacto ambiental ha sido deficiente y aún es bastante débil. Esto es válido con respecto al *drenaje, y* en especial *a la administración de acuíferos* y los diversos aspectos de la *gestión de las cuencas de captación:* deforestación, pastoreo excesivo, técnicas agrícolas inapropiadas, degradación del suelo, erosión y sedimentación.

La cobertura de los estudios sectoriales es mejor en el caso de tres de las cuatro esferas de problemas seleccionados. La cobertura de las *cuestiones relativas a tierras* es amplia, pero no muy completa. También es extensa la cobertura respecto a las *tarifas de agua, el funcionamiento y mantenimiento y los grupos de participantes considerados en conjunto.* La cobertura en materia de *administración y organización* es amplia, pero en general superficial. Se concentra en instituciones gubernamentales, y en forma ocasional toca el tema de sus relaciones con las organizaciones de beneficiarios del riego, pero casi nunca se centra en las organizaciones mismas. No se trató el tema de *la función de la mujer en los proyectos de riego.*

Varios de los informes más recientes del sector de riego —entre ellos los de Filipinas y la India— merecen una calificación destacada por su alcance y profundidad.

Si bien no fue posible evaluar la calidad en general, al comienzo del ciclo de los proyectos de riego, sus resultados demostraron ser sensibles a algunos aspectos de la *preparación* y la *evaluación*. Los evaluadores han constatado que la *calidad del diseño y la planificación* han sido aún más decisivos para el éxito del proyecto que la *suficiencia del diseño final*.

La supervisión de los proyectos de riego registró un nivel más alto al año —12 por ciento— que el promedio de los proyectos del Banco. Dado que el riego está en el extremo superior de la escala de complejidad de los proyectos, este resultado no es sorprendente. A nivel regional, Europa descolla por su bajo nivel de supervisión —33 por ciento por debajo de la norma del Banco y 40 por ciento por debajo del promedio en materia de riego; en cambio, Asia meridional se destaca por su elevado nivel —56 por ciento por encima de la norma del Banco y 39 por ciento por encima del promedio de los proyectos de riego. De los prestatarios importantes en la esfera del riego, cuatro cuentan con personal residente del Banco especializado en agricultura. Dos prestatarios han tenido niveles de supervisión excepcionalmente elevados, 53 por ciento y 55 por ciento superior al promedio, y dos han registrado niveles bajos —30 por ciento y 10 por ciento inferior al promedio. Los porcentajes elevados correspondientes a la supervisión pueden indicar cultura de ejecución, y los bajos, cultura de préstamos.

El prestatario y la ejecución

El promedio de *atraso en la ejecución* de los proyectos de riego —1,7 años— fue sólo ligeramente superior al promedio de todos los proyectos. Además de los factores corrientes como escasez de fondos del prestatario, los problemas de *adquisición de tierras y construcción* son causas importantes de atrasos en la ejecución de los proyectos de riego. Mientras la ejecución tiene un promedio de atraso de 30 por ciento, el 16 por ciento de las obras, como término medio, no se construye incluso en ese período más prolongado, lo que equivale a un atraso de 55 por ciento por unidad construida del proyecto.

Los *costos unitarios por hectárea* constituyen un indicador útil de la ejecución. El costo unitario medio de todos los proyectos de riego es de $4.800. Los proyectos evaluados no satisfactorios tienen costos unitarios que son 3,5 veces más altos que los estimados satisfactorios. No es sorprendente que los nuevos proyectos de construcción sean más costosos que los de rehabilitación. Los planes de riego por gravedad son más costosos que los de bombeo[2], y los planes de riego de arrozales son más caros que los demás. Esto da lugar a importantes diferencias regionales. Por ejemplo, los costos unitarios del plan medio en Africa al sur del Sahara fueron 13,3 veces más elevados que el promedio en Asia meridional. El cálculo de costos unitarios "reajustados" que toman en cuenta los trabajos programados que no se han ejecutado muestra que los problemas de ejecución se concentraron en las Américas, Asia oriental y Africa al sur del Sahara, en proyectos de rehabilitación y de arrozales, en planes de riego por gravedad y, lo que no sorprende, en proyectos evaluados no satisfactorios.

Cuestiones fundamentales en el diseño y la sostenibilidad de los sistemas

Entre los muchos temas planteados por las auditorías del Departamento de Evaluación de Operaciones (DEO) y las evaluaciones de los efectos de los proyectos de riego, se eligieron dos para ser analizados extensamente en razón de su importancia: el funcionamiento y mante-

nimiento (F&M) y el diseño de sistemas de riego de superficie en las zonas tropicales húmedas.

Funcionamiento y mantenimiento. En las evaluaciones se constatan problemas generalizados de funcionamiento y mantenimiento, de recuperación de costos, y con los grupos de usuarios. De los tres, el primero es el más importante porque repercute directamente en los beneficios. Los grupos que se favorecen con el riego pueden ser valiosos en sí mismos simplemente porque los miembros se identifican con el proyecto, en tanto que la recuperación de costos es una cuestión de transferencias entre los gobiernos y los beneficiarios, lo que puede influir en los incentivos para regar en forma eficiente. En parte, el entusiasmo del Banco por la recuperación de los costos del riego se debe a una supuesta vinculación entre la recuperación de los costos y un mejor funcionamiento y mantenimiento.

En el estudio se confirman conclusiones anteriores del DEO en el sentido de que normalmente no hay una relación entre tarifas de agua más altas y mejor funcionamiento y mantenimiento. Los ingresos provenientes de las tarifas de agua por lo general van a la tesorería general y no se destinan específicamente a F&M. Los estudios efectuados por el Banco Asiático de Desarrollo, la Fundación Ford, el Institute for Philippine Culture, el Instituto Internacional de Ordenación del Riego y la Philippine National Irrigation Administration indican que la autonomía financiera da por resultado importantes mejoramientos en la calidad y la eficacia en función de los costos. Esta autonomía a menudo adopta la forma de traspaso de las actividades de F&M a los beneficiarios, pero también existen otros planes. Cuando predomina la autonomía financiera y los usuarios pagan los costos de F&M y organizan ellos mismos estas actividades, mejora notablemente el funcionamiento y mantenimiento.

El Banco ha fomentado de diversas maneras la formación de grupos de beneficiarios del riego y el traspaso de los sistemas a ellos. Sin embargo, el desaliento ha sido más corriente que el éxito, que requiere algo más que convenios en que los prestatarios acuerdan establecer grupos de usuarios. En estudios empíricos se han identificado las condiciones que impulsan a los beneficiarios a establecer grupos de usuarios que perduren en el tiempo.

Diseño de sistemas de riego. En las evaluaciones se informa de problemas generalizados en el diseño de los sistemas de riego, sobre todo en los trópicos húmedos donde el drenaje y el control de las inundaciones constituyen ingentes problemas. En la mayoría de los casos, estos proyectos comenzaron con sistemas de cultivo de arroz basados en el suministro lento y continuo de agua, y se procuró convertirlos a sistemas más reticulados con mejores capacidades de suministro, a menudo diseñados para funcionar con control de cierre y apertura, y que supuestamente podían proporcionar agua para una variedad de cultivos cuando se necesitara (o en situaciones parecidas). Varias evaluaciones muestran que estos sistemas más reticulados, si bien se prestan para regiones más secas, no son apropiados en las zonas tropicales húmedas.

Estos sistemas más reticulados, en los trópicos húmedos sobre todo, tienen problemas de vandalismo de las estructuras por los agricultores y acaparamiento de agua por los que riegan primero. Esto trae graves consecuencias para los que están al final del sistema y para la sociedad en general.

Las soluciones propuestas se dividen en dos categorías. Una consiste en hacer que estos sistemas funcionen mejor mediante el mejoramiento del transporte de agua, de la reglamentación de las estructuras y de las comunicaciones para que el riego se proporcione cuando se requiera.

La otra solución propuesta es lograr la eficiencia y la confiabilidad operacional reduciendo la

flexibilidad del sistema. Un nivel más bajo de servicios de riego (aunque más alto de lo que se obtiene actualmente), que asegure un suministro de conformidad con un horario rígido, obliga a los agricultores a adaptar sus cultivos al horario de abastecimiento de agua. Esto supone cierto sacrificio de la optimización agronómica y económica. En algunos casos estas soluciones comprenden la instalación de bombas y el costo del bombeo. Lo que es importante, reducen la autonomía de los operadores del sistema, y por ende las oportunidades que tienen de coludirse con los beneficiarios privilegiados. Con la imposición de escasez de agua hay incentivos para ahorrar agua.

Recomendaciones

La mitad o más de los actuales préstamos del Banco para riego no se destina a la construcción de nuevos sistemas, sino que a ampliaciones, rehabilitaciones y mejoramientos de los sistemas en uso. A medida que transcurre el tiempo, son más las regiones del mundo donde los agricultores se enfrentan a una creciente competencia por el agua. También está aumentando el costo de preparación de nuevos emplazamientos para riego puesto que ya se han construido los que son más atrayentes desde el punto de vista económico. Además, los precios de los alimentos y las fibras que el riego contribuye a producir, y que lo justifican, se encuentran en niveles bajos sin precedentes, y es posible que se mantengan así. En esas circunstancias, está bien que el interés continúe desplazándose de las nuevas construcciones, pero no simplemente para rehabilitar proyectos existentes ateniéndose a normas antiguas. Los sistemas de riego funcionan en un ambiente cambiante y requieren constantes reformulaciones. El *mejoramiento* precisa la aplicación intensiva de soluciones técnicas y sociales para mejorar el riego actual, disminuyendo así los costos unitarios, conservando los recursos hídricos y perfeccionando los servicios a la población.

Cuando los inversionistas, entre ellos el Banco, evalúan proyectos de riego, deben tener en cuenta los costos y beneficios del suministro de agua para uso doméstico e industrial y de la salud pública, el mejoramiento de las zonas de captación y la seguridad de las represas.

Es más probable que tengan éxito los proyectos de riego de gran envergadura que los más pequeños, lo que posiblemente se deba a que hay economías técnicas de escala porque los proyectos de mayor magnitud atraen mejores administradores y los prestatarios están más dispuestos a adoptar las medidas que sean necesarias para asegurar el éxito de los proyectos más grandes y más visibles. No se justifica la tendencia en contra de los proyectos de gran magnitud.

Una razón que se suele esgrimir en contra de una mayor participación de los beneficiarios en el diseño y la ejecución de los proyectos es que ocasiona atrasos. Si se confirma la conclusión de este estudio, es decir que los atrasos de ejecución no menoscaban los resultados de los proyectos de riego, en ese caso hay menos razones para preocuparse de las demoras en la ejecución y más posibilidades de participación. En todo caso, la falta de participación a menudo reduce los beneficios y causa perturbaciones en los programas de ejecución.

Es más probable que el riego tenga éxito en los países con niveles más bajos de tipos determinados de distorsiones económicas. Este elemento debe considerarse en las decisiones relativas a inversiones.

La calidad de la construcción y la adquisición de tierras son problemas de ejecución que revisten importancia. La supervisión del Banco en los proyectos de riego debe centrarse en esos aspectos.

Rara vez hay una relación entre las tarifas por concepto de agua de riego y el funcionamiento

y mantenimiento. Hay razones valederas de eficiencia y de equidad para aumentar las tarifas, pero el mejoramiento del F&M no es una de ellas. Esta conclusión debe reflejarse en las directivas del Banco.

La manera más prometedora de mejorar el F&M es responsabilizar a los favorecidos con los proyectos de riego de sus propias actividades en este ámbito y proporcionarles apoyo técnico.

Ya sea que los beneficiarios celebren contrato de F&M con los departamentos de riego o con entidades privadas, o se encarguen ellos mismos del F&M, es necesario que estén organizados. Se conocen las condiciones que impulsan la formación de las organizaciones de grupos y su funcionamiento, y debe fomentarse en los proyectos apoyados por el Banco.

En los casos en que se requiere conservar los recursos hídricos y existen pocas probabilidades de que el aumento de las tarifas de agua será suficiente para lograrlo, el Banco y sus prestatarios deben procurar encontrar otros medios de fomentar el uso más eficiente del agua, por ejemplo, los sistemas de riego orientados a imponer escasez de agua mediante el racionamiento.

Se reconocen los problemas de diseño de sistemas de riego de superficie de gran escala en las zonas tropicales húmedas. Sea que su solución radique en sistemas más simples y menos reticulados en los que se integre el abastecimiento de agua por gravedad o por bombeo, o en otros técnicamente más avanzados y flexibles, las cuestiones relativas al diseño y las opciones en cuanto a bombeo merecen más atención y pruebas experimentales antes de aplicarlas en gran escala.

Las iniciativas en materia de salud relacionadas con el riego han tenido tal éxito que el Banco debiera considerar su ampliación, como parte de los proyectos de riego o en forma independiente.

Cuando hay una posible sinergia entre el riego y el mejoramiento de las zonas de captación, los proyectos financiados por el Banco deben sacar partido de esta sinergia.

El drenaje defectuoso o insuficiente es la mayor fuente de problemas ambientales que causa el riego. El Banco debe continuar haciendo hincapié en el valor del drenaje y financiándolo donde hay demanda. Debido a que los problemas de drenaje suelen deberse a una débil demanda y a problemas relacionados con las medidas que afectan a los grupos, la institución debe patrocinar experimentos para formular enfoques cooperativos a las inversiones en drenaje.

El Banco debe seguir aplicando su política con respecto al reasentamiento involuntario, y ayudar a los prestatarios a enfrentar los aspectos sociales de las inversiones en riego, siendo la meta el logro de equidad tanto para los reasentados como para la sociedad en general.

Notas

1. En la mayoría de los casos en parte son todavía estimaciones puesto que el pleno funcionamiento aún no se ha logrado en la mayoría de los proyectos de riego en el momento de la evaluación.

2. La categoría de riego por bombeo abarca una diversidad de tipos, siendo el más corriente el de aguas freáticas bombeadas para distribución local, pero también bombeada de ríos u otras fuentes a un sistema principal de suministro, o bombeada para distribución local desde canales. Lamentablemente, las evaluaciones no permitieron separar estas subcategorías, lo que hubiera resultado instructivo.

Résumé analytique

La demande mondiale de produits agricoles — denrées alimentaires et fibres — est aujourd'hui satisfaite. Si la faim subsiste, c'est que ceux qui ont faim ne peuvent traduire leurs besoins en une demande, ou bien que des troubles civils perturbent la circulation des vivres. Les prix des denrées de première nécessité sont proches de leur plus faible niveau historique, et les stocks sont adéquats. Jamais il n'aurait pu en être ainsi sans un demi-siècle d'investissements dans l'irrigation.

L'irrigation continuera à jouer un rôle critique dans notre aptitude à nous nourrir et à nous vêtir, sans parler de sa contribution majeure à la création d'emplois. Ce sont de plus en plus les terres irriguées qui devront fournir le supplément de production agricole que nécessitera l'augmentation de la demande de produits agricoles sous l'effet de l'accroissement démographique et de la hausse des revenus. L'eau qu'apporte l'irrigation est habituellement l'élément le plus critique pour la production végétale. Il existe de fortes corrélations positives entre l'irrigation et les autres éléments majeurs de la croissance agricole : engrais, semences améliorées, meilleures techniques culturales, lutte phytosanitaire intégrée et meilleure intégration aux marchés.

L'irrigation est, dans les pays en développement, le premier bénéficiaire des investissements publics dans l'agriculture. Elle absorbe aussi une grande part des dépenses publiques d'exploitation. Les cas où les irrigants paient ne serait-ce que les dépenses d'exploitation et d'entretien des systèmes publics sont peu nombreux.

L'irrigation a reçu 7 pour cent des prêts de la Banque mondiale, soit, entre 1950 et 1993, 31 milliards de dollars en dollars constants. Pendant cette période, la Banque a soutenu 614 projets ayant un élément d'irrigation, dont 365 où plus de la moitié des dépenses sont allées à l'irrigation. Plus de 100 projets d'irrigation sont en cours d'exécution et n'ont pas encore fait l'objet d'une évaluation rétrospective. Un nombre important de projets formellement classés comme relevant du crédit rural, de l'électrification ou du développement local soutiennent aussi l'irrigation.

La présente étude porte sur 208 projets d'irrigation financés par la Banque et ayant déjà fait l'objet d'une évaluation rétrospective (rapports d'achèvement, rapports d'évaluation rétrospective et études d'impact). Lorsque les conclusions de ces différents documents ne concordent pas, la préférence est donnée aux études d'impact sur les rapports d'évaluation rétrospective, et à ces derniers sur les rapports d'achèvement. L'analyse tient compte de la qualité parfois inégale des données. Elle examine aussi les 614 projets de la Banque comportant un volet irrigation que la Banque avait

approuvés à la fin de 1993, les 100 projets en cours, et des études non réalisées par la Banque qui éclairent certaines questions non élucidées par les évaluations.

L'étude est centrée sur deux questions. Quelle a été la politique de la Banque en matière d'irrigation? Et quelle a été la rentabilité (au sens le plus large du terme) des investissements d'irrigation? Les réponses devraient aider à améliorer ces investissements. Elles amènent à formuler des *conclusions* sur ce qui a ou n'a pas été efficace et sur l'évolution des politiques de la Banque en matière d'irrigation, et des *recommandations* sur les modifications possibles de ces politiques.

Politiques et prêts de la Banque

L'Asie a reçu 69 pour cent des prêts de la Banque à l'irrigation (proportion normale puisque la région regroupe 85 pour cent des terres irriguées des pays en développement). *Plus de la moitié de ces prêts sont allés aux zones tropicales humides de l'Asie*, où les systèmes d'irrigation servent surtout la *riziculture*. L'Inde est de loin le plus gros emprunteur (26 pour cent des prêts à l'irrigation). En moyenne, les projets réalisés en Asie ont été supérieurs aux autres, qu'il s'agisse de leur coût total, du montant du prêt, des surfaces irriguées, de la production, ou encore de l'attention que leurs problèmes ont suscitée.

Les autres prêts de la Banque à l'irrigation (31 pour cent) se sont répartis entre l'Afrique, le continent américain et l'Europe. En Afrique, ces investissements sont allés à de nombreux pays, mais surtout aux zones arides et semi-arides de l'Afrique du Nord et du Sahel et à Madagascar. Le projet africain moyen est relativement petit et complexe, ce qui explique que l'Afrique représente 30 pour cent du nombre des projets, mais 12 pour cent seulement du volume des prêts. La part du continent américain s'établit à 13 pour cent et le niveau des investissements a fluctué avec le temps, les années 80 marquant un minimum. Certains projets d'irrigation rizicole ont visé des zones humides, en Colombie et au Guyana par exemple, mais un plus grand nombre ont été réalisés dans les zones arides de la côte du Pacifique. Les prêts en Europe (5 pour cent) ont été concentrés sur les années 70 et le début des années 80, en faveur en particulier de la Roumanie, et ont totalement cessé depuis.

Les prêts de la Banque pour des projets d'irrigation ont diminué, après avoir culminé entre le milieu des années 70 et le début des années 80. Les investissements dans l'irrigation avaient commencé à augmenter très fortement, à l'échelle mondiale comme au niveau de la Banque, durant les années 60 en réponse aux crises alimentaires, au cours élevé des produits agricoles et à des anxiétés néomalthusiennes. La réponse de l'agriculture mondiale ayant été positive, les prix des productions végétales ont diminué, les problèmes agricoles ont semblé perdre de leur acuité, et les investissements dans l'irrigation ont diminué. Il est à craindre cependant que cette situation fasse naître un optimisme exagéré, que les investissements d'irrigation tombent à un niveau insuffisant et qu'il en résulte des crises dont souffriraient les populations les plus pauvres et les plus vulnérables.

Durant les années 50, la Banque avait approuvé en moyenne un projet d'irrigation par an; le nombre annuel des projets est passé à quatre durant les années 60 et à 26 dans les années70 et 80, et il a été de 15 jusqu'à présent pour les années 90. Le montant annuel moyen des prêts a représenté (en dollars de 1991) 37 millions de dollars durant les années 50, 343 millions de dollars durant les années 60, 1.120 millions de dollars durant les années 70, 1.273 millions de dollars durant les années 80, et 1.032 millions de dollars depuis 1990.

Jusqu'aux années 70, il n'y avait guère d'ambiguïté sur la définition d'un projet d'irrigation,

mais, en 1973, la Banque a commencé à financer beaucoup plus de projets dits de développement rural comportant un élément irrigation. Par ailleurs, pendant les années 70 et au début des années 80, correction faite de l'inflation, la taille moyenne des projets d'irrigation avait diminué, mais elle s'est amplifiée par la suite. L'accent s'est nettement déplacé du financement de projets visant exclusivement l'irrigation vers l'octroi de prêts sous-sectoriels.

Les prêts de la Banque à l'appui de l'irrigation ont principalement visé l'augmentation de la production céréalière. Pour plus de la moitié des projets d'irrigation, les céréales devaient être la seule production et, dans plus de 90 pour cent des cas, la spéculation prédominante. Il s'agissait le plus souvent du riz (seul produit pour plus d'un tiers des projets, et produit prédominant pour 60 pour cent des projets). Outre les céréales, les principales cultures des zones irriguées devaient être le coton, la canne à sucre, et les fruits et légumes.

La principale différence entre les divers projets d'irrigation, qu'il s'agisse de leur conception ou de leur environnement, *est la distinction entre projets rizicoles et non rizicoles.* Les premiers sont concentrés en Asie de l'Est et du Sud-Est, au Bangladesh, dans l'est de l'Inde, dans des régions où la pluviométrie moyenne est de 2.000 mm. La plupart des projets non rizicoles concernent l'Asie occidentale (dont le Pakistan et certaines régions de l'Inde), l'Afrique du Nord, la Côte ouest du continent américain, et l'Europe. En Asie occidentale et en Afrique du Nord, les projets d'irrigation évalués ont été réalisés dans des régions où la pluviométrie moyenne annuelle est inférieure à 400 mm.

Cette concentration des prêts de la Banque sur la riziculture dans les zones tropicales humides ne correspond pas à la répartition des terres irriguées dans l'ensemble du monde en développement, dont un tiers seulement environ se trouvent dans les zones tropicales humides.

Les pauvres ont effectivement bénéficié des avantages de la plupart des investissements d'irrigation. La taille médiane de la surface cultivée par les bénéficiaires des projet est de deux hectares. En moyenne, un projet sert 76.000 familles agricoles (d'une moyenne de 172.000 en Inde à 5.000 en Afrique subsaharienne). Mais ces familles agricoles ne sont pas les seules bénéficiaires directes : l'irrigation augmentant l'intensité culturale, elle accroît fortement aussi la demande de travail. Cette main-d'oeuvre additionnelle est fournie pour partie par les familles des exploitants eux-mêmes, et pour partie par l'embauche d'ouvriers. Le manque de données empêche de chiffrer cet effet, mais des millions de personnes ont trouvé du travail grâce aux projets réalisés.

Dans la plupart des cas, les projets d'irrigation financés par la Banque ne sont pas partis de zéro. Il n'est pas toujours possible de distinguer entre remise en état, extension, amélioration et nouveaux ouvrages, mais *il est certain que moins de la moitié des projets évalués visaient des travaux neufs.* Un cinquième environ des projets correspondaient clairement à des opérations de remise en état, le reste mêlant à divers degrés construction et réhabilitation.

Les prêts de la Banque ne couvrent qu'une partie des programmes d'irrigation de l'emprunteur, comme en témoigne le fait que la *Banque a peu souvent financé la construction de barrages.* Moins d'un sur quatre des projets évalués ont contribué à l'aménagement de barrages, et très peu de ces ouvrages étaient de grande taille.

Après la réinstallation et les grands barrages, le drainage est l'élément des projets d'irrigation qui vaut le plus de critiques à la Banque. *Un mauvais drainage a des conséquences écologiques négatives. De tous les éléments physiques des projets, le drainage est celui qui a été incorporé au plus grand nombre de projets et il figure également en bonne place dans les clauses des accords.*

Résultats des investissements dans l'irrigation

Il ressort des évaluations rétrospectives que 67 pour cent des projets d'irrigation ont donné des résultats globalement satisfaisants. Après pondération par la superficie servie, la proportion passe à 84 pour cent, taux meilleur que la moyenne pour l'ensemble des projets agricoles aidés par la Banque (65 pour cent, sans pondération), mais moins bon que pour l'ensemble des projets de la Banque (76 pour cent). Plus de 80 pour cent des projets d'irrigation aidés par des prêts de la Banque approuvés avant 1976 ont été classés satisfaisants, comme près de 80 pour cent de ceux approuvés depuis 1981. Pour les années de la période 1976–81, les notations moyennes sont moins bonnes. Cela pourrait s'expliquer par la complexité accrue et la moindre taille des projets d'irrigation approuvés durant cette période. Comme pour d'autres types d'opérations, la proportion des projets jugés satisfaisants a été moindre pour les projets d'irrigation réalisés au sud du Sahara.

Lors de leur évaluation, on avait estimé que la rentabilité économique des investissements d'irrigation serait en moyenne de 22 pour cent. Les taux moyens constatés[1] lors des évaluations rétrospectives sont de 15 pour cent. Il s'agit là de moyennes non pondérées. Si on les pondère en fonction de la superficie servie, les taux de rentabilité observés à l'évaluation rétrospective sont de 25 pour cent, contre une prévision de 29 pour cent.

L'impact global des projets d'irrigation financés par la Banque est donc relativement bon. Etant donné la complexité sociale et technique de l'irrigation, ce résultat est à porter au crédit des emprunteurs et de la Banque. Mais il est clair aussi qu'il reste de nombreuses possibilités d'amélioration pour le tiers des projets classés non satisfaisants comme pour les deux tiers des projets classés satisfaisants.

Parmi les six principaux facteurs pris en compte dans le calcul de la rentabilité économique, ceux qui affectent le plus les résultats des projets d'irrigation sont la superficie irriguée, le prix du produit final, le rendement des cultures, et le coût unitaire. Les écarts dans les délais d'exécution (durée globale ou retards) n'ont pas d'effets sur la rentabilité économique.

Durant la plupart des années 70 et 80, on a observé une baisse très sensible des *cours* internationaux des principaux produits de l'agriculture irriguée : riz, autres céréales, coton et sucre. Il se pourrait bien que ces prix restent faibles. Paradoxalement, cette baisse des cours, qui a notablement réduit les taux de rentabilité constatés lors des évaluations rétrospectives, tient probablement en partie aux investissements d'irrigation eux-mêmes, en particulier dans le cas du riz. Mais les pauvres ont énormément bénéficié de cet abaissement des prix des denrées et des fibres.

On observe une nette corrélation entre la *taille des projets*, mesurée par la superficie irriguée, et la rentabilité économique. Selon les estimations des évaluations rétrospectives, les coefficients de corrélation sont de 0,28 pour l'ensemble des projets, de 0,32 pour les projets d'irrigation par gravité et de 0,34 pour l'irrigation par pompage. Les résultats demeurent valides lorsqu'on bloque les effets des projets d'irrigation réalisés en Afrique subsaharienne, de taille bien inférieure à la moyenne et dont les résultats sont notablement décevants. S'agissant d'un phénomène social aussi complexe que l'irrigation, les niveaux de corrélation étonnamment élevés observés pour un seul facteur donnent à penser qu'il existe des économies d'échelle.

Le *Rapport sur le développement dans le monde 1991* faisait valoir que les *distorsions économiques* avaient une forte incidence négative sur les résultats d'un projet. Mais ni ce rapport ni la présente étude n'ont pu chiffrer les distorsions de prix internes et les imperfections du marché intérieur qui ont le plus d'impact sur les

projets d'irrigation. Parmi les distorsions testées, celles qui touchent les taux de change avaient un effet négatif plus marqué que celles des taux d'intérêt; les distorsions des échanges internationaux en revanche *améliorent* la performance économique des projets d'irrigation. L'hypothèse est que ces distorsions résultent des mesures prises par les pouvoirs publics pour protéger les paysans contre la faiblesse des cours internationaux, notamment dans le cas du riz. Pareille protection n'affecte pas directement la rentabilité économique du projet. A l'évidence, la perspective de rendements financiers plus élevés incite les producteurs à utiliser plus intensivement leur capital humain, d'où l'obtention de meilleurs résultats économiques.

L'une des hypothèses de travail de la présente étude était que *la rareté de l'eau* affectait la performance — en d'autres termes, que dans les zones arides les producteurs et les pouvoirs publics cherchaient plus activement à tirer le meilleur parti de l'irrigation et obtenaient de meilleurs résultats que ceux des zones humides où il y a assez d'eau pour l'agriculture pluviale. Mais cette hypothèse n'a pas été confirmée. On n'a trouvé aucune relation significative sur le plan statistique. En fait, les projets utilisant des eaux souterraines donnent des résultats un peu meilleurs dans les zones humides que dans les zones sèches, probablement parce que l'eau d'irrigation, venant en complément de l'eau de pluie, a une valeur unitaire plus grande.

On ne constate en revanche aucune relation entre les résultats des projets d'irrigation utilisant des eaux de surface et la pluviométrie. Lorsqu'il s'agissait de travaux de remise en état, d'extension ou d'amélioration, ces projets ont généralement visé des zones relativement plus humides. Le niveau plus élevé des coûts irréversibles et l'existence d'une tradition d'irrigation bien établie devraient les rendre plus rentables que les projets uniquement composés de travaux neufs, qui ont en général concerné uniquement des régions plus sèches.

La taille des projets *d'irrigation à l'aide d'eaux souterraines* est en moyenne quelque peu inférieure à celle des projets utilisant des eaux de surface, et leur coût par unité de superficie est un peu moindre. Néanmoins, selon les estimations des évaluations rétrospectives, les premiers ont une rentabilité économique supérieure de 21 pour cent à celle des seconds. Dans le premier cas, les groupes d'irrigants ont également deux fois plus de chances de bien fonctionner.

Contribution de la Banque

L'analyse des projets de l'échantillon montre que, dans ses études sectorielles, la Banque n'a guère prêté attention à la planification écologique, et en particulier à la *planification de l'allocation des eaux et des ressources naturelles*, mais cette situation s'améliore. Les divers aspects de l'impact sur l'environnement ont été insuffisamment traités dans les rapports sectoriels, et cette analyse laisse encore beaucoup à désirer. Cela est vrai du *drainage*, et en particulier de la *gestion des aquifères* et des diverses dimensions de la *gestion des bassins versants* : déboisement, surpâturage, inadéquation des pratiques agricoles, dégradation des sols, érosion et envasement.

Les travaux sectoriels sont meilleurs pour trois des quatre thèmes qui ont fait l'objet d'une attention particulière. Les *questions foncières* sont largement prises en compte, mais sans que l'analyse soit très approfondie. Le complexe exploitation et entretien/tarification de l'eau/participation des irrigants est lui aussi largement traité; de même que les questions de *gestion et d'organisation*, mais, dans ce dernier cas, de manière généralement superficielle. L'accent est mis sur les institutions publiques, et à l'occasion sur leurs rapports avec les associations d'irrigants, mais presque jamais sur le fonctionnement de ces associations. La problématique hommes/femmes n'est pas abordée. Plusieurs des rapports sectoriels les plus récents, notamment ceux qui concernent

l'Inde et les Philippines, se signalent par l'étendue et la profondeur de leurs analyses.

S'il n'a pas été possible d'évaluer globalement la qualité des projets lors de leur entrée dans le portefeuille, les résultats des projets d'irrigation se sont révélés sensibles à certains aspects de la *préparation* et de *l'évaluation préalable*. Les évaluateurs ont constaté que la *qualité de la conception et de la planification* avait été un facteur de réussite plus important encore que l'adéquation des plans d'exécution définitifs.

Les projets d'irrigation ont fait l'objet d'un effort annuel de *supervision* supérieur de 12 pour cent à la moyenne pour l'ensemble des projets de la Banque. Cela n'a rien de surprenant étant donné que les projets d'irrigation sont parmi les plus complexes. L'effort de supervision a été particulièrement faible en Europe (33 pour cent de moins que la norme de la Banque et 40 pour cent en dessous de la moyenne pour les projets d'irrigation) et particulièrement intensif en Asie du Sud (56 pour cent au-dessus de la norme de la Banque et 39 pour cent au-dessus de la moyenne des projets d'irrigation). La Banque a détaché des experts agricoles dans quatre pays représentant une large part de son portefeuille de projets d'irrigation. Deux emprunteurs ont fait l'objet d'un effort de supervision exceptionnellement intensif (53 et 55 pour cent au-dessus de la moyenne) et deux d'une supervision faible (30 pour cent et 10 pour cent en dessous de la moyenne), ces résultats pouvant refléter dans le premier cas une « culture d'exécution » et dans le second une « culture de prêt ».

Exécution — la contribution de l'emprunteur

Les *retards moyens d'exécution* s'établissent à 1,7 année pour les projets d'irrigation, ce qui est à peine supérieur à la moyenne pour l'ensemble des projets. Outre les facteurs habituels comme l'impossibilité pour l'emprunteur de mobiliser les fonds requis, les problèmes d'*acquisition de terrains et* de *construction* expliquent en grande partie les dépassements. La durée de l'exécution est en moyenne supérieure de 30 pour cent aux prévisions, mais 16 pour cent des travaux, en moyenne, ne sont néanmoins jamais réalisés, ce qui équivaut à un retard de 55 pour cent par unité réalisée.

Les *coûts unitaires à l'hectare* sont un bon indicateur de la réalisation des projets. Pour l'ensemble des projets d'irrigation, le coût unitaire moyen est de 4.800 dollars. Les projets classés non satisfaisants ont des coûts unitaires 3,5 fois supérieurs à ceux des projets satisfaisants. Bien sûr, les travaux neufs sont plus coûteux que les remises en état. L'irrigation par gravité est plus coûteuse que l'irrigation par pompage[2] et les périmètres rizicoles plus coûteux que les autres. Il en résulte d'importantes disparités régionales. Par exemple, les coûts unitaires du périmètre irrigué moyen en Afrique subsaharienne représentent 13,3 fois la moyenne de l'Asie du Sud. Le calcul de coûts unitaires « ajustés », tenant compte des travaux programmés mais non réalisés, montre que les problèmes d'exécution touchent surtout le continent américain, l'Asie de l'Est et l'Afrique subsaharienne, les projets de remise en état, les projets rizicoles, les périmètres d'irrigation par gravité et, bien sûr, les projets classés non satisfaisants.

Principaux problèmes touchant la conception et la durabilité des systèmes

Parmi les nombreux problèmes signalés par les audits et études d'impact du Département de l'évaluation (OED), deux ont été choisis pour faire l'objet d'une analyse approfondie en raison de leur importance : l'exploitation et l'entretien, et la conception des systèmes d'irrigation utilisant des eaux de surface dans les régions tropicales humides.

Exploitation et entretien. Les évaluations rétrospectives révèlent de vastes problèmes en ce qui concerne l'exploitation et l'entretien, le recouvrement des coûts, et les groupes d'usagers. Le premier de ces trois problèmes est le plus grave car il affecte directement les avantages des projets. La formation d'associations d'irrigants peut être utile du seul fait qu'elle responsabilise les utilisateurs de l'irrigation en leur donnant le sentiment que le projet est véritablement le leur, tandis que le recouvrement des coûts est une question de transferts entre l'état et les irrigants, qui peut affecter les incitations à une utilisation efficace de l'irrigation. Le vif intérêt que la Banque porte au recouvrement des coûts de l'irrigation résulte en partie de l'existence présumée d'un lien entre ce recouvrement et l'amélioration de l'exploitation et de l'entretien.

L'étude confirme les conclusions auxquelles était déjà parvenu l'OED, à savoir que normalement la vente de l'eau à un prix plus élevé n'implique pas nécessairement une exploitation et un entretien de meilleure qualité. Le produit des redevances d'irrigation vont généralement au trésor public et n'est pas réservé aux opérations d'exploitation et d'entretien. Des études effectuées par la Banque asiatique de développement, la Fondation Ford, l'Institute for Philippine Culture, l'Institut international de gestion de l'irrigation et l'Administration philippine de l'irrigation donnent à penser que l'autonomie financière se traduit par des améliorations majeures de la qualité et de l'efficacité-coût. Cette autonomie financière prend souvent la forme d'un transfert de la responsabilité de l'exploitation et de l'entretien aux irrigants, mais il existe d'autres modalités. C'est lorsque le régime est celui de l'autonomie financière et que les irrigants prennent en charge l'organisation et le coût de ces activités que l'on constate une amélioration de l'exploitation et de l'entretien.

La Banque a encouragé la formation de groupes d'irrigants et le transfert à ces associations, sous une forme ou une autre, de la responsabilité des systèmes d'irrigation, mais les déceptions ont été plus nombreuses que les succès. La réussite exige davantage que d'inclure dans les accords signés avec les emprunteurs des clauses les obligeant à créer des groupes d'usagers. Des études empiriques ont dégagé les conditions propices à la formation par les usagers d'associations durables.

Conception des systèmes d'irrigation. Les évaluations rétrospectives signalent d'importants problèmes liés à la conception des systèmes d'irrigation, en particulier dans les zones tropicales humides où le drainage et la maîtrise des crues posent de grandes difficultés. Dans la plupart des cas, ces projets visaient à transformer des périmètres rizicoles basés sur un système d'alimentation lente et continue en réseaux plus complexes, d'un débit supérieur et souvent conçus de manière à pouvoir être utilisés de façon intermittente, de sorte que l'eau puisse être fournie à la demande (ou à peu près) pour diverses cultures. Mais plusieurs évaluations rétrospectives donnent à penser que ces systèmes plus complexes, bien qu'adaptés aux régions plus sèches, conviennent mal aux zones tropicales humides.

Ces systèmes plus complexes, dans les zones tropicales humides en particulier, posent des problèmes de vandalisme et d'accaparement de l'eau par les irrigants se trouvant en amont. Ces pratiques ont de graves conséquences pour les irrigants se trouvant en aval et pour la société dans son ensemble.

Les solutions suggérées sont de deux ordres. La première est de faire en sorte que ces systèmes fonctionnent mieux en améliorant les ouvrages de transport et de régulation et en améliorant les communications pour rendre possible la distribution à la demande.

La seconde est d'assurer la fiabilité et l'efficacité opérationnelle du système en réduisant sa flexibilité. La fourniture d'un niveau de service

moindre (mais cependant meilleur que celui que reçoivent aujourd'hui la plupart des irrigants), en distribuant l'eau selon un horaire rigide, oblige les exploitants à conformer leurs cultures à cet horaire. Les solutions de ce type impliquent certains sacrifices par rapport à l'optimum agronomique et économique et elles peuvent nécessiter l'installation de pompes, avec les coûts que cela suppose. Considération importante, elles réduisent donc les risques de collusion avec certains irrigants privilégiés. En faisant de l'eau une ressource rare, ces systèmes incitent à l'économiser.

Recommandations

La moitié ou même davantage des prêts actuels de la Banque à l'irrigation vont non pas à des travaux neufs, mais à l'extension, à la remise en état ou à l'amélioration de systèmes existants. Avec le temps, l'eau fait l'objet d'une concurrence de plus en plus vive dans un nombre croissant de pays. L'aménagement de nouveaux périmètres devient aussi de plus en plus coûteux, les sites les plus économiques étant déjà exploités. De plus, les cours des denrées alimentaires et des fibres que l'irrigation aide à produire et qui justifient la mise en place de services d'irrigation sont à leur plus bas niveau historique et risquent d'y rester. Dans ces circonstances, il est justifié de continuer à réduire la part des travaux neufs, sans pour autant se borner à remettre en état « à l'identique ». Les conditions et les besoins ne cessent d'évoluer et les systèmes d'irrigation doivent donc être constamment repensés. L'*amélioration* des systèmes suppose que l'on fasse appel à toutes les options techniques et sociales disponibles pour abaisser les coûts unitaires et renforcer l'efficacité afin d'économiser l'eau et de fournir un meilleur service aux bénéficiaires.

Quand les investisseurs, y compris la Banque, procèdent à l'évaluation préalable de projets d'irrigation, ils doivent tenir compte des avantages et des coûts de la fourniture d'eau aux ménages et aux entreprises, ainsi que de toutes leurs implications pour la santé publique, l'amélioration des bassins versants, et la sécurité des barrages.

Les grands projets d'irrigation présentent des chances de succès plus grandes que les petits — probablement en raison d'économies d'échelle techniques, parce que les grands projets attirent de meilleurs gestionnaires, et parce que les emprunteurs sont plus disposés à prendre les mesures nécessaires pour assurer le succès de projets plus visibles. Il n'y a donc pas de raison d'avoir des préventions contre les projets de grande envergure.

Un argument fréquemment avancé contre une participation accrue des bénéficiaires à la conception et à la réalisation des projets est que cela entraînerait des retards. Si la conclusion de la présente étude se confirme, à savoir que les retards d'exécution ne compromettent pas les résultats des projets d'irrigation, il y aura moins de raisons de se préoccuper de ce risque et plus de raisons d'encourager la participation des bénéficiaires. En tout état de cause, l'absence de participation réduit souvent les avantages des projets et perturbe les calendriers d'exécution.

L'irrigation a plus de chances de réussir dans les pays moins touchés par certains types de distorsions économiques. Il ne faut pas l'oublier dans les décisions d'investissement.

La qualité des travaux et l'acquisition des terrains présentent des problèmes majeurs au stade de l'exécution. La Banque devrait porter une grande attention à ces deux aspects dans ses activités de supervision.

Il est rare qu'il existe un lien quelconque entre le prix de l'eau d'irrigation et la qualité de l'exploitation et de l'entretien. De bonnes raisons d'efficacité et d'équité peuvent justifier de relever le prix de l'eau, mais l'amélioration de l'exploitation et de l'entretien n'en fait pas

partie. Les directives de la Banque devraient en tenir compte.

Le moyen le plus prometteur d'améliorer l'exploitation et l'entretien est d'en confier la responsabilité aux irrigants eux-mêmes en leur fournissant un appui technique.

Que les irrigants sous-traitent les activités d'exploitation et d'entretien à des entités publiques ou privées, ou qu'ils s'en chargent eux-mêmes, ils doivent être organisés. Les conditions propices à la formation d'associations d'irrigants et à leur bon fonctionnement sont bien connues et les projets soutenus par la Banque devraient contribuer à l'établissement de pareilles conditions.

S'il est important d'économiser l'eau et s'il est peu probable que l'on parvienne à relever suffisamment le prix de l'eau pour encourager les économies, la Banque et ses emprunteurs devraient chercher d'autres moyens d'encourager une utilisation plus efficace de l'eau, notamment par le rationnement de l'offre.

La conception des grands programmes d'irrigation utilisant des eaux de surface dans les zones tropicales humides posent indubitablement des difficultés. Que leur solution réside dans la mise en place de systèmes plus simples, basés sur des réseaux moins complexes et intégrant irrigation par gravité et par pompage, ou qu'il faille recourir à des systèmes plus sophistiqués et plus flexibles, il faut prêter une attention critique aux questions de conception et au choix des systèmes de pompage, et procéder à des essais pilotes avant d'appliquer à grande échelle les solutions retenues.

Les mesures prises en faveur de la santé à l'occasion d'opérations d'irrigation ont donné de si bons résultats que la Banque devrait envisager de développer ces initiatives dans le cadre de projets d'irrigation ou de façon indépendante.

S'il existe une synergie potentielle entre l'irrigation et l'amélioration des bassins versants, les projets aidés par la Banque devraient chercher à en tirer parti.

Un drainage défectueux ou insuffisant est à l'origine de la plupart des problèmes d'environnement liés à l'irrigation. La Banque devrait continuer à insister sur l'importance du drainage et à financer des travaux de drainage s'il existe une demande. Dans ce domaine, les problèmes tiennent souvent à la faiblesse de la demande et aux difficultés de toute action collective, de sorte que la Banque devrait encourager la mise à l'essai de démarches coopératives pour la mise en place de systèmes de drainage.

La Banque devrait continuer à appliquer ses directives concernant les réinstallations involontaires, et devrait aider les emprunteurs à traiter les dimensions sociales des investissements dans l'irrigation, le but étant d'assurer un traitement équitable aux personnes déplacées comme à l'ensemble de la société.

Notes

1. Il s'agit encore d'estimations, car, dans la plupart des cas, les projets d'irrigation n'avaient pas encore atteint leur régime de croisière au moment de leur évaluation rétrospective.

2. Par irrigation par pompage, on entend divers types d'irrigation : le plus souvent, l'eau est puisée dans une nappe souterraine pour distribution locale, mais elle peut aussi provenir de cours d'eau ou d'autres sources et approvisionner un grand système de distribution, ou encore être puisée dans un canal et distribuée localement. Malheureusement, les évaluations rétrospectives ne permettent pas de distinguer entre ces différentes catégories, ce qui aurait pourtant été utile.

1. Introduction

Irrigation[1] accounts for 7 percent of Bank[2] lending—more than any other subsector. From 1950 through 1993, the Bank lent roughly $19 billion in current terms (or $31 billion in 1991 dollars) for various forms of irrigation in 614 projects which, with the contributions of borrowing governments, farmers, and various cofinanciers, constituted an investment of $52 billion in current terms ($84 billion in 1991 dollars). Irrigation has attracted to the Bank some of its greatest notice, both favorable and unfavorable. This study reviews the record of how the Bank's involvement in irrigation, through lending and in other ways, has affected peoples' lives.

Two-thirds of the evaluated irrigation projects supported by the Bank had satisfactory results. When they are weighted by size, 84 percent did. The average return to the resources invested in these projects was, therefore, quite good. But one-third had less than satisfactory results, and there have been some noteworthy failures. There is ample room for improvement.

This study reviews the evolution of Bank policy and lending in this large and complex sector. It examines the evaluation record for factors associated with success and failure. Based on empirical work and analysis, by the Bank and others, the study recommends ways to improve irrigation performance.

Chapter 2 examines the evolution of Bank irrigation policy: the actual policy rules, and why a policy paper on irrigation was never written. Based on interviews with irrigation task managers and their supervisors, the account is supplemented by information on informal sources of policy. *Chapter 3* reviews the evolution of Bank irrigation lending by decade and by theme.

How well did Bank policy and lending achieve their purposes—better irrigation to help farmers (mostly small, poor farmers) to produce more rice and other crops, and also to provide more rural people with jobs and better access to drinking and other household water, hence better health and life-quality, and even to provide urban households and factories with water and sometimes power? *Chapter 4* discusses the outcomes of irrigation lending: first overall evaluation assessments, then factors that go with success or failure. These factors emerge from analysis of evaluations of 208 Bank-supported irrigation projects.

Chapter 5 analyzes Bank pre-lending processes: sector work and "quality at entry" (the sum of project identification, preparation, and appraisal) and post-lending processes: project supervision and evaluation. Implementation, a borrower process, is the first step in achieving sustainable results. *Chapter 6* reviews and analyzes implementation as seen through evaluations and as seen by staff.

Chapter 7 highlights two of the most salient lessons that emerge from evaluations of Bank irrigation lending. One is rooted in social organization and suggests a behavioral solution; it involves how to improve operation and maintenance (O&M), and, incidentally, cost recovery, by fostering financial autonomy and irrigator "ownership." The other is rooted in engineering problems (with social dimensions) and possible engineering solutions; it involves ways to improve surface-system design by making sure a project is appropriate to its specific site.

Almost all evaluated Bank irrigation projects were approved before 1983. The study's results pertain only to those projects where Bank lending has been completed and on which there has been an evaluation. Despite a lack of systematic information on the results of more recent projects, the study touches on the directions in which Bank irrigation lending has moved in the last decade. *Chapter 8* summarizes analyses of recent appraisal reports and the findings of reviews and of interviews with a sample of the task managers of the 111 most recent irrigation loans, most of them financed by loans that are still disbursing and yet to be evaluated.

The concluding *Chapter 9* sums up the study's findings and recommendations.

The historical context

Agricultural changes in recent centuries have been driven by population growth and a universal propensity by consumers to reduce the portion of their resources they spend on agricultural goods as they get better off. Intensification in agriculture has been a response to shortages or fear of shortages, both leading to higher prices for farm goods.[3] However, the constantly declining role of agriculture generally keeps returns to farm labor, enterprise, and other factors of production at levels below returns in the rest of the economy.

The word "irrigation" refers to an extraordinarily large variety of activities. Many think of irrigation as a storage dam on a majestic river with off-take structures and a network of canals and drains. For others, it is a well equipped with a pump that is linked by water channels to nearby fields, or a shaffud or shilpa to lift stream water to a field by hand, or stone weirs to trap seasonal water in a wadi, or bunds, sluices, and pumps to control water levels in a delta. These varieties of irrigation have little in common except that they all involve moving water to a place and time where it benefits crops. They all result in farming that uses more labor and produces more output per hectare than its nonirrigated predecessor.

This diversity makes it difficult to analyze irrigation. A study of Pakistan's Indus system, with its immense dams, thousands of kilometers of canals and drains, and millions of farms requires different categories than a study of a tubewell in Bangladesh that permits a handful of farmers to extend cropping in winter months, or a study of a several-hundred hectare Brazilian farm served by well, pump, and central-pivot sprinkler system. The engineering and agronomy are totally different; so are the underlying elements of social organization.

"Typically, throughout the world, irrigation is associated with dense populations, high levels of cropping intensity, and organizationally-advanced civilizations."[4] Initially, farming depends on rain and takes place where the water regime and other factors (such as temperature and soils) are favorable.[5] Population growth then pushes farming into marginal areas, raising the marginal costs of expanding production. At some point, it pays to invest in irrigation to expand production instead of expanding the land frontier. Initially, irrigation occurs where the unit investment costs to increase production are lowest and then expands to more marginal, more expensive sites. The rising costs of developing ever more

marginal sites for irrigation are compensated by the development of cost-saving techniques unique to irrigation. As the economic and agronomic milieu changes, so does the selection of appropriate irrigation structures and system.

Characteristically, irrigation started in the best farming areas. As population density rose, the costs of expanding the farming frontier became prohibitive. The Nile Valley is a good example; the drying of the Sahara desert forced people into the Nile flood plain. The river valleys of China, south India, the Indo-Gangetic Plain, Japan, Korea, Mesopotamia, and Sri Lanka offer less dramatic examples. The fertile islands of Indonesia (Bali, Java, and Madura) early reached high population densities; the sea then became a natural barrier to crop expansion. Sometimes, the losers of wars have established agricultural frontiers in their refuge areas to preserve their identity. The Hindu principalities of Bali, the Ifugao of the Philippines, the Diola of Senegal, and the Dogon of Mali all turned to irrigation and other types of agricultural intensification in highly marginal areas.

In the last 50 years, irrigation development has continued to be concentrated in areas of high population density and high population growth, most notably in parts of China, India, and certain other Asian countries. Where population density was lower but growth was high (and especially where there is enough rainfall for rainfed farming to be practical), agriculture expanded mainly by bringing new lands into cultivation. This was the case in most of sub-Saharan Africa, all of Latin America except the dry west coast, and pockets of Asia. Yet this horizontal expansion was minor compared to the vertical expansion brought about by technological improvements. For the 1962-90 period, 8 percent of the increase in world cereal production is attributable to horizontal expansion and 92 percent to "vertical" increases produced by irrigation and other intensification measures. The same proportion applies for developing countries as a group. Even in the remaining areas with greatest land availability, sub-Saharan Africa and Latin America, "vertical" expansion accounted for 52 percent and 71 percent respectively of the increase.

The "vertical" intensification, mainly in wheat and rice production, that began in the late 1960s has been called the Green Revolution. This is not the place to recount the history or predict the future of the Green Revolution.[6] Suffice it to say that plant-breeding innovations have gone hand-in-hand with increased use of fertilizers and the expansion of irrigation. As many writers have noted,[7] new, high-yielding varieties outperform their predecessors over a wide range of conditions, but they outperform them by much more when the plants get nutrients and water where and when and in the amounts they prefer.

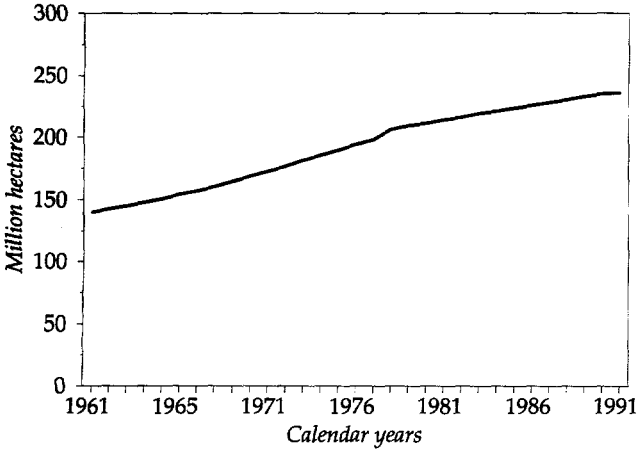
By 1970, with world farm prices still high, technological optimism—which had risen to the point that development planners sometimes asserted that agriculture could be the leading growth sector—had inspired increased agricultural investment. The lion's share of public agricultural investment, and a significant part of private investment, was in irrigation.

Now that world staple food prices are in a prolonged and serious decline—the fruit, in part, of the Green Revolution—technological optimism persists, but the investment that might permit intensification to continue is harder to come by. Private investors respond to market forces, while public-sector planners typically share the popular perception that agricultural intensification will take care of itself, even though the conjuncture of forces that inspired the Green Revolution is no longer present.

Irrigation investment

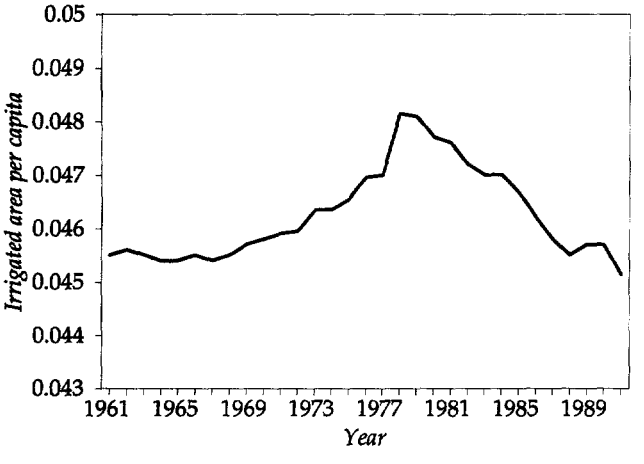
There are no reliable statistics on global irrigation investment. Those on irrigated area are not

FIGURE 1.1: WORLD AREA IRRIGATED



Source: Bank Economic and Social Database, FAO Fertilizer Datafile.

FIGURE 1.2: WORLD IRRIGATED AREA PER CAPITA



Source: Bank Economic and Social Database, FAO Fertilizer Datafile. World Population Prospects, 1992 Revisions from the United Nations.

much better and, before 1961, exist only for selected countries. Figure 1.1 shows the Food and Agriculture Organization's (FAO) estimates.

Global area irrigated grew by around 2 percent a year in the 1960s and 1970s, slowing to closer to 1 percent in the 1980s (see Figure 1.2). Five countries—China, India, Pakistan, the United States, and the ex-USSR—account for nearly two-thirds of world irrigated area; China, India, and Pakistan together account for nearly half. Figure 1.3 shows that the irrigated area in China grew rapidly through 1977 and then stagnated, while India's irrigated area grew rapidly through 1984 and then slowed. Pakistan's irrigated area has expanded little of late as that country has devoted most of its efforts to improving drainage on existing irrigated land to avoid losses to salt and waterlogging. Since 1979, the rest of the world has been responsible for maintaining the average by irrigating new land at a higher rate than the five leaders.

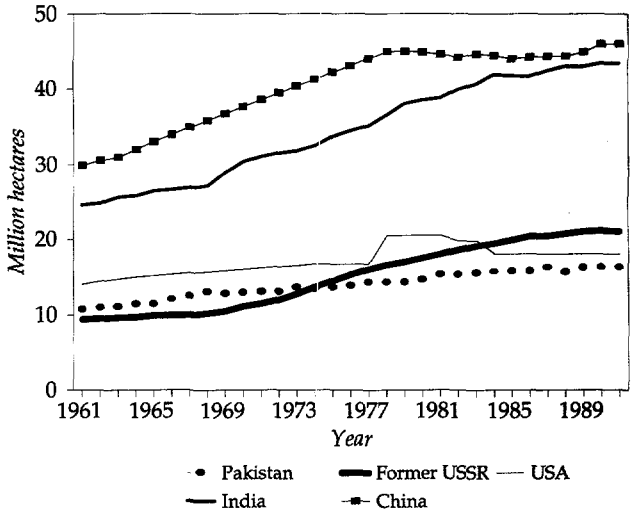
During the rapid growth period, expansion of irrigation "hardware" (canals, dams, flow regulators) outran changes in irrigation "software" (customs, institutions, operating rules). Most of this growth was in Asian public-sector surface systems, especially in China, India, and the ex-Soviet republics of central Asia and their neighbors. These systems have severe O&M problems, often stemming from slow change in irrigation customs. Farmers, and societies, did not get full anticipated value from these investments during the boom period. Many are now struggling to maintain production in the face of salt and waterlogging resulting from delayed drainage investments. Irrigated area per person, which held steady in the 1960s and grew in the 1970s, has been falling throughout the 1980s and 1990s.

Figure 1.4 shows how World Bank lending for irrigation projects fits into this historical picture. (All figures here are in 1991 US dollars.) In the 1950s, the Bank made only six loans for irrigation, with total annual lending averaging $37 million. Average lending for the 41 projects in the 1960s was $343 million, more than nine times as great. In the 1970s, real irrigation lending was multiplied by more than three as loans were made to support 256 projects; average annual lending was $1,120 million. The 1980s

saw a modest increase of 14 percent from this high base; Bank loans supported 258 projects at an average annual lending figure of $1,273 million. The division into decades obscures the trend that can be seen in the graph, which smooths annual variations by using a three-year moving average. In real terms, Bank irrigation lending became significant in 1960, rose dramatically from 1973 to a peak in 1978, and has fallen since then.

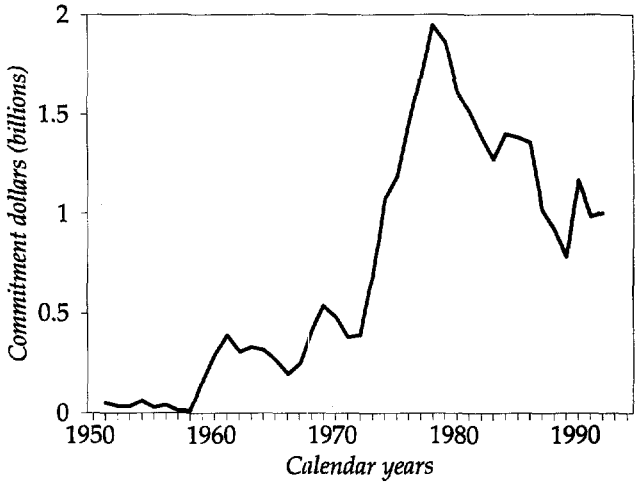
The Bank, like other parts of the development assistance community, has responded to price trends and development perceptions in making loans for irrigation. When agricultural prices started to rise and there was pessimism about food supplies, the Bank began to invest heavily in irrigation, a trend that intensified during the Green Revolution period. The continuous and substantial fall in world staple food prices since then has prompted the Bank to lessen its emphasis on irrigation. This response to currently favorable conditions carries with it some risk that agriculture may be unable to respond to future demand. Whatever the likelihood of this scenario may be, the stakes for the world's poor are high.

FIGURE 1.3: AREA IRRIGATED, FIVE LEADING COUNTRIES



Source: Bank Economic and Social Database, FAO Fertilizer Datafile.

FIGURE 1.4: WORLD BANK IRRIGATION LENDING (CONSTANT 1991 DOLLARS, THREE YEAR MOVING AVERAGE)



Notes

1. Irrigation includes drainage. It means *any alteration of the natural order to improve the way crops get water.* By this definition, repairing the seawall defenses in Guyana (Guyana's Sea Defense Project, Loan 559, approved September 1968) is an irrigation project because it avoided crop losses that would have occurred if sea dikes broke down, salt water intruded, and excess fresh water could not be evacuated at low tide. The Sfax Flood Protection Project in Tunisia (Loan 2289, approved June 1983) is not classified as irrigation because the area protected was urban.

2. World Bank or Bank, unless otherwise noted, means both International Bank for Reconstruction and Development (IBRD) and International Development Association (IDA). Loan, unless otherwise specified, means both IBRD loan and IDA credit, and excludes "nonproject" lending.

3. The classical case is made by Ester Boserup, *The Condition of Agricultural Growth*, Chicago: Aldine, 1965.

4. Randolph Barker, E. Walter Coward, Gilbert Levine, and Leslie E. Small, "Irrigation Development in Asia: Past Trends and Future Directions," *Cornell Studies in Irrigation No. 1*, Ithaca: Cornell, 1984, pp. 1–2. There have been exceptions, particularly in developed countries such as the US and the erstwhile USSR, where irrigation was used to settle sparsely populated regions.

5. Yujiro Hayami, Christina C. David, Piedad Flores, and Masao Kikuchi, "Agricultural Growth Against a Land Resource Con-

straint: The Philippine Experience," *Australian Journal of Agricultural Economics* 20, December 1976, pp. 144–159.

6. For macrohistory of the diffusion of the Green Revolution, see Dana G. Dalrymple, *Development and Spread of High-yielding Wheat Varieties in Developing Countries*, Washington, DC: Agency for International Development, 1986; Dana G. Dalrymple, *Development and Spread of High-yielding Rice Varieties in Developing Countries*, Washington, DC: Agency for International Development, 1986; and David H. Timothy, Paul H. Harvey, and Christopher Dowswell, *Development and Spread of Improved Maize Varieties and Hybrids in Developing Countries*, Washington, DC: Agency for International Development, 1988. The best micropicture of this diffusion is probably Robert E. Huke and J. Duncan, "Spatial Aspects of HYV Diffusion," *Seminar on Economics of Rice Production in the Philippines*, Los Baños: International Rice Research Institute, 1969.

7. See, for instance, Vernon Ruttan, "The Green Revolution: Seven Generalizations," *International Development Review* XIX, 1977, pp. 16–23.

2. Bank policy

It is convenient to divide Bank irrigation lending into three policy periods, marked successively by an emphasis first on infrastructure, then on agricultural expansion, and finally on consolidation. In the beginning, irrigation was virtually synonymous with agriculture. Through the first two periods, irrigation lending expanded rapidly, but not as rapidly as other agricultural lending. In the consolidation period, irrigation and other agricultural lending have fallen both absolutely and as shares of Bank lending. But quantity is hardly the only interesting factor. The character of Bank irrigation lending has been changing too.

The infrastructure period—1948–71

From the time its irrigation lending began, in 1948,[1] to the Bank's 1971 reorganization, consistency in irrigation lending policy was not a problem. All agricultural projects, including irrigation, were processed in a single division, which later became a single department. Consistency could be assured by discussions among colleagues in meetings or informally. There was no need for policy papers or operational directives. When the agricultural deputy chief reviewed the 16 irrigation projects approved between 1961 and 1968, it was found that the water-charge policy imbedded in the loan agreements usually provided for recovery of O&M costs and at least partial recovery of investment costs.[2]

There is not much of a written record to document early policy changes, but they were taking place. In the early years the Bank refused to lend for rehabilitation of irrigation, or of anything else. Rehabilitation was considered something that borrowers should do with their own resources and not truly an investment; to lend for it would simply encourage poor maintenance. This policy changed at some point in the late 1960s. That change proved important for Bank irrigation lending. It is arbitrary to separate rehabilitation from upgrading of existing facilities and from extending them (with or without upgrade). OED's records of Bank irrigation loans between 1950 and 1992 show that 18 percent were exclusively for rehabilitation, while half were for a combination of rehabilitation, completion, and extension of existing projects.

The other policy changes of this early period are succinctly summarized in a two-page section on irrigation in a 1972 publication, *World Bank Operations: Sectoral Programs and Policies*. Through the 1950s, irrigation lending had been primarily for construction of dams and main distributary canals, but there was a growing realization that dams and canals were not enough. Thus, in the early 1960s, irrigation lending expanded to include complementary investments needed to make the investments in dams and canals more efficient: on-farm works, input supplies, extension, roads, processing

TABLE 2.1: EVOLUTION OF IRRIGATION-RELATED BANK DIRECTIVES

Topic	*Date*	*Instrument*[a]	*Application*	*Substance*
Cost recovery	Mar 71	OPM 2.61	All agriculture	Cost recovery section of particular interest for irrigation. Beneficiaries should pay public costs. In agriculture, as minimum, O&M costs completely recovered.
	May 76	CPM 8.4	Irrigation	Guidance in applying OPM 2.61 to irrigation: volumetric water charges desirable; efficiency emphasized; second bests include land betterment levies; no *prima facie* reason to focus on O&M cost; progressivity preferred.
	Jun 80	CPN 2.10	Irrigation	No major change from CPM 8.4.
	Feb 84	OMS 2.22	All revenue-earning subborrowers (but not applied to irrigation)	Whether public or private, revenue earning enterprises should recover costs, including debt service, and contribute to expansion by selling products and services.
	Mar 84	unnumbered VP policy note	Irrigation	Earlier policy affirmed but O&M is serious problem; water charges should at least meet O&M cost.
Dam safety	Jun 77	OMS 3.80	All dams	Independent design review and periodic inspections if staff warrants, normally for larger dams.
International waters	Oct 77	OMS 2.32	Cross-border waters	Bank will not finance projects on international waters that would cauSpe appreciable harm to other riparians. Prior consultations, planning, and agreement urged.
	Apr 90	OD 7.50	(same)	Same policy, more detail.
Participation	Aug 78	OMS 2.12	All projects	Beneficiaries and government agencies should be involved from identification and design.
Project preparation	Oct 78	OMS 2.28	All projects	Detailed design should be completed before Board approval. (Inspired by developments in irrigation lending.)
Involuntary resettlement	Feb 80	OMS 2.33	All projects (mainly irrigation and power)	Oustees must get reasonable chance to regain or better earlier standard of living. Resettlement should be minimized, planned.
	Oct 86	OPN 10.08	(same)	Advice on how to implement OMS 2.33; emphasis on land for land lost, productive capacity.

and marketing, research, credit, coops, and training. In many instances, Bank financing touched only these complementary investments, since the main works had already been built. Returns to such projects were said to be very high. Lending for irrigation was expanding rapidly, but not nearly as rapidly as for agriculture as a whole. As a result, irrigation's share of agricultural lending fell from 77 percent in FY48–63[3] to 44 percent in FY64–68 and 34 percent in FY69–71. The "hardware" element in agricultural lending was declining in two ways: nonhardware projects were gaining share at irrigation's expense, and nonhardware was becoming a larger share of the irrigation projects themselves.

(Table 2.1 continued)

Topic	*Date*	*Instrument*[a]	*Application*	*Substance*
	Jun 90	OD 4.30	(same)	Same policy, more detail.
Tribal people	Feb 82	OMS 2.34	All projects	When projects encroach on lands of "tribal peoples" who are not the intended beneficiaries, their interests must be safeguarded and, if feasible, their well-being enhanced.
	Sep 91	OD 4.20	(same)	"Indigenous peoples" must benefit; their informed participation is required.
Wildlands	June 86	OPN 11.2	All projects	Seek balance between converting wildlands to more intensive human uses and preserving their environmental values. Public goods from wildlands may be poorly understood or undervalued. Irrigation is particularly concerned because these include reservoir protection.
Environment: dams and reservoirs	Apr 89	OD 4.00 Annex B	Dams and reservoirs	Bank only finances projects in compliance with environmentally and economically sound policies. Adverse environmental impacts should be avoided, minimized, or compensated for. Opportunities to increase environmental benefits should be sought in project design.
Disclosure of information	Jun 89	AMS 1.10	All projects	Bank wishes to be open about its activities. Presumption in favor of disclosure in absence of compelling reasons to the contrary.
Nongovernmental organizations	Aug 89	OD 14.70	All projects	Staff should avail of opportunities to work with and through NGOs. (Possible importance of NGOs mentioned in earlier directives on dam safety, resettlement, and tribal peoples.) Reasons not to.
Environmental assessment	Oct 89	OD 4.00 Annex A	All projects	Environmental consequences should be recognized early in the project cycle and taken into account.
	Oct 91	OD 4.01	(same)	Same policy, more detail.
Poverty reduction	Dec 91	OD 4.15	All projects	Makes this an explicit purpose in Bank operations from initiation onward.
Environmental action plan	Jul 92	OD 4.02	All projects	Bank fosters preparation and implementation of environmental action plan in country; reflects findings and strategies of plan in its work.

a. Instruments may be divided into those that are directives—operational policy memoranda (OPM), operational policy statements (OPM), and operational directives (OD)—and those that are meant to provide staff guidance—central projects' memoranda (CPM), central projects' notes (CPN), operational policy notes (OPN), unnumbered policy notes, and administrative manual statements (AMS).

The agricultural expansion period—1972–81

An urge to formalize Bank policies blossomed in 1971. Coordination became necessary because operations were decentralized into geographical regions. The first operational policy memoranda (OPM) were issued in March 1971, among them OPM 2.61 on agriculture.

Work on the first policy papers began in 1972. Producing an irrigation policy paper was part of the work program of the Agriculture and Rural Development Division (AGR) of the Central Projects Department, newly created to assure policy leadership and coordination to the Bank's newly decentralized operational units. Twelve rural subsectors were covered by policy papers during those years, starting with

rural development, land reform, agricultural credit, and rural electrification in 1975. Irrigation, the largest subsector, never was.

From the beginning, AGR's efforts to get agreement on an irrigation policy paper met resistance from Operations—principally from the chiefs of the main divisions making irrigation loans, and sometimes their staffs and directors. AGR felt that proponents of irrigation lending did not welcome anything that might limit their freedom to design projects and to lend. What AGR saw as policy direction, the Operations' practitioners saw as meddling. Although the AGR irrigation advisers were engineers, most of their associates were economists. Most of the leading practitioners—mainly engineers—saw an irrigation policy paper as an attempt by economists to interfere with engineers' freedom to do their job. They pointed out that irrigation is the most variegated and site-specific subsector of agriculture, which is itself the most variegated and site-specific sector of Bank lending. Therefore, they have argued, there are, by nature, few generalizations that apply to irrigation as a whole. Irrigation requires maximum ingenuity to solve the specific problems of specific sites.

This perspective came to be shared by AGR management, which adopted a less formal approach to irrigation lending. The Bank's irrigation adviser used AGR's review of all draft appraisal reports to stress two themes: the importance of *drainage*, and greater *cost recovery*. The same themes were stressed in seminar and conference talks, in AGR working papers,[4] and in informal meetings.

On the formal side, the Bank was promulgating directives governing its lending. Directives may be loosely divided into rules meant to govern staff conduct, and guidance to staff, often on how to carry out the rules. The directives of special interest to irrigation are listed in Table 2.1 by topic.

Formal directives do not play a large role in day-to-day irrigation policymaking. However, they do contribute to defining the context—the margins of the environment in which that policy is made. Thus, the topics covered by irrigation-related directives in the 1971–81 period established the policymaking context.

Cost recovery has clearly been salient for the Bank. As OPM 2.61 stated in March 1971, "The recovery of all project costs from beneficiaries is a normal aim for projects financedby the Bank." But even that early OPM recognized agriculture's special characteristics, by offering a loophole: "As a minimum, operation and maintenance costs should be recovered completely."

Under what circumstances were staff obliged to insist on the maximum of full recovery and under what circumstances would the minimum—complete recovery of O&M costs—be acceptable? For irrigation, guidance was given in 1976 by CPM (central projects memorandum 8.4, which was revised in 1980 as CPN (central projects note) 2.10 (later called operational policy note 2.10) and "amended" in March 1984 by an unnumbered policy note issued by the Vice President, Operations Policy "for filing with OPN 2.10." The rules have not changed since 1971. However, the glosses of OPM 2.61 have (a) stressed the recovery of O&M costs to promote adequate O&M, and (b) recognized cost recovery through mechanisms other than water charges, such as land betterment levies and market taxes.

The other five topics in Table 2.1 defined by directives in the 1972–81 period have been less controversial. (The number of amendments and revisions is a good measure of how controversial a directive is.) At first blush, it might appear that the rules are things that conscientious irrigation professionals would do automatically in any case. Some of the rules are quite general, apply to all projects, and do not particularly relate to irrigation. Nevertheless, selection of any

particular topic is an indication of concern. All irrigation engineers are concerned about *dam safety* because dam failure has tragic consequences.[5] Since 1977, therefore, staff have been instructed to provide for independent design review and periodic inspection of dams. Also since 1977, the *international waters* OMS has precluded proceeding with projects that might cause appreciable damage to riparians without prior consultation, planning, and agreement. Since 1980, for projects that would force people to be resettled, project processing may proceed only after provisions have been made to give oustees a reasonable chance to regain or better their standard of living, something that, the record shows, is all too easy for irrigation professionals to overlook. *Involuntary resettlement* may result from any kind of project, but the big problems usually stem from construction of storage reservoirs for irrigation and hydropower projects in which some people are forced to move, through no fault of their own, for the public good.[6] Acquisition of private land for adduction canals and drains also causes problems.

The 1978 *participation* and *project preparation* directives also betray the existence of problems. While the Bank early recognized the value of local knowledge in designing any kind of project, including irrigation systems, some staff did not.[7] The prohibition on presenting projects to the Board prior to completion of detailed design (a prohibition that has been widely violated, according to numerous OED audits) was probably a response to premature presentation of irrigation projects. The Bank's great expansion of the 1970s, and its establishing and attempting to meet lending targets, led to a downgrading of technical and economic screening. In the irrigation subsector, this led to the practice of presenting projects for approval before the engineering was complete. Concerns about this practice prompted the writing of OMS 2.28.

Part of this great expansion was the Bank's rural-development focus, starting in the early 1970s. The effects of this policy on irrigation lending will be covered in Chapter 3.

The consolidation period—1982–94

By 1982, policy papers covered almost all of agriculture's subsectors but irrigation, the biggest one. As noted above, Bank irrigation lending had started to decline, but not as a result of policy directives. World investment in irrigation had slowed, too. Chapter 3 takes a closer look at what happened to irrigation lending, and Chapters 4, 6, and 7 at what happened to irrigation. As enthusiasm for rural development waned (especially for the notion that multiple facets could be integrated in a single project), the indistinct line between irrigation and other types of rural projects that was common in the 1971–81 period became sharper. Irrigation projects become easier to identify again, with fewer tenuously related components in irrigation projects and fewer irrigation components hidden in "integrated" rural projects. Projects were more apt to cover the entire sector too and less to be limited to specific works at a specific site.

This evolution in policy was evident neither in policy directives that touched on irrigation, nor in discussion or other policy papers emanating from AGR and other parts of the Bank, nor, of course, from any irrigation policy paper.

Policy directives affecting irrigation in the 1982–94 period[8] present an interesting contrast to those of the earlier period. Their tenor is defensive and was a reaction to external criticism directed at the Bank. The 1982 *tribal people* (later indigenous people) OMS was not inspired by irrigation problems but by problems arising from urban projects in Latin America. Nevertheless, it soon became an additional hurdle that irrigation projects had to clear. The 1986 *wildlands* OPN affects irrigation because it requires justification and "balance" whenever

wildlands are converted to more intensive uses. Although a rising percentage of irrigation projects involve rehabilitation or upgrading, that OPN provides guidance whenever new land is irrigated. The 1989 operational directives (ODs) on *environment* and *NGOs*, and the administrative manual statememt (AMS) on *disclosure of information*, include a good deal of common sense that any responsible irrigation professional ought to use in designing and processing a project. What they actually require is modest. But for an increasingly embattled irrigation subsector, they create a presumption of guilt and the requirement to prove innocence. This generalization extends to the 1991 *poverty reduction* OD and the 1992 *environmental action plan* OD, even though few categories of investments attack poverty as obviously as irrigation does, and few, when planned and executed properly, have such obvious beneficial effects on the environment.

Directives are hardly the only source of policy. To the traditional themes of cost recovery and drainage, new AGR irrigation advisers added emphasis on better technical preparation of projects and water management. Still unable to generate consensus on a general policy paper, AGR undertook a series of narrower studies on policies governing groundwater, institutions, management, world water demand, drainage,[9] and, of course, cost recovery.

The policy discussions on irrigation cost recovery continued in the consolidation period. OED's first irrigation sector study in 1981[10] highlighted the absence of uniformity in Bank irrigation cost recovery practice. The study revealed that the Bank's right hand had pressed Turkey hard to get water charges up from 85 percent to 100 percent of O&M costs while its left hand was making repeated irrigation loans to Indonesia, where water charges recovered 15 percent of O&M and there were no serious efforts to reform the system. Clearly, forces other than policy rules and policy statements were shaping policy.

Following OED's study, AGR focused more on diversity in cost recovery. AGR's "Irrigation Water Charges and Cost Recovery Policies: A Policy Perspective" (1983) grapples with the cultural reasons that lead many borrowers to virtually ignore the recovery of O&M costs through water charges. This study showed that project experience "generally showed no association between water charges and water use." It concluded that "other factors are much more important in determining farmers' water management techniques ... at the field level."[11] In short, there was no empirical support for the theoretically correct argument that raising water charges to the long-run marginal value of the water improves water-use efficiency.

Under these circumstances, the AGR working paper argued, "Bank policy in this area should be based on 'second best' criteria. 'Second best' from a practical standpoint may be to have cost recovery cover, at a minimum, the recurrent O&M costs of irrigation systems."[12] Why O&M? The working paper recognized that "to achieve the full advantage from a system of cost recovery for O&M it is necessary that the revenues recovered [be] directed toward O&M costs."[13] Therefore, it argues, "funds from water charges are a necessary but not a sufficient condition for 'good' or 'adequate' O&M activities."[14] On that basis, the working paper concludes:

> *(i) in general the principles [of general policy] are sound and should continue to guide the Bank's efforts in this area; (ii) the evidence on implementation suggests, however, that more emphasis should be given to linking cost recovery with the operation and maintenance of irrigation systems.*[15]

This working paper produced a storm of criticism from Bank economists, who saw no reason for pricing irrigation water other than on the basis of long-run marginal cost. Consequently, the March 1984 policy note, based on the working paper in question, did not represent a con-

sensus. It remained unnumbered and was issued as advice by the Vice President, Operations' Policy "for filing with" OPN 2.10 after editing. Editing consisted of removing a section on the importance of organization and also removing the "teeth" of the recommendation —"The Bank will lend for irrigation development only to those countries prepared to mobilize funds and make them available for the purpose of financing irrigation (including O&M costs)."[16] Later, in 1993, the penultimate draft of *Water Resources Management: A World Bank Policy Paper* encountered the same vociferous criticism when it made a similar recommendation.

A 1986 irrigation sector study by OED on cost recovery, again finding pervasive failure to recover O&M costs and only 15 percent compliance with covenants, attacked the link between water charges and O&M. It found no evidence nor any theoretical reason to expect that higher cost recovery would produce better O&M, concluding that "it is time to take a more pragmatic and comprehensive approach to this issue."[17]

The 1983 agriculture (AGR) working paper failed to recognize that there are alternatives to assigning irrigation O&M to the government irrigation department, a public sector monopolist. It neglected to consider that O&M could be done (indeed, often is done) by irrigators themselves or by other private parties. In retrospect, it is clear that these oversights were what led to the recommendation for water charges *for the purpose* of improving O&M, even while recognizing the absence of a connection between water charges and O&M.

The water resources management policy paper

In 1991 the Bank was under increasing pressure for its alleged neglect of popular participation in irrigation and other water projects, and for its failure to see the impact of its water projects on other water uses and on the environment as a whole. Two irrigation projects stand out among those that attracted attention: Mahaweli Ganga in Sri Lanka and Narmada in India.[18] Work then began on *Water Resource Management: A World Bank Policy Paper,* which was published in 1993. The paper showed that the Bank, after years of finding irrigation too vast a subject for a policy paper, now found it too narrow.

Water Resource Management is a comprehensive document, written with growing water scarcity in mind and therefore particularly relevant to irrigation in countries suffering from water scarcity. It advocates, and pledges Bank support for, a comprehensive approach to water resources and incentives for good water management. The paper gratified those who had sought an irrigation policy paper without disturbing practitioners who feared that such a policy statement would prevent them from applying the best combinations of engineering and economic solutions to the highly site-specific problems of irrigation projects. The paper's advocacy of flexibility on irrigation water pricing aroused considerable debate during the review process. As had happened earlier, general economists argued for simple long-term marginal value pricing, while AGR's staff, its consultants, and the Bank's operating divisions argued that market imperfections and other irrigation-sector circumstances justify more flexibility. In the end, *Water Resource Management* both affirms the general desirability of marginal-value pricing and recognizes the need for flexibility.

Formal and informal policy sources

Did the absence of a policy paper give rise to chaotic and uncoordinated Bank efforts in the irrigation sector or allow innovative solutions to irrigation's environmentally specific problems? To find out, OED staff interviewed

current irrigation task managers and division chiefs, as well as a number of individuals who were active in Bank irrigation loan-making and sector-study writing earlier, to ascertain their working practices, especially at the time of project identification, preparation, and appraisal. A particular effort was made to find out the extent to which staff members pinpointed worthwhile projects, reacted to project ideas from borrowers or some other source, or simply limited themselves to financing them.

When Bank task managers and their chiefs were asked about the provenance of specific projects, it became clear that the predominant source of irrigation project proposals was borrower governments. Less than half of project content was attributed to other influences: the beneficiaries, the Bank, external project preparers, or other external financiers. Remarkably, this was still very much the case with major irrigation borrowers where the Bank has made major efforts to influence policy through heavy implementation assistance and administration of United Nations Development Programme technical assistance programs, as in India. Where the borrower had little irrigation tradition, however, as in some countries of sub-Saharan Africa, nonborrower policy inspiration was higher. In these cases, perhaps borrower "ownership" was lower too.[19] Given the depth of sector dialogue, of course, any attempt to separate project ideas into those of the borrowers' and those of the Bank's is an oversimplification. Nevertheless, staff interviews indicate that the Bank has been more a taker of borrowers' irrigation project ideas and less a maker of them than is commonly supposed.[20]

The interviewees said that the policy pronouncements and directives discussed above define the framework within which they operate, but they reported that the framework set by the rules is very much at the periphery of their operating concerns. For the most part, their input (therefore the Bank's nonfinancial contribution to irrigation policy) stems mainly from personal contacts with other professionals within the Bank and from the task managers' personal reservoir of experience.

Survey evidence indicates that Bank task managers with more years of tenure tend to have gained this experience outside the Bank, whereas those who have become irrigation task managers recently draw primarily on experience gained through Bank irrigation work. Many of the irrigation engineers with extensive experience outside the Bank derived their formative ideas from work in southern France, Iran, Israel, North Africa, and in the western US—all arid or semi-arid areas. Some of them got their outside experience in more humid areas, often in parts of what was once the British Empire, such as the Indian subcontinent and Malaysia. Some interviewees expressed concern that the more-experienced staff tend to apply techniques appropriate to areas where they learned their trade to other areas where such techniques may not be appropriate. However, concerns were also expressed about staff with less tenure whose experience stems principally from Bank work. An example is AGR's 1990 annual report on the irrigation subsector, which says, "There is ... cause for concern because some of the positions of irrigation engineering are replaced by nontechnical staff (economists) and some agricultural divisions with substantial irrigation programs have not been staffed with engineers for some time. There is risk of decline of quality of work in the near future if this trend continues."[21] Since this survey reveals the critical importance of staff experience to the day-to-day making of irrigation policy, the experience of Bank irrigation staff—both its amount and its appropriateness—is manifestly of critical importance.

Notes

1. The Bank's first irrigation loan was Iraq's Wadi Tharthar Flood Control (Loan 26, approved June 1950) for $12.8 million. It was preceded by a loan for a multipurpose project, principally power and irrigation—Chile's Fomento & Endesa S.A. (Loan 5, approved March 1948) for $13.5 million.

2. Willi A. Wapenhans, "Note on Pricing of Irrigation Water," unpublished paper, World Bank: Agricultural Projects Department, July 7, 1969.

3. The 1972 *World Bank Operations: Sectoral Programs and Policies*, p. 39, says 60 percent.

4. See, for instance, Paul Duane, "A Policy Framework for Irrigation Water Charges," World Bank Staff Working Paper No. 218, Washington, DC: World Bank, July 1975.

5. No Bank-financed dam has failed, although Tarbela dam in Pakistan came very close while it was being tested. The Tarbela incident provoked formalization of practice in OMS 3.80.

6. OED has reviewed Bank experience in Report No. 12142, "Early Experience with Involuntary Resettlement: Overview," June 1993. The series contains two case studies on irrigation: Report Nos. 12132 and 12133, impact evaluations on India Karnataka Irrigation Project (Credit 788-IN) and India Maharashtra Irrigation II Project (Credit 954-IN), both June 1993. The two other case studies, Report No. 12141, impact evaluations on Ghana's Kpong Hydroelectric Project (Loan 1380-GH) and on Thailand's Khao Laem Hydroelectric (Loan 1770-TH), both June 1993, cover power projects, of which Khao Laem has an irrigation component while Kpong does not.

7. See Box 7.1.

8. Modifications made to directives on topics already covered were minimal.

9. Some of the more important papers are: Ian D. Carruthers and Roy Stoner, "Economic Aspects and Policy Issues in Groundwater Development," World Bank Staff Working Paper No. 496, Washington, DC: World Bank, 1981; Daniel W. Bromley, "Improving Irrigated Agriculture: Institutional Reform and The Small Farmer," World Bank Staff Working Paper No. 531, Washington, DC: World Bank, 1982; James E. Nickum, "Irrigation Management in China: A Review of the Literature," World Bank Staff Working Paper No. 545, Washington, DC: World Bank, 1982; Santiago Friedman, "World Water Availability and Demand: An Overview," AGREP Division Working Paper No. 108, July 1983; and José Olivares, "Options and Investment Priorities in Irrigation Development," Washington, DC: World Bank, August 1987 (a study financed by the United Nations Development Programme and the governments of France and the Netherlands). Moreover, the number of Bank technical papers devoted to irrigation (q.v.) mushroomed in this period.

10. OED Report No. 4321, "Water Management in Bank-supported Irrigation Project Systems: An Analysis of Past Experience," April 1981.

11. Annex II, para. 12, p. 4. Based on case studies of Bank-supported projects in Bangladesh, China (Taiwan Province), India, Indonesia, Korea, Mexico, Morocco, Myanmar (Burma then), Nepal, Pakistan, the Philippines, Senegal, Sri Lanka, Sudan, Yugoslavia, and Zimbabwe.

12. Ibid., p. 12, para. 4.2.

13. Ibid., para. 4.4, p. 12.

14. Ibid., para. 3.29, p. 10.

15. Ibid., para. 1.1, p. 3.

16. Ibid., para. 5.1, p. 15.

17. OED Report No. 6238, "World Bank Lending Conditionality: A Review of Cost Recovery in Irrigation Projects," June 1986, para. 3.06, p. 8. See also p. 7. The OED review does *not* mention that OMS 2.22 of February 1984 on financial performance covenants for revenue-earning enterprises was *not* applied to public irrigation agencies. In view of the Bank's experience with irrigation cost recovery to that time, irrigation agencies were not treated like public utilities that provide telephone service or electric power. Irrigation agencies, unlike other utilities, cannot readily measure or even control how much of the commodity they deliver to individual users.

18. Sri Lanka's massive Mahaweli Ganga development program was the object of four IDA credits and one Bank loan: Credit 174 for $15.46 million and Loan 653 for $14.54 million, both approved in January 1970, Credit 701 for $19 million, approved in April 1977, Credit 979 for $3 million, approved in January 1980, and Credit 1166 for $90 million, approved in June 1981. India's massive Narmada River development program was the object of two IDA credits and one Bank loan: Credits 1552 and 1553 for $100 and $150 million respectively and Loan 2497 for $200 million, all approved in March 1985. These programs have come under attack for lack of fairness in resettling oustees from reservoir flooding and canal construction, as well as effects on flora and fauna. Ironically, both programs realize or expect to realize most of their benefits from power generation, not from irrigation.

OED has audited all but the most recent of the Mahaweli Ganga projects. The first (Credit 174 and Loan 653) and the technical assistance project (Credit 979) were judged satisfactory overall and the second unsatisfactory. The remaining Mahaweli project and the Narmada project have been recommended for OED audit. In 1993, India renounced further Bank financing of Narmada River development. As of end August 1993, $170.32 million of the loan and credit balance had been canceled, $348.39 million had been disbursed, and there were $15.96 million of then undisbursed funds that had not been canceled.

19. Some instances of high external content and unsatisfactory results are Kenya's Bura (Credit 722, Loan 1449), Senegal's Senegal River Polders and Debi-Lampsar (Credits 350 and 775), Syria's Balikh (Loan 975), Burkina Faso's Niena Dionkelé (Credit 1013), Chad's Sategui Deressia (Credit 489), Laos' Agricultural Development and Rehabilitation (Credit 760), Mauritania's Gorgol Noir (Credit 1068), and many others.

20. This is consistent with the basic conception of the Bank as an institution that screens investment proposals prepared by borrowers and, as lender of last resort, finances those that are technically, financially, and economically viable, and which would not find alternative financing.

21. H. Plusquellec and W. Ochs, "Annual Report—Irrigation Subsector," unpublished World Bank document, July 23, 1990, p. 12.

3. Bank lending

To discern patterns in Bank irrigation lending, the study analyzed the richer but narrower mine of information on 208 evaluated irrigation projects and the broader but poorer mine of information available on all irrigation projects, whether evaluated or not.

There have been 614 projects with major or minor irrigation components. As a result of definitional problems, this list is not the same as the Bank's standard classification.[1] Total irrigation lending is not significantly different from what the Bank reports. However, Bank irrigation reviews underreport small-scale pump irrigation because it often figures in Bank records as rural credit, electrification, or other projects. Consequently, the share of large-scale, gravity irrigation in Bank lending is generally overreported.

Analysis of the records of all 614 projects shows when and where the Bank lent for irrigation but not much more. The reports on the subset of 208 *evaluated* projects yield additional information about their characteristics. Most of the 208 projects have been the subject of more than one evaluation. Where assessments differ, impact evaluations take precedence over audits, which in turn take precedence over project completion reports (PCRs).

As Figure 3.1 shows, the cohort of 208 projects includes virtually none after 1982. Fully 97 percent of evaluated irrigation projects were approved between 1961 and 1982. There is little coverage of early lending or of the much bigger group of loans that are still disbursing. (Chapter 8 analyzes trends in projects approved since 1982 but not yet evaluated.) Besides this obvious temporal bias, there is another. On the whole, when loans are being disbursed on schedule, it means that the project is unfolding satisfactorily, and vice-versa. In years for which not all PCRs have been received, the projects lacking PCRs are more likely to be performing unsatisfactorily.

To extract information in a systematic way from the 208-project set, OED staff devised a list of questions based on earlier reviews. Many of the answers bear on project results and will be dealt with in Chapter 4. They also give a much better picture of the Bank's irrigation lending than can be gleaned from the 614-project global list.

The results of analyses of both the global list and the narrower evaluated sample are synthesized below, first by decade, then thematically.

Irrigation lending by decade

Bank lending for irrigation started in the 1950s with a $12.8 million loan to Iraq.[2] Five other loans—for projects in Chile, India, Japan, Peru, and Thailand—were approved during the

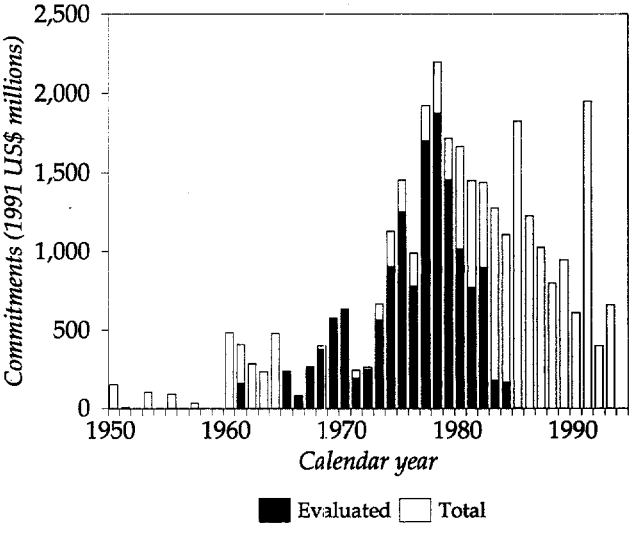
decade. Total irrigation lending for these six pioneering projects—$66 million—amounted to less than 1 percent of the approximately $20 billion of irrigation lending through 1993 and 3 percent of all Bank lending in the decade.

The 41 irrigation projects supported in the 1960s were therefore a large expansion of such lending: $739 million, equivalent to 8 percent of all Bank lending in the 1960s. This lending was about 4 percent of all Bank irrigation lending through 1993 (11 percent when comparing constant instead of current units to correct for inflation).

Some of these early projects might have been called subsectoral adjustment projects if they had occurred in recent years. A $90 million loan to support a $838 million irrigation investment in Pakistan was part of the Indus waters settlement and was not surpassed in size for 14 years. India received six loans in 1961 and 1962, all but one for specific projects. Continentwise, 75 percent of the 1960s' irrigation lending went to Asia, with the rest split almost equally between the Western Hemisphere and Africa. About half the lending was used for projects in arid and semi-arid areas and about half for projects in well-watered areas, most of the latter to grow rice. About one-fifth was invested in temperate regions with little or no winter crop, and about four-fifths in tropical or subtropical regions.

In the 1970s the Bank initiated its AGR classification system, and it is easier to identify irrigation lending in projects classified as something else (as well as irrigation projects that included significant amounts of nonirrigation lending). During the decade, 256 projects containing irrigation lending were approved.[3] The irrigation content ($6,052 million) of the lending, equivalent to 11 percent of all Bank lending in the 1970s, accounts for 30 percent of all Bank irrigation lending through 1993 (36 percent when comparing constant units).

FIGURE 3.1: WORLD BANK IRRIGATION LENDING (TOTAL AND EVALUATED)



In the 1970s the "packaging" of Bank irrigation lending changed. Of the 41 projects on the global list approved in 1970 through 1973, five (12 percent) were rural credit projects, one was a rural development project with an irrigation component, and about three more are hard to classify as either irrigation or area development. Following a rural development speech in Nairobi by the Bank's president in 1973, the number of multifaceted projects rose. Of the 215 projects on the global irrigation list approved in 1974 through 1979, only about half were clearly irrigation projects. Of the other half, one-third were called agricultural sector or area-based agricultural development. Many of these were termed integrated. Another one-eighth were credit projects, many of them principally for financing irrigation. The rest were a scattering of perennial crop and livestock projects, a watershed improvement project, and an extension/research project, all with irrigation components. From 1974 through the end of the 1980s, the projects the Bank classifies as irrigation were more likely to contain

farm research and extension, village water supply, and all-purpose pavements as well.

While irrigation projects were getting more complicated, they were getting smaller. This trend is not evident until adjustment is made for the rise of the US dollar price level. In current terms, average irrigation lending per project was $11 million in the 1950s, $18 million in the 1960s, and $24 million in the 1970s. In constant terms, however, there was a 48 percent drop in the average amount of irrigation per loan from the 1960s to the 1970s. The average projected irrigation cost of projects dropped 68 percent as the share financed by the Bank rose. (See Table 3.1.)

Many of these small "rural development" projects were in small countries, many of them in Africa. Africa's share of irrigation lending did not rise in the 1970s, but its share of approved irrigation projects did, from 10 percent to 31 percent. (See Table 3.2.) Even projects in which irrigation was the predominant purpose got smaller and more diverse, notwithstanding a large upsurge in large-project irrigation lending to India, Indonesia, Mexico, and Thailand. Asia continued to attract the bulk of lending for irrigation in the 1970s, though its share fell from three-fourths to two-thirds as European countries began to get irrigation loans.

TABLE 3.1: IRRIGATION PROJECTS BY DECADE

	Projects containing irrigation	*Lending in projects containing irrigation (1991 US$m)*	*Irrigation lending in these projects (1991 US$m)*	*Cost of projects containing irrigation (1991 US$m)*	*Irrigation costs in these projects (1991 US$m)*
1950s					
Decade	6	430	372	1,805	1,561
Average/year	1	43	37	181	156
Average/project		72	62	301	260
1960s					
Decade	41	3,963	3,426	16,220	14,024
Average/year	4	396	343	1,622	1,402
Average/project		97	84	396	342
1970s					
Decade	256	17,091	11,201	43,466	27,623
Average/year	26	1,709	1,120	4,347	2,762
Average/project		67	44	170	108
1980s					
Decade	258	21,993	12,729	60,512	32,900
Average/year	26	2,199	1,273	6,051	3,290
Average/project		85	49	235	128
1990–93					
Decade	53	5,454	3,611	14,023	7,944
Average/year	15	1,558	1,032	4,007	2,270
Average/project		103	68	265	150

The decline was particularly sharp in projects where irrigation accounted for less than half of the project's spending. Comparing the sizes of loans made in 1974–79 with those made in the 1960s after adjustment for inflation, the irrigation spending contained in the average 1974–79 loan that was more than 50 percent irrigation was 87 percent as large as in the 1960s; the irrigation spending in the average 1974–79 loan supporting irrigation but in which irrigation was less than 50 percent was 11 percent as large as in the 1960s. In short, the bulk of the fall was due to the inclusion of small rural development projects with smaller irrigation components vying for manage-ment attention with a wide variety of other interventions.

In the 1980s there were 258 projects containing some irrigation lending.[4] The funds loaned for irrigation in these projects ($9,874 million), equivalent to 6 percent of all Bank lending for the 1980s, accounted for about 48 percent of all Bank irrigation lending through 1993 (41 percent in constant units).

Real irrigation lending only rose by 14 percent in the decade, while Bank lending as a whole rose by 81 percent. In real terms, Bank irrigation lending peaked in 1978 and has trended downward since then (see Figure 1.4).[5] The rate at which the Board approved projects that included irrigation fell from 35 a year in 1974–79 to 26 a year in the 1980s.

In the 1980s, irrigation projects and the loans that supported them again got bigger. In projects including irrigation, in real terms, the irrigation component of loans rose by 11 percent compared to the 1970s, well below the comparable figures for the 1950s and 1960s. The average real estimated irrigation per project rose by 19 percent, at which level it too was below the 1950s and 1960s. As in the 1970s, these figures are heavily influenced by the inclusion of numerous smaller projects in which irrigation was a relatively minor component. Again, half the project cost in the 258 projects on the global list was not for irrigation; half the projects were less than half irrigation; 84 percent of those more than half irrigation were identifiably irrigation projects, while 16 percent of those less than half irrigation were. In short, identifying 1980s irrigation lending is difficult. As in the 1970s, irrigation was frequently "hidden" in sector, area development, and credit projects. There are subtle differences from the 1970s, however. There were fewer credit projects in the group, and fewer projects were termed "integrated" or "rural development" than in the 1970s.

Geographically, Asia continued to dominate irrigation lending in the 1980s, its share rising to nearly three-fourths again. Europe's share fell to zero by the end of the decade as Romania stopped borrowing and other borrowers graduated. The shares of Africa and the Americas stayed nearly the same. As before, the average

TABLE 3.2: IRRIGATION LENDING BY CONTINENT AND DECADE

	Irrigation lending (% of global amount)				*Projects (% of global number)*				*Average irrigation lending amount (1991 US$m)*				
Decade	*Asia*	*Americas*	*Africa*	*Europe*	*Asia*	*Americas*	*Africa*	*Europe*	*Asia*	*Americas*	*Africa*	*Europe*	*World*
1950s	75	25			67	33			70	47			62
1960s	75	12	13		71	20	10		89	51	112		84
1970s	66	12	13	9	47	14	31	7	61	37	18	55	44
1980s	73	12	11	4	47	13	34	5	76	44	16	39	49
1990–91	61	23	16		60	17	23		69	93	47		68
Total	69	13	12	5	50	14	30	5	71	47	21	48	51

African irrigation loan was small. Africa accounted for 34 percent of the operations involving irrigation but only 11 percent of the lending amount. African lending per operation was one-fourth of that in Asia.

In 1990–93 there were 53 projects that included irrigation, 9 percent of the total through 1993.[6] The funds loaned for irrigation in these projects ($3,642 million), equivalent to 5 percent of all Bank lending for 1990–93, accounted for about 18 percent of all Bank irrigation lending through 1993 (11.5 percent in real terms).

It is risky to generalize on the basis of such a short period and of a sample of only 53. However, a few trends are worth noting. The size of irrigation loans and of projects again increased, the former by 21 percent, the latter by 13 percent compared with the 1980s. Real project size was 33 percent smaller than in the 1960s. There were big irrigation-sector loans to big borrowers, notably Brazil, China, and Mexico. The portion of projects that were explicitly irrigation projects rose to well over half. Among those that were less than half irrigation, the mix changed. Credit, notably, practically disappeared, while sector and area-based projects accounted for nearly all of this group. Just as there was a tendency to package all irrigation lending into an irrigation subsector loan, there has been a tendency to include quite a lot of irrigation lending in huge sector loans, such as those to Mexico and Venezuela. This is what makes that average size of the less-than-50 percent irrigation projects very large. These large loans to Brazil, Mexico, and Venezuela increased the share of the Americas to 17 percent of the projects and 23 percent of the money, principally at the expense of Asia. African projects continue to be small relative to those of other continents, but not quite so small as in the past.

While the amount of irrigation financed per loan rose, the rate at which the Board has approved irrigation-containing loans has fallen farther, from 26 a year in the 1980s to 13 a year in the 1990s. After a very large increase in irrigation lending in 1991, the Bank's annual irrigation commitments resumed the downward trend begun in 1979.

Lending by theme

The above information tells us little about how Bank lending was supposed to affect people. That sort of information is not contained in the Bank's general databases, except for superficial appraisal estimates of the number of people who benefited. Evaluations, however, shed light on what was being lent for and how it is supposed to affect people.

Geographical distribution

Most irrigation lending—50 percent of the projects and 69 percent of the money loaned—has occurred in Asia, where most of the poor people who are targets of Bank development efforts live. (See Table 3.2.) India alone has accounted for 11 percent of the loans and 26 percent of the lending. Asia's dominance should be seen in context; about 85 percent of the developing world's irrigated area is in Asia.[7] Central and South America, with about 8 percent of the developing world's stock of irrigation, accounted for 14 percent of projects and 13 percent of loans. Africa accounted for 30 percent of the projects and 12 percent of the lending; about 7 percent of the developing world's irrigated area is in Africa.

Evaluated benefits

The objective of most projects was to increase grain production. Increased grain production was the predominant anticipated benefit in 91.5 percent of the projects, indeed, the exclusive one in 56 percent. The other anticipated outputs were mainly increments in cotton, fruits and vegetables, and sugar. An increase

in *rice* production was the predominant anticipated benefit in 60 percent of the projects, and the sole one in 38 percent.

Climatic distribution

Well over half of the evaluated irrigation projects were situated in humid tropical areas. In fact, more than half were in humid areas in Bangladesh, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand, and Vietnam, and the humid parts of India and Nepal. Most of these were predominantly rice projects—all of the 49 projects in Southeast Asia, and 54 of the 56 projects in East Asia. In most instances, a single annual crop of rice, and sometimes two, would grow without irrigation in these areas. Irrigation serves to enlarge double-cropped areas—the principal benefit—and to increase the yields from pre-irrigation (or pre-improved-irrigation) cropped areas.

The concentration of Bank irrigation lending in the humid tropics contrasts with the location of existing irrigated areas in developing countries. Only about one-third of these are in tropical and subtropical humid and subhumid areas.[8]

Bank loans have also supported quite a few wheat and fruit and vegetable projects in the arid and semi-arid Mediterranean area, a dozen projects on the western side of the Americas that put water from the mountains to good use in the western deserts, a dozen very diverse projects in the African Sahel, a drainage scheme in the coldest part of China that permits large-scale mechanized grain and soya farming, attempts to grow rice on peat soils in Madagascar, and many more. In the Middle East, where average annual rainfall per project area is 320 mm, and in North Africa (370 mm), Europe (560 mm), and sub-Saharan African (680 mm), evaluated irrigation projects are more likely to be irrigating desert or near-desert.

Beneficiaries and size

The average evaluated project aimed to serve 76,000 farm families, ranging from the big projects in India designed to benefit, on average, 172,000 families to the smaller projects of the Americas, of North Africa, and of sub-Saharan Africa, designed to benefit 10,000, 7,000, and 5,000 families each, respectively. The average area to be irrigated was about 132,000 hectares, ranging from 282,000 hectares in India and even a little higher in the rest of South Asia to 26,000 hectares for sub-Saharan Africa and 17,000 hectares for North Africa. The average size of benefited farm per project, averaged for all projects, is 216 hectares. This figure is misleading, however, because 12 projects (eight of them in Romania and one each in China, Ethiopia, Iran, and Malaysia) involved state farms or plantations of several thousand hectares each. For the 12 projects with the largest farm size, the average was 3,260 hectares. The average farm size for the other 196 projects was less than 20 hectares, and most of them were less than two hectares. The median size of the farms benefited by the 208 projects was 2.1 hectares. When they got project benefits, these farmers were expected to be able to raise, on average, 1.54 crops per year. Regional differences in expected cropping intensity are not terribly significant; the figure is lowest in northern areas, where winter is a factor, and highest in Southeast Asia, where irrigated areas (Java and the central Luzon Plain, for instance) are very densely settled.

Public-private balance

Overwhelmingly, the 16 million farm families benefited by the 208 evaluated irrigation projects were small, unincorporated private entrepreneurs. The exceptions were the 12 state farm or irrigated plantation projects referred to above. Even in these latter cases, the beneficiaries were usually more akin to private operators organized by a public agency. The degree to

which they are private is much higher today as state farms have been turned over to workers and plantation workers have been made more autonomous.

In the popular paradigm, irrigation is a public service provided to private farmers—a large canal system, with or without water storage facilities, built and operated by government with little input from private beneficiaries, and sometimes in ways that are insensitive to their wants. This model has its basis in fact. There are many such projects. Some even involve government take-over of systems that were built and run by local, nongovernment bodies.[9] However, a rival paradigm is of irrigation as a private service to private farmers—of small, independent, private farmers pumping from groundwater (and usually failing to use their pumps to capacity or to sell water to neighbors). Bank financing of this sort of completely private irrigation is underrepresented in the 208-project evaluation set. Even so, 30 percent of the evaluated projects were predominantly based on groundwater, most but not all of them on private, small units. (Another 25 percent use both surface and groundwater.)

Chapter 8 discusses the accelerating trend, often independent of the Bank but also promoted and encouraged by the Bank, to privatize public irrigation systems. Only the beginnings of this trend are evident in the most recent of the 208 evaluated projects. The Philippines' Communal Irrigation Development Project (Loan 2173, approved June 1982), recognizing Philippine traditions of irrigation self-management, pioneered the turnover of smaller surface systems to irrigators. In South Asia, poorly functioning public tubewell schemes are being replaced with private ones in a planned way—in Pakistan, starting with Salinity Control and Reclamation (SCARP) Transition Pilot Project (Credit 1693, approved May 1986), and de facto in India, starting with Second Uttar Pradesh Public Tubewells Project (Credit 1332, approved March 1983), which was intended to improve public tubewell operations but failed to do so. These projects are currently being audited.

Participation

The evaluation record contains little information on beneficiary participation. This parallels the weaknesses in irrigation sector work: that while participation was always mentioned, the discussion could rarely be called thorough. Discussion of organization and management has invariably focused on the organization and management of public agencies, but never, in the sample analyzed, on the irrigators themselves or other private groups.

Participation, of course, means different things to different people. OMS 2.12 of August 1978 (see Table 2.1 above) clearly targeted participation of government agencies as well as irrigators. Participation may be more narrowly construed as applying primarily to farmers and oustees. The study construes it thus because this is what is most often conspicuously lacking, with negative results for all concerned. The users of working irrigation systems have always organized themselves into some kind of group, whether legally and publicly recognized or not. But only 30 percent of the irrigation evaluations mention water users' groups, the third lowest of 19 factors covered by this study's analysis. Generally, the evaluations only mention groups organized and recognized by governments. While these groups were regarded as satisfactory by only 44 percent of the evaluations that mentioned them (the lowest satisfactory rating for any factor except cost recovery), it appears that a "satisfactory" classification had more to do with their legal status than with how useful they were to their members.

Gender

The Bank's irrigation evaluations seldom mention gender. A review of OED's evaluation

textbase shows that gender issues are mentioned in only 3.7 percent (10 of 271) of irrigation documents. None of them include a significant discussion of gender, or a proposal for action, or mention an action taken.[10] OED's most specific work on the effect of irrigation on women was in two impact evaluations. A survey of beneficiaries of Morocco's Doukkala irrigation projects (OED Report No. 7876, June 1989) revealed that the projects had greatly increased women's labor input, which the women in question (and the authors of the impact evaluation) regarded more as a burden than as an opportunity. By contrast, a survey of beneficiaries of Turkey's Seyhan irrigation project (OED Report No. 5745, January 1985, p. 14, para. 2.30) revealed that "Women's field labor has vanished, at least in landowning families. Rather than replace it with other economic activities ... , women have tended towards housewifery as a new status of relative leisure .... Formerly men controlled what little money there was in families, but now women supervise consumption expenditures." One beneficiary reported, "Weaving is for the herding hill families. Our hardest work now is to reach out and turn on the television or the stove." As the analysis of Bank irrigation sector work in Chapter 5 shows, Bank irrigation sector work has been gender neutral, and most sector studies do not address gender issues at all.

Fortunately, there are other sources of information on gender concerns in Bank irrigation lending. As part of its study on *Gender Issues in World Bank Lending* (1995), OED compiled information on gender dimensions of projects not only from OED but also from the Bank's Women in Development group and its predecessors, and from elsewhere. While the information obtained since July 1987 is comprehensive (if not about results, at least for the intentions reflected in appraisal reports), coverage is spotty prior to that date. From FY67 to FY87, a specific gender action was proposed in the appraisal documents of at least 14 (5 percent) of the 270 irrigation projects. This percentage compares to 7 percent for all of the Bank's 3,936 projects. Gender was a bit less likely to be subject for action at appraisal for irrigation projects. This is surprising in view of the obvious special impact of irrigation projects on household water, which is almost universally the predominant domain of women. More recent gender trends in irrigation projects are treated in Chapter 8.

Mention of gender and even inclusion of specific actions at appraisal does not necessarily translate into results, as an on-going audit of Egypt's New Land Development (West Nubariya) Project (Credit 1083, approved October 1980) shows. The appraisal report is unusually sensitive to the stress of settlement, particularly on women, as well as thorough in describing women's problems and their economic and social effects. Unlike many appraisals, however, it does not stop there but includes specific actions to address the problems: project components to improve women's literacy, health, population education, and handicraft development, and their success in dairying and poultry and rabbit raising. So that women can get this training and still work, day care centers are provided. This multifaceted program was to be carried out by the Community Development Section of the project unit. OED's audit found that the project was carried out by the Irrigation Ministry, which was little interested in such matters, which are generally handled by the Agriculture Ministry. Digging canals and land shaping were straightforward matters run directly from Cairo. Initially the project unit, including a Community Development Section to carry out the women's program, was not set up. Later, when it was set up, it was not staffed for some time. The excellent women's development program described in the appraisal report did achieve something. The PCR reports, "In addition, the Community Development Section ... has set up a women's program to promote better child care and nutrition, in addition to

Box 3.1: Using what exists—better vs. new construction

Worldwide, there seems to be a deep-seated human tendency to want to do something new and to denigrate what is mundane and day-to-day. The excitement of inaugurating a new project is greater than that of maintaining an existing one.

In irrigation, new construction seems to get unwarranted precedence over not only operation and maintenance, but also over upgrading existing schemes, and even over completing new schemes that have been started but not completed. Cutting the ribbon for a new project gets more publicity than routine O&M, even though the latter may produce more benefits at less cost.

The Bank's irrigation sector work (see Chapter 5) has turned up this bias in country after country. An example is the excerpt from a recent country agricultural strategy paper, in which the names have been deleted to protect the guilty. The shoe, however, fits many feet.

In the past, <Country X> has built dams that remain underutilized. Under half of the large-scale irrigation (LSI) schemes are operational. The failures of the system are evident in the fact that farmers have sunk their own tubewells on an estimated one-quarter of the LSI command area. Yet, the Government continued to build large-scale irrigation schemes which require heavy investments in new dams and conveyance facilities. In addition, because of inadequate maintenance and operations, <Country X> currently has a number of dams and irrigation schemes in need of rehabilitation and repair. Given the sunk costs involved, rehabilitation and completion of networks would have a higher return than new schemes ....

Government's stated priority for development is now focused on the <Y Region>. The <Y> is viewed as a new frontier and a potential for the irrigation of 150,000–200,000 ha is said to exist in that region. The Government intends the <Y> to complement the <rest of the country> both for the domestic market and for exports. Analysis of the technical, financial, economic, marketing, and environmental aspects of such development is required.

sewing and handicraft."[11] However, the women's program was not deemed important enough to warrant mention in the audit.

The above example is consistent with the findings of *Gender Issues in World Bank Lending* that, while attention to gender issues has increased over time in project documents, it is by no means obvious that gender actions have. This enhanced attention to gender issues seems to be especially the case for irrigation. From the mid-1970s to the mid-1980s, influence of the prevailing "rural development" paradigm for irrigation projects emphasized the need to include women's training, health, and child-care programs. Over time, the care devoted to describing these features of irrigation projects has increased.

Diversity

Irrigation projects have been extremely diverse, even excluding those, such as engineering credits, which put no additional water directly into plants' root zones. About 62 percent were predominantly for surface irrigation, and about 30 percent were predominantly groundwater projects. Perhaps more significantly, about a quarter of them were a mix of the two. The Middle East, Romania, South Asia, and, to a lesser extent, sub-Saharan Africa have a higher than average share of pump projects, most of which pump groundwater, but some of which pump from rivers or other sources. In humid East and Southeast Asia, where paddy culture predominates, surface irrigation is far more prevalent than pumping.

New projects-rehabilitation-upgrades

Irrigation projects supported by the Bank are rarely entities built from scratch. About half of the sample were partly intended to rehabilitate existing systems, and 18 percent were entirely for rehabilitation. Rehabilitation projects were the rule in humid East and Southeast Asia. By contrast, there has been little financing of rehabilitation in Europe and Africa, obviously for different reasons.

Of the half of the sample composed of new-construction projects (45 percent entirely new construction), Bank financing, more often than not, has been for new construction to extend what was already well underway or for irrigation works that had, in some cases, already been in operation for a long time. Similarly, rehabilitation has generally gone well beyond deferred maintenance, often involving considerable upgrading or improvement of pre-existing facilities. Although the distinction is far from neat, it is important to bear in mind that Bank-financed interventions are usually deeply imbedded in what went before. In most cases, it is hard to separate the Bank intervention from the rest of the sector, regardless of whether the loan supported a project, a sector intervention, or was "policy-based." (See Box 3.1.)

Operation and maintenance

Recognition of the salience of operation and maintenance problems has resulted in increasing use over time of legal covenants binding borrower governments to provide "adequate" funds for O&M. Analysis of evaluation ratings of 19 specific aspects of irrigation projects rated O&M satisfactory only 45 percent of the time, the third lowest of the 19. When Bank staff were polled on irrigation implementation problems, Operational staff rated both operation and maintenance to be salient problems; OED staff considered operation a major problem and maintenance to be of average importance.[12]

In the 1950s and early 1960s the Bank chose not to take an interest in O&M because it was considered recurrent expenditure rather than investment. Later in the 1960s, however, the Bank agreed to finance rehabilitation. Many Bank-financed irrigation projects in Indonesia, for instance, are principally for deferred maintenance. Guyana, Sea Defenses (Agriculture) Project (Loan 559, approved September 1968) may have been the first such project in fact; Turkey, Irrigation Rehabilitation Project (Credit 281, approved January 1972) was the first in name.

More recently, the Bank has come close to financing irrigation maintenance and operation in the name of financing deferred maintenance, as in Philippines, Irrigation Operations Support Project (Loan 2948, approved June 1988). Whether what is being financed is capital or recurrent is less interesting than whether it is useful for the borrower and for irrigators and whether it is a catalyst for sustainable changes. In this regard, the trend not just to rehabilitate but to upgrade existing irrigation facilities is heartening. An example is India, National

Water Management Project (Credit 1770, approved March 1987), which seeks not merely to restore ill-operated and ill-maintained systems to the state they would have been in with proper O&M, but to analyze their problems and redesign them, making appropriate and low-cost engineering and operating changes to improve the quality of irrigation service.

Fiscal equity

This study has already discussed the Bank's strong conviction that those who benefit from economically profitable government actions ought to cover the costs of those actions.[13] Cost-recovery concerns are rooted in ideas of fiscal equity, but in the Bank they became entangled with ways to improve poor irrigation O&M when Bank analysts assumed that such O&M would be carried out by government institutions and that costs recovered from irrigators through water charges would be paid to government O&M agencies. OED studies have pointed out the weakness of these assumptions in Bank directives.

In practice, the Bank pursues its fiscal objectives mainly through legal covenants. Review of these covenants shows that irrigation sector covenants have been highly standardized rather than tailored to individual country conditions. The principal adaptation to country conditions has been that, where there was sharp disagreement with a borrower, cost-recovery studies were prescribed. Where there is not, a move toward recovery of at least O&M costs and some share of capital costs has been prescribed. In intermediate cases, covenants were dated and borrowers engaged themselves to implement the as-of-then unknown findings of the studies after discussions with the Bank, sometime also by fixed dates. As OED studies have shown,[14] such covenants usually have not been kept.

Despite the Bank's intense focus on fiscal equity in irrigation lending from its very inception, evaluation has found the results satisfactory less often than for any other aspect of irrigation. Cost recovery was rated satisfactory in only 31 percent of the projects rated, far below the second-lowest rated aspect (water-users' groups).

Dams

In some minds, the Bank is associated with the construction of large dams. In fact, the Bank has only occasionally financed large-dam construction. Only 46 (less than one-fourth) of the evaluated projects involved *any* dam construction.[15] Many of the surface systems (46 totally and another 21 partially) were run-of-river, with no storage reservoirs. Twenty-one of the projects involved providing surface irrigation from dams or tanks already in existence and where Bank loans helped pay for additional headworks, canals, drainage, roads, land-leveling, land consolidation, resettlement of oustees, or something else. There have been more projects in which the Bank has financed headworks, pumps, canals and cross-regulators, drainage, roads, and land leveling than in which the Bank has financed dams.

Dam safety, as noted in Chapter 2 above, has been a Bank concern from its earliest lending. When policy started to be formalized into directives, dam safety was the second irrigation-related subject to be covered, by OMS 3.80 of June 1977. These directives have been effective.[16]

Environment

Drainage. Lack of attention to drainage often leads to irrigation-system problems, and the Bank is often attacked for an alleged failure to pay sufficient attention to drainage. However, of all the components of irrigation, drainage was the one found in the largest number of evaluated projects. Nearly three-fourths of the evaluated projects (144) included financing for drainage. Drainage was invariably included in

Bank-financed projects in Europe, Latin America, and North Africa. Despite the fact that almost all projects in East and Southeast Asia were designed to increase rice production, which has greater tolerance for waterlogging than almost any other crop, 89 out of 107 involved drainage works. Dragging down the average were India, where only 14 of 31 projects involved drainage works, and the rest of south Asia, where only 17 of 32 projects did so. An Economic Development Institute review of environmental problems in irrigation projects[17] demonstrates how prevalent drainage problems are, but also how little the Bank's evaluations tell us about drainage.

Drainage problems are concentrated in dry areas with salty soils, where inadequate drainage leads to waterlogging and the build-up of salt and alkalinity, and in wet areas where farmers are trying to grow crops other than rice. The Bank's interventions are many, from northeastern China to Mexico and Peru, but the largest interventions have been in two of the countries with the most serious problems, Egypt and Pakistan.[18] In Egypt, construction of the Aswan High Dam (which was not Bank-financed) in the 1960s and ancillary works permitted agricultural intensification on 2.35 million hectares of old land and development of 0.38 million hectares of new land. As anticipated, high water tables and salt damage resulted when farmers took advantage of abundant, cheap water. There were other major changes to the ecosystem. Starting in 1970, the Bank made a series of seven loans to support four projects to help install the drainage made necessary by the Aswan-induced changes in the system.[19]

The most acute drainage problems are in the world's largest irrigation perimeter, the Indus valley in Pakistan. Drainage is difficult because the vast, 13 million hectares command area is extremely flat. Moreover, groundwater is either saline away from the river or is a lens of fresh water overlying deeper saline aquifers near the river. Add a limited supply of river water (which itself contains a small amount of salt), negligible rainfall, 60-year old canal systems lacking a drainage component and more than 100 million people depending on the irrigated farming systems, and the recipe for potential ecological disaster is complete. Small wonder that Pakistanis so frequently speak of the twin menace of waterlogging and salinization.[20]

Pakistan has been attacking this problem with help from donors and with financing from seven Bank loans focused specifically on salinity and drainage.[21] Closing of a number of these loans was greatly delayed, thereby delaying PCRs and subsequent evaluations. The first audit is currently in progress; its results and current trends will be discussed in Chapter 8.

Even in Bank-financed irrigation projects that did not focus on drainage, attention to drainage has been intense. The prevalence of drainage works recorded in evaluation documents is not the only evidence. This study also looked at a sample of irrigation appraisal reports and legal documents. Where drainage was not an indicated part of project works, attention to it was often required by the legal documents. During reviews of prospective irrigation loans in the 1970s and 1980s, the Bank's irrigation adviser consistently asked about two matters: adequacy of drainage and cost recovery. While drainage has proved to be a problem, it has not been for lack of Bank attention.

Health. Irrigation has a massive impact on the health of farmers and everyone else nearby because it changes the water regime. Since many of the most important human diseases are water borne, the drainage and land-leveling aspects of irrigation make a positive contribution to human health. A great danger posed by irrigation, however, is that it can increase biodiversity, making the microenvironment hospitable to such creatures as anopheles mosquitoes and snails, which are hosts to the vectors for

malaria and schistosomiasis. When the Bank finances projects, the staff are supposed to make sure that the borrower has taken effective precautions against such outcomes, but this has not always sufficed.

India's Krishna River valley in northern Karnataka was malaria-free in April 1978 when the Bank's Karnataka Irrigation Project (Credit 788) was approved. Narayanapur Dam was already largely built and a small area irrigated. The project completed that dam (and started another at least two decades prematurely) and financed massive canal construction and ancillary works and services. There was a lot of seepage from the dam and canals, creating pools of standing water in a semiarid area. During implementation, a contractor brought in workers from an area of Andhra to which malaria had returned. These workers worked night shifts side by side with local workers. Mosquitoes transferred the malaria vector and the disease returned to the region.

Appraisal of Upper Krishna (Phase II) Irrigation Project (Loan 3050/Credit 2010, approved May 1989) was lengthened by protracted discussions over how to remedy the unsatisfactory results of involuntary resettlement resulting from the 1978 project. A public health consultant accompanied the Bank's missions and, working with local public health authorities, reached agreement on remedial measures that would control malaria in the region and prevent a repetition of its introduction and spread. These measures were included in the 1989 project.

While malaria control is finally coming to the upper Krishna valley and most projects have coped with the malaria menace, results from two projects highlight the need for eternal vigilance. Ethiopia's Awash valley was malaria endemic when the Revised Amibara Irrigation Project (Credit 707, approved May 1977) started. Although the valley was included in the project's malaria control program, the emphasis of that program was changed during implementation, leading to an increased incidence and causing the PCR to plead for stronger environmental and health services to provide adequate surveillance and control in the post-construction era. Once implemented, Turkey's Seyhan Irrigation Stage II Project (Loan 587/Credit 143, approved 1969) was poorly maintained. Vegetation-choked drainage canals and burrow pits provided breeding foci for mosquitoes and led to a malaria epidemic. Though the epidemic was brought under control, the OED audit warns that "with many countries presently abandoning or neglecting their malaria control programs, as did Turkey ... the experience of this project offers an important lesson for the Bank and its borrowers not to relax their concern with problems of environmental impact."[22]

If the Bank's success in dealing with malaria in irrigation projects has been mixed, the evaluation record suggests that efforts to control bilharzia have been more consistently positive. This is part of the record of Ethiopia's Revised Amibara Project: "The project caused significant ecological changes ... which dried up flood fed swamps resulting in the destruction of snail habitats with a subsequent decrease in bilharzia <schistosomiasis> within the project area."[23]

The Bank's greatest efforts to control schistosomiasis have been in Egypt, where they enhanced successful German-Egyptian efforts in the Fayoum starting before 1968. From then until 1986, the Bank helped extend this model to the rest of Egypt through its major funding of drainage. While the schistosomiasis results are overshadowed by the larger drainage components, the audit of Second Upper Egypt and Second Nile Delta (OED Report No. 7338, June 1988) highlights them. The audit stresses the high level of understanding and trust between Ministry of Health staff and the Bank's consultant, whose advisory services extended over a decade and a half.

Successful attacks on schistosomiasis and malaria are also found in irrigation projects that were rated unsuccessful overall. For instance, in the Philippines, the audit and the PCR respectively found that National Irrigation Systems Improvement Projects (NISIP) I and II (Loans 1414 and 1526, approved May 1977 and February 1978, respectively) as well as Medium Scale Irrigation Project (Loan 1809, approved March 1980) were seriously flawed in conception and achieved very modest irrigation improvements. However, in all three cases, health components were highly successful. In NISIP I, for instance, schistosomiasis control was expected to account for 18 percent of project costs but was cut to only 2.5 percent, thanks to unexpected efficiencies in drain construction and improved treatment technology. Schistosomiasis prevalence on Leyte dropped from 18 percent at appraisal to 12 percent in 1984 and 5 percent in 1988. In the affected areas of Mindanao, prevalence fell below 2.5 percent. The Medium Scale Project's irrigation development activities on Palawan were deemed largely inappropriate, but its thorough anti-malaria campaign (involving residual spraying of houses, fogging of villages and campsites, biological measures including construction of bio-ponds, seeding of streams with larvivorous fish, clearing of stream banks, preventative treatment surveys, entomological controls and evaluations) was successful. Malaria cases dropped from 1,025 in 1980 to 10 in 1987, all of which were found in persons from other islands. The Ministry of Health has been sustaining the program since 1988.

The Philippine evaluations beg the question of the value of these irrigation-related health interventions, but by any valuation the benefits clearly far exceed the costs. The prevalence of irrigation-related health interventions that are more socially and economically successful than the irrigation investments themselves suggests the wisdom of trying irrigation-related health investments on their own.

Malaria and schistosomiasis are not the only aspects of health addressed through Bank irrigation loans. Sudan's New Halfa Irrigation Rehabilitation Project (Credit 1022, approved May 1980) improved and built water treatment plants operated by local councils. After initial delay, this system worked. However, the PCR expresses fears about future supply and operation, and the component is not mentioned by the audit.[24] Mali's Sud Agricultural Development Project (Credit 669, approved December 1976) financed general rural health services successfully, according to its PCR. Its successor, Second Mali Sud Rural Development Project (Credit 1415, approved October 1983) encountered coordination problems between the national health service and the cotton development company, with the latter ultimately taking responsibility.[25]

Catchment effects. Drainage and health are the two largest of irrigation's environmental effects, but they do not begin to exhaust them. OED's audit of the Philippines' Magat River multipurpose projects[26] describes two others. Reservoir construction ousted farmers, who resettled on steep slopes above the reservoir where they practiced bush-fallow farming, thus destroying forest and causing soil depletion and erosion, hence accelerated reservoir siltation.[27] This is a rather unusual example where irrigation development caused catchment deterioration. Usually, catchment deterioration is a secular process unrelated to irrigation development but with negative consequences for irrigation. The most obvious of these is erosion, leading to siltation of canals (and the expense of cleaning them) and of reservoirs (and the shortening of their useful lives).

Although irrigation development rarely causes catchment deterioration, the connection between erosion and siltation makes irrigation projects a good vehicle for catchment improvement. The Bank has sometimes missed such opportunities because of internal jurisdictional

disputes. Before the 1987 reorganization, for instance, irrigation lending to India and Nepal was handled by one division, soil conservation by another. Each was jealous of its territory; irrigation projects contained no catchment improvement, and vice versa.[28] Some Bank irrigation loans have been followed by catchment improvement loans; in Tunisia, Sidi Salem Multipurpose Project (Loan 1431, approved May 1977) was followed by Northwest Rural Development Project (Loan 1997, approved May 1981), a major purpose of which was to avert siltation of the Sidi Salem reservoir.

Involuntary resettlement. Storing water has many environmental effects, but the most wrenching is the involuntary resettlement of people forced to move for a public purpose because they live in the submergence area (and those affected because part of their lands or work places are submerged). OED's study on the subject, in addition to its four case studies, reviewed 65 evaluated projects involving involuntary resettlement.[29] Just over half of these (34) were irrigation projects. Of the one-quarter of the projects (16) whose evaluation failed to mention resettlement, 13 were irrigation projects. Most of the rest were hydroelectric projects. Regionally, the 65 projects were concentrated in East and Southeast Asia (32 percent) and South Asia (25 percent), and countrywise in India, which alone accounted for 15 projects with resettlement and 12 of the 34 irrigation projects with resettlement—more than one-third.

OED's resettlement study concludes that Bank guidelines, formalized in OMS 2.33 in February 1980, are appropriate. They prescribe that oustees should be provided a reasonable opportunity to regain or better their prior standard of living and that satisfactory plans for accomplishing this must be in place before the Bank appraises a project. While it is not formally prescribed, there is a strong suggestion that a land-losing oustee be given the resources and a chance to get replacement land if he wishes. The study also concludes that "the guidelines are not always implemented" and "Bank guidelines are seldom applied in India." The study recommends that the Bank not finance projects in the absence of "action and some demonstrable government commitment to conform to Bank guidelines and policies" in resettlement.[30] The frequent failure of resettlees to receive the treatment to which Bank policy entitles them not only constitutes a grave injustice and leads to unwarranted human suffering, but also subjects irrigation development to unfavorable public attention and justifiable criticism. Review of the economic analyses of irrigation projects involving resettlement shows that the costs of resettlement have frequently been seriously underestimated or even completely ignored. This review also shows that in no single instance would including the full, and even ample, costs of resettling and rehabilitating affected people according to Bank guidelines cause the economic rate of return to change by 1 percent. Inclusion of these costs would never have caused an irrigation project deemed worth financing to be deemed unacceptable. In short, the cost of correcting the very real and all too common injustices that tend to bring irrigation with storage into disrepute is quite manageable. Chapter 8 discusses what has been happening in irrigation projects approved since those already evaluated and discussed here to bring about justice for oustees.

Notes

1. Isolating a figure for irrigation in Bank lending is not simple. Problems stem both from imperfect record-keeping and from fuzziness in definition. These result in a large number of peculiarities in classification, both at the project level and within projects.

2. This operation was preceded by a multipurpose project, Chile's Power and Irrigation Project, Loan 5, approved in March 1948, for $13.5 million.

3. Ninety-one percent of the irrigation lending in the decade is in the 154 of these projects devoted more than half to irrigation.

4. Eighty-nine percent of the irrigation lending in the decade is in the 131 of these projects devoted more than half to irrigation.

5. Figure 1.4 shows the extent to which 1991 is an outlier, even when "smoothed" by using a three-year moving average.

6. Ninety-five percent of the irrigation lending in 1990–93 is in the 33 of these projects devoted more than half to irrigation.

7. Estimate based on FAO data files. See CGIAR, Technical Advisory Committee, *Review of CGIAR Priorities and Strategies*, Rome: FAO, TAC Secretariat, April 1992, Table 4.2, p. 47. Developing countries, as defined by FAO, exclude Japan and European countries that have borrowed from the Bank for irrigation.

8. Ibid. By FAO reckoning, 35.4 percent of the developing world's irrigated area is in FAO Agro-ecological Zones 2 (warm subhumid tropics), 3 (warm humid tropics), 6 (warm subhumid tropics with summer rainfall), and 7 (warm/cool humid tropics with summer rainfall).

9. For example, almost all of the medium-sized National Irrigation Systems Improvement projects in the Philippines had started as nongovernmental systems before the national government attempted to improve them with the help of the NISIP I and II loans (Loans 1414 and 1526, approved May 1977 and February 1978, respectively). See audit, OED Report No. 10669, May 1992.

10. In Josette Murphy and Varsha Malhotra, "A Review of Attention to Gender, Poverty, and Participation in PCRs, Audits and Studies," unpublished OED study, December 1992, Table 2, p. 5 and Table 4, p. 6. Mentions in nonirrigation agricultural documents were even fewer, 15 in 653 documents or 2.3 percent.

11. OED Report No. 10631, June 1992, para. 1.24, p. 6.

12. See Chapter 6, section on implementation as seen by staff, and Figure 6.1, below.

13. See Chapter 2, above.

14. OED Report No. 4321, "Water Management in Bank-supported Irrigation Project Systems: An Analysis of Past Experience," April 1981, and Report No. 6283, "World Bank Lending Conditionality: A Review of Cost Recovery in Irrigation Projects," June 1986.

15. Contrary to popular impression, the Bank is a minor financier of dams. Based on records of the International Commission on Large Dams, the Bank has been involved in financing about 3 percent of the large dams built since 1951 and in financing ancillary works such as irrigation facilities associated with existing dams in roughly another 7 percent. Typically, the Bank agrees to finance irrigation or hydropower investments once a borrower has financed and is completing a dam. Despite the Bank's modest role as a dam financier, its dam safety standards have had considerable influence. These standards are increasingly applied to dams that the Bank does not finance when it finances appurtenant works. No dam covered by these standards has ever failed. During initial trials, releases from Pakistan's Tarbela dam, one of the large dams the Bank did help finance, damaged spillways and the stilling basin, but the problem was solved. See Guy LeMoigne, Shawki Barghouti, and Hervé Plusquellec, eds., *Dam Safety and the Environment*, World Bank Technical Paper No. 115, Washington, DC: World Bank, 1990.

16. Still, the Bank has had reminders that dam safety requires eternal vigilance. During negotiations for Loan 1908 (approved October 1980) to Mexico for the Ocoroni Irrigation Project, the borrower submitted a letter on dam safety and the personal histories of experts for a panel to review dam design, construction, and operation. On the strength of this submission, no legal covenant on the subject was included. The first two supervisions, however, raised concerns about compliance with OMS 3.80. Since there was no covenant, the Bank had no legal remedies. The PCR recommended that dam safety covenants be included in future projects.

17. See Jumana Farah, *Environmental Considerations in Selected Bank-funded Irrigation and Drainage Projects—Approved Before and After January 1st, 1977—With Emphasis on the Adverse Environmental Effects*, Washington, DC: World Bank/Economic Development Institute, May 1993. This publication is structured around the checklist in *Environmental Assessment Sourcebook* Volume II, Sectoral Guidelines, World Bank Technical Paper No. 140, Washington, DC: World Bank, 1991. The Sourcebook looks only at negative environmental effects of irrigation. So does the EDI publication.

18. The central Asian countries with massive drainage and salinization problems in the Aral Sea basin have only recently joined the Bank.

19. Nile Delta Drainage Project (Credit 181, approved March 1970), Upper Egypt Drainage Project (Credit 393, approved June 1973, Second Upper Egypt Drainage Project (Loan 1285/Credit 637, approved June 1976), and Second Nile Delta Drainage Project (Loans 1439 and 1440/Credit 719, approved May 1977). These projects have been audited and found satisfactory, with economic rates of return ranging from 14 to 25 percent (OED Report Nos. 3993, June 1982, 5146, June 1984, and 7338, June 1988). For more information on Egypt's economy at the time of Aswan construction and absorption of Aswan-induced changes, see Khalid Ikram, *Egypt: Economic Management in a Period of Transition*, a World Bank Country Economic Report, Baltimore: Johns Hopkins, 1980.

20. For background on Pakistan's irrigation system, see Shams ul Mulk, "Water Resources Management—Pakistan's Experience," Lahore: Water and Power Development Authority, 1993. A 28-page summary of this paper will be published in *Valuing the Environment: Proceedings of the 1st Annual International Conference on Environmentally Sustainable Development*, Washington, DC: World Bank, 1994.

21. Khairpur Ground Water and Salinization Project, Credit 22, approved June 1962; Salinity Control and Reclamation Project (SCARP) VI, Credit 754, approved December 1977; SCARP Mardan, Credit 877, approved January 1979; Fourth Drainage Project, Credit 1375, approved May 1983; Left Bank Outfall Drain Project, Credit 1532, approved June 1984; SCARP Transition Pilot Project, Credit 1693, approved May 1986; and Second SCARP Transition Project, Credit 2257, approved June 1991.

22. OED Report No. 2747, November 1979, p. 10.

23. OED Report No. 8708, May 1990, p. 12 (PCR).

24. OED Report No. 10396, March 1992, p. 8. The audit of this and two other Sudan irrigation projects is OED Report No. 12053, June 1993.

25. The PCR of the first project is OED Report No. 7324, June 1988. The first and second projects are covered by group audit, OED Report No. 9688, June 1991.

26. OED Report No. 7923, June 1989 covering Magat River Multipurpose Project (Loan 1154, approved July 1975), Magat River Multipurpose—Stage Two—Project (Loan 1567, approved May 1978), and Second Magat River Multipurpose—Stage Two—Project (Loan 1639, approved December 1978), as well as Chico River Irrigation Project (Loan 1227, approved March 1976).

27. There are other environmental effects that are not highlighted in irrigation evaluations or on which no pattern emerges, among them effects on water quality, microclimate (humidity, rainfall), fisheries (usually creation of but sometimes negative), reservoir-induced seismicity, and, of course, generally making the environment more hospitable to humans and most plants and animals, domesticated or otherwise.

28. The problem has since been overcome. Current trends are discussed in Chapter 8.

It is easy to exaggerate the synergies between irrigation and catchment development. The principal benefits of soil conservation and catchment improvement almost invariably occur up-catchment from avoiding loss of cropped area and improving soil quality and cropping. Down-catchment benefits from canal desilting avoided and reservoir silting avoided are usually relatively minor, the latter because siltation in early years usually fills storage that is "dead" anyhow, while "live" storage filling is so far in the future that its present value is small. See William B. Magrath, "Economic Analysis of Soil Conservation Technologies," pp. 71–96 in John B. Doolette and W. B. Magrath, eds., *Watershed Development in Asia: Strategies and Technologies*, World Bank Technical Paper No. 127, Washington, DC: World Bank, 1990.

29. OED Report No. 12142,"Early Experience with Involuntary Resettlement: Overview," June 30, 1993, Annexes A and B, pp. 31–39. In one-quarter of the cases (16), evaluations contain no information on resettlement. Report No. 12142's coverage differs slightly from that of this study. It covers projects evaluated from 1975 through 1993; this study covers all projects evaluated before 1992.

30. Ibid., p. v, paras. 14 and 15.

4. Outcomes

Overall assessments

In 1981[1] and in 1989,[2] OED attempted to sum up the outcomes of irrigation projects as shown by evaluations. Those efforts, however, were based on such small samples that statistical analysis could not be used. The evaluated irrigation cohort is now large enough for statistical analysis. In this chapter, information from the 208 projects evaluated through 1991 is analyzed for indications about what leads to good, or bad, irrigation project outcomes.

This presumes, of course, that performance can be satisfactorily defined. There is considerable literature on this subject. As Leslie Small says in reviewing it:

> *There is surprisingly little agreement on how this performance should be assessed. Disciplinary biases are often evident in the choice of performance measures. Some social scientists place considerable emphasis on the nature and extent of farmer participation in irrigation decisions. Economists are likely to approach the problem through some form of benefit-cost analysis. Agronomists may focus on production, while engineers often focus on engineering efficiencies.*[3]

Examination of performance measures shows clear biases. High irrigation efficiency (the volume of "useful" irrigation water delivered by the system, divided by the volume used) is a goal for engineers, but not necessarily the only thing a society wants. Sociologists are interested in how users' groups are formed and function, and in how irrigation bureaucracies work. Agronomists hope that irrigation will increase crop production or make it more efficient. Economists may point out that production gains may be achieved but at too high a social or economic cost.

Making an irrigation project work in a socially useful way has been compared to running a successful business or completing a decathlon.[4] A successful irrigation project is one in which disparate factors work together. This is what economists attempt to measure. We say "attempt" because economics has not been totally successful in placing values on irrigation's benefits and costs. Nevertheless, it is economic measures that come closest to capturing the social value of irrigation in all its dimensions.

The Bank evaluates its projects in the course of supervision missions (summarized in annual reviews of portfolio performance), in PCRs, and in OED's audits and impact evaluations. Each of these instruments achieves a better perspective on the project as a whole than its predecessor and is better able to put short-term concerns about disbursements and implementation into a broader perspective. Where evaluation

instruments disagree, this study accepts the verdict of the most mature instrument: impact evaluations over audits and PCRs, and audits over PCRs, and all evaluation instruments over supervisions. In this way, two comprehensive assessments of the 208 evaluated irrigation projects have been constructed. One shows *satisfactory or unsatisfactory ratings* (in other words, whether the project was a good thing for the borrower and whether, on the whole, the project met its objectives); the other shows *evaluation estimates of economic returns* to project investments.

There are 192 irrigation projects that have received both appraisal and evaluation internal rate of return (IRR) estimates and an overall outcome rating (satisfactory/unsatisfactory). Of these, *67 percent were rated satisfactory. Their average estimated economic IRR at evaluation was 15 percent.*

These numbers mean that one-third of the 192 Bank-supported irrigation projects had *un*satisfactory outcomes. Satisfactory outcomes for all 192 would have been better for the borrowers and the farmers, but such a high degree of success would also have signaled that the Bank was financing sure bets instead of taking risks or trying to innovate. Similarly, since the average economic IRR expected from these projects at appraisal was 21 percent, an evaluation average of 15 percent means that one-third of expected net benefits failed to materialize. But a 15 percent return on investment after allowing for inflation is quite impressive, especially because most irrigation projects require large initial investments and have a long gestation period before net benefits materialize.

Table 4.1 and Figures 4.1 and 4.2 put these figures in the context of other Bank lending and show their evolution. Irrigation's satisfactory ratio (67 percent) is slightly better than that of agriculture as a whole (65 percent) but below the all-project average (76 percent). Irrigation's average evaluation economic IRR (15 percent) is slightly better than that for agriculture as a whole (13 percent) but slightly below the all-project average (16 percent). Irrigation's "optimism gap" between the economic returns expected at appraisal and at evaluation—7 percentage points—is much smaller than the disappointing 11 percentage point fall-off for agriculture as a whole but not significantly different from the all-project average of 6 percentage points.[5]

Irrigation's "optimism gap" is not significantly different from that for all projects.[6] Nevertheless, it is instructive to assess the gap in terms of the most important six inputs to rate of return calculation: irrigated area, crop yield, cropping intensity, crop price, investment cost, and implementation delay. Ratios of appraisal and evaluation estimates of these parameters and of rates of return were constructed and used as explanatory variables in Box 4.1. While the *average* evaluation estimate of *cropping intensity* was almost identical to the appraisal estimate, the ratio for individual projects explains one-fifth of the variation in the "optimism gap." A crude proxy for *unexpected rice prices* explains 16–17 percent; presumably, a better measure of unexpected price changes would do even better. The other four factors are not significantly related to changes between the appraisal and evaluation IRR estimates. The six factors together (as measured by imperfect proxies) thus account for 36 or 37 percent of the disappointment in rate of return.

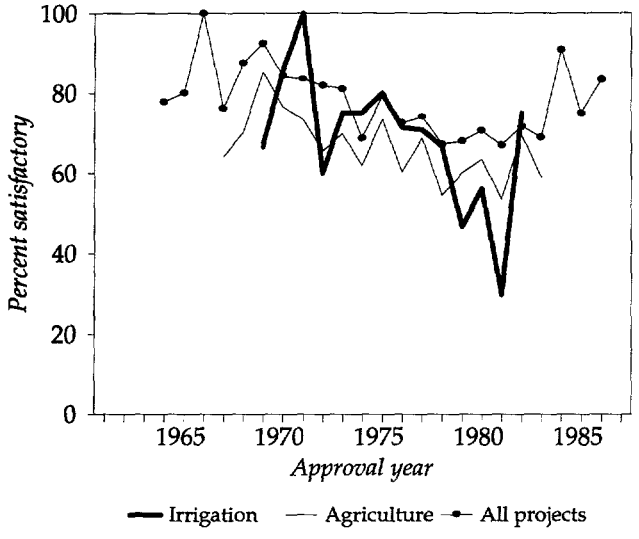
Although the return to each and every project is important, especially to their beneficiaries and borrowers, Bank-financed irrigation projects vary greatly in size. Adjusting for size gives a better indicator of average outcomes from irrigation lending. *Weighting economic IRRs by size of area served by irrigation, the average appraisal IRR is 29 percent. The average evaluation IRR is 25 percent. The weighted "optimism gap" is only 4 percentage points. The weighted percentage of the*

TABLE 4.1: OVERALL PROJECT RATINGS, BY APPROVAL YEAR (1961–87)

Project type	*1961*	*1962*	*1963*	*1964*	*1965*	*1966*	*1967*	*1968*	*1969*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*Group figures*
Irrigation																												
Number	1				2	1	4	4	6	7	3	10	8	16	15	14	24	21	15	16	10	12	2	1				192
Average approval EIRR	14				13	12	12	25	15	21	15	21	17	21	24	21	19	21	21	26	27	28	19	24				21
Average evaluation EIRR	14				16	14	7	15	10	25	18	14	16	14	19	11	13	13	12	15	10	20	14	16				15
Percent satisfactory	100				100	100	50	75	67	86	100	60	75	75	80	71	71	67	47	56	30	75	50	100				67
Agriculture																												
Number	1			1	2	1	14	10	27	30	30	35	43	58	49	58	61	66	55	52	41	33	22	4	4	1	1	699
Average approval EIRR	14			24	13	14	18	21	19	23	21	23	22	28	22	26	23	23	28	24	25	25	25	23	28	18	21	24
Average evaluation EIRR	9			21	14	18	10	14	15	18	18	15	13	13	13	12	13	10	14	12	13	16	11	13	4	16	23	13
Percent satisfactory	0			100	100	100	64	70	85	77	73	66	70	62	73	60	69	55	60	63	54	70	59	75	50	100	100	65
All projects																												
Number	4	1	1	9	10	10	21	40	67	76	85	94	106	115	116	120	120	141	125	116	82	92	58	22	20	6	2	1,659
Average approval EIRR	15	17	16	12	15	16	17	17	19	21	19	20	20	23	22	24	22	23	24	24	24	27	24	32	21	18	60	22
Average evaluation EIRR	15	17	22	13	15	17	12	16	18	20	17	16	14	13	15	14	16	15	15	16	15	16	18	22	15	24	54	16
Percent satisfactory	75	100	100	78	80	100	76	88	93	84	84	82	81	69	79	73	74	67	68	71	67	72	69	91	75	83	100	76

Notes: Data for nonirrigation projects are from the OED Annual Review Database. Irrigation project data are from the OED Irrigation Evaluation Corpus Database. Only projects with an appraisal economic internal rate of return (EIRR), an evaluation EIRR, and a satisfactory or unsatisfactory OED rating are included.

FIGURE 4.1: EVOLUTION OF OVERALL PROJECT RATINGS



evaluated irrigation portfolio that was rated satisfactory is 84 percent. The poor performance of small projects, which account for a minor share of irrigated area and output, dragged down the unweighted average return to irrigation projects and their unweighted performance rating. When these small projects are given their appropriate weight, average irrigation returns, as measured by evaluations, are more than half again as high as the unweighted average for the Bank's portfolio. Satisfactory ratings are well above average. The optimism gap between appraisal and evaluation is small.

For two reasons, these overall ratings are surprising. *First,* the typical irrigation project is *extremely complex.* Success is not a "simple" engineering matter but involves complex sociological, agronomic, and organizational changes. In agriculture, only integrated rural development projects rival irrigation projects in complexity. Making irrigation projects work is difficult. Pumping money into a rural credit institution or strengthening an extension service is relatively simple, and building a textile factory or a school is child's play.

Second, irrigation lending produces (or fails to produce) concrete outcomes because it can usually be determined whether an irrigation project produced additional grain or cotton or sugar, or (on the negative side) a rising water table or more salinization or impoverished people ousted during dam construction. There is often a nonirrigated area nearby that can be used to measure whether increases in production stemmed from the irrigation investment or were part of a general improvement. Moreover, an irrigation project's *lack of positive outcomes is harder to hide* than a lack of outcomes for structural or sectoral adjustment loans, or education loans, or, in the agricultural sector, credit and extension loans. Of the irrigation projects evaluated, 92 percent have been subjected to the test of a quantified economic analysis beforehand and during ex-post evaluation. This analysis is far from capturing all aspects of project benefits and costs, but it is more exacting than the analysis used, for instance, on agricultural sector loans.

The precision and stability of assessments

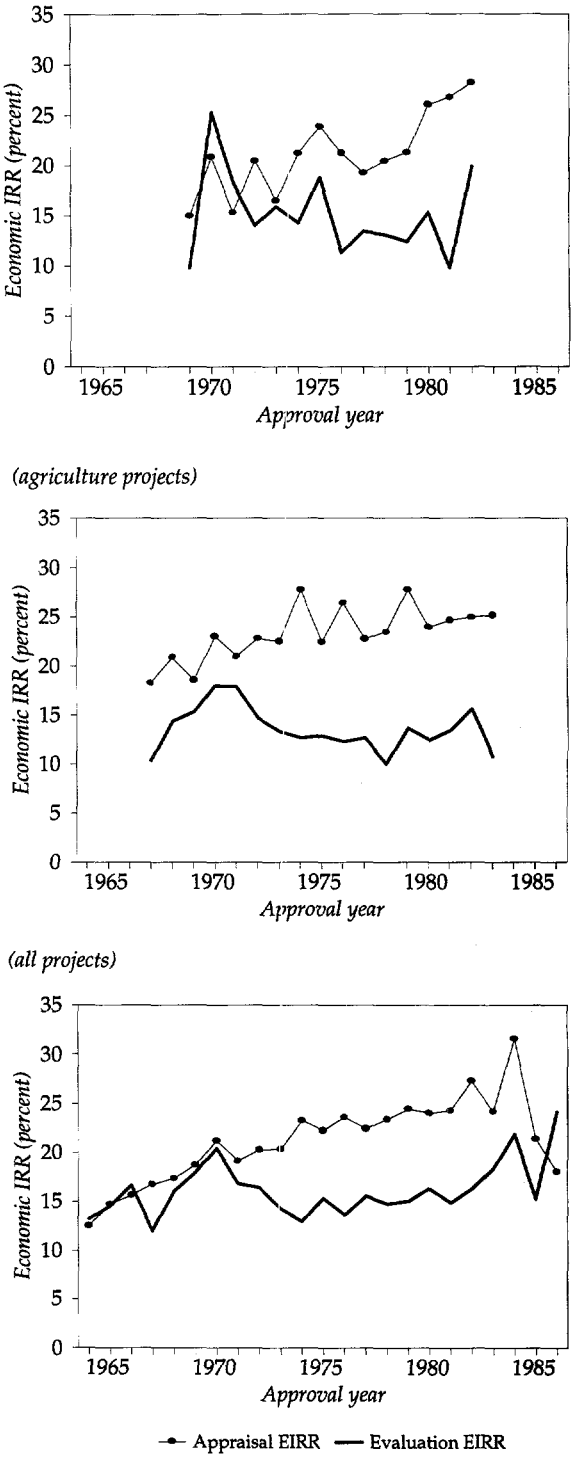
As Table 4.1 and Figures 4.1 and 4.2 show, a significant "optimism gap" between appraisal and evaluation expectations started emerging for all Bank projects in the early 1970s and has been present since the mid-1970s. That gap was a bit slower to emerge in irrigation. If irrigation-project ratings are sorted by evaluation year instead of by approval year, there is a rather dramatic drop in evaluation ratings starting in 1988. In 1990 this change was reinforced by a fall in the ratings of irrigation projects in the Bank's largest irrigation borrower, India. Before that date, 17 of 18 Indian projects had been rated satisfactory; in 1990 and 1991, only six of 13 were. Critics have proposed that OED evaluation standards before 1988 were unduly lax, particularly that they failed to take to task unrealistically high assumptions about efficiency of irrigation water use both at appraisal and at evaluation.[7] According to this theory, audits since that date have been more exacting and

more accurate, meaning that pre-1988 projects were probably less satisfactory than OED records show. This theory of a tightening and improving of OED standards of irrigation evaluation is attractive but has proved impossible to verify. While many water-use-efficiency assumptions embodied in many earlier irrigation loans, in India and elsewhere, were clearly chimerical, there is no hard evidence that those assumptions have improved with time.

That statement raises questions about the precision and stability of overall evaluation ratings. They are admittedly based on subjective judgments. How much agreement is there between judges, and between judges who view a project at different times in its life cycle? The discrepancy between final supervision ratings and evaluation ratings—the "disconnect"—is discussed in the Chapter 5 section on Bank processes. Supervision focuses more on disbursements and implementation while evaluation focuses more on outcomes. Therefore, in 23 percent of evaluated irrigation projects, the evaluation found unsatisfactory outcomes while the last supervision found no problems, or minor ones. There is no systematic information on differing assessments between borrowers and Bank Operational staff.

The two major components of evaluation—Operations' PCR ratings and OED audit ratings—can be compared only for a small, nonrandom sample of projects audited from 1988 to 1992. Of these 251 projects, 105 were agricultural, of which 27 were for irrigation. OED changed the PCR ratings 14 percent of the time for all projects, 19 percent for all agriculture, and 22 percent for irrigation. As with the supervision-evaluation "disconnect," changes were more common in irrigation than in the larger groups. OED was far more likely to downgrade the PCR rating than to upgrade it. The net downgrade was 7 percent for all projects, 9.5 percent for all agricultural projects, and 7.5 percent for irrigation projects.[8] While many

FIGURE 4.2: EVOLUTION OF PROJECT ECONOMIC IRRs



Box 4.1: Sources of the "Optimism Gap"

Previous work on the shortfall of evaluation economic internal rates of return (IRRs) relative to appraisal estimates, or the "optimism gap," has mainly involved simple reporting of gaps for respective groups of projects. The variables that make up these rates of return are known, but detailed data have not formerly been available. For irrigation, however, there is sufficient information at the project level. Statistical analysis can shed light on the dominant components contributing to the "optimism gap."

The benefit side of irrigation benefit/cost analysis is mainly a product of area irrigated, cropping intensity, yield, and price. The cost side is usually dominated by construction cost. Because of the discounting involved in calculating rates of return, time delays also matter. The dependent variable used for the regression analysis is the evaluation/appraisal ratio of economic IRRs. Similarly, an evaluation/appraisal ratio was constructed for area, cropping intensity, and project cost with dummy variables used for directional estimates (higher/lower) of yield and price.

Output price changes, especially for rice and other grains, play a key role in explaining the

The "optimism gap," unexpected prices, and other factors

Explanatory variable(s)/sample	*Number*	*Adjusted R^2 using price dummy*	*Adjusted R^2 using paddy price proxy*
Output price + cropping intensity			
Paddy only	49	.30	.38
Paddy dominant	71	.26	.34
Output price + cropping intensity + area + yield + investment cost + lag			
Paddy only	49	.29	.37
Paddy dominant	71	.27	.36

audits include critiques of PCR rates of return, most audits do not recalculate them. Therefore, a similar comparison for rates of return is much less useful.[9]

OED impact evaluations recalculate economic returns. For irrigation, as for the Bank's whole portfolio, impact outcomes are more sobering than PCR and audit outcomes (and much more sobering than appraisal expectations). When OED last compared economic-return estimates for the whole portfolio, the average economic IRR reported to the Board in the staff appraisal report (SAR) was 19 percent, compared to 15.5 percent at the PCR/audit stage and 9.6 percent according to the impact evaluation.[10]

(Box 4.1 continued)

"optimism gap." To improve on the directional dummy, a price proxy was constructed for rice. For each approval year, a ratio was constructed using the 30-year stream of prices projected in that year and the actual prices from approval to evaluation plus evaluation projections for the rest of the 30-year stream, in the same units of account and discounted to the present at 15 percent. The table shows the results.

Adjusted R^2 figures are used to permit direct comparison between the various regressions. The results show that nearly 40 percent of the unexpected, and, on balance, disappointing results in economic returns were associated with unexpected output price changes and unanticipated cropping intensities. The addition of data on yields, investment costs, and implementation lags provided only marginal improvements for the 71 paddy dominant projects. Using the derived paddy price ratio instead of the directional dummy for prices improves the "fit" by 8 to 9 percentage points. However, it was a surprise to find in separate bivariate regressions that the effect of changes in cropping intensity performed much better than unexpected output price effects. Some of the unexpected shortfall for output price effects is at least in part due to the inability of even the derived proxy to reproduce the output price series used in each project.

The importance of output price and cropping intensity is not surprising. Cropping intensity is, in fact, an excellent proxy for how well an irrigation system is working. The fact that, on average, evaluation cropping intensities were *almost as high* as anticipated at appraisal is strong evidence that the average Bank-financed irrigation project worked rather well. To some extent, this technical success compensated for the very major disappointment in output prices in all but the earliest years. Irrigation projects were hit harder by disappointing output prices than any other major group of Bank-financed projects. And yet, thanks to their relatively good technical results—as indicated by the cropping intensity proxy—the "optimism gap" for irrigation projects is the same as, not worse than, that for the Bank's whole portfolio, and is in fact significantly better than the rest of the agriculture sector.

The outcomes for the 20 impact-evaluated irrigation projects[11] are remarkably similar to those for all projects: 17.7 percent according to appraisal, 14.8 percent according to PCR/audit, and 9.3 percent according to impact evaluation. In *both* cases, appraisal expectations had been downgraded by one-fifth to one-sixth by PCR/audit, then by *another* 31 percent by impact-evaluation time, so that impact-evaluation outcomes were just over half of appraisal expectations. Average returns at impact evaluation were expected to average less than 10 percent. For the 20 irrigation projects, all had been expected to show an economic internal rate of return of 10 percent or more at appraisal. At the time of PCR/audit, 17 did; at impact evaluation, only 11 did.

These outcomes are cause for concern. The small number of projects that were impact-evaluated may not be a random sample, but if it is, the problem may be that supervisions and PCRs, and audits as well, may be looking at projects before all their warts show, therefore projecting outcomes that are too sanguine. In that case, the comprehensive unweighted irrigation assessment that two-thirds of the projects had satisfactory outcomes and produced economic returns of 15 percent may also be too sanguine.

Three points are worth insisting on here. First, overall ratings are no more than indicative summary indicators. Second, irrigation is not unique but shows exactly the same pattern of overall ratings as the Bank's portfolio as a whole. Third, there is ample room for improvement.

Performance factors

It is in this context that the evaluation record was searched for clues on how to improve irrigation lending. Available are (a) *quantitative data* on areas irrigated (cropping intensity, implementation time, construction cost, and, usually, estimates at appraisal, completion, and full development); (b) *directional data* (crop prices and yields were higher/same/lower at evaluation than appraisal estimates); and (c) *evaluation ratings* (satisfactory/unsatisfactory/no mention) of projects on a number of indicators covered in some (but not all) evaluations: appraisal, environmental impact, quality of planning and design, preparation, water availability, farm credit, reliability of water distribution, civil works completion, construction quality, supervision, water efficiency, extension, adequacy of final design, distributional equity, operation and maintenance, cost recovery, coordination, water users' groups, and monitoring and evaluation (M&E).

As in trying to explain the origins of the "optimism gap" (see Box 4.1 above), the search for clues starts with an examination of the relationship of the parameters used to calculate the evaluation rate of return. While this exercise produces interesting results, not surprisingly for a complex technical and social phenomenon like irrigation, it is not just output price, cropping intensity, area, yield investment cost, and implementation delay that explain success or failure. Often factors behind these proximate parameters are what really matter. In a few cases at least, it has been possible to test popular theories.

Six proximate factors

In an attempt to explain the evaluation assessment of what happened (regardless of appraisal expectations), parameters similar to those used in "optimism gap" analysis were selected as independent variables for multiple regression analysis, with evaluation economic rate of return as the dependent variable.

The six independent variables selected are the most important inputs to the IRR calculation. They also have some plausible theoretical relationship to outcomes.

- The evaluation estimate of *irrigated area* at completion was selected to explore the hypothesis that "small is beautiful" or, conversely, that there are economies of scale in irrigation.

- The evaluation estimate of *cropping intensity* was selected because cropping intensity is thought to be a good proxy for how well an irrigation system is working, and also because cropping intensity relative to appraisal expectations was significantly related to outcomes relative to appraisal expectations.

- Whether crop *yields* estimated at evaluation were better or worse than appraisal estimates was selected because yields are

thought to be a good proxy for how well an irrigation system is working. This inadequate proxy is the only yield indicator available from evaluation records.

- It stands to reason that output *prices* are a critical determinant of success or failure. In the case of the "optimism gap," the relatively crude paddy price proxy proved to be significant and was more powerful than the simple directional indicator available from evaluations. In an effort to explain not the gap but the evaluation rate of return itself, the numerator of the paddy price proxy was selected. This proxy captures, imperfectly to be sure, the actual international rice prices (and current projections in the case of future years) over the period of economic analysis for each project—the prices that should have been used to recalculate the evaluation rate of return. The proxy was applied both to irrigation projects whose only evaluated output was rice and to all evaluated irrigation projects.

- *Investment cost* was selected because it is generally thought to be an indicator of outcomes. But is it the absolute cost or the unit cost that matters? Absolute cost might be little more than another indicator of project size. At first blush, cost per unit irrigated area would seem to be bringing the area factor into play a second time but, actually, it is taking it out. Investment cost per area (unit cost) is a proxy for how sophisticated the project is (although clearly projects with low unit costs can exhibit a high degree of engineering sophistication) as well as how efficiently it is designed and constructed. Though imperfect, this indicator was selected in hopes of clarifying the argument between those who believe that success generally comes from spending a bit more and doing the job right, and those who believe success generally comes from simplifying and cutting unit costs.

- *Implementation time* was selected because timely implementation as well as delays in implementation are thought to be closely related to economic returns. It is not theoretically obvious whether outcomes should be related to absolute implementation time or to the gap between how long implementation was supposed to take and how long it did take. A big gap is generally taken as a sign of trouble. Both were assayed as independent variables.

Some summary statistics resulting from the multivariate regression analyses are shown in Table 4.2. There were 108 irrigation projects (six of them with negative IRRs) for which there are evaluation data for all six independent variables and for the dependent variable; 48 of them constitute a more homogeneous subset with rice as the only evaluated benefit. In tests for multicollinearity among the independent variables, area and investment cost were found to be too highly collinear to allow both variables in the regression. Investment cost was dropped, and unit investment cost, which is sufficiently independent, was used in the analysis. Four of the six factors are significantly related to overall outcomes as measured by evaluation economic IRR. Two are not.

- *Implementation*, whether measured as the difference between expected and actual implementation time or the actual time, showed *no significant* relationship to outcomes. This is surprising, since intuition would suggest that implementation problems and delays prejudice project outcomes, especially when the time value of resources is taken into account. The analysis belies that intuition. Apparently, delays in benefits caused by implementation problems are pretty much canceled out by delays in costs. Perhaps Albert Hirschman's "hiding hand" principle is at work, with protracted implementation providing time for imagination to solve problems not even anticipated at

TABLE 4.2: OVERALL OUTCOMES: PROXIMATE EXPLANATORY FACTORS[a]

Irrigation projects: all crops (n=108)			*Irrigation projects: rice only (n=48)*		
Independent variable	X^2 *statistic*	*Probability of significance*	*Independent variable*	X^2 *statistic*	*Probability of significance*
Size	14.03	.9998	Output price	12.63	.9996
Yield	12.96	.9997	Yield	6.86	.991
Unit cost	11.16	.999	Size	5.57	.981
Output price	7.70	.994	Unit cost	4.59	.967
Cropping intensity	1.29	.744	Cropping intensity	2.63	.895
Implementation delay[b]	1.29	.744	Implementation delay	0.30	.415
<OLS R^2>	.33		<OLS R^2>	.45	

a. Because evaluation rates of return below zero are censored to a value of -5%, the tobit procedure, which uses maximum likelihood techniques, was used. Because the number of censored values in the data set is low (six of 108 in the all-crops group and five of 48 in the rice-only group), the ordinary least squares (OLS) R^2 statistic, which is not strictly valid in this case, is offered as a summary statistic.
b. Implementation time and implementation delay did not differ significantly. Neither was significantly related to outcomes. The regression outcomes for implementation time are not reported.

appraisal (and which would certainly have led to the projects' abandonment had they been anticipated). Two examples of irrigation projects that survived horrendous implementation problems, adapted to them, and still managed to achieve just barely satisfactory overall ratings are Vietnam's Dau Tieng (Credit 845, approved August 1978) and Mexico's Rio Fuerte/Rio Sinaloa (Loan 1706, approved May 1979).

- *Cropping intensity* (which proved to be significant in explaining the *difference* between appraisal and evaluation economic return estimates) does *not* have a *significant* relationship to evaluation IRR.

- *Investment cost* is more complicated. As Table 4.2 shows, investment cost, for which evaluation project cost is a good proxy, is not significantly related to evaluation IRR. However, *a significant amount of the variation in outcomes is caused by unit cost*—project investment cost per irrigated area. The relationship is inverse—that is, higher unit costs mean lower returns. This seems so obvious as to be not worth stating but for the common argument that the Bank should be willing to put a little more money into its projects to increase the chance that they will work well. This simple regression analysis does not mean that that argument may not be correct in many circumstances.[12]

- For *yield*, evaluation data provide only the crudest indicator: completion/full development crop yields were higher/the same/lower than appraisal estimates. As the table shows, this directional dummy *is quite significant in explaining outcomes.* Projects where farmers get better yields than expected at the time of appraisal are better overall, and vice versa. If the yield proxy were better, the explanatory power of the yield variable might be much higher. Of course, the analysis does not give us any clue about the multitude of farming and other factors that determine yields.

- *Output price*, represented by the paddy price proxy, *also significantly explains overall outcomes.* It is highly likely that its explanatory power would be considerably higher with a variable that more accurately reflected the impact of output prices on IRR calculations.

This relationship is examined in greater depth below.

- Project *size*, as measured by completion irrigated area, *is a highly significant explanatory variable, more so than the others*. Projects that support bigger irrigated areas have a strong tendency to get better outcomes. The quality of the data on irrigated area is reasonably good. This relationship is also examined in greater depth below.

More light is shed on these relationships by analyzing the outcomes of only the 48 projects (five of them with negative IRRs) where rice alone was the evaluated output and evaluation data for all seven variables were available. As Table 4.2 shows, the paddy price proxy fits better when paddy is the output. Although the paddy price proxy is still not a complete representation of output price effects on IRR, it is much closer. Its X^2 value is as high as or higher than that for project size for this smaller, more homogeneous sample. Size, the yield dummy, and unit cost do not matter as much for overall outcomes in this smaller sample as they did in the larger one, but they are still significant.

The above analysis only looks at the most proximate factors influencing overall outcomes in the most obvious way. The data available permit a closer look at the two most important proximate factors (output price and project size) and an exploration of four of the many other factors that lie behind them.

Unexpected output price changes

The leading benefit from irrigation was an increase in grain production. Such increases were the only benefit identified in 59 percent of the projects, and the predominant one in 92 percent.[13]

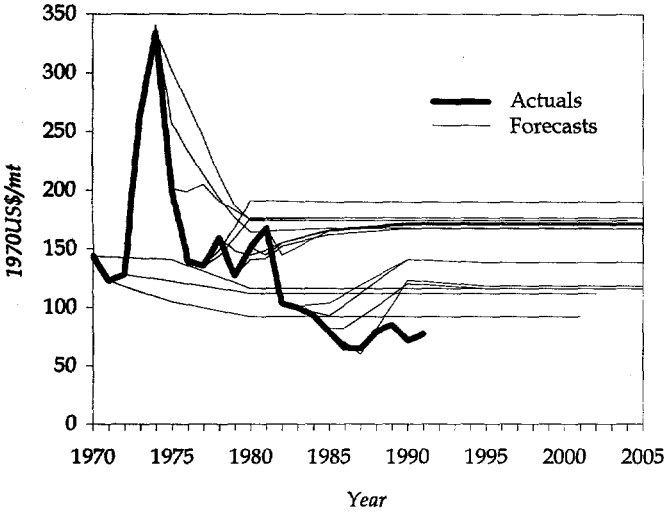
As the above analyses of the "optimism gap" and the factors explaining evaluation outcomes show, the value of the evaluated benefits—especially grains and rice in particular—has a lot to do with outcomes. The available data clearly indicate that appraisal estimates of future prices deviated significantly from actual prices. Future grain and other agricultural prices are simply not predictable. In the early 1970s, higher-than-expected grain prices tended to improve appraisal economic rates of return. Since then, IRRs have been negatively influenced by lower-than-expected prices.

An indication of the seriousness of the problem can be seen graphically in Figure 4.3, which charts (a) the international rice price, in constant US dollars, and (b) the official constant-dollar[14] rice price forecasts. Both were supplied by the Bank's International Trade Division.[15] The forecast prices are shown branching from the actual price series with a one-year lag. Thus, the branch from the 1970 actual price shows the forecast used in 1971 appraisals. Because 30 years is the modal period over which irrigation benefits and costs are projected in economic analysis, 30 years of projected prices have been shown where available. Approval dates for evaluated irrigation projects range from 1961 to 1985, with nearly 70 percent falling between 1970 and 1979.

For the period in question, the projected prices were almost invariably higher (and usually much higher) than the actual prices. The forecasts of rice prices used in appraisals made from 1974 through 1982 predicted prices much higher than those that actually prevailed. This period covers 76 percent of the evaluated irrigation projects with rice as the only crop output.

Other than rice, other grains, cotton, and sugar are the principal evaluated irrigation benefits. Wheat is the principal other grain, and its price is an excellent proxy for the rest. The wheat-price story is similar to that of rice. For cotton, the price forecasts made in 1974 through 1979 were quite close to actual prices between 1974

FIGURE 4.3: INTERNATIONAL RICE PRICES: ACTUALS AND BANK FORECASTS



Source: The World Bank's Internal Trade Division.

and 1980. However, the cotton price forecasts all failed to anticipate the real halving of the international cotton price between 1980 and 1986, both before it happened and while it was going on.

The low grain and other farm commodity prices that reduce irrigation rates of return are good news for the world's poor. Lowering the prices of the items in the worker's market basket is one of the objectives of development, both on its own merits and because it fosters industrialization. Was investment in irrigation partly responsible for these low prices? The answer must be yes, although actually calculating the effect of Bank irrigation investment on farm commodity prices is beyond the scope of this review. It is a plausible hypothesis, however, that the effects were not negligible. That is particularly the case for rice, given the thinness of the world rice market and the concentration of Bank irrigation lending on rice projects.

The point here is not to criticize price projection methodology,[16] but simply to say that the price expectations on which benefit estimates were made turned out to be generally much too high. This was clearly a major factor in the disappointing outcomes found by the evaluations. The evaluation cohort included 83 projects designed specifically to produce more rice. Figure 4.4 shows, for each approval year that had more than five rice projects, the average anticipated rate of return and the average evaluation rate of return. The shortfalls are about what the difference between appraisal and evaluation rice price estimates would have led one to expect.[17]

There is no lesson here for future investment in irrigation projects. Future output prices will be a critical determinant of irrigation project outcomes, but there is no satisfactory way of predicting them. The sweep of the past 20 years of data should tell us one thing, however. Despite sophisticated methodology, as Figure 4.3 shows,[18] price forecasts are usually projections of what happened in the recent past. This has proven to be a false guide to the future as often as not. Projecting the present falling trend of almost all agricultural prices into the future may be just as likely to prove false.

Project size

The argument over appropriate irrigation-project size is a venerable one. Even before the founding of the World Bank, there was substantial controversy in the United States over whether the US Army Corps of Engineers was wise to build large dams for irrigation and power. Those who opposed the dams argued that it would be cheaper and better to build a larger number of smaller dams farther upstream. The proponents of the large dams, frequently engineers or economists, argued that the large projects' economies of scale would make them cheaper and better than smaller dams.

This perennial argument, which has generated more heat than light, has shifted to the discus-

sion of hydraulic projects in the developing world. Is small better? Or do small projects have the same drawbacks as large ones but without the same efficiencies?

There is no blanket answer to this question. Each catchment or subcatchment area is different, meaning that the technical possibilities for developing it ought to be analyzed and compared individually. Nevertheless, Bank evaluation outcomes were analyzed in an attempt to discern general patterns. As shown above in the multivariate analyses, full-development irrigated area is very significantly and directly correlated to outcomes.

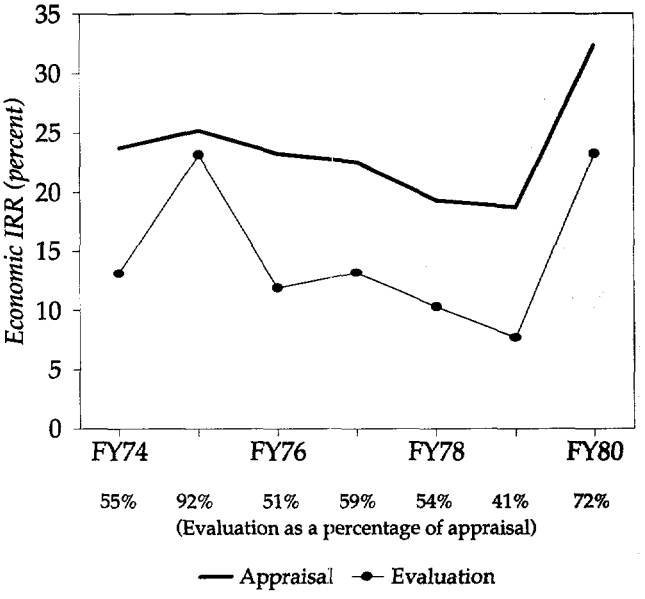
Since groundwater and surface irrigation projects have different characteristics, projects that came close to being purely one or the other were examined to determine whether there was any relationship between project size and outcomes.

At appraisal, a direct relationship was expected between projected project size and projected economic return. The correlation coefficient was 0.24 (confidence level of nearly 100 percent for rejecting the null hypothesis).

After eliminating projects that were neither clearly surface projects nor clearly pump projects, the same test was applied to surface projects and groundwater projects. By appraisal expectations, size and economic outcomes were directly related. For gravity projects the correlation coefficient was 0.28 (confidence level of nearly 100 percent). For pump projects it was 0.31 (confidence level of 99 percent because of the smaller number of projects).

The positive relationship between project size and economic returns grew stronger at evaluation in all three cases. For all projects, the correlation coefficient is 0.28 (confidence level of nearly 100 percent). For gravity projects, it is 0.32 (confidence level of nearly 100 percent). For pump projects, the correlation coefficient is 0.34 (confidence level of 99 percent).

FIGURE 4.4: ECONOMIC IRRS: PADDY PROJECTS



To test the robustness of these relationships, possible sources of multicollinearity were sought. Bank-financed irrigation projects in sub-Saharan Africa are, on average, smaller than projects elsewhere, and they have, on average, a poor record. This was not, however, the source of the size-to-success correlation. Correlations between size and success were not significantly lower when sub-Saharan Africa projects were omitted. Moreover, the sub-Saharan African irrigation projects themselves showed a significant correlation between size and success.

To see whether unseen factors were tilting the relationship, size and success were examined for all 73 rice projects in the evaluated group, for all evaluated rice projects east of Pakistan (60), and for all evaluated rice projects east of Bangladesh (39). These groups are far more homogeneous than the diverse group of evaluated

TABLE 4.3: PROJECT SIZE AND ECONOMIC OUTCOMES[a]

	Number	*Correlation coefficient*	*Confidence level[b] (%)*
Appraisal estimates			
All projects	192	+.24114	99.92
Gravity projects	112	+.27994	99.72
Pump projects	54	+.30848	97.67
Evaluation estimates			
All projects	187	+.28027	99.99
Gravity projects	108	+.31828	99.92
Pump projects	53	+.34489	98.86

a. Appraisal or evaluation irrigated area and economic internal rate of return.
b. Chi-squared test, rejecting H_0 : rho=0.

irrigation projects. Correlation coefficients were higher still for the more uniform subsets: 0.46, 0.40, and 0.56 respectively. Despite smaller numbers of projects being analyzed, confidence intervals were close to 100 percent.

For evaluated Bank irrigation projects, the bigger the project, the higher the likelihood of favorable economic outcomes. For a social phenomenon as complex as irrigation, these correlation coefficients of the single factor of project size with economic outcomes is surprisingly high. Since there can be little doubt which way the causality arrow points in this case, project size explains roughly 10 percent of the variance in economic outcomes. The costs imposed by larger projects—farmland and towns flooded, people displaced, and lands waterlogged from overirrigation and salted because of poor drainage—are bigger than those for small projects and attract more unfavorable attention, but the larger projects' benefits are bigger too.

Each situation differs. There is no substitute for careful analysis and comparison, but, on balance, the benefits of scale generally outweigh the costs. Big can be beautiful.

The proximate factors that generate calculations of IRRs are only the most obvious causes of good irrigation outcomes. Success is associated with large projects, high output prices, and high yields. But why, and what stands behind these and other proximate relationships? This is a question for the ages, and this study can only begin to answer it in a small way. With the data available, however, it is possible to begin to look at three specific hypotheses about nonproximate factors behind irrigation project performance.

Economic distortion

World Development Report 1991 (WDR) found that distortions in a country's economy adversely affect development project.[19] Using the same rates of return used here, the WDR checked for the effects of trade restrictions, exchange-rate overvaluation, and distortion of credit markets. These are not the only distortions whose effects might have been analyzed, but they are the ones for which credible summary indicators exist.[20]

All of the distortions had significant and large negative effects on project outcomes as measured by evaluation rate of return. Exchange-rate overvaluation had the highest impact, trade restrictiveness the next highest, and interest-rate distortions a smaller but still significant effect.[21] The lesson from these findings is that reductions in distortions are likely to help projects succeed.

The lesson for the Bank is that good outcomes from development investments are more likely if they are made in countries that have few distortions or that are reducing them.

The same analysis was carried out for evaluated irrigation projects. The results are less robust because the irrigation set is from 10 to 13 percent the size of the WDR set. Limited data on economic distortions prevent use of much of the evaluated irrigation cohort. Nevertheless, the results were significant. A summary, with comparison to WDR outcomes for all evaluated projects, is shown in Table 4.4.

Under a regime of *exchange-rate distortions*, irrigation project performance is significantly impaired, but the impairment is less than for all projects. Medium overvaluation of the currency (20 to 200 percent) is associated with an average reduction in the return on irrigation investments of 16 percent, about the same as for all projects. But high overvaluation (more than 200 percent) is associated with a reduction in average irrigation project return of 23 percent, compared to a striking 60 percent for all projects. Under conditions of high exchange-rate overvaluation, irrigation projects still managed, on average, to achieve satisfactory economic returns of 13 percent, while projects as a whole did not. Irrigation projects thus appear to be better insulated from the negative effects of exchange-rate distortions than other projects.

Interest-rate distortions were found to be associated with a modest but significant drop in the economic returns to irrigation projects—a reduction of 14 percent if real interest rates were negative compared to the return if real interest rates were positive. The reduced return for all projects under conditions of interest-rate distortion was 12 percent.

TABLE 4.4: ECONOMIC DISTORTIONS AND PROJECT OUTCOMES[a]

	Irrigation			*WDR91 Table 4.2*[c]		
Policy distortion index	*Average EIRR (%)*	*n*[b]	*n %*	*Average EIRR (%)*	*n*[b]	*n %*
Trade restrictiveness	14.0	45			475	
Highly restrictive	12.8	17	38	13.6	266	56
Somewhat restrictive	16.9	19	42	15.4	122	26
Nonrestrictive	10.3	9	20	19.3	87	18
Exchange rate overvaluation	15.8	133			1,025	
High overvaluation (>200%)	12.9	10	8	7.2	66	6
Medium overvaluation (20-200%)	14.1	25	19	14.9	266	26
Low overvaluation (<20%)	16.7	98	74	18.0	693	68
Real interest rate	19.0	78			712	
Negative	17.0	17	22	15.4	316	44
Positive	19.8	61	78	17.5	396	56

a. This table duplicates the methodology in the *World Development Report 1991* Table 4.2 for the OED irrigation evaluation corpus (208 projects). The data were supplied by the WDR team via Rhoda Blade-Charest. Projects were characterized by the value of the indices at the time of evaluation. Coverage of the variables across time and countries is limited, most noticeably excluding 35 irrigation projects evaluated in 1991. Further limitations on sample size result from irrigation projects evaluated without evaluation ERRs. See the WDR91 technical notes for index definitions.
b. Reflects projects for which there exists an index value and an evaluation EIRR.
c. Figures are for public (such as non-IFC) projects.

For all evaluated Bank projects, *foreign trade distortions* are associated with major reductions in returns. Compared to returns in a free trade environment, returns to all projects in a somewhat restrictive environment were reduced by 20 percent, and those in a highly restrictive environment by 29 percent. The effect of foreign-trade distortions on irrigation projects is quite different. Those in a free trade environment averaged an economic IRR of only 10 percent, those in a moderately distorted trade environment averaged a 17 percent return, while those in a highly distorted environment showed an average return of 13 percent. Although the numbers involved are modest, these relationships are significant.

How do irrigation investments benefit from foreign trade distortions, especially from moderate ones? It would take a great deal of detailed work to be certain about the reasons, but one presumption is that these numbers show the effects of some governments' protection of their irrigated farmers from the weak international markets for almost all farm goods in the last two decades.[22,23] (See Figure 4.3.) Experiences within several countries provide examples of successful irrigation in dry areas and problem projects in wetter ones—for example, Morocco's Doukkala and Gharb projects, Mexico's Sinaloa and Panuco projects, or Tunisia's Southern and Medjerda projects.

Subsidizing the prices of crops produced by irrigated farms makes life sweeter for irrigators, raising their financial returns. But if economic analysis corrects for these subsidies, how can they affect economic returns? Evidently because the happy, subsidized irrigators use their irrigation facilities better, throwing themselves into their farming, their transplanting, their weeding—the picking up of spilled grain around the thresher—with more gusto. (Nevertheless, the distortions will foster economically inappropriate factor use and may be costly for the economy, hence unsustainable.)

How much do macroeconomic distortions affect the outcomes of irrigation projects? As with projects as a whole, the answer is not known. The three indicators of economic distortions used are not exhaustive—they are the indicators that are readily available. They do not measure the effects of civil war and other disturbances, and they do not measure the effects of the distortions that appear to be the most devastating—internal price distortions and shortages that make it difficult to buy or sell certain things at any price. In Madagascar, for example, the Mangoky project was designed to irrigate the porous alfasols on the drier side of the island for cotton growing. When the government paid poor prices for cotton and general economic distortion reduced the utility of money, farmers grew rice, which they could eat, but for which the soils and irrigation system were ill-suited.[24] Similar distortions in the Sudan were the main factor in unsatisfactory outcomes from a number of irrigation projects.[25]

When one facet of an economy is distorted, others also tend to be distorted. The measures of distortion examined above may therefore be proxies for other distortions. The internal price distortions in Madagascar, the Sudan, and elsewhere were hardly independent of foreign trade, interest rate, or exchange rate distortions. Yet this complementarity is not complete either, because distortion coincided with worse irrigation outcomes in two cases and better outcomes in one case.

In sum, OED analysis provides only a partial glimpse of the effects of macroeconomic distortions on irrigation projects.[26] This partial glimpse suggests that macroeconomic distortions have a major impact on irrigation project performance which is usually, but not always, a negative one. If that is so, the policy implication is that irrigation lending should be steered to countries with low policy distortion or at least to countries where policy distortions are not

antagonistic to the agricultural enterprises in question.

Water scarcity

The availability of water for agriculture depends on a host of factors of which rainfall (except in a few places) is the most important.[27] But the utility of rainfall to agriculture also depends on many factors, including the timing of the rainfall, temperature, soil type, and drainage. Still, total annual rainfall is the best readily-available measure of water scarcity. By comparing the outcomes of irrigation projects with annual rainfall in project areas, it is possible to get some idea of the effect of water scarcity on irrigation projects.

It stands to reason that irrigation will arouse more energy and attention in arid areas, where sufficient water can be a matter of life or death, than in humid areas, where the water problem is more likely to be too much than too little. It is commonly believed that irrigation systems in arid areas work better than those in humid areas, or at least that they are maintained and operated well, simply because of their intrinsic importance. The opposite side of the coin is the view that the temptation to neglect irrigation systems is greater in wet areas. Evaluation reports of neglect do in fact come principally from the humid area (see below).

To test these hypotheses, estimates of economic returns at appraisal and at evaluation, and overall ratings, were analyzed for correlation with annual rainfall[28] and over a range of rainfall amounts. See Table 4.5 for results.

The relationship between annual rainfall and *evaluation* IRR was not quite significant. (The relationship between annual rainfall and appraisal economic IRR was significant.) Thus, the hypothesis was not confirmed. On the contrary, outcomes were somewhat better in high rainfall areas, and worse in drier areas. For *evaluation* IRRs, the correlation coefficient was a weak 0.07 (confidence level of 63 percent for rejecting the null hypothesis). (For appraisal IRRs, Bank staff's best guess before approval, the correlation coefficient is 0.24, a confidence level of nearly 100 percent.) There may be some explanatory linear relationship between rainfall and economic returns that staff expected at appraisal, but there is clearly no significant relationship between rainfall and evaluation estimates of returns. In short, *the weak association between more rainfall and better outcomes is not significant. But the absence of the expected association between better outcomes and low rainfall is.*

For analytical purposes, rainfall classification zones were used: 0-499 mm (where little rainfed cropping is possible);[29] 500–1,499 mm (where serious rainfed cropping is practiced but there are definite water constraints and rainfed rice is risky at best); and 1,500 mm and over (where total rainfall is adequate even for rice, though water distribution may be a problem).

For the 208 evaluated projects, the expected economic return averaged 18 percent for the dry zone, 20 percent for the medium zone, and 26 percent for the wet zone.

The evaluation outcomes indicate that optimism about wet-zone projects at the time of appraisal was justified. Evaluation economic returns averaged 13 percent for the dry zone, 14 percent for the medium zone, and 17 percent for the wet zone. Overall ratings confirm the impression. Of dry zone projects 61 percent were satisfactory, of medium zone projects 66 percent were, and of wet zone projects 68 percent were satisfactory. The overall satisfactory percentage for irrigation projects where rainfall exceeded 2,000 mm was 76 percent.

Analysis of rates of return in wet, medium, and dry rainfall zones was conducted separately for surface and groundwater projects.

TABLE 4.5: RAINFALL AND RESULTS[a]

	All projects	*Gravity projects*	*Pump projects*
Evaluation estimates			
Total number	192	110	53
Correlation coefficient	+0.06567	+0.0433	0.1078
Confidence level, rejecting H_0: rho=0	63.46%	34.65%	55.76%
Rainfall 0–499 mm			
Number	40	19	12
Average economic IRR	13%	14%	9%
Overall satisfactory rating	61%	63%	42%
Rainfall 500–1,499 mm			
Number	87	57	21
Average economic IRR	14%	13%	18%
Overall satisfactory rating	66%	61%	76%
Rainfall 1,500+ mm			
Number	65	40	22
Average economic IRR	17%	15%	20%
Overall satisfactory rating	68%	69%	73%
Appraisal estimates			
Total number	200	116	55
Correlation coefficient	+0.2361	+0.1316	+0.3094
Confidence level, rejecting H_0: rho=0	99.92%	84.09%	97.85%
Rainfall 0–499 mm			
Number	42	19	12
Average economic IRR	18%	20%	15%
Rainfall 500–1,499 mm			
Number	89	57	21
Average economic IRR	20%	19%	23%
Rainfall 1,500+ mm			
Number	69	40	22
Average economic IRR	26%	23%	30%

For the 55 groundwater projects, evaluation outcomes indicate that the expected strong direct relationship between rainfall and return was justified, but with the middle zone doing better than expected. Evaluation economic returns averaged a disappointing 9 percent for the dry zone, 18 percent for the medium zone, and 20 percent for the wet zone. Again, the overall ratings confirm the impression. The "satisfactory" percentage for dry zone projects was only 43 percent; for medium zone projects it was 76 percent, and for wet zone projects 73 percent.

For the 116 surface projects, no relationship was expected between amount of rainfall and returns at appraisal. Evaluation outcomes indicate that there was, indeed, no such relationship. Evaluation economic returns averaged 14 percent for the dry zone, 13 percent for the medium zone, and 15 percent for the wet zone. These figures were confirmed by the overall ratings. The "satisfactory" percentage for dry zone projects was 63 percent, for medium zone projects 61 percent, and for wet zone projects 69 percent.

However attractive the notion, evidence from the Bank's evaluations does not support a simple inverse relationship between the amount of rainfall and the performance of irrigation projects. However, some patterns emerge in analyzing project outcomes by rainfall classification zones when groundwater and surface projects are examined separately.

Groundwater projects alone show a weak but direct correlation between rainfall and outcomes. Groundwater projects have done poorly in arid zones but quite well in medium and wet zones. Most likely this is because irrigation supplements rainfall in medium and wet zones. Supplemental supply is by far the most valuable type of irrigation water per unit. However, there is no way of knowing that from the evaluation outcomes.

Surface projects showed no significant relationship between rainfall and outcomes, although it was expected that there would be an inverse relationship between rainfall and return, particularly for surface irrigation projects (see Table 4.5). The null outcomes are at odds with theory.

It is true that the unit value of a small amount of irrigation water that supplements rainwater and saves a nominally rainfed crop was very high, but it is also true that it usually costs a lot to provide that irrigation water when and where it is needed.

One theory is that wet zone returns were higher than expected because irrigation is traditional in these zones. Hence, the theory runs, wet-zone projects are upgrades or rehabilitations that benefit from large sunk costs. This hypothesis was examined by determining whether rehabilitation projects were concentrated in wetter areas. In fact, they were. The average rainfall for the 59 evaluated projects that were rehabilitations or extensions of existing projects was 1,343 mm/year, 30 percent higher than the average of 1,036 mm/year for the 89 evaluated new-construction projects.

In sum, the reasons why surface irrigation projects in wetter zones get just as good evaluation ratings as those in drier zones are not fully understood. Nevertheless, this finding does nothing to weaken the finding of a number of recent audits and impact evaluations that *design problems* are concentrated in wet-zone surface systems. This problem will be discussed in Chapter 7.

Surface vs. groundwater

Well and pump schemes are perceived to be more amenable to private development on a small scale, while surface, gravity irrigation is often only feasible as public development on a large scale. Like most generalizations about irrigation, this one ignores a host of exceptions. It ignores the complementarities between groundwater and surface systems, such as the pumps that depend on surface irrigation to provide the groundwater they pump, and the surface schemes that depend on pumping to prevent waterlogging. It ignores the counterintuitive fact that small, private tubewell irrigation often costs more public money per hectare irrigated than large-scale public surface systems.[30] Despite all these caveats, groundwater and surface irrigation are partially separable. In planning irrigation, there is some flexibility to emphasize one or the other.

Many projects are a mix of surface and groundwater irrigation. According to the evaluation record, only 37 projects (18 percent) were mixed. The true figure is probably much higher, however, since audits have revealed many examples of planned surface projects where farmers subsequently invested in pumps to complement the gravity system.[31] There are agricultural credit projects that finance investment in tubewells that would have nothing to pump if surface irrigation projects did not recharge the aquifer.[32] Nevertheless, the 116 projects (56 percent) that evaluations classify as gravity projects and the 55 (26 percent)

TABLE 4.6: GRAVITY AND PUMP PROJECTS COMPARED[a]

	Gravity[b]		*Pump*[c]		*Mixed or NA*	
Location (no. of projects)						
Sub-Saharan Africa	11	9%	7	13%	5	14%
East Asia and Pacific	42	36%	12	22%	5	14%
Middle East and North Africa	5	4%	3	5%	9	24%
Latin America and Caribbean	13	11%	5	9%	4	11%
Europe and Central Asia	8	7%	8	15%	8	22%
South Asia	37	32%	20	36%	6	16%
Total	116		55		37	
Average loan size						
Current $million	49		36		34	
Constant 1991 $million	93		69		61	
Average rainfall (mm)	1,226		1,304		960	
Economic rate of return (%)						
Appraisal	21		24		19	
Evaluation	14		17		13	
Average OED rating						
Satisfactory	73		37		24	
Unsatisfactory	41		18		11	
Not rated	2		0		2	
Water user groups						
Satisfactory	13		13		2	
Unsatisfactory	25		6		4	
None reported	78		36		31	
Average command area (hectares)						
Appraisal estimate	162,295		98,917			
At completion	165,793		97,044			
Average project cost (current $million)						
Appraisal	115		89			
Evaluation	136		97			
Average implementation length (year)						
Appraisal estimate	6.0		5.3			
Actual	7.8		6.9			
Delay	1.8		1.7			

a. Data from the OED Irrigation Evaluation Corpus Database except for cost data from the Annual Review Database.
b. Any project based solely or primarily on gravity distribution.
c. Any project based solely or primarily on pumped distribution.

that they classify as pump projects are probably separate enough to warrant analysis about differences in performance.

Groundwater projects on the whole are somewhat smaller than surface projects. Their projected average full-development command area is 59 percent of the surface project equivalent, and their project cost is 77 percent of surface equivalent, which means that projected cost per area benefited is 30 percent higher. On average, the Bank loan per pump project is 74 percent of the surface equivalent. Otherwise, there are no obvious differences between pump and surface projects that would affect outcomes, except their design.

Pump projects were expected at appraisal to do better than gravity projects. Their average appraisal economic IRR was 24 percent, compared to the 21 percent expected of gravity projects.

At evaluation, the re-estimate of economic IRR for pump projects was 29 percent below expectations, compared to 33 percent for gravity projects. Pump projects' economic IRR at evaluation averaged 17 percent, compared to 14 percent for gravity projects. Evaluations rated 67 percent of the pump projects satisfactory overall, and 64 percent of the surface projects.

These differences are not large enough to suggest a major shift in emphasis, especially so in view of the frequent interrelationship between surface and groundwater systems. But the outcomes do argue for paying more attention to the possible role of pumping and groundwater irrigation when designing surface systems.

There is one other significant difference in performance between surface and groundwater projects that is not apparent from the differences in economic returns or the overall ratings. Although the evaluations reported about the same proportion of *water users' groups* for each type (34 percent), pump project users' groups were operating satisfactorily in 68 percent of the cases but only 33 percent were doing so in the case of gravity projects. This difference stems, in part, from the fact that the average pump project was only 58 percent as large as the average gravity-feed project. It is easier for smaller groups to organize and function. The success of group functioning is also significantly and inversely correlated with size of command *within* the pump project group, and even more so within the gravity group. The size factor, however, does not account for all of the difference between the two groups. Perhaps the pump, which is obviously the heart of the system and needs to be operated and maintained, gives a natural focus to group activities.

The better performance of irrigators' groups where projects are smaller, or where there is a focus that permits large projects to be divided as in the case of pump-focused groups, puts the robust big-is-beautiful finding into perspective. An International Fund for Agricultural Development study of its 13 evaluated irrigation projects (Jacques Kozub and Arthur Domike, *The IFAD Experience with Project Design and Implementation*, Rome: IFAD, 1994, p. iv) concludes that while "Economies of scale inherently favour large projects" these advantages are frequently lost. By subdividing large projects into management units in which irrigators can organize themselves, it should be possible to retain the economies of scale, and to realize the benefits of active user participation. The IFAD study (p. v) concludes that "A promising alternative to centrally managed irrigation projects is the communally managed (or farmer-owned) irrigation system."

Notes

1. See John M. Malone, Poonsook Mahatanankoon, and Andreas Meimaris, "Post-project Evaluation in Irrigation and Drainage—The Experience of the World Bank," *Proceedings of the International Commission on Irrigation and Drainage, Special*

Session, Grenoble, 1981, pp. 121–146, based on 24 projects, and OED Report No. 3421, "Water Management in Bank-supported Irrigation Project Systems: An Analysis of Past Experience," April 1981, based on 26 projects.

2. See section on impact evaluations, irrigation, and development, in *Evaluation Results for 1989*, Operations Evaluation Department, Washington, DC: World Bank, 1990.

3. Leslie E. Small, "Evaluating Irrigation System Performance with Measures of Irrigation Efficiencies," unpublished paper, September 1991, p. 1. This paper was prepared for the International Food Policy Research Institute/International Irrigation Management Institute initiative on irrigation performance. Also see Leslie E. Small and Mark Svendsen, "A Framework for Assessing Irrigation Performance," *Irrigation and Drainage Systems* 4, pp. 283–312. Both contain bibliographical references to numerous scholarly arguments for "partial" performance measures.

4. Robert Picciotto, "Irrigation in the 1990s: A Role for the Bank," *Developing and Improving Irrigation and Drainage Systems: Selected Papers from World Bank Seminars*, Guy LeMoigne, Shawki Barghouti, and Lisa Garbus, eds., World Bank Technical Paper No. 178, Washington, DC: World Bank, 1992.

5. The "disconnect"—the difference between each project's last supervision rating and its evaluation results—is also almost identical for irrigation and for the Bank's entire lending program.

6. For analysis of the "optimism gap" for all projects, see Gerhard Pohl and Dubravko Mihaljek, "Project Evaluation and Uncertainty in Practice: A Statistical Analysis of Rate-of-return Divergences of 1,015 World Bank Projects," *World Bank Economic Review*, May 1992, VI, No. 2, 255–77. For irrigation projects, however, more and better information has been marshalled. The analysis that follows is more complete.

7. See Hervé Plusquellec, "The Value of Performance Studies of Irrigation Projects for Lending Agencies," to be published in *Irrigation and Drainage Systems Journal* (Netherlands).

8. There are 251 projects for which the audit has been "delinked" from the PCR and whose PCR and audit were published in different years:

Annual review year of audit	*Projects reviewed*	*Projects rated separately*	*(%)*
1988	169	1	0
1989	263	0	0
1990	359	59	16
1991	278	113	41
1992	282	78	28
Total	1,351	251	19

Of the 251 projects, OED changed Operations' overall rating in 14 percent of the cases (35). Nine of these (26 percent) were upgraded from unsatisfactory to satisfactory; 26 (74 percent) were downgraded from satisfactory to unsatisfactory.

Of the 251 delinked projects, 105 (42 percent) were agricultural. OED changed the ratings of 20 (19 percent) of these. Five (25 percent) were upgraded; 15 (75 percent) were downgraded.

Of the 105 delinked agricultural projects, 27 (26 percent) were irrigation. That is 11 percent of all delinked projects. OED changed the ratings of six (22 percent) of these. Two (33 percent) were upgraded; four (67 percent) were downgraded.

9. Of the 251 "delinked" projects on all sectors, only 135 (54 percent) of PCRs calculated economic rates or return. Three-fourths (101) of the audits of these PCRs left the rate of return (ROR) unchanged or reported none. Only one-fourth (34) recalculated the ROR. Five raised it (an average of 12 percent); 29 lowered it (an average of 12 percent). This reduced the average "delinked" PCR economic IRR of 17.8 percent to an audit average of 15.5 percent. The differences and the numbers are small for all projects and become insignificant for the smaller irrigation sample.

10. OED Report No. 5718, "Sustainability of Projects: First Review of Experience," June 1985, summarizes results for 31 projects, 23 of which have economic IRR estimates for all three stages (and nine of which are irrigation projects). (See Table 1, p. 8.) Average estimated returns were: appraisal—19.0 percent; PCR/audit—15.5 percent; and impact evaluation—9.6 percent. OED Report No. 6073, February 1986, summarizes results for 14 fertilizer projects, 11 of which have estimates for all three stages. (See Table 6, p. 47.) Average estimated returns were: appraisal—20.5 percent; PCR/audit—19.7 percent; and impact evaluation—15.4 percent.

11. *Evaluation Results for 1989*, Annex 3, Table 3–4 reports on the two subprojects of Mexico's Third Irrigation Project (San Juan and Lagunera), separately, hence its total of 21. If these subprojects are reported as one, the average appraisal estimate of economic IRR is 18.0 percent instead of 17.7 percent and the average impact estimate is 9.7 percent instead of 9.3 percent.

12. High-ranking Indian engineers have long pointed out that Bank-financed projects there have higher unit costs than their own; they have argued that this "gold-plating" is wasteful. Bank staff have argued that the higher unit costs pay for themselves in better results. This study's analysis in no sense settles this and similar arguments. The documentation of the link between low unit costs and high returns does, however, reinforce what should be the professional bias of irrigation engineers and economists—to get good farming results per unit cost of materials and other inputs used.

13. Paddy alone is by far the most important grain, being the only benefit in 38 percent of the projects and the predominant one in 62.5 percent. Nongrain benefits are principally cotton, sugar, and fruits and vegetables.

14. The data, presented by Commodity Projections in various constant dollar bases, have all been adjusted to 1970 constant dollar values for purposes of comparison.

15. In years with multiple forecasts, the series closest to the calendar year's end is used.

16. Bank price forecasting has evolved from its simple beginnings in the early 1970s. Traditionally, Bank near-term (mainly

one-year) forecasts were based on supply-demand relationship models; longer-term forecasts were based on projections of supply costs alone. Therefore, the latter, which are of critical importance to project economic analysis, failed to take account of demand trends, a fact that may have contributed to their poor predictive record in the case of agricultural commodity prices. More recently, the Bank has used futures markets for near-term projections after finding them just as reliable as its own methods; models for long-term projections have become much more sophisticated. For a brief discussion of practice in 1986, see R. C. Duncan, "EPDCS' Primary Commodity Price Forecasting: Procedures and Performance," unpublished Bank internal draft, May 1986, and OED Report No. 6073, "Sustainability of Projects: Review of Experience in the Fertilizer Subsector," February 1986, p. 41, para. 7.24.

17. The proper comparison is between the appraisal year *forecast* for the benefit period in the economic analysis (typically from project year three to year 30 but varying by project) and the combination of *actual prices* for the period between appraisal and evaluation and the *forecast* in the evaluation year for the remaining period of benefits. To make more than a visual comparison, it would be appropriate to weight the yearly benefits to account for the fact that unequal quantities of benefits occur in different years and to discount future benefits (not normally at the IRR) to reflect societal time preferences. Such a procedure would generate single indicative numbers that could be compared. Their impact on internal rates of return, however, would still not be straightforward, depending on the time pattern of costs and of costs relative to benefits.

18. For more on Bank commodity projection methods and results, see Angus S. Deaton, "Commodity Prices, Stabilization, and Growth in Africa," unpublished paper from Princeton University/Research Program in Development Studies and Institute for Policy Reform, September 1992, draft.

19. See World Bank, *World Development Report 1991*, Washington, DC: World Bank, 1991, Table 4.2.

20. The most ambitious attempt to map the distortions that affect agriculture is Anne O. Krueger, Maurice W. Schiff, and Alberto Valdés, *The Political Economy of Agricultural Pricing Policy*, Baltimore: Johns Hopkins, 1991, 5 vols. Results are summarized in Schiff and Valdés, *The Plundering of Agriculture in Developing Countries*, Washington, DC: World Bank, 1992.

21. See Daniel Kaufman, "The Forgotten Rationale for Policy Reform: The Productivity of Investment Projects, Preliminary Findings and Implications of Research-in-Progress," unpublished paper prepared at the World Bank, April 1991. Distortion categories used in this section are those used in the WDR analysis. See this paper for details.

22. For a sympathetic discussion of Malaysian rice protection policy, its incentive effects on farmers, and its relation to the economics of rice irrigation investments, see OED Report No. 9714, June 1991, audit of four rice irrigation projects in peninsular Malaysia.

23. For example, in the case of sugar in Morocco. Sugar is the major output of the Doukkala irrigation projects. Protection of north African wheat was also introduced with the Bank's blessing by aligning the governments' producers' prices not to world market prices but to the "undistorted" world market prices. See OED Report No. 11654, February 1993, audit of Tunisia's Agricultural Sector Adjustment, Loan 2754. The same phenomenon occurred in Morocco under the Agricultural Sector Adjustment Loan, 2590, but the audit of that loan, OED Report No. 7868, June 1989, did not mention it, but did show how the government's price regime was more favorable to irrigated than to rainfed farmers.

24. See OED Report No. 8460, March 1990, PCR for Madagascar's Mangoky Agricultural Development Project, Credit 881.

25. See the cluster OED audit, currently in draft, of Sudan's New Halfa Irrigation Rehabilitation Project, Credit 1022; Blue Nile Pump Schemes Rehabilitation Project, Credit 1118; and White Nile Pump Schemes Rehabilitation Project, Credit 1119; as well as OED Report No. 11707, March 1993, PCR for Sudan's Agricultural Services Project, Credit 1201.

26. Presumably the effects of irrigation on macroeconomic distortion are minor.

27. Along the Nile, rainfall is negligible but water is available.

28. A far better gauge would have been precipitation divided by potential evapo-transpiration. This measure encompasses the effects of temperature, wind, humidity, among others. Arid is defined as 0 to 0.2, semi-arid as 0.2 to 0.5, and so on. Unfortunately, this datum is not available for the projects in question.

29. Except in Mediterranean (that is, winter rainfall) zones with water retentive soils, like parts of North Africa.

30. See article by S. Guhan in A. Vaidyanathan, *Water Control Institutions and Agriculture: A Comparative Perspective*, Trivandrum: Center for Development Studies, 1983.

31. Notably OED Report No. 9205, December 1990, on Thailand's Eleventh and Twelfth Irrigation Projects, Loans 1787 and 2022; and OED Report No. 9714, June 1991, with respect to Malaysia's Second Muda Irrigation Project, Loan 1717, and Krian-Sungei Manik Integrated Agricultural Development Project, Loan 1632, but not the others covered in this audit.

32. For instance, the audit of India's Fourth Agricultural Refinance and Development Corporation Credit Project, Loan 2095/Credit 1209, covered by OED Report No. 7925, June 1989.

5. Bank processes

The Bank processes that precede lending comprise *sector work*, and identification, preparation, and appraisal, which collectively may be referred to as generating *quality at entry*. Those that follow lending comprise *supervision* and the various forms of *evaluation*. In this chapter the study analyzes Bank performance of these processes with respect to irrigation. A sample of irrigation sector work was subjected to content analysis to gauge attention paid to selected issues of current concern and the quality of that attention. Irrigation preparation, appraisal, supervision, and evaluation itself were examined, using data from evaluations and from other OED work.

Sector work

The Bank uses both sector work and project analysis in its efforts to make sure that its loans foster economic and social development. Project analysis is concerned with a project's technical feasibility and with its financial and economic attractiveness. The objective is to discover whether funding of a project, based on its own merits, makes sense. Sector work is concerned with whether the project fits into its country and sector priorities, how it compares with other possible projects, or what sector investment strategy should be. Thus, sector work is not only an indication of the Bank's concerns but also, in conjunction with project analysis, a guide to Bank investment.

Irrigation has generated a large quantity of sector work, from a 1949 sector study in Iraq to 1992 studies of the Philippines. Some sector work has been vetted and formalized in "grey cover" Bank documents; more has remained in draft. This review concentrates on 37 reports covering all borrowing regions and all the major irrigation borrowers, as well as a number of minor ones. Asia is underrepresented in the sample, with 46 percent of the sector studies but 70 percent of Bank irrigation lending. Africa, particularly the Sahel, is overrepresented, with 35 percent of the sector studies but only 11 percent of Bank irrigation lending.

Some of the studies pertain to river basins within countries, some cover entire countries, and one takes an international river basin as its topic. Some cover water resources as a whole, while others confine themselves to irrigation. Some were done to address a specific problem, others to satisfy general curiosity about the sector or to fulfill a work program commitment. Some were done entirely by Bank staff, and others by consultants. All were prepared with varying degrees of collaboration by the borrowers.

To guide the assessment, a checklist-cum-questionnaire base was created for three groups of issues raised in the review and in the Bank's *Water Resources Management: A Policy Paper.*

In a broad sense, sector work is concerned with the physical, economic, and institutional environment into which projects are inserted and how they affect it. The checklist focused first on *environmental planning*, specifically in reference to water allocation and, more generally, in relation to resource planning. Second, it looks at the *specific environmental effects* of irrigation in relation to drainage, to aquifer use, and to catchment effects. Third, it covered *sector work on irrigation lending* in relation to land issues, the O&M-water charges-participation constellation, gender issues, and organization and management. The following analysis of irrigation sector work is not exhaustive, but it is relevant to other concerns raised in the review.

As irrigation projects and understanding of their effects have become more complex, so has sector work. Earlier, sector work focused on which individual irrigation investment projects were most suitable for Bank investment. By the mid-1970s, however, the familiar elements of "modern" sector work are evident: description of the entire sector, its problems, and recommendations for improvement. Increasingly, sector reports have taken a more integrated and comprehensive approach, viewing irrigation as one among many water uses. What sort of attention has Bank irrigation sector work paid to the nine issues named above?

Water allocation

In the sample as a whole, the amount of attention paid to water allocation is modest. The subject received significant attention in one-third of the reports (12), and is mentioned only briefly in another one-third (13), usually as an issue requiring consideration, and is not mentioned at all in the remaining third (12).

Four of the 12 that pay significant attention to allocation discuss the water resources available but do not discuss competing water uses or allocation within irrigation between different projects or between irrigation and nonagricultural water uses. In this sense, they are only slightly more useful than the studies that only mention the subject briefly. The other eight reports discuss how water might actually be allocated. Of these, two (Jordan 1984 and Jamaica 1984) are essentially water-allocation reports in which irrigation is just one water user. Three others are thorough only in their discussion of allocation of water between irrigation and hydropower.[1] Only three (India 1991, Indonesia 1989, and Philippines 1992) are principally irrigation-sector studies that include a thorough discussion of water allocation.

Coverage of water allocation in sector reports has been getting somewhat better over time. Of the 12 sector reports issued since 1988 (and not counting Mexico 1990, which only covers cost recovery), one-fourth do not discuss the issue, one-fourth discuss it briefly, one-fourth discuss the water resources available but not their allocation, and one-fourth are judged to have achieved thorough coverage of water allocation. The same cannot be said of a single pre-1989 irrigation sector report.

It is natural that, as sector work on irrigation has become more comprehensive, more attention has been paid to water allocation. That tendency is reinforced by water's actually becoming more scarce in more countries with the passage of time. As population and income per head grow, water consumption grows but the supply of clean, fresh water does not. Therefore, it is a little surprising to find that coverage of water-allocation issues, while better than in the past, still is less than thorough. It is also surprising to find that recent reports that did *not* cover water allocation are on Mali and Mauritania, where water is scarce everywhere, and on Madagascar and Mexico, large parts of which suffer from water scarcity.

Resource planning

Water allocation is one aspect of resource planning. To what extent did irrigation sector work discuss the broader topic of resource planning?

One-third (12) of the 37 reports discussed resource planning thoroughly, and one-fourth (9) mentioned the subject only briefly. Two sector reports had little to say on the subject and proposed further study. One-third (13) did not discuss resource planning.

Most of the sector reports that discuss resource planning thoroughly are recent, whereas most of those that ignore it are from earlier periods. There is a considerable overlap of water resource coverage and resource planning coverage. The average date of reports without water-allocation discussion is 1980, while that of reports with thorough discussion is 1986–87. Of the reports from 1984 to the present, two-thirds discussed resource planning thoroughly, a figure that rises if the 1990 Mexico report, devoted exclusively to cost recovery, and the 1989 Poland report, devoted exclusively to drainage, are excluded.

Drainage

In arid zones, inadequate or inappropriate drainage is perhaps the most severe problem that, over the long run, reduces the benefits of irrigation and leads to noxious environmental effects. This knowledge has seeped into the popular mind through reports on saline and waterlogged areas in Pakistan that are going out of production.

The number of reports that discuss drainage thoroughly (14, more than one-third) was equal to those that ignored the subject. Another quarter (9) discuss it briefly, including problems of tidal drainage.

There is no evidence that sector-work coverage of drainage has gotten better over the years. Of the 12 reports from 1989 onwards analyzed, five do not mention the subject, three discuss it briefly, and four give more coverage. These four include the 1989 report on Poland, which focuses on drainage because that is the country's leading irrigation problem.

Aquifer management

Nearly one-third of the irrigation projects supported by the Bank are predominantly based on groundwater exploitation. Furthermore, many of the Bank-supported surface irrigation projects enhance groundwater supplies as a secondary effect because they help to recharge the aquifer.[2] Bank-supported projects vary widely in their approach to aquifer management, ranging from complete laissez-faire to highly centralized planning.[3] Aquifer management problems have begun to be recognized in broader development circles—for instance, through awareness that groundwater mining in northwest Mexico may end agricultural production in the Costa de Hermosillo.

Irrigation sector work has paid little attention to aquifer management. Seventy percent of the reports (26) did not discuss it. Of those that did, most gave it only a brief mention (9), and in only four cases could the discussion be called thorough.

Catchment management

There is no methodological reason why the partial analysis used to evaluate projects could not encompass the benefits and costs that specific irrigation investments impose on the catchment area in which the project is located and that secular developments in the catchment impose on them. OED audits have shown,[4] however, that Bank appraisals frequently fail to capture the catchment effects of irrigation projects. Sector work, designed to take a broad and comprehensive approach to the impact of Bank loans, should compensate for this failure.

Catchment effects include deforestation, overgrazing and inappropriate farming, soil degradation, erosion, and reservoir silting. These interrelated phenomena are common in surface system catchment areas. If there is a storage dam, they occur both above and below the dam. It is not so obvious, however, that irrigation is the *cause* of these catchment effects. More often than not, deforestation, overgrazing, and inappropriate farming in the catchment area above the reservoir turn out to be independent phenomena resulting from secular changes fostered by population growth and, sometimes, by inappropriate land tenure arrangements, agricultural price policies, or credit subsidies. Sometimes, however, irrigation has fostered abusive use of the upper catchment area through ineffective policies to promote resettlement of reservoir oustees.[5]

Catchment degradation can have serious effects on surface irrigation systems through reservoir and canal silting, and on groundwater systems by changing runoff rates and, hence, aquifer recharge. Irrigation projects can be an opportunity to address these environmental problems, whether they have serious consequences for irrigation or not, and whether they stem from irrigation or not.

Catchment management also has a dimension through which it overlaps with water allocation, as mentioned above: allocation of water between projects within the same basin. Completion of the Bank-assisted Upper Krishna projects in India's Karnataka State will decrease water available to surface systems downstream in Andhra Pradesh. Production is already being curtailed in these downstream systems for want of water. While relations between the two states present political and administrative problems, economic rationality would suggest that optimal use of the scarce basin water resource be studied.[6] Similar examples abound. Does irrigation sector work deal with these issues?

For the sector work sample as a whole, the answer is usually "no." Three-fourths (28) of the reports did not discuss any of the catchment issues mentioned above. Five expressed concern over catchment management, erosion, and siltation from up-catchment. Two expressed such concerns and indicated a need for planning. Only one, the 1992 India irrigation sector study, can be said to have discussed catchment effects thoroughly.

Land issues

As indicated below, land acquisition problems were a serious issue that delayed implementation of surface systems in particular. To what extent did sector work evince an awareness of such problems?

The 28 reports that discussed land issues treated them in a wide variety of ways and with different degrees of thoroughness. Explanation of the tenure system and the problems with it was the most common theme, treated in 16 of the reports. Most reports dealt with amount of irrigable land, size of holdings, and availability of land for irrigation works and for irrigated agriculture. Of these, five dealt with land availability, 12 with the amount of land, and three with the amount of land, size of holdings, and the effect of that size on farmers' ability to invest. In four cases, existing or possible future water rights associated with the land were discussed. In only three cases did reports discuss the agronomic qualities of the irrigated or to-be-irrigated land. One-quarter (9) of the studies did not discuss land issues.

O&M-water charges-participation

Chapter 7 below discusses an emerging consensus that operation and maintenance problems, irrigators' ownership of their systems, and cost recovery are interrelated.

Most sector reports mentioned all of these topics, usually integrating the discussion of the

three. Only four did not mention any of them. Of the rest, all discussed operation and maintenance, all but one discussed water charges, and all but seven discussed the role of water users' associations. Of the two-thirds of sector reports that discussed all three elements of the constellation, most often their interrelationships were recognized. Of those that did not, five stressed the interrelationship of O&M and water charges but discussed participation separately; two stressed the relationship between O&M and participation but treated water charges separately; one discussed the relationship between participation and water charges while discussing O&M separately. Fully 14 reports recognize the relationships among the three. Of these, all but one are judged to have been thorough in their coverage, and 10 are considered to have covered the topics well.

All of the sector reports that discuss the three topics of the constellation offer recommendations. The most common are fiscal ones: increase water charges (14); introduce land taxes (4); decrease subsidies (4); and increase funding to O&M (6). There are suggestions for improving O&M other than increasing the funding and they are engineering ones: rehabilitate the systems (5) and modernize the systems (3). The "sociological" recommendations, however, are more numerous: create water users' associations (10), and increase farmer participation (6).

Gender

Irrigation affects men and women differently. Even if they have equal roles in agriculture, which they usually do not, women almost always have primary responsibility for such household tasks as food preparation, washing, and providing drinking water. Irrigation affects the quantity, quality, and proximity of the water that can be used for these tasks. However, except for the most recent studies on India and Mexico, none of those analyzed were found to have addressed the subject.

Organization and management

Thirty-five of the 37 sector reports discussed organization and management of irrigation agencies. In irrigation, as in other sectors, the Bank lends with the borrowing government's guarantee, usually to or through public agencies. The sector studies focused primarily on the organization and management of *public-sector* institutions, which are largely seen as the ones that make irrigation work. There is a modest amount of attention to the organization and management of irrigation by irrigators themselves, and to the division of responsibilities between public agencies and irrigators and their organizations.

The most frequent recommendations on organization and management are quite safe ones that would be difficult to quarrel with in any circumstances: improve planning (16); improve training (13); improve coordination among agencies (12); improve staff (8); institute a coordination agency (6); and improve budgetary procedures (2). A relatively small but significant number of the reports discussed the structure of the agencies and their relations with private groups, recommending decentralization (9), increased involvement with water-users' associations or farmers (6), and increased involvement with the private sector (irrigators or others). None of the reports analyzed focused on organization and management of irrigators' or other private groups.

Summary

The typical irrigation sector report leaves a great deal to be desired in addressing the broader environmental issues that have always been critical for successful irrigation and that are currently attracting attention. The time horizon is typically too short to capture fully the environmental, not to mention the social and economic, impact of irrigation policies. As regards *environmental planning*, coverage of water allocation in

particular and resource planning in general has been weak, but is improving.

Coverage of *special areas of environmental impact* has been poor and is still quite weak. This is the case for drainage, an important source of environmental troubles in numerous countries, and especially so for aquifer management and the various dimensions of catchment management: deforestation, overgrazing, inappropriate farming, soil degradation, erosion, and silting. (Even though irrigation gets blamed for a lot of these even when it is not responsible for them, it could be used as a vehicle for attacking these problems.)

Coverage is better for the three of the four *problem areas* selected. Coverage of land issues is broad but varied and none too thorough. Coverage of the O&M-water charges-participation constellation too is broad. Since the consensus that these factors are, or ought to be, interrelated has only recently emerged, it is gratifying that most irrigation sector work has recognized the interrelationship for some time. Coverage of management and organization was broad but generally superficial. It focused on management and organization of government institutions, occasionally on their relations with irrigators' organizations, and never on the irrigators' organizations themselves. There was no coverage of gender issues.

The encouraging note about irrigation sector work is that a number of the most recent reports, notably India 1991, Indonesia 1989, and Philippines 1992, get the highest marks for breadth and depth of coverage of the issues studied.

Quality at entry

A 1992 Bank self-evaluation, *Effective Implementation: Key to Development Impact*, investigated the disappointing performance of all projects and focused attention on projects' "quality at entry," that is, quality when they were first approved by the Board. "Quality at entry" refers to the quality of projects that borrowers prepare and present and, from the Bank's point of view, of the Bank's project appraisal as well as participation in project identification and preparation, which are essentially borrower responsibilities. Despite its manifest importance, neither the above-mentioned report nor subsequent Bank responses have proposed how to measure quality at entry.

While not presuming to complete a measurable definition of "quality at entry," evidence from OED's irrigation evaluations do examine some aspects of it, confirming that "quality at entry" is significantly related to project results. Four judgments extracted from the 208 evaluations of irrigation projects shed light on "quality at entry": quality of preparation overall, specific quality of planning and design, adequacy of final design, and quality of appraisal. Irrigation evaluations provide no insights into the quality of project identification.

Preparation

Preparation has been found to be significantly related to project outcome in other OED studies, notably in *1992 Evaluation Results*. In the case of irrigation, this relationship was also significant. Of the 208 irrigation evaluations, 176 (85 percent) rated preparation. Of these cases, 91 (52 percent) found preparation satisfactory, and 85 (48 percent) found it unsatisfactory. The 176 ratings cover projects approved from 1961 through 1985, with all but a few approved from 1969 through 1982. There is no clear evidence of a temporal trend, though a higher percentage of satisfactory judgments in 1974–79 is noticeable.

Projects in which preparation was rated unsatisfactory had an average evaluation rate of return of 10 percent, and those in which it was rated satisfactory an average of 19 percent. If

preparation was rated satisfactory, there was an 84 percent probability of a satisfactory rating overall; if unsatisfactory, only 48 percent. There is a strong and statistically significant association between preparation and results.

But is that association evidence that good preparation produces good irrigation results? Or are evaluators influenced by the known quality of a project's results when they rate preparation satisfactory or unsatisfactory? There is no definitive answer to this question, but evaluation findings on two specific aspects of preparation provide a partial one.

Quality of planning and design was rated by 152 (73 percent) of the 208 irrigation evaluations. Of these, 92 (61 percent) found quality of irrigation planning and design satisfactory and 60 (39 percent) found it unsatisfactory. The 152 observations cover projects approved from 1961 through 1984, with all but a few approved from 1969 to 1982. There is no clear evidence of a temporal trend, though a higher percentage of satisfactory judgments in 1974–79 is noticeable.

Projects in which quality of planning and design was rated unsatisfactory had an average evaluation rate of return of 8 percent, and those in which it was rated satisfactory an average of 17 percent. If quality of planning and design was rated satisfactory, there was a 79 percent probability of a satisfactory rating overall; if unsatisfactory, only 42 percent. There is a strong and statistically significant association between planning and design quality and results. There is even a stronger coincidence between planning and design quality—one aspect of preparation—and the assessment of preparation as a whole.

Adequacy of final design was rated in only 109 (52 percent) of the 208 irrigation evaluations. Of these, 51 (47 percent) found final design adequate, and 58 (53 percent) found it inadequate. The 109 observations cover projects approved from 1965 through 1983, with all but a few approved from 1972 to 1982. Adequacy of final design is precisely what OMS 2.28 of October 1978 aimed to improve (see Table 2.1). There is a clear, though modest, improving trend from 1972 to 1982, although even the most recent results show plenty of room for improvement. There is no apparent link between the OMS and the trend, which had begun earlier.

Projects in which adequacy of final design was rated unsatisfactory had an average evaluation rate of return of 11 percent, and those in which it was rated satisfactory an average of 16 percent. If preparation was rated satisfactory, there was a 71 percent probability of a satisfactory rating overall; if unsatisfactory, 60 percent. These are statistically significant associations, but not as strong as was expected. Promulgation of OMS 2.28 stemmed, in part, from the conviction that adequacy of final design contributes strongly to good results. Evaluators' judgments, however, do not indicate that adequate irrigation design is strongly associated with success or failure.

Using evaluation data on irrigation project preparation as a whole, together with that on the two components of preparation, there is still no statistical way to be sure that the evaluators were satisfied or unsatisfied with these elements of "quality at entry" as a function of hindsight—that is, their knowledge of the project's results. However, common sense says that, at least to some extent, it is preparation that is causing results. In making their judgments, evaluators were better able to distinguish adequacy of final design from preparation as a whole (and from results) than they were about the quality of planning and design. In so doing, they attached *less importance to final design than to the quality of the process by which it was arrived at*. Given the diversity of irrigation projects, it is quite natural that some irrigation projects go forward before design is finalized, which is contrary to OMS 2.28 but not necessarily a fatal flaw. *The quality of the design and*

planning process, whether finalized by Board approval or not, is more important.

Appraisal

Appraisal has been found to be significantly related to project outcome in other OED studies, notably in *1992 Evaluation Results*. In the case of irrigation, this relationship was also significant. Of the 208 irrigation evaluations, 179 (86 percent) rated appraisal. Of these cases, 110 (61 percent) found quality of appraisal satisfactory and 69 (39 percent) found it unsatisfactory. The 179 observations cover projects approved from 1961 through 1985, with all but a few from 1969 to 1982. There is no clear evidence of a temporal trend.

Projects in which appraisal was rated unsatisfactory had an average evaluation rate of return of 7 percent, but those in which it was rated satisfactory had a rate of 20 percent. If appraisal was rated satisfactory, there was an 83 percent probability of a satisfactory rating overall; if unsatisfactory, only 39 percent. These correlations are very strong and significant. It is possible, as it was in the case of preparation, that evaluators judged appraisal quality as a function of their overall project assessments. Nevertheless, the results argue strongly for improving the quality of preparation and appraisal, the two main components of quality at entry. Results in the irrigation subsector also strongly confirm OED's findings on preparation and appraisal in *1992 Evaluation Results*.

Supervision

Supervision means any actions performed by Bank Operations Departments in connection with a loan or credit after Board approval. Operational Directive 13.05 cites four purposes of supervision: to ensure implementation of the project as agreed, to identify problems and help the borrower resolve them, to cancel projects that cannot reach their objectives, and to learn how to improve project design.[7]

Bank supervision, in fact, goes far beyond accountability. While project implementation is the borrower's responsibility, Bank supervision includes an element of implementation assistance. That element is limited by budgetary considerations and could be constrained by staff availability.

Operations Departments are given budget ceilings for supervision. Otherwise, supervision would tend to expand over time because Operational staff develop a strong interest in the implementation of the projects they appraise. Unlimited implementation assistance would impinge on the borrower's basic right, and duty, to implement the project. For Bankwide loans approved and closed between FY74 and FY91, actual supervision has averaged 14.1 staff weeks/project/year for projects of more than three years.

Division chiefs can use their supervision coefficients flexibly, allocating more to some projects and less to others. The average projects during the FY74 through FY91 period lasted 7.3 years between Board approval and loan closing. The average loan amount was $48 million in current terms, or $83 million in 1991 dollars. The average staff input per irrigation project per year was 15.8 weeks, 12 percent above the average for all projects. Part of the explanation must lie in the greater average size of irrigation projects ($83 million in 1991 dollars for irrigation vs. $67 million in 1991 dollars for the average Bank operation) and part in the complexity of most irrigation projects. The figures show that irrigation has been getting its fair share of Bank supervision.

Averages conceal significant differences by region. Irrigation supervision input is below or at the Bank average for Europe (9.4 staff weeks/project/year for 16 projects), East and Southeast

Asia (11.7 for 49 projects), and North Africa and the Middle East (12.2 for 17 projects). Irrigation projects in Latin America and Caribbean (16.0 for 17 projects) and sub-Saharan Africa (17.1 for 16 projects) are above the Bank coefficient but near the irrigation average. South Asia (22.0 staff weeks/project/year for 54 projects) stands out as a region where special attention was paid to irrigation supervision. Inputs for the region were nearly 40 percent above the irrigation average and 56 percent above the Bank average.

The high South Asian average is a consequence of intense supervision in Bangladesh and India. Supervision for India's 28 irrigation projects consumed 24.5 staff weeks/project/year;[8] for Bangladesh's 12 projects, it consumed 24.1. Of the 15 irrigation projects worldwide to which 30 or more staff weeks of supervision/year were devoted, nine were in India and three were in Bangladesh. Both countries have substantial resident Bank agricultural units with irrigation specialists. In both countries, much supervision was done by field offices (at significant cost savings). In both countries, supervision missions were more likely to be staffed by irrigation engineers than in other countries. Moreover, supervision by headquarters' staff was complemented by the use of top-level irrigation engineers who had recently retired from government service. This was particularly true in India.

Other countries with major irrigation lending and resident Bank agriculture units committed less than average resources to supervision. In Indonesia and Thailand, for instance, resources committed to irrigation supervision were 11.1 and 14.3 staff weeks/project/year respectively, below the irrigation average and, in the case of Indonesia, well below the Bank average for all projects. Irrigation projects in these two countries are well above average in complexity, and their annual review of implementation and supervision ratings based on Bank supervision missions show that, in the case of Indonesia, Bank staff thought they were having more-than-average implementation problems.[9] In short, supervision inputs suggest a strong implementation-assistance "culture" in Bangladesh and India, and a lending "culture" in certain other countries.

The above information, obtained mainly from the Bank's management information system, shows that the Bank put a somewhat greater *quantity* of staff input into irrigation supervision than into the rest of its projects, but it shows nothing about the *quality* of that input. There is no simple measure of supervision quality. Two indications of quality might be the *continuity* of the staff supervising given projects and the *professional qualifications* of supervising staff. This information has not been tabulated for the more than 3,000 supervision missions of the 208 irrigation projects that have been evaluated or of the more than 7,000 missions to the larger number of projects involving significant amounts of irrigation. Staff continuity has been assessed by interviewing a nonrandom, nonstratified sample of irrigation task managers, while professional qualifications have been assessed by a random sampling of supervision reports, supervision terms of reference, and the data sheets of irrigation PCRs. This sampling shows that staff continuity was unusually high, and that, while economists and agricultural economists predominated among the supervisors, engineers were well represented. Since irrigation projects are farming projects, the paucity of professional agriculturalists is noteworthy. Staff interviewed invariably felt that more supervision would have been better.

The available evidence suggests that Bank supervision of irrigation projects was better than its supervision of other types of projects. What evidence is there of the effects that supervision quantity and quality had on irrigation project outcomes?

Other OED studies, notably the *1992 Evaluation Results*, have found adequacy of supervision to

be significantly related to project outcome. The correlation between supervision assessment and the overall assessment was positive and significant, but less positive and less significant than was the case for preparation and appraisal. In the case of irrigation, supervision's relationship to overall assessment was not significant, given the smaller number of projects in the set.

Given the weak relationship between supervision adequacy and results in irrigation, examples will not prove a point. Nevertheless, the example of the two high-irrigation-supervision and the two low-irrigation-supervision countries cited above is instructive. For Bangladesh and India, the "high" countries, evaluation rates of return were 29 percent and 21 percent respectively, well above the 15 percent average for all evaluated irrigation projects. For Indonesia and Thailand, the "low" countries, evaluation rates of return were 15 percent and 12 percent, respectively.

OED's *1992 Evaluation Results* also looks at Bank Operations' self-evaluations during supervision, as well as the relationship between those self-evaluations and subsequent evaluations in project completion reports and by OED,[10] as discussed in Chapter 4's discussion of implementation and overall assessments of outcome. Suffice it to say here that Operations' ratings from its annual review of project performance (ARPP), essentially based on supervision ratings, are considerably more sanguine than subsequent PCR and OED evaluation ratings, a phenomenon sometimes referred to as the "disconnect." As project implementation progresses, supervision ratings (as reflected in ARPP ratings) get progressively less sanguine. Even the last such rating of a project, however, was considerably less likely to report substantial problems than the subsequent PCR or OED evaluation was to find unsatisfactory performance. For the period 1975–92, for *all* projects, the final ARPP ratings, stemming from supervision, reported that 84 percent of investment projects had no major problems. PCRs and OED evaluations found 71 percent satisfactory. Thirteen percent is the *net* "disconnect"—the net downgrade of supervision-based ratings by subsequent evaluations. Four percent of the projects that PCRs and OED evaluations found satisfactory were found to have major problems in the supervision-based ratings, while 17 percent that the evaluations found unsatisfactory were found to have no major problems in ARPP.[11]
In other words, these rating systems disagreed (had a *gross* "disconnect") by 21 percent.

In *agriculture*, final supervision-based ratings found 76 percent of projects with no major problems, but evaluations found only 59 percent satisfactory. This produced a net "disconnect" of 17 percent. In irrigation, final supervision-based ratings found 86 percent of projects to have no major problems. PCRs and OED evaluations then found 64 percent satisfactory. Four percent of the *irrigation* projects that evaluations found satisfactory had been found to have major problems in the supervision-based ratings; 27 percent that the evaluations found unsatisfactory were found to have no major problems in ARPP. In sum, while supervisions gave irrigation higher marks than agricultural projects and all projects received, the divergence between these assessments and subsequent evaluations was bigger for irrigation than for the other groups: a *gross* "disconnect" of 31 percent, and a *net* one of 23 percent. Thus, the optimistic bias at appraisal carried over to supervision. Evidently, the focus on implementation and inputs at the expense of development impact by supervisors is even more pronounced in irrigation than in other parts of the agricultural portfolio.

Evaluation

For irrigation, as for its other operations, the Bank evaluates its work in a variety of ways. As discussed above, *supervision* provides feedback.

As noted elsewhere, during supervision "development objectives have not received the critical attention that they deserve. The overall status ratings seem to be dominated by short-term concerns about project implementation, while development objectives reflect longer-term optimism that objectives will be achieved once implementation problems are resolved. Ratings on both overall status and development objectives are excessively optimistic in the early years of implementation."[12]

Each successive evaluation takes a longer-term perspective and, as Chapter 4 shows, each makes, on average, a harsher assessment than its predecessor.

Except for the most recent loans, the *borrower* has been obliged, in accordance with the legal agreements, to make a *completion report* once a loan was closed. A significant number of borrowers comply with this covenant; their efforts show a wide spectrum of length, comprehensiveness, and analysis. Since the advent of the Bank's new PCR style in 1989, however, borrowers have been encouraged to fulfill their completion reporting obligation by commenting on and reacting to a Bank Operations' initiated PCR. In cases where borrowers continue to do their own evaluations, these are often summarized as "Part II," the borrower's reaction to Bank Operations' draft PCR.

Since 1972, the *Bank's Operations staff* have been required to prepare a *completion report* on each closed loan. This requirement, however, traditionally received a low priority, given competing demands for operational resources. By the 1980s there was a massive backlog of undone PCRs, and many of those that were done and submitted to OED for review were completed by research assistants or consultants who had no direct knowledge of the project and based their reports exclusively on file research. At the insistence of the Board, this backlog has now been greatly reduced. The quality of staff assigned to PCR work has probably improved. Irrigation, and the rest of agriculture, has always benefited from having a significant proportion of the sectoral PCRs prepared by professional staff from FAO/Cooperative Program (CP) on the basis of field visits. It is now standard procedure (whether FAO/CP, Operational staff, or consultants are involved) for the last field supervision mission to be used to gather data for the PCR. The Bank's Programming and Budgeting Department once provided an allocation of 10 person weeks for the production of a PCR. Typically, Operational divisions used to prepare PCRs much more quickly, diverting part of their allocation to reinforce project preparation, appraisal, and supervision. Although the budget provided for PCR production has declined to about 7 weeks, that provision is now more likely to be used for PCR preparation than in the past.

The PCR allocation is manifestly insufficient to perform a thorough evaluation of a project except where the borrower has done the bulk of the work beforehand, either by gathering data through a monitoring and evaluation system or by conducting its own thorough PCR, or both. Such support is still rather the exception than the rule. Therefore, it is also exceptional, for instance, for PCRs to do a thorough job of updating the financial and economic analysis used to justify projects at appraisal. This process typically involves changing the SAR assumptions by using actual construction costs and actual prices and price projections as of completion. Where agricultural results to date diverge significantly from appraisal estimates, the original targets are usually maintained but the full-development point may be moved farther into the future. This fairly superficial re-estimate of a project's economic impact (financial results are typically treated less thoroughly) is nevertheless a major improvement on appraisal estimates.

The next stage of evaluation—independent *audit by OED*—is reached by about 40 percent of

Bank investment projects and all "adjustment" loans. A higher portion of irrigation projects has been audited. Roughly 60 percent of all Bank investment projects have been evaluated only through the PCR. For the 208 irrigation projects evaluated through 1991, 31 percent had been evaluated only through the PCR, whereas 69 percent—143 of them—are covered by both a PCR and an OED audit.

The quality of audits is constrained by the resources put into them, normally one staff week in the field interviewing irrigators and irrigation technicians and visiting facilities, and 4.5 weeks studying files, interviewing Bank staff, drafting, and incorporating criticisms. The resource constraint clearly precludes research. Audits benefit from their independence, however, and sometimes incorporate research or monitoring results overlooked by earlier evaluations. The resources available permit verification, or otherwise, of earlier evaluations. Characteristically, audits do not recalculate economic returns, except occasionally when some major mistake or omission is discovered in the PCR.

Irrigation is fortunate in having been the object of nearly half of OED's final step in evaluation, the "second look" or *impact evaluation*. This instrument was devised for long-gestation projects, of which irrigation has a great number. Hence, 10 percent of completed irrigation projects have been impact-evaluated, compared with less than 3 percent for other sectors.

Impact evaluations vary considerably but generally command considerably more resources than audits. All but a few involve commissioned research conducted by nongovernmental organizations in the country where the project is located. Through interviews and surveys, the impact on beneficiaries and the beneficiaries' assessment of that impact are ascertained. The impact evaluation also has the luxury of a more circumspect view of the project, coming, as it does, when the project is more mature. Whereas the average irrigation PCR and the average audit are prepared 10 years after project approval, the average irrigation impact evaluation is conducted 15 years after project approval.

Lessons learned at all stages of the evaluation process are fed back into Bank Operations and into borrowers' development and investment policies in a wide variety of ways, both formal and informal. One source of these lessons is OED studies like this one. This study as a whole, and most particularly Chapters 3, 4, 6, and 7, are based on analysis of irrigation evaluations. In assessing the credibility of the results, it is important to bear in mind the quality of the evaluation evidence, which is a factor of the quantity and quality of resources devoted to it and to the quality of its organization. Despite attempts to systematize the process, evaluation is subjective and judgmental at its core. Intelligent policymakers would not wish it to be otherwise. Nevertheless, when interpreting the evaluation finding that the working of water users' groups in a given project is satisfactory or unsatisfactory, it is well to bear in mind that what might satisfy one evaluator might not satisfy another. With that proviso, and with the proviso that the categories into which information from 208 evaluations have had to be forced for purposes of comparison are not always defined with absolute precision, the evaluation data, on which Chapters 4, 6, and 7 are largely based, cover irrigation projects that range widely in type, location, and time.

Review of the evaluation process shows that the largest single problem is the quality of information available even after lending operations have formally closed. This affects all projects, but irrigation is especially affected because implementation and the generation of project benefits is more likely to be a protracted affair. Much of the time and effort spent producing impact evaluations and audits as well as PCRs and supervisions involves attempts to gather

pertinent, accurate information—often with scant success. The evaluation process could be made much more efficient and would be greatly simplified if projects generated their own pertinent and accurate data. Effective self-monitoring and evaluation by projects would prove extremely useful to the Bank, the borrower, and anyone else interested in evaluation. If information could be provided in a more timely fashion, M&E would prove even more valuable to project directors and other field staff responsible for getting the job done.

Notes

1. Hydropower is less competitive for water than household, industrial, or commercial water use. Like navigational water use or use for flood, silt, or salinity control, hydropower consumes almost no water. Hydropower does, however, move the water to lower elevations further downstream where, usually, it is less useful for irrigation. It requires timing of dam and reservoir operation to meet power demand. This timing is not likely to suit crop demand for irrigation water. Thus, nonconsumptive water use for hydropower is competitive with irrigation.

Attempts to model the competition and the complementarity of hydropower and irrigation water use show that the business is extremely complicated. An example is the massive models of water availability and use in the Narmada River basin constructed by Indian Institute of Management and Tata Institute for Economic and Social Research, and World Bank staff as part of the evaluation of two major and two minor dams on that river: Sardar Sarovar, Indira Sagar, Maheshwar, and Omkeshwar. Even these models do not optimize water use except by laborious iteration. As a review of the Bank's lending for multipurpose dam projects shows, dam and reservoir operation is not dictated by optimization rules but by the struggle of interest groups, characteristically with farmers pitted against urban interests and their thirst for water and water-generated power. Even where irrigators' rights are entrenched during project design and implementation, experience shows that irrigators have a difficult time defending their rights and maintaining their share of water and the times they get it in the face of competition from the nonfarm sector. See, for example, the PCR for Myanmar's Kinda (Nyaunggyat) Dam Multipurpose Project, Credit 1031, OED Report No. 10698, June 1992.

2. The difference between component efficiency and basin efficiency is critical. Much has been written on surface irrigation component efficiency, the percentage of water from a main canal that reaches the root zone of useful plants and gets taken up. An efficiency of 40 percent is quite good. Projects have been based on surface system improvements to increase water-use efficiency, sometimes ignoring the fact that basin efficiency may already be very high. Water that is "wasted," in the component efficiency sense, may be used by pumping from the aquifer or recouped for surface irrigation through downstream reflows. Of course, like water used but not used up to generate hydropower, the "wasted" water is at a lower elevation, from which it may need to be pumped for irrigation use. For a general, technical analysis, see Harald D. Frederiksen, "Discussion of Some Misconceptions About Water Use Efficiency and Effectiveness," unpublished, but the main points of which may be found in Harald D. Frederiksen, *Drought Planning and Water Efficiency Implications in Water Resources Management*, World Bank Technical Paper No. 185, Washington, DC: World Bank, 1992. For a specific discussion of how one country invested to improve irrigation water-use efficiency when basin efficiency was already close to 100 percent, see Mahmoud Abu-Zeid and David Seckler (eds.), *Round Table on Egyptian Water Policy*, Cairo: Ministry of Public Works and Water Resources, Water Research Center; Arlington: Winrock International Institute for Agricultural Development, 1992, particularly pp. 29–43 and Annex, pp. 5–8.

3. There is a preference for planning in Bank-financed projects. India's Tamil Nadu Agricultural Credit Project (Credit 250, approved June 1971) is an example. In this project, actually a well irrigation project long used as a teaching case by the Bank's Economic Development Institute, the borrower agreed to an elaborate authorization system to make sure the wells financed were sited so as to rationalize aquifer use. OED's impact evaluation on Bangladesh Shallow Tubewells Project (Credit 724-BD), Report No. 11031, August 1992, finds that the Bank's insistence on authorization and siting criteria in this case placed obstacles in the way of development because it encouraged bureaucratic meddling in a situation where aquifer mining was not a problem.

4. For example, in the Philippines, the Upper Pampanga River Irrigation Project (Loan 637, approved August 1969) ran into severe problems of reservoir siltation, mainly as a result of overgrazing of the upper catchment. Contrary to popular opinion, this erosion problem did not stem to any significant extent from improper resettlement of reservoir oustees. To solve the problem, which the appraisal economic analysis did not take into account, the Philippines had to take a second loan—the Philippines' Watershed Management and Erosion Control Project (Loan 1890, approved July 1980). For information, see OED Report No. 4555, June 1980, the audit of the first project, and OED Report No. 9906, September 1991, the PCR of the remedial project.

5. Resettlement has been addressed in OED Report No. 12142, "Early Experience With Involuntary Resettlement: Overview," June 30, 1993, and the supporting impact evaluation studies of four projects in three countries.

6. An OED audit of India's Upper Krishna Irrigation Project (Credit 788, approved April 1978), together with two other Indian irrigation projects, is currently being completed.

7. See OED's Report No. 10606, "Bank Experience in Project Supervision," April 1992, especially para. 1 of the Evaluation Summary, and subsequent paragraphs referred to therein.

8. While India's supervision input per project per year has been exceptionally high, the input per unit of commitment amount has been low. Supervision staff weeks/million 1991 dollars committed/project for India was 1.4, compared to 2.6 for all covered irrigation projects and 4.9 for sub-Saharan African irrigation projects.

9. On a scale on which higher numbers indicate more severe problems, the average Indonesian irrigation rating was 1.94; for Thailand, 1.78. By comparison, the world irrigation average was 1.90 and that for South and Southeast Asia was 1.77. For reference, average annual review of implementation and supervision irrigation ratings for India and Bangladesh were 2.12 and 1.91.

10. See OED's *1992 Evaluation Results*, 1994, pp. 99–101.

11. For details, see *1992 Evaluation Results*, loc. cit. and Annex Table 2.12, as well as OED Chapter 6 below.

12. See *1992 Evaluation Results*, p. 101.

6. Implementation

The purpose of Bank irrigation lending is to get sustainable results: crops, drinking and other household water, healthier living conditions. Chapter 6 looks at project implementation, a key step in achieving sustainable results. It does so in two ways: first by analyzing evaluation results, and second by surveying how Bank staff perceive implementation problems and analyzing the results.

Implementation as seen through evaluations

This section analyzes evaluations for information on problems that Bank-financed irrigation projects have encountered when borrowers implemented them. It is divided into three parts, the first on the magnitude of implementation delays and the second on their causes. Even though the analysis in Chapter 4 shows that, surprisingly, implementation delays of irrigation projects have no effect on economic returns, delays are, nonetheless, an indication of implementation problems. The third part examines what can be inferred about differential implementation problems from *unit costs* of different kinds of projects.

Magnitude of delays

Irrigation projects, especially surface projects, have a reputation for suffering major and serious implementation delays, measuring elapsed time from loan approval to closing. For the 208 evaluated irrigation projects, the average delay was 1.7 years—the difference between expected implementation time of just under six years and actual time of seven and a half. This is only 7 percent greater than the Bankwide average and 17 percent greater than the agricultural-sector average. It is less than the average implementation delay in education, energy, population, tourism, transport, drinking water, and technical assistance projects. Implementation delays in irrigation projects, in other words, have not been nearly as serious as is generally believed.

There was not much difference in implementation delay between gravity and pump projects. Gravity projects were supposed to be implemented in six years and took 7.8 in fact, a delay of 1.8 years. This was only slightly longer than the 1.7 years for pump projects, which were supposed to be implemented in 5.3 years and actually took 6.9. (See Table 4.6.)

The reason for the difference between the facts and the stereotypes is suggested in some evaluation documents.[1] What was implemented between loan approval and closing was often quite different from what the appraisal projected—generally less. In reviewing irrigation evaluations, an assessment was made of the achievement of construction targets at

closing and at completion. Assessments at closing and completion covered a wide range, from 5 percent to 200 percent completed. On average, only 84 percent of construction had been completed by closing, and it was estimated that the average project would be only 91 percent complete by the time of completion.[2]

The average delay in irrigation project implementation was 30 percent. But only 84 percent of the works were constructed. Therefore, the implementation delay per unit actually built was greater—55 percent. The problem was only a little worse in surface projects (19 percent of facilities not completed at closing) than in pump projects (15 percent not completed).

Causes of delays

According to Bank evaluations, the most common reasons for delays were shortage of borrowers' funding (mentioned in 46 percent of cases), procurement problems (38 percent), problems with design preparation and changes (36 percent), construction materials' shortages (29 percent), the all-embracing rubric "institutional problems" (27 percent), problems with contractors (26 percent), and land acquisition problems (22 percent).

All of these are generic problems not peculiar to irrigation. There is no evidence of any difference in the number-one cause—*shortage of borrowers' funding*, generally taken as indicating weak project "ownership" by the borrower—between irrigation projects and other projects. The same is probably true of *procurement problems*. There is ample evidence, however, that irrigation had more than its share of *design change problems*. A significant number of audits have found that irrigation projects were rushed to approval before engineering and preparation were complete, leading to costly redesign during implementation.[3] The practice was common in southeast Asia and other regions as well. That it led to delays in more than one-third of irrigation projects is not surprising. The evaluation record does not reveal whether the release of OMS 2.28 in October 1978, detailing the degree of design required before the Board would receive projects for approval,[4] affected this practice.

Land acquisition and *construction* delays are generic too, but irrigation projects generally require more of them than other projects do. These characteristics do not stand out statistically as causes of implementation delay, but many audits and impact evaluations show that they are salient.

Land acquisition ranks as the seventh most important cause of implementation delays for all irrigation projects and the fourth most important for surface projects. These rankings fail to capture the importance that many audits and impact evaluations attribute to land acquisition problems, which frequently end up delaying implementation of surface projects.[5]

Even with the tendency in the 1970s and early 1980s for irrigation lending to finance more software and, since then, to cover the entire subsector, irrigation is much more hardware-intensive than most types of projects. It finances more civil works. Therefore, more problems with procurement, shortages of construction materials, and contractors are encountered.

Construction quality has been a salient concern of technical irrigation staff. It is also a recurring theme in supervision reports. Staff consider construction quality a good indicator of a borrower's seriousness of purpose. However, evaluations generally report that construction quality was satisfactory. Of the 208 evaluations, 59 percent reported on construction quality; of these, only 36 percent reported that it was not satisfactory. This result is not credible in light of the prominence of construction problems (ranking second, fourth, and sixth) among factors

reported as causing implementation delays. But those same evaluations report a significant link between construction quality and results. Projects in which construction quality was rated unsatisfactory had an average evaluation rate of return of 10.5 percent, compared to 16 percent for those in which it was rated satisfactory. If construction quality was rated satisfactory, there was a 77 percent probability of an overall satisfactory rating; if unsatisfactory, only 52 percent. These differences are statistically significant. Poor construction quality frequently leads to duplicative rehabilitation projects that should not have been necessary. It adds to O&M costs as well.

Unit costs

Unit costs (actual project costs per hectare of completion irrigated command) are a revealing implementation indicator. Unit costs for different projects are not comparable because, per hectare, different projects are designed to do different things in hopes of realizing different benefits. Unit costs are generally low where minor improvements are made to existing

TABLE 6.1: AVERAGE UNIT COSTS[a]

	Unit cost ($/ha)	*Number*	*Adjusted unit cost ($/ha)*	*Number*	*Adjusted/ unadjusted ratio*
All	4,837	191	7,950	184	1.64
Satisfactory	2,643	128	2,906	125	1.10
Unsatisfactory	9,294	63	18,637	59	2.01
Gravity	5,584	113	10,355	112	1.85
Pump (mostly from groundwater)	3,766	52	4,415	46	1.17
Mixed	3,727	26	3,846	26	1.03
New construction	7,740	86	12,915	81	1.67
Rehabilitation	1,633	34	5,258	34	3.22
Rehabilitation and extension	3,171	55	3,834	54	1.21
Paddy	6,374	73	11,063	72	1.74
Nonpaddy	3,886	118	5,950	112	1.53
Selected areas					
East and South Asia	2,831	112	4,694	107	1.66
East Asia	4,291	56	7,379	56	1.72
South Asia	1,370	56	1,746	51	1.27
India	1,421	30	1,596	27	1.12
Europe	4,743	17	4,759	17	1.00
Middle East	5,062	9	4,663	7	0.92
Africa	12,925	30	20,833	30	1.61
North Africa	4,911	12	5,226	12	1.06
Sub-Saharan Africa	18,269	18	31,238	18	1.71
Latin America and Caribbean	3,923	20	10,283	20	2.62

a. Two measures of unit cost are used. "Unit cost" is defined as the actual project cost ($US) measured at evaluation divided by the completion command area (hectares) measured at evaluation. "Adjusted unit cost" is "unit cost" with the denominator adjusted by the completion achievement of construction target (%) measured at evaluation. Two projects, Lake Chad Polders (Chad) and Black Bush Irrigation (Guyana), had completion command areas measured at evaluation equal to zero. This resulted in infinite measures of unit cost, and thus they were not included in the calculation of averages.

systems, as in India's Maharashtra Water Utilization Project (Credit 1383, approved June 1983). At the other extreme, unit costs are infinite for projects like Chad's Lake Chad Polders Project (Credit 592, approved April 1975) and Guyana's Black Bush Irrigation Project (Credit 820, approved June 1978), where no command area was completed. Nevertheless, unit costs are a useful summary indicator of implementation.

Table 6.1 lists, for various groups of projects, unit costs and unit costs adjusted for partial achievement of construction in command areas reportedly completed.

Of course, much more was spent per hectare on *new construction* projects than on *rehabilitation* and/or extension projects, either before or after the adjustment. Presumably, the benefits/hectare from new construction projects were greater too. The difference between adjusted and unadjusted figures shows that there were severe implementation difficulties in some rehabilitation projects.

Gravity irrigation had 48 percent higher unit costs than *pump* irrigation, which generally provides a higher and more valuable level of service.[6] The adjusted/unadjusted ratio also shows that the average gravity project had more implementation problems.

Given that rice is generally grown in wet areas where irrigation might be called upon to produce less change in the natural order, one might have expected that unit costs would be lower for *rice* than for *nonrice* irrigation. The opposite is the case, and the adjusted/unadjusted ratio shows that rice projects had somewhat more extensive implementation problems.
As might have been expected, *unsatisfactory* projects had much higher unit costs—3.5 times those of *satisfactory* projects before adjustment, and 6.4 times after adjustment. This shows that unsatisfactory results are accompanied by much higher unit costs and that, on projects that turn out to be unsatisfactory, the projected works are much less likely to get built by the time of loan closing.

Regional differences in unit cost figures should not be misconstrued. High figures in sub-Saharan Africa do tell a story about implementation difficulties there. Obviously, a much more dramatic improvement in on-farm net benefits is required to justify the high unit costs of the average sub-Saharan project than the average South Asian project. But the adjusted/unadjusted ratio may be more revealing. In Europe, the Middle East, North Africa, and South Asia, irrigation projects built the quantity of works that appraisals expected them to. In Latin America especially, but also in East Asia and sub-Saharan Africa, they did not.

Implementation as seen by staff

Any picture of irrigation implementation obtained solely from analysis of the evaluation record is far from complete, a fact stressed by Bank staff and outside reviewers of this study in interviews and written comments. To complement that picture, Bank and OED staff dealing with irrigation were asked to give their views on implementation problems.[7]

In addition to obtaining staff assessments of irrigation implementation problems, these two groups were asked to shed light on the differences between supervision and evaluation assessments of the same projects. This gap exists for all Bank projects but is considerably larger for irrigation. Staff in the agricultural division of Asia Technical Department (ASTAG) see irrigation projects before and during supervision; OED staff see them during evaluation.

The results for the two groups (see Figure 6.1) show strong agreement about important

problems during early project stages. Both groups stressed the importance of irrigation *system design* and the *effectiveness of Bank preparation and appraisal* as problems in irrigation projects. Both groups gave *planning and resource assessment* (which belongs to early project stages) and *system maintenance* greater than average importance, though Operational staff made them second and fifth most important overall, whereas evaluators gave them just above-average importance. These judgments enforce the recognized need for attention to "quality at entry" for all Bank projects and to improving compliance with OMS 2.28 on proper project preparation as well as the judgment below that defective O&M is irrigation's most pressing problem.

Both groups agreed that the four *agricultural* areas (agricultural support design, technical support, production factors, and processing/marketing/transport) and *drainage system design* were not problem areas. (Drainage system implementation is another matter.) This consensus provides an important complement to the view of implementation that emerges from the evaluation record above.

Despite the overall consensus, several categories showed major differences between the two groups. Most notable was *project implementation,* in which Operational staff are involved through supervision and which they consider the top problem area; the independent evaluators, not directly involved, give it a less than average importance. Another category much more important to Operational staff was *basic data availability.* Conversely, the evaluators stressed *outside project factors* and *other project elements* much more heavily than their Operational colleagues.

These differences are consistent with a "disconnect" between supervision and evaluation. But are they due to differences in the professional backgrounds of the two groups, to differences in their contact with the projects, or both? Operational staff see project preparation, appraisal, and supervision. OED evaluators see projects after supervision has ceased. There was also concern about the rigor of the exercise, given the small number of respondents. And did the low importance attached to agricultural factors stem from the near absence of agriculturalists among the respondents?

To find out, the questionnaire was circulated at the Bank's 1992 Irrigation and Drainage Seminar. The 69 respondents classified themselves as engineers (38), economists (18), agriculturalists (10), and others (3). Inferring from the responses of this larger sample, professional background did *not* drive the differences between engineer Operational staff and economist evaluators. The seminar engineers echoed the ASTAG engineers' ranking of problem areas. However, the seminar economists, mainly Bank Operational staff, revealed more similarity of views with the engineers than with the OED's irrigation evaluators, most of whom have been economists.

There was a remarkable consensus (less strong among agriculturalists than within the three other groups) that agricultural problems are not salient. As one senior agriculturalist put it, "One has to admit that, if irrigation service is provided, farmers will figure out how to make the most of what is offered in the context of the incentives they face. Availability of advice on how to adapt to irrigation, of inputs and even of markets just are not the big implementation problems."

This evidence suggests that the *stage* at which professionals deal with irrigation projects and the *role* they play influence their assessment of implementation problems. As indicated above, there is widespread agreement across professional groups as to what those problems are.[8]

TABLE 6.2: IRRIGATION IMPLEMENTATION PROBLEMS: STAFF PERCEPTIONS

1. Basic data availability
Water resources data
Land resources data
Rainfall data
Soils classification data
Temperature and evaporation

2. Planning and resource assessment
Land capability
Water availability
Climatic factors
Crop potentials
Agricultural planning
Engineering planning
Feasibility analysis
Economic and cost data
Topographic mapping
Assessment of environmental fatal flaws

3. Irrigation system design
Layout and alignment
Cropping pattern
Detailed water requirements
Mode of operation
Sizing of canals
Hydraulic and structure design
Construction materials
Constructability
Design standards
Technical design capability
System layout
Cost effectiveness
Plans and specifications
Tendering
O&M equipment needs

4. Drainage system design
Basic drainage criteria
Drain layout
Type and sizing
Disposal requirements
Plans and specifications
Tendering

5. Agricultural support design
Cropping
Agricultural research
Agricultural extension
Fertilizer
Pesticide
Agricultural processing
Operational equipment
Credit
Marketing
Monitoring and evaluation

6. Other project elements
Environmental design
Institutions
Financial arrangements
Audit capability
Monitoring and evaluation
Training
Technical assistance
Government clearances
Land acquisition
Catchment area treatment

7. Project implementation
Procurement and bidding
Project management
Construction quality
Timeliness of construction
Timeliness of programs
Cost control (or overruns)
Personnel management
Overall project supervision
Training
Technical assistance
Consultant performance

8. System water operations
Bulk supply availability
Equity over service area
Timely to user
Quality as promised
Reliability to farmer
System performance

9. System maintenance
System facilities maintenance
Maintenance shops and offices
Organization
Staffing level
Training
Equipment adequacy
Funding level
Management/timeliness
Effectiveness

10. Agricultural technical support (after operations)
Agricultural extension
Access to information
Water user associations
Agricultural research

11. Agricultural production factors
Crop varieties
Cropping patterns
Pest control
Fertilizers
Farm credit
Farm equipment/labor
Cultural practices
Climatic conditions over evaluation period
Environmental impacts

12. Processing, marketing, and transport
Support agroindustries
Environmental limitations
Farmgate prices
Farm cooperatives (marketing or processing)
Marketing effectiveness
Markets available
Road net adequacy

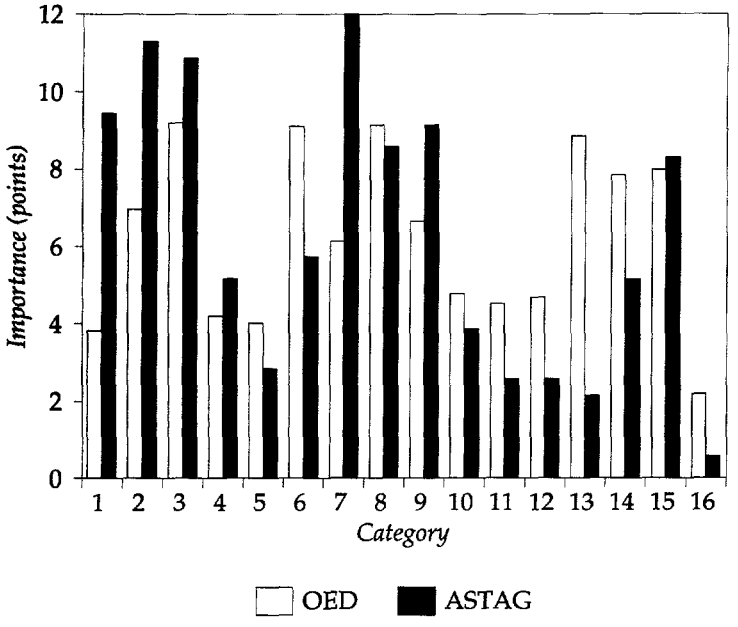
13. Outside project factors
International commodities prices
Country monetary policies
Political corruption
Natural disaster (flood or drought)
Inflation

14. Cost recovery, taxation, regulations, and benefits
Farmer repayment capacity
Water charges
Other charge mechanisms
Product taxes
Land taxes
Other constraints
Profit levels
Net income change

15. Effectiveness of World Bank preparation and appraisal
Technical initiatives
Influence of project formulation (positive or negative)
Internal rate of return (before and after)
Adequate SAR/presentation
Adequate supervision
Components complete
Supplemental project
Follow-on project needed

16. Other factors not in above categories
War
Civil disorder
Major political disruption

FIGURE 6.1: IRRIGATION IMPLEMENTATION PROBLEM AREAS: STAFF PERCEPTIONS



Classifications

1. Basic data availability
2. Planning/resource assessment
3. Irrigation system design
4. Drainage system design
5. Agricultural support design
6. Other project elements
7. Project implementation
8. System water operations
9. System maintenance
10 Agricultural technical support
11. Agricultural production factors
12. Processing/marketing/transport
13. Outside project factors
14. Cost recovery/taxation/ regulation/benefits
15. Effectiveness of Bank preparation and appraisal
16. Other factors not above

Source: W.G. Battaile and W. Price, "How Irrigation Could be Improved: Results of a Survey of Professionals," *Water Policy and Water Market*, selected papers and proceedings from the World Bank's Ninth Annual Irrigation and Drainage Seminar, World Bank, 1994.

Notes

1. See OED Report No. 7580, December 1988, on India's Maharashtra Irrigation II Project, Credit 954. The PCR argued that cost overruns were 10 percent but the Evaluation Summary pointed out (paras. iii and iv) that, since SAR construction targets were only 65 percent achieved, the unit cost overrun was 70 percent. What applies to cost overruns applies to time overruns.

2. The averages are heavily influenced by four outliers (Mexico's Bajo Rio Bravo and San Juan Irrigation Project, Loan 2100, approved March 1982; Malaysia's Rompin-Endau Area Development Project, Loan 1957, approved March 1981; Kenya's Bura Irrigation and Settlement, Loan 1449/Credit 722, approved June 1977; and Mauritania's Gorgol Noir, Credit 1068, approved September 1980) that have very small actual command areas and therefore exceedingly high unit costs. Without these four, average completion of construction was 90 percent rather than 84 percent.

3. See, for example, OED Report No. 8239, December 1989, audit of Vietnam's Dau Tieng Irrigation Project (Credit 845, approved August 1978).

4. See Table 2.1 above.

5. There are major national variations, from none in Romania, a centrally planned economy during the implementation period of the Bank's irrigation loans, to a major source of delay in countries with a strong common-law tradition, such as India.

6. In many situations, gravity is a prerequisite to pump, recharging the groundwater with water not used by plants and giving pump irrigation something to pump. Here, pump projects are mainly based on pumping groundwater but also include pump projects not based on groundwater.

7. Bank staff with experience with irrigation projects were asked to reveal their perception of problem areas in irrigation. In March 1992 a questionnaire was created by the agricultural division of the Asia Technical Department (ASTAG). In a series of brainstorming sessions, members of the irrigation unit identified hundreds of problems encountered in irrigation implementation, eliminated duplication, and grouped the remaining 129 problems into 16 categories (see Table 6.2). The questionnaire was first completed by the ASTAG irrigation unit, predominately engineers, and then by the OED staff who audit irrigation projects, mostly economists. A fixed number of points had to be allocated between the 16 problem categories to show their relative importance.

8. For a more detailed presentation and analysis of the evidence, see William Battaile and William Price, "How Irrigation Could be Improved: Results of a Survey of Professionals," *Water Policy and Water Markets*, Guy LeMoigne, William Easter, Walter Ochs, and Sandra Giltner (eds.), selected papers and proceedings from the World Bank's Ninth Annual Irrigation and Drainage Seminar, Washington, DC: World Bank, 1994, pp. 45–51.

7. Key issues in system design and sustainability

Many of the most important lessons of experience found in the evaluation record cannot be derived from statistical analysis alone. To tap the riches and subtlety of audits and impact evaluations, it is necessary to explore themes that crop up repeatedly and, where appropriate, to supplement them with findings of studies done outside the Bank. Chapter 7 explores two constellations of lessons. The first involves *operation and maintenance, water charges, financial autonomy,* and *irrigators' ownership*. The second involves three aspects of *system design* as it relates to *water scarcity.*

O&M and water charges

One might conclude, on the basis of the statistical record, that operation and maintenance of irrigation systems are often problems, but not problems of the first magnitude. Yet most PCRs and even audits occur too early in the life of irrigation projects to detect serious problems in operation or maintenance; they are more likely to focus on delays in construction. Some 43 percent of the evaluations do not mention operation and maintenance. Of the 57 percent that do, 31 considered O&M unsatisfactory but almost as many, 26, found it satisfactory.

This is a clear instance where the findings of impact evaluations and of other truly retrospective looks (audit and PCR comments on predecessor projects, non-Bank studies) paint a different picture from that of the statistical analysis. In the evaluation record, examples abound of irrigation systems whose *operation* bears little resemblance to that anticipated at appraisal. One cannot assume, of course, that the *design* of system operation was optimal. Deviations can be for the better. What the evaluations show, however, is that operation was often flawed. The most common problem was insufficient water delivery, and in fact often none, at the tail-end of canals.[1] Sometimes, that was because head-enders were taking more than their share.[2] Sometimes, there was just not enough water to operate the entire command area.[3] And sometimes system operation was chaotic for unknown reasons.[4] Cases are sometimes found where the system is hardly being operated at all, perhaps because doing so would not help anybody very much.[5]

Maintenance is also a much more serious problem than statistical analysis would suggest. OED audits rarely pay much attention to poor maintenance, though they usually mention it. OED impact evaluations, however, do focus on poor maintenance.[6] So did OED's 1986 study of irrigation cost recovery,[7] which found that poor maintenance, by leading to poor irrigation system performance, was a major factor behind irrigators' reluctance to pay water charges and thus to violate cost-recovery covenants. Further evidence that poor maintenance is a wide-

spread problem can be found in the multitude of staff appraisal reports for follow-on projects with their accompanying legal covenants, which stipulate that borrower O&M allocations will be raised to levels that assure "adequate" O&M (often several times prevailing levels). It can also be found in the PCRs, which take note of inadequate maintenance but assume, in their calculations of economic IRRs, that O&M allocations will rise to "adequate" levels and stay there. O&M problems can be seen in the Bank's financing of so many rehabilitation projects. Almost all of them, when scrutinized, turn out to be deferred maintenance projects.[8]

The Bank's classic remedy for O&M problems (apart from making rehabilitation loans) has been to require increased public spending on O&M, the spending to be covered by higher charges for water. Higher water charges have been imbedded in the legal covenants of hundreds of loans. In the case of irrigation, the Bank has linked cost recovery to O&M.

OED's 1986 study confirmed that poor maintenance leads to poor cost recovery. Therefore, it might seem logical to assume, as the Bank's irrigation cost recovery policy does, that better cost recovery would lead to better maintenance and operation. But usually it does not. OED's 1986 study comments that:

> *The reason for stressing recovery of O&M costs ... stems from the keen awareness that failure to provide adequate O&M tends to limit the success and sustainability of the project, and oftentimes, necessitates premature rehabilitation. Apparently, it has been assumed that if sufficient funds for O&M are recovered these would be allocated to O&M—an assumption that in most cases is not justified.*[9]

The Bank's recently issued *Water Resource Management: A Policy Paper* emphasizes the need to plan and to allocate scarce water rationally between competing uses. To this end, it advocates, where circumstances permit, full economic pricing of water. It would be wrong, therefore, to dismiss the use of water charges to improve water-use efficiency too hastily.[10] As Svendsen has argued:

> *Nothing is closer to the heart of Western economic theory than the idea that prices mediate between supply and demand and, appropriately set, result in the efficient allocation of resources. We do economic theory grave injustice, though, when we expect it to perform this minor miracle on commodities that are not paid for on a per unit basis.*[11]

Svendsen explains that irrigation water deliveries in the developing countries are very rarely volumetric and that it would be impractical to make them so. Many irrigation systems are so constructed that water cannot be cut off to irrigators who do not pay. Besides, most water charges are a small fraction of what they would have to be to affect farmers' allocational decisions if all other problems could be overcome.

There are two reasons why it is wrong to assume that if sufficient funds for O&M are recovered they will be allocated to O&M. The most common practice is not to earmark water charges but to pay them into the central treasury, whence they can be allocated rationally for the public good by omniscient planners or legislators whose decisions reflect the social welfare function. Under these circumstances, there is *no link* between paying water charges and getting good O&M.[12] And even if there were a *financial link*, there may be little or no link between the irrigation ministry's O&M budget and the quality of the O&M because there is no *incentives link*. The ministry's O&M wing is a public-sector monopolist that is not directly accountable to irrigators. There is ample evidence to suggest that O&M done by public irrigation agencies is often neither cheap nor effective. Under the circumstances, as

Svendsen says, "it is reasonable to assume that larger budgetary outlays to irrigation agencies from the central treasury would not result in commensurate improvements in system performance."[13] The morality of requiring irrigators to pay in water charges whatever costs such an unaccountable agency incurs is open to question.[14]

Evaluation does not entirely confirm the conclusions of the 1986 OED study and of the non-Bank experts (outlined above). Each evaluation was examined for information on O&M and on cost recovery. Of the 118 evaluations that rated O&M, 53 found it satisfactory and 65 found it unsatisfactory. The findings on O&M were not significantly related to performance assessment. Projects with satisfactory O&M averaged an evaluation economic IRR of 13.9 percent, while those with unsatisfactory O&M averaged 14.2 percent, an inverse but not significant relationship.

Cost recovery was rated in 51 percent of the 208 projects. Of these, 32 percent found cost recovery satisfactory, while 68 percent found it unsatisfactory. The findings on cost recovery were significantly and inversely related to performance assessment. Projects with satisfactory cost recovery averaged an evaluation economic IRR of 13.1 percent, while those with unsatisfactory cost recovery averaged 16.1 percent, significantly higher. If these data are to be believed, what amounts to public subsidies to irrigation users through nonrecovery of costs from users leads to more efficient use of irrigation systems.

There are 77 evaluations that rated both an irrigation project's O&M and its cost recovery. In 57 of the cases (74 percent), either both were satisfactory or neither was—a result that suggests a pattern, even though the literature and OED's 1986 irrigation cost-recovery study doubt the existence of a connection between O&M and cost recovery.

After taking note of this pattern, the 1986 study concluded that "It cannot be assumed that this is a causal relationship, nor, if so what is the direction of causality."[15] Moreover, even if cost recovery did determine the adequacy of O&M (and common sense would suggest the reverse), the 1986 study reported that the Bank's best efforts to obtain cost recovery had produced full compliance in only about 15 percent of the cases.[16] The only reasonable conclusion, then, is, that:

> *Rather than concentrating on questions of how much higher we should raise irrigation fees and how we can get farmers to bear a larger share of the costs, it is time to take a more pragmatic and comprehensive approach to this issue.*[17]

O&M, financial autonomy, and irrigators' ownership

The Bank's evaluation record suggests that a "more pragmatic and comprehensive approach" has yet to be devised by the Bank for the O&M problem, which was already widely recognized when OED highlighted it in 1986. There are signs, however, that researchers outside the Bank may have gotten closer to a solution, beginning with a 1986 study of irrigation service fees in Asian countries commissioned by the Asian Development Bank (ADB) and carried out by the International Irrigation Management Institute (IIMI).[18] Although the authors' findings are similar to those of the OED and Svendsen studies of the same year, their analysis and prescriptions add up to the sought-after pragmatic and comprehensive approach.

The IIMI study authors found little merit in the World Bank's concern about recovering irrigation costs from irrigators, considering it arbitrary, unlikely to contribute much to increasing water-use efficiency, and not a particularly effective way to address problems of equity or deficient public savings. The authors

contend that *financial autonomy* is the key. When the entity that collects the fees is able to use them to oversee O&M, O&M improves. O&M does not improve if the agency is dependent on budget allocations unrelated to fee collections and, often, to performance. The ADB-IIMI study leans heavily on experiences in financial decentralization in Indonesia, Korea, and the Philippines.

The key to financial autonomy is linkage, or feedback. Most of the agencies examined in the ADB-IIMI study were *public irrigation authorities*. These can be reorganized into *commercial water-service units* that are public, often with customer involvement in management. The ADB-IIMI study found that when their budgets depended on the collection of water-charges, the agencies took an active interest in what the payers wanted done and what the payers thought of the agencies' work. The irrigators saw a connection between paying for services and getting results. These findings are reflected in recent Bank work, notably "Pakistan—Irrigation and Drainage: Issues and Options," Report No. 11884-PAK, March 1994.

Very often, financial autonomy means assigning both the collection of fees and responsibility for O&M to a *users' group*. While this is not the only approach to financial autonomy,[19] a number of experts make *devolution the key to improving O&M.*[20] Although it may be suggested that this form of devolution simply follows currently popular ideas about the benefits of privatization, beneficiaries' "ownership," participation, and the like, and that skepticism is therefore called for, a review of recent literature strongly suggests that it is a major factor in improving O&M.

The Bank's evaluation record does not present such a clear picture on the success of devolution. Although users' groups invariably exist in fact, whether or not they are formalized and recognized by governments and the Bank, only 62 irrigation evaluations (30 percent) commented on them. Of that number, the users' groups in 28 projects were found to be performing satisfactorily; in 34 projects they were performing unsatisfactorily. The evaluation economic IRR of projects with satisfactory performance by users' groups averaged 13.8 percent, while that of projects with unsatisfactory users' group performance averaged 18.3 percent, an inverse relationship that is significant despite the small number of observations. Both the lack of attention to users' groups and the inverse relationship between their performance and overall project performance contrast markedly with theoretical expectations and with the picture painted by the literature.[21]

Recorded satisfactory and unsatisfactory water users' group experiences tend strongly to run together with satisfactory and unsatisfactory O&M and cost-recovery experiences. As common sense would lead one to expect, the relationship with O&M was stronger. Of the 50 instances where both users' groups and O&M were rated, the rating was the same 72 percent of the time. But the relationship with cost recovery was also strong. Of the 49 instances in which both were rated, the judgment was the same 67 percent of the time. These simple cross tabulations do not tell us anything about cause and effect.

The literature suggests that satisfactory users' groups beget satisfactory O&M, which begets satisfactory cost recovery. Indeed, if the ownership of the system (at least the lower reaches thereof, in the case of large surface systems) has been turned over to one or more irrigators' groups, they are then responsible for O&M, whether they do it themselves, contract the job to the irrigation department, or contract it to someone else.

Either way, *part of the problem of recovering public O&M costs is solved.* That is, *there are no such costs for the parts of the system turned over.*[22] Since the

instances in which the fisc has managed to collect the fees necessary to cover these O&M costs are few and far between, the fisc would gain, even though it would still bear the investment costs and O&M costs of undevolved major public works. All that is needed to realize this vision is to transfer ownership of irrigation systems to working groups of irrigators.

This "pragmatic and comprehensive approach" is worthy of serious attention, but experience suggests that *a turnover approach will not be easy to implement, nor will it work in all circumstances.* The 34 water users' groups found unsatisfactory by evaluations are not the only such.

Review of appraisal reports shows that the Bank has been paying increasing attention to users' groups, at least during project preparation and appraisal.[23] But experience suggests that covenants by which borrowers bind themselves to form irrigators' groups are a poor substitute for understanding the conditions under which irrigators form successful groups and then trying to foster those conditions from the beginning.

While Bank evaluations offer no guidance here, *studies of irrigation groups* have been searched for evidence of what makes them work well or not work well, and of what functions they perform well or badly.[24] *The most important lesson* seems to be the importance of recognizing that the members of groups will have to bear costs as well as benefits.

- Organizations that endure operate with clearly defined boundaries as regards the area they serve, who can belong, and their functions.
- Member contributions are proportional to benefits.
- There is no taxation and no altering of water-allocation rules without representation.
- Auditors of physical conditions and irrigator behavior are accountable to irrigator members.
- Rule violators suffer punishments that fit their crimes.
- Users and their officials have low-cost, local ways to resolve disputes.
- Government recognition is not necessary, but governments must, at least, not challenge the irrigators' groups.
- Organizations are formed of "nested groups" of very small and larger organizations, each with appropriate responsibilities.

These principles, paraphrased from Ostrom,[25] are cited throughout the literature. While the principles, like the laws of motion, are so simple as to seem trivial, some associations have been stillborn, some have died in infancy, and some have lived on but performed no useful function because of deviation from these principles. They provide clues on how to promote financial autonomy and responsibility for O&M. The goal of this "more pragmatic and comprehensive approach" is not just more participation, with its benefits for the souls of the irrigators, but better O&M, which would mean more food, probably more equity, and more sustained irrigation systems that do not ruin the environment.

One of the prerequisites of this approach is government willingness to devolve. Irrigators' self-management can hardly occur in the teeth of opposition from the state. Why might the state wish to devolve irrigation O&M responsibilities? Under what conditions does it happen? The Bank's evaluation record holds few clues. A major experiment in devolution has been going on for a decade in the Philippines[26] and is generally recognized to be useful.[27] (See Box 7.1.) Similar experiments in Indonesia, Mexico, Nepal, and Turkey are more recent and, though they are

Box 7.1: Bank staff and irrigation turnover in the Philippines

For centuries, Philippine farmers have formed local groups to build and manage substantial areas of irrigation. In this century, however, most of the growth in irrigation has come from government-built "national" systems. Also, increasingly, the National Irrigation Administration (NIA) had been taking more responsibility in nongovernment-built "communal" systems.

Starting in 1974, some visionary leaders in NIA decided to try to restore irrigators' authority over their systems where feasible. From 1976 to 1980 NIA used pilot projects to develop a participatory process; irrigation associations helped design and construct improvements on their systems and were completely responsible for system operations. NIA subsequently made such processes standard in their communal irrigation projects; this approach was incorporated into the Bank's Communal Irrigation Development Project (Loan 2173, approved June 1982). Given the Bank's nurturing of this local initiative, it is important to remember that some Bank and Philippine participants had reservations, as the following quote from a Bank project officer illustrates:

> *If you are building a communal system, you do need participation in construction .... But with water supply, you don't make decisions in popular meetings. Certain things cannot be delegated. The location of headworks has to be determined by topography and hydrology, not by referendum. Only a bad engineer would totally ignore people, but you can't replace engineering knowledge by dipping into folk wisdom.*[a]

Despite such reservations, experience showed that participation provided more functional irrigation. NIA started the Management Turnover Program (MTP) to devolve as much responsibility as possible for "national" systems to users. A staged approach was planned, starting with Stage I, in which irrigators' associations cleaned canals for a fee, and culminating in complete turnover of smaller systems to irrigators' associations (Stage III) and complete turnover of subsections of large systems (Stage

promising, it is too early to draw conclusions.[28] Such experiments are not limited to surface irrigation. Pakistan has been helping users' groups and private individuals to replace public tubewells with World Bank financial support.[29]

All governments that have undertaken major irrigation devolution have done so during periods of fiscal stringency, if not crisis.[30] While fiscal crisis may be a necessary condition for irrigation devolution, it is not a sufficient one. Many other governments in fiscal crises have not devolved nor even raised water charges to cover O&M expenses, an act that seems to be even more difficult than devolution in many cultures.

The efficiency gains claimed by proponents of devolution are unproven as yet. Further experimentation and research on the topic deserve high priority.

(Box 7.1 continued)

II). Under Stage II, associations would collect fees, keeping a portion for their O&M expenses and paying a portion to NIA for its main-system management. With the Bank's encouragement, this concept was changed. NIA contracted with the associations to collect users' fees and clean canals. That made the association more a labor contractor than an irrigation system manager.

Frances Korten, an NGO representative who knows the process well, comments:

> *The Bank had an important role in subverting the original vision of a 'turnover' program and the momentum that had been generated .... The Bank, of course, was not the only force opposed to the turnover concept. No bureaucracy likes to fire its personnel .... However, the Bank's opposition to the stages concept aligned it with those resistant to the turnover program and contributed to the abandonment of some of the important concepts ....*
>
> *Why was the Bank resistant to ... the real turnover of management responsibility to farmers? The Bank officers involved ... had been supportive of participation in the communals .... One possible source of this resistance may have been a concept that was being applied more widely in Bank O&M irrigation loans at that time. The general problem the Bank was addressing was that countries don't spend enough on maintenance, so their irrigation systems deteriorate and then they have to get loans from the Bank to do major rehabilitation that would not have been necessary if the systems had been routinely maintained. The Bank's answer to that problem in 1986 was to require irrigation agencies to set and meet targets for O&M expenditures .... The switch ... solved that problem .... The unfortunate consequence, of course, was that the switch undermined farmers' authority over systems and hence the potential for interest, leadership and capacity in the association.*

On national systems, for years, MTP got only as far as canal cleaning and fee collection by irrigators—substantially less than full farmer authority. Recent Bank lending supports further turnover but progress has been deliberate.

a. J. Austin, D. Warwick, and Kevin Murphy, "Philippine National Irrigation Administration," Boston: Harvard Business School, 1984.

Water scarcity and system design

In 1984, when Cornell University launched its Studies in Irrigation series, the first publication focused on the failure of large public systems in South and Southeast Asia to live up to expectations.[31] This area, like a number of other parts of the world, had a centuries-old tradition of community irrigation, but by 1940 irrigation in South and Southeast Asia had fallen far behind that in East Asia.[32] In the last fifty years, South and Southeast Asia have engaged in a protracted struggle to catch up. This effort has fallen short of expectations for two reasons.

The first reason is that public irrigation systems have grown faster than the institutions needed to regulate them and make them work, such as irrigators' associations. Moreover, South and

Box 7.2: How to improve public irrigation bureaucracies

The logic of turning irrigation systems over to irrigators is compelling. Turnovers are currently very much in vogue. Initial results are encouraging. Nevertheless, in the current enthusiasm for turnover, it is important to remember that the public sector will retain a major role, not just in planning and building irrigation systems, but also in operating and maintaining them, and/or in oversight of O&M. It is difficult to imagine how farmers could operate and maintain major, multipurpose systems, or why they should. Also, leaving aside the major headworks, there are going to be many situations in which irrigators with financial responsibility for O&M of their distributaries wish to contract for O&M, sometimes even with public agencies. Therefore, public irrigation bureaucracies remain important.

How can societies get the most out of their irrigation bureaucracies? Irrigation evaluations testify to the existence of lots of problems but offer no particular insights into their solutions. As Chapter 8 reports, recent lending has accentuated earlier trends to support "institutional strengthening." Yet there is little consensus on what works and little evidence of success.

As background for *World Development Report 1994: Infrastructure for Development*, the Bank commissioned a comparison of irrigation bureaucracies[a] to find out what conditions lead to "a competent and relatively honest technocratic cadre," "a high-quality civil service" insulated from day-to-day political interference, which the Bank argues is the key to the east Asian "miracle."[b]

According to Wade, public irrigation agencies' problems stem from the facts (a) that they are normally monopolies, (b) that ready comparators of performance do not exist because all systems are different, (c) that the agencies' essential O&M operations are carried out by highly dispersed operators out of direct supervision and peer pressure, and (d) which have results that are not easily attributable to an individual's action/inaction. The canal patrollers and their immediate supervisors are in closer (and tense) contact with

Southeast Asian governments tried to build irrigation from the top down. Traditionally, irrigation is built from the bottom up. For this reason, the norms of cooperative behavior, the community organization, and the sense of community ownership that accompany successful, long-enduring systems have not had a chance to evolve in many large, public irrigation systems. Therefore, in South and Southeast Asia there is a dualistic structure. Smaller, user-managed systems are maintained and operated well, even though they have not benefited from current knowledge of the best practices and are often handicapped by this fact. Larger, public systems have more modern design but are poorly operated and maintained because the "behavioral" aspects of the systems are primitive.[33]

The second reason is *inappropriate design*. The Cornell study faults "outsiders from developed

(Box 7.2 continued)

farmers, who want more water than system-wide rules permit, than with their supervisors. In this situation, ripe for collusion to allocate water other than according to the general plan and interest, how can the irrigation bureaucracy foster conscientiousness among staff to make the organization's goals the basis for their own actions?

The Wade study (p. 55) concludes: "The contrast is stark: the Indian organization has virtually no incentives for conscientious work ..., while the Korean organization is full of both individual and collective incentives."

Interestingly, the incentives are *not* in the pay scales. Both Indian and Korean irrigation bureaucracies are paid only a small portion of the marginal value of their work. In India, differential salaries and bonuses that go with promotion are much higher than they are in Korea. However, these are not a significant incentive to conscientious work. Indian employees are locked into closed cadres on joining the service. Few have promotion prospects. Those prospects depend on length of service, not in-job performance out of fear that performance ratings would be abused. There is little or no in-service training. Recruits are not assigned to their own localities and are rotated frequently to avoid bureaucratic capture by locals. Supervision too is predicated on institutionalized lack of trust; it aims at discovering grounds for punishment.

By contrast, though Korean pay gradients are small, there are major opportunities for promotion based on performance and teamwork. There is in-service training. Recruitment is meritocratic. Employees serve their career in their home locale and are encouraged to identify with "their" irrigation system. Supervision aims to solve problems and build trust.

The most pertinent contrast may be outside the recruitment-compensation-supervision matrix. The Korean system works to build group spirit; the Indian system does not. Korean irrigation workers all wear the same kind of clothes and eat together. In India, even foreigners can identify the status of Indian irrigation employees from dress and noncommensality, even at lunch breaks on

(continued on next page)

countries <who> tend to attempt to directly transfer technology that is successful in the developed country to the developing country" and "planners and designers who do not have significant long-term operational experience ... <and who> tend to reflect the bias of their personal experience."[34]

The study cites examples of inappropriate technology transfer from Britain, California, Israel, and Taiwan. A former OED evaluator is even more pointed: "A more specific technical reason for poor system performance ... has been the tendency to use successful desert irrigation technology in tropical monsoon climates."[35]

These observations are consistent with OED's evaluation record. With only one exception,[36] it is in the Asian humid tropics that recent

(Box 7.2 continued)

canal patrol. Korean team-building sometimes goes to great lengths, including team prizes for charity work, interunit team sport competitions, and Friday morning group calisthenics.

Interaction with irrigators is different too. Water charges, according to Wade (p. 49), are the focal point of that interaction: "An organization will ... pay particular attention to the source of its revenues .... Indian irrigation departments tend to pay particular attention to the state treasury and those who can influence its spending decisions. The Korean <irrigation units> tend to be more oriented to farmers for their operating costs and salaries come mostly from user fees." The Korean bureaucracy awards money prizes to irrigators of units that pay quickly. Canals are state property in both countries but Korean farmers view them as partly "theirs." They contribute labor to canal maintenance, which is done by the department; in India, maintenance is normally contracted to private entrepreneurs. Irrigators who depend on canals have little sense of ownership.

a. Robert Wade, "Public Bureaucracy and the Incentive Problem: Organizational Determinants of a 'High-quality Civil Service,' India and Korea," unpublished paper, World Bank, 1994.

b. John Page et al., *The East Asian Miracle: Economic Growth and Public Policy*, New York: Oxford, 1993, pp. 14, 11.

irrigation impact evaluations and audits have found inappropriate design in rice projects.

A brief digression is in order here to explain *why* the importing of design from drier regions should prove to be a problem in South and Southeast Asia.

Why rice irrigation is different

The purpose of most of the world's irrigation is to help grow more rice (Oryza sativa), the preferred staple of over half the planet's human population. The rice plant is unique among irrigated plants in two respects. Its roots do not need to take oxygen from air pockets in the soil so that, unlike most other useful plants, it thrives on waterlogging. And it needs much more water to thrive than almost all other major irrigated crops. The following estimated crop water requirements—in this case, what would permit plants to thrive in "average" Asian irrigated conditions—show the unique place of rice:

Approximate average water requirements in Asia for major irrigated crops[37]

Crop	*mm/hectares/crop*
Paddy (transplanted)	1,240
Sugarcane	1,600
Cotton	750
Sugarbeet	650
Vegetables and annual fruits	450
Other grains	330[38]

It is not surprising that rice (and sugarcane and bananas) tend to be grown where water is cheap for farmers, and that that tends to be the case where water is plentiful. These characteristics are the most important determinant of what kind of irrigation is practiced where.

There is a concentration of irrigation projects in humid, hot locales where rice is the predominant output. These accounted for 60 percent of the irrigation projects evaluated. More than

four-fifths of these are found in the area stretching from the humid eastern side of India eastward through Indonesia. The other 40 percent of evaluated irrigation projects—those where rice is not predominant—are spread over the drier parts of the developing world.

Traditionally, rice has been grown in hot climates where water is cheap and abundant. It is the only starchy staple that can withstand the great rainfall volume and intensity of these regions. Rice can be flooded. Flooding is not essential for good crops, but it reduces weeding. Therefore, the design and operation of a rice-growing irrigation system is fundamentally different from that for other crops. Wheat, maize, and especially cotton will die if their soils do not dry periodically so that the roots can get oxygen from air. Seckler has argued[39] that rice irrigation systems are unique in that they do not require management—indeed, that management only makes them worse. This is an exaggeration, but not by much. What is wanted is enough water to keep the plant wet all the time.[40] A small, constant flow will do. Field-to-field irrigation is acceptable because a down-catchment farmer will use what an up-catchment farmer wastes. Such arrangements are quite common in highly sophisticated systems in the highly subsidized rice sectors of Japan and Korea.

In short, given rice's characteristics, it is not surprising that irrigation systems designed for other crops do not suit it very well. And if there are problems with attempts to use nonrice systems to irrigate rice, it is not surprising that they are concentrated in humid, tropical Asia, where most of the world's rice is grown and where most of the Bank's irrigation lending has taken place.

OED's paired impact evaluations

In a precursor to this review, OED commissioned field surveys of paired large-scale surface irrigation projects in two humid, tropical locations in the Philippines and Thailand, and in two arid, subtropical locations in Mexico and Morocco. On the basis of these field surveys, OED impact evaluations were prepared.[41] The Mexican and Moroccan systems are quite different in their level of sophistication. The Moroccan system has above-ground concrete field channels and an elaborate system of water control and allocation; the Mexican system has ground-level, mostly unlined canals and simple, old-fashioned up-and-down gates. The Moroccan system was more expensive per hectare than the Mexican system.

Both systems were found to be effective; both delivered water more or less as they had been designed to. In both cases, farmers trusted the systems and intensified their cropping and their use of inputs accordingly. Their farming options without irrigation were unattractive. They did not grow rice; there was not nearly enough water for everyone to grow rice, and water allocation was pretty much as planned. In other words, no favored few stole water from their neighbors in order to grow rice.

The Philippine and Thai systems were low-technology systems by current standards in France, Israel, Japan, or the United States, but represented a large advance over existing systems in those monsoon areas. The upgraded systems replaced field-to-field rice irrigation with gravity service, which required canals high enough to command the farm land. Much of their anticipated benefits were expected to come from providing water in the dry season, which large reservoirs made possible.

Both systems were relatively ineffective. Operation and maintenance broke down, and equity problems developed as head-enders took more than their share. Dry-season irrigation has become limited to fields close to canals in the head reaches. All of these phenomena are

characteristic of many large systems in the humid tropics.

Evidence from the OED paired impact evaluations tends to confirm the Cornell thesis. Farmers and irrigation agencies in arid areas tend to make their systems work, whether they have sophisticated or basic technology. Large, public, rice-growing irrigation projects in the humid tropics develop major operational problems. Their design is inappropriate, and their social organization has not had time to grow from the bottom up. Water deliveries are a far cry from what they were designed to be. Farmers vandalize the system to get water.[42]

Recent OED audits

A number of OED audits, mostly conducted since the paired impact evaluations, have sought to explore the ideas that the data from these impact evaluations raise. These audits confirm the impression of design problems in large, public, rice-irrigation schemes in South and Southeast Asia. The problems they find fall into three clusters. Evidence from these audits and from other studies is presented below, along with some possible solutions suggested by the audits and by other research.

The rice deltas. Anyone who has flown over the Mekong Delta when the river is in spate realizes that water is quite available. Even in the "dry" season, topography is so flat that drainage is difficult. Canals function as much to carry water away from rice fields and for transport as to get water to the rice fields. The same observations apply in varying degrees to the deltas of the Red, Chao Phya, Irriwadi, Ganga-Meghna-Brahmaputra, Mahanadi, Godavari, Krishna, and Kauveri rivers.

OED's 1989 and 1990 audit of five Thai projects[43] found that the design introduced into the flat Chao Phya plain was quite probably inappropriate. By a system of dams and canals, the historic Chao Phya system was to be changed so that water could be delivered to farms by gravity—from river flow during the monsoon season and from storage in the dry season. A critic echoes the 1989 audit:

> *The near obsession of canal engineers with commanding the fields and avoiding pumping is only understandable if the system is a non-over-extended desert system in contiguous operation, and the innovations of pumping technology in the last forty years are ignored. An overextended canal system on high fills, much of which is used only during an occasional wet season drought, is very difficult to justify economically.*[44]

Resolving the economic argument would require further study. Without a doubt, however, this system is not working as planned.[45] It is easy to see the irrigation pattern. During the dry season, crops are cultivated along the major canals, which are used as reservoirs by farmers, who lift the water the short distance to their fields using axial-flow pumps. The land not within pumping distance of canals is left fallow. During the wet season, rice is cultivated everywhere. Canal water is helpful during wet-season droughts and can be delivered by gravity but, at other times during the wet season, it is not needed.

The same critic suggests an alternative: a network of low-level canals, which take less farmland, from which farmers will have to pump water to save crops during wet-season droughts, and from which they will pump in the dry season, as they do now.[46] Such an alternative would be far cheaper but would forego irrigating land that a gravity-command system would irrigate. While this irrigation foregone would be great if the gravity-flow system worked as designed, it might not be so great in practice.

While there is probably no real prospect of removing existing high-canal systems in rice

deltas, the alternative at least merits study, especially because of widespread evidence that farmers in other delta rice systems spontaneously use low-lift pumps in an unplanned manner to overcome shortcomings in gravity systems that are unable to meet their demands. This is certainly the case in Ecuador, Malaysia, Thailand, Vietnam, and probably elsewhere as well.[47]

One of the Bank's irrigation success stories involves a humid, tropical, Asian rice-growing delta where the Bank and the borrower have agreed on irrigation systems that involve more pumping and less gravity-feed. The Bangladesh Chandpur polder scheme was originally designed to have a conventional gravity system, but when construction started in the 1970s, farmers refused to give up their land for canals. The project was redesigned to provide water by pumping from improved drains within the polder, which has proved quite successful.[48] Despite interest from the borrower, the Bank did not become involved in the Ganga Kobadek project, which, like Chandpur's original design, involved more gravity distribution. Ganga Kobadek has failed to provide benefits.

Not only did the Bank wisely avoid large gravity-distribution irrigation projects in Bangladesh, but it channeled a large portion of its lending into financing shallow tubewells. OED's impact evaluation of Bangladesh Shallow Tubewells Project (Credit 724)[49] found that this was such a high-return activity in economic and financial terms that investments would have been made even without Bank involvement, but for one thing. Bank involvement supported those forces in Bangladeshi society that favored deregulation and privatization of tubewells. This led to reforms without which the spectacular growth of tubewell development would not have taken place. This development has produced most of Bangladesh's recent agricultural growth.[50]

Tertiary canals and on-demand water. Many of humid tropical Asia's large public irrigation schemes were massive and yet technically minimal when they were first built. In the last 20 years, substantial Bank lending has gone into "completing" these schemes by increasing their degree of reticulation and making it possible to vary water deliveries in response to farmer demand. This design tendency has been criticized and competing design visions advanced.

Before World War II, the irrigation systems along the Malacca Strait consisted of gated sea walls and channels that were simultaneously intended for adduction and eduction.[51] In what is now Pakistan and northwest India, gravity systems "spread" water, providing a flow of 0.28 liters/second and fixed irrigation turns long enough to irrigate only 20-to-30 percent of the cultivable land in wet season and 35-to-45 percent in dry season. Canals brought water to large "chaks."[52] When the Mae Klong gravity canal project was built in Thailand and the Muda River Scheme was built in Malaysia, water was spread through main canals and secondaries.[53] None of the designs of these systems envisaged customized response to the irrigation demands of individual farmers nor delivery of water to individual plots. Farmers were expected to do the best they could with what the system provided—that is, to adjust their *crops* to the available *water.*

These systems came to be considered incomplete. The Malaysian Drainage and Irrigation Department based its vision largely on Japanese systems, which are designed to grow paddy and therefore to deliver a small stream of water more or less constantly. Completion involved separating canals from drains and expanding the network to tertiary canals and turn-outs to individual farms. This philosophy was implemented with Bank assistance in a series of projects along the west coast of Peninsular Malaysia, notably Barat Laut Selangor, Sungei Manik, Trans-Perak, Krian,

and Muda II.[54] The "completion" of Mae Klong involved the installation of a system of tertiaries and on-farm investments, ignoring the fact that farmers had already completed the system by finding their own ways to compensate for the system's shortcomings:

> *Twenty-five percent of the project area was already being irrigated with low-lift pumps in the dry season to produce a high-yielding rice crop. Nothing was made of this spontaneous use of an appropriate technology except to assume that it would be displaced by a free gravity canal system.*[55]

Bandaragoda and Garces-Restrepo explain the philosophy behind changing the Lower Swat and Chasma Right Bank canals in Pakistan "from the traditional approach of 'protective' irrigation to that of 'productive' irrigation." Water duties were substantially increased, and channels and outlet structures were redesigned to "permit more appropriate matching of water deliveries to crop water needs" so that optimum productivity levels could be achieved.[56]

The Pakistani case is an example of an attempt to "complete" a classical warabandi system so that it would give on-demand irrigation service equivalent to that given by a tubewell with adequate groundwater (but without the pumping costs). This example from a non-Bank project is from a wheat-dominant irrigation mode and therefore, while analogous to the problem cluster, is not strictly comparable. More common is the attempt to introduce more "complete" systems in rice areas, as illustrated by the Nagarjunasagar complex in India's Andhra Pradesh.[57] Traditionally, irrigation in Andhra means rice. The system was designed, however, to supply lower doses of water sporadically at higher rates to areas of light alfasols that were "zoned for irrigated dry"—that is, nonrice crops were to be grown and the system was built accordingly. Before the huge system was completed, however, large amounts of water were available to canals in the completed head reaches. Farmers who were not meant to grow rice did so. But the system was not meant to supply water for rice, and when structures got in the way of rice-growing, farmers broke them. Operations are chaotic. Today, the completed areas are consuming far more water than intended, so that large areas commanded or that will be commanded by canals in the lower reaches will receive no water. The most extreme example of "completing" a rice irrigation system is India's sophisticated, gravity, piped-distribution system—Kallada Irrigation and Treecrop Development Project.[58] While it is too early to make a definitive judgment on the appropriateness of this project's design, which is unique, it appears that it is more sophisticated and costly than the benefits warrant.

The designs of this diverse group of projects had in common a desire to meet individual demands (as a tubewell with an adequate aquifer does) by increasing the projects' degree of reticulation, the rate at which they deliver water, by making water delivery intermittent, and by increasing drainage. These are all the things needed to irrigate crops other than rice. The impulse to permit diversification out of rice is quite reasonable in this era of low and falling rice prices, but all of these projects were unsuccessful. They were unsuccessful in a way that has contributed to the impression that all large gravity systems in the humid tropics degenerate into operational chaos, often accompanied by vandalism of the structures and illegal arrangements between some irrigators and public system operators.[59]

Competing design visions. There are different design concepts on how to resolve this systemic problem, which may be somewhat oversimplified as follows:

> *One sul group sees the problem largely as one of the hydraulic instability of extensively-gated manually operated systems and sees the solution*

as being the modernization of these systems with automatic downstream control structures and other feedback mechanisms designed to achieve hydraulic stability. The other sub group of design engineers has accepted the reality of farmer damage in wet season drought and gone to the cruder and more robust 'structured' design, giving up on the possibility of just-on-time <on demand> delivery of water to crops in the hopes of preserving the civil works.[60]

The advocates of what might be called the *crop-based* or *demand-driven* solution (in which the amount of irrigation water delivered is tailored to crops farmers choose to grow) are aware that more than hydraulic instability is involved, but they believe that creative engineering can solve the social problem. They are quite aware, in a world of low rice prices, of the need to diversify out of rice. If farmers on adjacent plots are to grow rice and chilies in the same season, neither the traditional, low-reticulation, field-to-field paddy systems nor the water-spreading warabandi systems will do.[61]

The crop-based solution is based on engineering innovations that will permit large, centrally managed systems to deliver water by gravity when, where, and in the quantities that farmers demand.[62] It is a *water-to-crops* system. The quality of such on-demand service would give farmers' the equivalent of their own tubewell and enough water in the aquifer to supply their demand. In efficient surface systems, water would be cheaper than in comparable pump systems, and farmers could optimize their cropping subject to other constraints (land, labor, investment resources) because the water constraint would have been broken.

Demand-driven, crops-based advocates argue that the evolution of the world economy points toward the need for their type of solution. Economic progress constantly increases the role of trade and the demand for high-value crops at the expense of staples. Plant science produces new and better varieties that always have more precise water requirements than their predecessors. Population growth and resulting demand inexorably lead to higher input use and agricultural intensification. The agriculture that survives in the twenty-first century will have to be more precise and better able to adjust to market shifts than is the case today. Therefore, irrigation systems limited to suboptimal service or that inhibit farmers from switching crops to adjust to markets are becoming obsolete. The solution lies in bringing engineering ingenuity to bear so that centrally controlled systems can respond to individual demands.[63] Some of their favorite devices for doing so are downstream-controlled regulators, flow dividers, crested weirs and other modular distributors, and central control.

What impresses the advocates of what may be called a *water-based* or *supply-driven* solution (in which farmers tailor their cropping to irrigation water delivered) is the poor performance in practice of crop-based, demand-driven systems. One Bank paper, referring to the west and south Indian practice of "sanctioning" crops, then supplying them with water, argues:

Field experience of demand systems where cropping patterns are agreed and approved has generally been poor: there are opportunities for corruption in deciding who is sanctioned to grow what area of which crops; the resulting demand pattern is complex and difficult to meet; since the farmer is entitled to the water to meet the needs of the crop, a vicious circle of under-performance is invoked, where the authorities will tend to plan for lower irrigation intensities, which are easier to meet, rather than set demanding targets; farmers become lax and wasteful in their irrigation practices, safe in their assurance of 'enough' water to grow the sanctioned crop.[64]

Some partisans of this camp maintain that while it may be possible to meet demands in a large surface system where individual farms

are big, as in California, it is impossible to plan and execute the many gate operations needed to deliver tailor-made slugs of water to individual farms while maintaining hydraulic stability in the canals where the farms are small, as they are in most developing countries. Others maintain that such a system is impossible for reasons of human organization:

> *The technology certainly exists but the human institutions in pluralistic societies do not. Something more consistent with physical and organizational reality needs to be considered.*[65]

The supply-driven solutions (which bear a variety of names, including "warabandi" and "structured system") invariably involve providing less water than farmers would demand and providing it on a predetermined schedule, so that *crops* are adjusted to *water* supply. By giving farmers little say about water supply, the system can be simplified and, at lower levels, made automatic. Because there is little discretion, collusion between head-end irrigators and canal officials is minimized. Most would acknowledge that such a system is suboptimal. They argue, however, that the cost in crops not produced because farmers have less freedom to optimize cropping is more than offset by the fact that such a system is manageable[66]—that pre-determined water delivery schedules can be met with a high degree of certainty, so that farmers can bank on getting irrigation water at specific times and plan accordingly.

Inconclusive evidence. It is beyond the scope of this review to compare and assess the merits of crop-based, demand-driven systems and water-based, supply-driven systems. The most this review can do is point to a small amount of field work that is beginning to shed light on the question.

A difficulty for the demand-driven camp is that no large gravity system serving small farms in the humid tropics as yet incorporates the modern design features advocated (such as automatic down-stream controls). No large gravity system in that area has yet succeeded in delivering on demand to small farmers growing a variety of crops. An experiment to explore the possibilities was built into the Kedung Ombo project in Indonesia[67] but, regrettably, implementation of this experiment has been faulty.

The water-based, supply-driven camp can at least point to a large working example of what it advocates, the almost 15 million hectares of systems in the Indian and Pakistani Punjab and adjacent areas designed according to Lacey's 1930s 'Regime Theory' and now known as warabandi (fixed turn) systems. Over large areas, warabandi works; it delivers water when and where it is supposed to; tail-enders get most of the water they should get most of the time. This is known because of the influential research of a group of scientists who actually measured what happened in the field on the Phabra distributary of the Second Main Bhakra Circle near Hissar, Haryana, India in 1981–82.[69]

Since then, debate has focused on how far short of optimal warabandi is and on the geographical limits of the area in which it can work well. While it has been officially recommended for adoption in all areas of India for over a decade, most observers doubt its appropriateness outside the arid and semi-arid areas where scarcity can be imposed by design. In fact, almost all attempts to foster the use of the warabandi system outside of its traditional area have failed.[69]

Recent publication of the field research findings of IIMI scientists conducted on four distributaries of the Lower Chenab Canal in the Pakistani Punjab in 1987–89 shows that warabandi may fail to work even in its core region.[70] The operational chaos and creative modification of the system by head-enders documented by IIMI recall the shortcomings of demand-based systems.[71]

Field research in 1991 on 24 sample chaks of the Bhakra Main Line and Barwala-Sirsa Systems near Hissar, Haryana, India,[72] combined with modeling of cropping alternatives, demonstrate that the sacrifice involved in accepting the warabandi system's rigidities vis-à-vis a crop-based on-demand system is either minimal or nonexistent, depending on the rains.[73] This research also shows that farmers under warabandi conditions practice deliberate underirrigation to make the best use of rationed water.[74]

This research is clearly only the beginning of what it will take to discover operational solutions to this design problem. Meanwhile, however, areas of consensus are beginning to emerge between the competing design visions. There is consensus on the need to eliminate anarchy and on the importance of flexibility, which can be added to supply-driven systems through pumping.

Run-of-river schemes in steep catchments. In many parts of the humid tropics, the mountains almost meet the sea except for a narrow coastal plain where rice is grown. Rivers are short and steep until they enter the coastal plain, where they are diverted to help rice-growing by preventing damage from wet-season droughts and also growing a second crop on a small area as river flow permits. Topography makes storage reservoirs uneconomic. Such conditions prevail along much of the coast in the Philippines, Vietnam, Java, and some other Indonesian islands. Individual schemes are usually of modest size (1,000 to 5,000 hectares) but the total area of such schemes is large, though not on the scale of rice-growing in the major deltas.

OED audits have criticized the design of projects in Indonesia and the Philippines designed to improve rice irrigation under these topographical circumstances.[75] Without adding reservoirs, these projects invested heavily in cross-regulators and in a more articulated network of tertiary canals to improve water delivery. The payoff was expected to come mainly in the form of expanded dry-season cropping.

The audits found that the payoff did not materialize. Without storage, these run-of-river systems could only expand dry-season cropping by spreading roughly the same amount of water over a greater area. Land now being irrigated in dry season would have to get less water to provide some for the expanded area. Established dry-season irrigators were only willing to accept that solution if greater efficiency could be achieved, such as wasting less water or getting the same output with less canal water by improved control and timing. The audits found that the sophistication and social cohesion needed to make this kind of operation possible were lacking. In fact, canals were allowed to run full when river flow permitted, except under flood conditions. The systems and their gates were barely operated at all. Farmers often plowed over project-financed tertiaries, which were of no value to them. The audits do not offer a solution to this design problem except to suggest that greater community cohesion would be needed to make the systems work as designed.

Research conducted by the Institute of Philippine Culture (IPC) shows that it is possible to create such cohesion. Over half of the irrigated area in the Philippines is under nongovernment managed systems, usually of 4,000 hectares or less.[76] The National Irrigation Administration (NIA) has assisted about half these systems to upgrade. NIA is also involved in a program of enhancing irrigator participation and in turning over functions to them. IPC picked 46 communal systems being upgraded by NIA between 1981 and 1983, 24 of them with irrigator participation[77] in design, construction, and subsequent management, and 22 without it.

There were significant differences, with the participatory systems realizing exactly the kind of results anticipated by the appraisals of the

projects mentioned above, while the nonparticipatory systems realized results similar to those found by the audits. Four salient facts will illustrate the difference. While both participatory and nonparticipatory groups expanded irrigation by about the same amount in the wet season (18 percent and 17 percent respectively on average), participatory systems expanded dry-season irrigation by 35 percent, roughly double the 18 percent for nonparticipatory systems, all without increased access to water. Participatory systems' average paddy yields rose 7 percent in wet season and 21.5 percent in dry season, while those of nonparticipatory systems rose 2 percent and fell by 1 percent, respectively. Fifty-eight percent of participatory systems used rotational distribution in dry season vs. 36 percent for nonparticipatory systems. On participatory systems, 9 percent of NIA-built canals were abandoned by farmers, compared to 18 percent on nonparticipatory systems.[78]

The figures presented above show that the participatory systems were achieving what the audited projects were meant to achieve, but did not. The participatory groups were more likely to be actually operating their systems, most notably by practicing rotation in dry season and spreading the water over a greater area without harming any farmers because less water was wasted. Better system operation even meant that results were a little better in the wet season, even though size of the irrigated area did not change. And the systems were a little better built, thanks to local knowledge. This evidence shows that an inappropriate design can sometimes be made appropriate with the right changes in social organization.

The two most salient themes that emerge from OED's irrigation evaluations pertain to irrigation as a whole: its sociological, agricultural, engineering, and economic dimensions. One appears to be rooted in social organization and may have a "behavioral" solution; the other appears to be an engineering problem with possible engineering solutions. And yet, as noted above, the two are inextricably intertwined. The following seems appropriate:

> *Which is more important for better management of irrigation water: organizational improvements in water users' organizations ..., or improvements in water conveyance structures? This question may be equivalent to asking a person whether his left or right leg is more important.*[79]

Notes

1. It is important to remember, however, that, because the amount of water available to any system will vary from year to year, every system must have an area that bears the brunt of fluctuations in supply. *Some* irrigators in one or more areas must absorb them by getting irregular water deliveries—a lower level of service. In warabandi systems, this "tail"—that is, the area bearing the brunt of irregular deliveries—is spread among all irrigators.

2. See, for instance, OED Report Nos. 9716, June 1991 (audit of India's Karnataka Irrigation Project, Credit 788; Gujarat Irrigation Project, Credit 808; Second Maharashtra Irrigation Project, Credit 954; Subernarekha Irrigation Project, Credit 1289; and Andhra Pradesh Irrigation and Command Area Development Project, Loan 1251) and 9909, September 1991 (audit of India's Orissa Irrigation II Project, Credit 1397). Some of these projects already have serious operational problems because head-enders are taking more than their allotted share, depriving the tail-enders of irrigation water. The Andhra project is the prime example. In the other cases, head-enders are exceeding their allocations, but tail-enders have not felt the problem yet because the canal network is not yet complete. It is apparent in each of these cases, however, that overirrigation at the head will have drastic, deleterious operational consequences once the network is completed. A similar problem is raised in OED Report No. 9993, October 1991, audit of Vietnam's Dau Tieng Irrigation Project, Credit 845. In very humid, tropical Vietnam, the audit warns that overirrigation at the head-reaches and failure to operate the system as designed (not appraisal design in this case since this project was barely designed at that stage) will curtail water available for Ho Chi Minh City and for tail-enders, and may lead to waterlogging at head-reaches to the extent of destroying the hardpan and making animal traction impossible.

3. See the PCR (OED Report No. 10698, June 1992) for Myanmar's Kinda (Nyaunggyat) Dam Multipurpose Project, Credit 1031. There is not enough water to irrigate most of the command. The PCR maintains that Myanmar has suffered an unprecedented drought and that higher rainfall will return, fill the reservoir, and permit design irrigation to be carried out. Independent observers doubt this explanation and suspect that river flows were

seriously overestimated. OED has not yet audited this project, which is currently rated "satisfactory" and which would probably retain its satisfactory rating on the basis of its power benefits even if the worst fears about long-run water availability are confirmed.

Another highly satisfactory project in which river flows were overestimated is the Muda project in Malaysia. See OED Report No. 1295, September 1976 (audit), and OED Report No. 3587, August 1981 (impact evaluation) on Malaysia's Muda River Irrigation Project, Loan 434; and OED Report No. 9714, June 1991 (audit), on Malaysia's Second Muda Irrigation Project, Loan 1717. While mis-estimation of river flows means there will never be enough water to fully irrigate a second crop, and while the intensifications in Muda II did not pay, the basic project is an example of what irrigation can do. Even the highly critical impact evaluation admits that equity improved and that all social groups are better off as a result of the project.

4. An example is OED Report No. 9714 (audit) on Malaysia's Krian-Sungei Manik Integrated Agricultural Development Project, Loan 1632.

5. See, for example, the discussion in OED Report No. 10669, May 1992 (audit), on Philippines's First and Second National Irrigation Systems Improvement Projects, Loans 1414 and 1526. Without storage capabilities, cross-regulating gates were virtually useless and are simply left open whether there is water in canals or not. A similar situation seems to exist in many of the subprojects covered by OED Report No. 7956, June 1989 (audit) on Indonesia's X, XIV, and XV Irrigation Projects, Loans 1578, 1811/Credit 995.

6. See especially OED Report No. 8494, March 1990 (impact evaluation) on the Philippines' Aurora-Peñaranda Irrigation Project, Loan 984 and Credit 472; Thailand's Northeast Thailand Irrigation Improvement Project, Credit 461; and Second Northeast Thailand Irrigation Project, Loan 1630. Poor maintenance led to erratic water delivery, declining willingness to pay water charges, and declining collections.

7. OED Report No. 6283, June 1986.

8. Of the 200 projects in the irrigation evaluation sample that involve works and can be classified, 18 percent (36) are purely rehabilitation projects and another 32 percent (64) are partly rehabilitation. Of course, the distinction between "rehabilitation," which is the consequence of inadequate maintenance or catastrophe and is designed to restore a prior level of service, and "upgrading" or "improvement" to raise the level of service is not clear. India's National Water Management Project, Credit 1770, approved March 1987, for example, is neither new construction nor rehabilitation; it is based on the proposition that application of engineering to *existing* irrigation systems will yield cost-effective measures that upgrade the level of service.

9. OED Report No. 6283, "World Bank Lending Conditionality: A Review of Cost Recovery in Irrigation Projects," June 1986, p. 4, para. 2.03.

10. For a recent presentation of the classical argument, see Rajan K. Sampath, "Issues in Irrigation Pricing in Developing Countries," *World Development* 20, July 1992, pp. 967–977. Ultimately, the author is able to bring himself to concede (p. 975) that one way to improve performance is "to separate the operation and maintenance part of the irrigation projects from the fiscal budget of the government and require the irrigation agencies to generate their own O&M budget from the sale of irrigation services," all of which requires water users' organizations that would collect fees and interface with the irrigation bureaucracy.

11. Mark Svendsen, *Meeting Irrigation System Recurrent Cost Obligations*, ODI/IIMI Irrigation Management Network Paper 86/2b, London: ODI, August 1986, p. 5.

12. A point made in the Pakistani context by OED's forthcoming audit of Pakistan's Agricultural Sector Adjustment, Loan 2986, approved August 1988. However, in circumstances where absence of linkage between irrigation water charges and O&M is critical, many OED audits have not made that point. See, for example, OED Report No. 11381 (audit), on Turkey's Agricultural Sector Adjustment, Loan 2585, approved June 1985.

13. Svendsen, op. cit., p. 6.

14. These arguments are not original but are borrowed, for the most part, from Leslie E. Small, *Irrigation Service Fees in Asia*, ODI/IIMI Irrigation Management Network Paper 87/IC, London: ODI, April 1987, and from Christopher Perry's unpublished memorandum to Bevan Waide, February 7, 1984.

15. OED Report No. 6283, p. 8, para. 3.06.

16. Ibid., p. 8, para. 3.05.

17. Ibid., p. 7.

18. Leslie E. Small, Marietta S. Adriano, and Edward D. Martin, *Regional Study on Irrigation Service Fees: Final Report*, Digana: IIMI, 1986. This study is more accessible as: Leslie Small et al., *Financing Irrigation Services: A Literature Review and Selected Case Studies from Asia*, Colombo: IIMI, 1989. The authors relied, inter alia, on extensive interviews with World Bank irrigation staff.

19. See, for instance, the situation encountered by an OED audit team in the Dumacaa project in Quezon Province of the Philippines. The irrigators on a distributary, to whom "ownership" (including O&M) had been devolved, asked the local branch of the National Irrigation Administration to take the job back. They were happy to pay but preferred to have an outside, presumably professional, party tell them what O&M had to be done and when. NIA resumed these functions to everyone's satisfaction. Report No. 10669, May 1992, the Philippines' NISIP I & II Projects, Loans 1414 and 1526.

20. See Svendsen, op. cit., pp. 7–9 or Walter E. Coward Jr. and Norman Uphoff, "O&M Costs in Irrigation: Reappraising Government and Farmer Responsibilities and Rights," unpublished paper prepared for the USAID/Asia Bureau Regional Conference for Agricultural and Rural Development Officers, Los Baños (Philippines), April 22–26, 1985.

21. This result may only serve to highlight the uncertainty of evaluation judgments. Experts suggest that satisfactory users' groups probably affect O&M positively and will lead to better long-term economic results with rehabilitation avoided.

22. Major dams, major headworks, and major canals are truly public utilities and generally serve purposes other than irriga-

tion (power generation, flood control, navigation). For that reason, it would be inappropriate to devolve O&M of Miguel Aleman, Sidi Salem, Tarbela, or Dau Tieng to groups of farmers who happened to be cultivating with water from their reservoirs.

23. Ruth Meinzen-Dick and Michael M. Cernea, "Design for Water User Associations: Organizational Characteristics," unpublished World Bank paper, September 12, 1991, intended as a chapter in "Building Organizational Capacity for Irrigation and Water User Associations in World Bank Projects," still under preparation. The paper examines SARs of irrigation projects approved in fiscal years 1975, 1984–86, and 1990.

24. See especially Shui Yan Tang, *Institutions and Collective Action: Self-governance in Irrigation*, San Francisco: Institute for Contemporary Studies Press, 1992, and Elinor Ostrom, *Crafting Institutions for Self-governing Irrigation Systems*, San Francisco: Institute for Contemporary Studies Press, 1992. The former is closer to the case studies; the latter, to generalizations and theory. The bibliographies of these books are a good entry point into the published material on irrigators' groups. They are a product of the USAID Decentralization: Finance and Management Project being carried out by Associates in Rural Development, the Indiana University Workshop in Political Theory and Political Analysis, and others.

25. Ostrom, op. cit., pp. 67–76, Chapter 4, "Design Principles of Long-enduring, Self-organized Irrigation Systems."

26. Devolution started with the "communal" systems, traditional systems that have always been user-run but about half of which had been "assisted" by NIA. The best source on restoring these systems to full user control is Frances F. Korten and Robert Y. Siy (eds.), *Transforming a Bureaucracy: The Experience of the Philippine National Irrigation Administration*, West Hartford: Kumarian; Manila: Ateneo de Manila University, 1988. NIA now has a Management Turnover Program (MTP) for the 162 "national" systems, the larger, public irrigation projects serving 645,789 hectares. As of mid-1992, systems covering 68 percent of the service area were in MTP; those covering 49 percent had organized their irrigators' associations; and those covering 2 percent (12,032 hectares) had reached a Type III or Stage III contract where they are actually fully turned over. See NIAConsult Inc., "Proposed Study on NIA's Development of the Management Turnover Program (MTP) in the National Irrigation Systems," unpublished proposal submitted to the International Economic Relations Division, Operations Policy Department, the World Bank, June 22, 1992, p. 2.

27. OED's Report No. 8494, March 1990, impact evaluation on the Philippines' Aurora-Peñaranda Irrigation Project, Loan 984/Credit 472, deals with decentralization, O&M, and water charges. At the time, O&M was far from fully devolved; water users' associations were being given incentives to pay up on their water charges. When NIA-executed O&M broke down, tail-enders ceased to get canal water and ceased to pay water charges. The impact evaluation report's map of the "happiness index" of irrigators shows a pattern of deliveries radically different from the design pattern.

OED's Report No. 10669, May 1992, an audit of the two Philippine NISIP projects, focuses on other problems. It does, however, note with approval NIA's decentralization, devolution of functions, and encouragement of users' association autonomy (noting, however, that users sometimes prefer to delegate responsibility back to NIA—see the Dumacaa experience and endnote 19 above).

28. On Indonesian developments, see Jan L. Gerards, Birong S. Tambunan, and Bachtiar Harun, "Payment for Irrigation Services in Indonesia: Creating Mutual Accountability through Participation and Voice; Experience with Pilot Project Introduction (1989–1991)," paper B42 from ICID Eighth Afro-Asian Regional Conference, Bangkok, 1991, and for the World Bank role in O&M developments, see Sushma Ganguly, "Indonesia: Subsector Approach/Time Slice of an O&M Program," paper presented to World Bank Eighth Annual Irrigation and Drainage Seminar, Baltimore, December 1991. Unpublished material suggests, however, that public authorities are, in fact, not devolving qualifying systems as per plans and that significant lessons learned in the Philippines are not being applied in Indonesia.

On Mexican developments, see José L. Trava, "Transfer of Management for Large-scale Irrigation Districts to WUAs in Mexico," paper presented to World Bank Eighth Annual Irrigation and Drainage Seminar, Baltimore, December 1991. On Nepali developments, see Richard Reidinger and Upendra Gautam, "Promoting Private Irrigation Development: The Irrigation Sector Program Experience in Nepal," Irrigation and Drainage Session Proceedings of Water Forum, American Society of Civil Engineers, Baltimore, August 2–6, 1992. On Turkish developments, see Joma M. Mohamadi's unpublished aide memoire of Bank supervision mission, Turkey: Drainage and On-Farm Development Project, Loan 2663, April 1994.

29. For a description of developments, see Ashraf Hussain and Petros Aklilu, "Public and Private Irrigation Development: Pakistan Experience," paper presented to World Bank Third Annual Irrigation and Drainage Seminar, Annapolis, December 1986. Financing of the program started with Pakistan SCARP Transition Project, Credit 1693, approved May 1986, an OED audit of which is forthcoming, and has continued with other IDA-financed projects.

30. The best comprehensive discussion of devolution of irrigation systems is D. L. Vermillion, "The Turnover and Self-management of Irrigation Institutions in Developing Countries," unpublished discussion paper, Colombo: IIMI, June 1991. Also by same author, see "The Transition to Self-managing Irrigation Institutions in Developing Countries," unpublished paper presented at Common Property Conference, University of Manitoba, Winnipeg, September 26–29, 1991.

31. See Barker, Coward, Levine, and Small, op. cit., pp. 2–3 for summary of problem, and pp. 6–21 for evolution of Asian irrigation, and pp. 25–29 for description of the resultant dualistic structure.

32. Ibid., p. 7.

33. Ibid., p. 45 inter alia. The authors emphasize the importance of developing behavioral norms not just for irrigators but for the irrigation bureaucracy as well.

34. Ibid., pp. 35 and 48 respectively.

35. Robert Burns, "Irrigated Rice Culture in Monsoon Asia: The Search for an Effective Water Control Technology," *World Development* XXI, May 1993, pp. 771–789. Here, "desert irrigation technology" refers to control of surface water systems, not to desert on-farm water-saving technologies, such as drip or sprinkler.

36. See OED Report No. 7543, December 1988, Yemen's Second and Fourth Tihama Development (Wadi Rima) Projects, Credits 805 and 978.

37. The "average," obviously, covers a wide range depending on rainfall and humidity at the relevant times of year, soil water-holding characteristics, wind, variety of crop grown, husbandry methods, and more. The figures below are adjusted estimates based on four sources: *Irrigation Agronomy in Monsoon Asia*, FAO, 1971; *Crop Water Requirements*, FAO Irrigation and Drainage Paper 24, 1977; *Yield Response to Water*, FAO Irrigation and Drainage Paper 33, 1979; and *Management of Irrigation Water*, Waltair: Andhra Pradesh Agricultural University, 1976.

38. Obviously, total water requirement per crop is only the crudest indicator. Irrigation system design requires knowledge of crops' preferred timings of water. Paddy, an aquatic or semi-aquatic plant, prefers constant humidity—flooding except around germination and tillering; hence, while total water use is high, design rates of delivery will be low. This water regime would kill the other principal irrigated plants that depend on periods of soil drying when they can take oxygen from soil air pockets. Sugarcane's water requirement is spread over 12 months; that of vegetables and some grains over as little as three months. Species, even closely related ones such as maize and sorghum, differ widely in tolerance to water stress. Water stress affects yield of a single species very differently at different points in the plant's life cycle. These factors and others, including rainfall probabilities and soil moisture-holding characteristics, affect or should affect design and design duty of irrigation systems.

39. David Seckler, "The Management of Padi Irrigation Systems: A Laissez-Faire Supply-Side Theory," *The Management of Padi Irrigation Systems—A Debate*, ODI Irrigation Management Network Paper 11b, London: ODI, May 1985, pp. 2–10.

40. While rice, alone of the staples, will survive continuous waterlogging, it will do far better if, after keeping soil saturated during the growth cycle, the field is drained 15–20 days before harvest (cf. in OED Report No. 9714, June 1991, audit of Malaysia's Krian-Sungei Manik Integrated Agricultural Development Project, Loan 1632).

41. OED Report No. 7876, June 1989, Mexico's Rio Panuco Irrigation Project, Loan 969, and Rio Sinaloa Irrigation Project, Loan 970, and Morocco's First and Second Doukkala Irrigation Projects, Loans 1201 and 1416; and OED Report No. 8494, March 1990, Thailand's First and Second Northeast Irrigation Improvement Projects, Loan 1630/Credit 461, and the Philippines's Aurora-Peñaranda Irrigation Project, Loan 984/Credit 472.

42. Here and for the rest of this chapter, the experience of humid, tropical, rice-growing, South and Southeast Asia is emphasized. This is entirely appropriate because (a) it is where both the world's irrigation and particularly the Bank's irrigation lending are concentrated, and (b) it is where most Bank and non-Bank irrigation has taken place. However, many of the lessons extracted from the South and Southeast Asia experience apply to other humid, tropical areas where irrigation is primarily for paddy: the north coast of South America (Guyana, two projects, Colombia, one project, Brazil, two projects); Madagascar (three projects); and West Africa (Cameroon, two projects, and to some extent Senegal, three projects, which, though arid, irrigates in a delta). They are less likely to be applicable for rice irrigation in temperate Korea (five projects) or savannah West Africa (Burkina Faso, Chad, The Gambia, Mali, Mauritania, Niger, eight projects).

43. OED Report No. 7935, June 1989, on Thailand's Phisanulok and Second Chao Phya Irrigation Projects, Loans 1149 and 1468, and OED Report No. 9205, December 1990, on Thailand's Eleventh and Twelfth Irrigation Projects, Loans 1787 and 2022.

44. Burns, op. cit., p. 16, para. 66.

45. Deltas, being flat, require drainage. It is difficult to build two hydraulic networks, one to bring water and one for drainage, in an area of slight gradient. Channels below grade can serve to supply and to drain

46. Systems that store water in below-field canals from which farmers pump over short lifts to fields are not confined to the humid tropics. For a description of how such a system works in Egypt, which is arid but has year-round water, see Nicholas Snowdon Hopkins, *Agrarian Transition in Egypt*, Boulder: Westview, 1988.

47. See discussion in OED Report No. 9714, June 1991 (audit), on Malaysia's Second Muda Irrigation Project, Loan 1717, and others. These very small, very low lift, axial flow pumps are also widely used in Vietnam, where they may have been invented by inverting an outboard motor propeller and placing it and the shaft in a casing. They were not in use in the Dau Tieng Project at the time of audit (OED Report No. 8239, December 1989) because the amount of canal water available was enough to supply that part of the command already developed at that time with more water than required in all seasons. Moreover, there was a severe shortage of fuel, lubricants, pumps, and spare parts in Vietnam at that time.

48. See OED Report No. 8805, June 1990 (audit), on Bangladesh's Drainage and Flood Control Project, Credit 864, and also Burns, op. cit., para. 70, p. 17.

49. See OED Report No. 11031, August 1992 (impact evaluation), on Bangladesh's Shallow Tubewells Project, Credit 724–BD.

50. The paired impact evaluation of the West Bengal well irrigation project just across the border is now in draft and will, when completed, provide interesting comparisons.

51. Described briefly in OED Report No. 9714, June 1991.

52. For the best description of these systems, see D. J. Bandaragoda and Carlos Garces-Restrepo, *Crop-based Irrigation in Pakistan: Initial Efforts in the North West Frontier Province*, ODI Irrigation Management Network Newsletter, London: ODI, October 1992, pp. 3–24, specifically p. 4.

53. See OED Report Nos. 9205, December 1990, and 9714, June 1991.

54. All covered in a joint audit (OED Report No. 9714, June 1991) except Trans-Perak Area Development Project, Loan 1960, for which see the PCR, OED Report No. 9479, April 1991.

55. OED Report No. 9205, December 1990; also cited in Burns, op. cit., para. 53, p. 13.

56. Bandaragoda and Garces-Restrepo, op. cit., pp. 3–4.

57. See OED Report No. 9716, June 1991, the audit, among others, of India's Andhra Pradesh Irrigation and Command Area Development Project, Loan 1251. For examples of similar problems, see the following projects in India's Subernarekha Irrigation Project, Credit 1289, covered by group audit mentioned above, Orissa Irrigation II Project, Credit 1397, audited in OED Report No. 9909, September 1991, or certain earlier audits of Andhran and Orissan projects (OED Report Nos. 3499, June 1981, and 5661, May 1985), or the Andhra/Karnataka Tunghabadra Project, which was the source of empirical information for Robert Wade's publications on rent-seeking behavior in the irrigation bureaucracy. See his "The System of Administrative and Political Corruption: Canal Irrigation in South India," *Journal of Development Studies* XVIII, 1982, pp. 287–327.

58. The audit of Loan 2186 and Credit 1269 is currently being prepared. See OED Report No. 9369, February 1991 (PCR).

59. For a summary of the growing literature on rent-seeking and public irrigation systems, see Robert C. Repetto, *Skimming the Water: Rent-seeking and the Performance of Public Irrigation Systems*, Washington, DC: World Resources Institute, 1986.

60. Burns, op. cit., p. 14, para. 58.

61. Except, of course, that warabandi farmers can and do do so by channeling available flow to a smaller crop area using inexpensive, seasonal on-farm water control structures. See S. I. Bhuiyan, *Irrigation and Water Management for Diversified Cropping in Rice Irrigation Systems: Major Issues and Concerns*, ODI/IIMI Management Network Paper 89/3, London: ODI, June 1989, pp. 26.

62. An excellent example of this approach is the pedagogic material compiled by Hervé Plusquellec for the Bank's Economic Development Institute. See Plusquellec, *Improving the Operation of Canal Irrigation Systems* (an Audiovisual Production), Washington, DC: World Bank/Economic Development Institute and Agriculture and Rural Development Department, 1988.

63. For a good example of this kind of thinking, see World Bank, "Concepts for the Future in Irrigation Planning," *Demand Patterns of Irrigation Requirements in 2000 A.D. and Beyond*, Seminar Proceedings, February 7–9, 1981, New Delhi: Government of India, Ministry of Irrigation, Narmada PP Cell, August 1981, pp. 33–49. The Bank's vision of the "new style project" is most succinctly set out at paras. 84, 85, 91, and 92. See also Bandaragoda and Garces-Restrepo, op. cit., in which IIMI representatives in Pakistan advocate conversion of a warabandi system to something intermediate between it and a full on-demand system, a crop-based system that has substantial flexibility in adjusting water to crops.

64. Perry, op. cit., p. 6, para. 32.

65. Burns, op. cit., para. 65, p. 16.

66. On this point, see especially D. J. W. Berkoff, *Irrigation Management on the Indo-Gangetic Plain*, World Bank Technical Paper No. 129, Washington, DC: World Bank, 1990, p. 16. This excellent paper analyzes four gravity systems that run the gamut from the "structured" Bhakra system in an arid region serving (relatively) large farms to the "unstructured" Gandak system in a humid area serving very small farms.

67. Partly financed by the Bank through Indonesia's Multipurpose Dam and Irrigation Project, Loan 2543, approved May 1985, which is still disbursing.

68. Results first published in David Seckler, Rajan K. Sampath, and S.K. Raheja, "An Index for Measuring the Performance of Irrigation Management Systems with an Application," *Water Resources Bulletin* XXIV, 1988, pp.855–869, though a sumary of results appeared much earlier in *Econmic and Political Weekly*. For a full account, see David Seckler, S.P. Malhotra, and and S. K. Raheja, "A Methodology for Monitoring the Performance of Large-scale Irrigation Systems: A Case Study of the Warabandi System of Northwest India," *Journal of Agricultural Administration*, Vol. 17, No. 4, 1984.

69. These were a central part of Bank lending in the Indian states of Andhra, Karnataka, Maharashtra, and Gujarat. The failure in Andhra was documented by Robert Wade, "Irrigation Reform in Conditions of Populist Anarchy: An Indian Case," *Journal of Development Economics* XIV, April 1984, pp. 285–303. Early success in the Girna command in Jalgaon, Maharashtra is attributed (S. N. Lele, R. K. Patil, and D. N. Kulkarni, *Rotational Water Supply on the Girna Canal System*, Bombay: Government of Maharashtra, Planning Department and Irrigation Department, 1979) to warabandi, but this interesting and successful example of water distribution turned out to be "rigid shejpali." There are unconfirmed reports that a number of medium surface systems in Gujarat have recently converted to warabandi with great success (personal communications).

70. Muhammad Nawaz Bhutta and Edward J. Van der Velde, "Performance of Secondary Canals in Pakistan Punjab: Research on Equity and Variability at the Distributary Level," in *Advancements in IIMI's Research 1989–91: A Selection of Papers Presented at Internal Program Reviews*, Colombo: IIMI, 1992, pp. 235–262.

71. Due to faulty maintenance, canals and outlets at head-reaches had been enlarged so that head-enders got more water than their entitlement and tail-enders got little or nothing. The IIMI program designed and carried out maintenance to correct this problem and restore designed deliveries. It did. However, within less than a year, the system had again been "creatively" maintained by head-enders.

This pattern has been reported in Pakistani warabandi areas but not in Indian ones. What makes the difference? The authors have not offered an explanation. Observers have offered two possible explanations that may be mutually reinforcing. Firstly, far more canals are lined in India. With lined canals, it is much easier to restore the canal to its original profile while maintaining (which is critical to proper warabandi functioning), and for others to see that this has been done. With unlined canals, it is not, so that it is easy to cheat. Secondly, some observers allege that the Pakistani Punjab's soak-political context makes it easier for head-enders to assert themselves. Yet another possibility is that circumstances ob-

served in this study are not typical: warabandi design had been destroyed earlier and delivery schedule to head was not followed.

72. See S. G. Narayanamurthy, "Returns to Surface Irrigation in Haryana," unpublished paper, Vadodara, 1992.

73. Perry, op. cit., p. 10, para. 47. None under high rainfall (862 mm), 0.3 percent under normal rainfall (616 mm), and 8 percent under low rainfall (405 mm).

74. S. G. Narayanamurthy, "Do Farmers Plan to Maximize the Return to Water Under Rainfall Variations," unpublished draft, Vadodara, 1992.

75. See OED Report No. 10669, May 1992 (audit), on the Philippines' First and Second National Irrigation Systems Improvement Projects, Loans 1414 and 1526, and OED Report No. 7956, June 1989 (audit), on Indonesia's Irrigation Projects X, XIV, and XV Projects, Loans 1578 and 1811/Credit 995.

76. For historical evolution up to 1978, see Masao Kikuchi, Geronimo Dozina Jr., and Yujiro Hayami, "Economics of Community Work Programs: A Communal Irrigation Project in the Philippines," *Economic Development and Cultural Change*, 1978, pp. 211–225. In 1952, communals accounted for 69 percent.

77. For a description of what "participation" meant in these instances, see Jeanne Frances I. Illo, "Farmers, Engineers and Organizers: the Taisan Project," in Frances F. Korten and Robert Y. Siy Jr., op. cit., pp. 31–60.

78. See Romana de los Reyes and Sylvia Ma. G. Jopillo, "The Impact of Participation: An Evaluation of the NIA's Communal Irrigation Program," in Korten and Siy, op. cit., pp. 90–116. Figures cited are from pp. 95, 97, 98, and 106.

79. David Gisselquist, *Demonstrating Command Area Development*, Dhaka: Tangail Agricultural Development, 1989, p. 2.

8. Current directions

Decisionmakers are impatient to know the results of irrigation investments and policy in the last decade, but the results in the evaluation record are from projects that were approved 10 or more years ago (see Figure 3.1). It takes that long to learn how irrigation projects affect people—the irrigators and those who eat and wear their produce and those who provide services for irrigators. Feedback and lesson-learning is a protracted process.

In the absence of evaluations of results, it is possible to report on more recent lending and policy trends by looking at what staff appraisal reports say the Bank is doing and cross-checking this information with interviews of irrigation task managers and advisers. That is what Chapter 8 does. The trends analyzed below represent both continuity and change.

Regional or national sector lending

The most obvious recent trend is toward large irrigation sector loans covering entire countries or regions thereof. This trend has been the highlight of AGR's three most recent annual reports on irrigation and drainage.[1] The projects that give rise to this trend take a variety of forms, however.

Sometimes, what appears to be a sector loan is lending for carefully specified projects with minimal policy or institutional development content. The recent Iran Irrigation Improvement Project (Loan 3570, approved March 1993) is an example. It financed four discrete irrigation systems. These subprojects have engineering feasibility studies, just as the Bank's (better prepared) project loans of an earlier era did. They are reminiscent of earlier projects, such as India's Maharashtra Composite Irrigation Projects (MCIP) I, II, and III (Credits 736, 954, and 1621, approved July 1977, October 1979, and July 1985, respectively), two of which financed the distribution system for Paithan dam and the other of which also financed specific works. Another apparent sector loan, Brazil's Irrigation Subsector Project (Loan 2950, approved June 1988), is actually 78 percent rural electrification, specifically construction of substations and 22,000 km of power lines along rivers in the southern third of the country to enable private farmers to operate irrigation pumps. This reverses an earlier phenomenon: pump irrigation packaged as rural electrification, principally in India.[2] Whatever their names, such loans do not finance a portion of the irrigation lending program in return for reforms, as sectoral adjustment loans purport to do. Irrigation loans have traditionally included institution-building components and policy conditionalities.

Another form of the trend toward sector loans is best exemplified by an IFAD project, Ethiopia's

Small-scale Irrigation and Conservation Project (IFAD Loan 131, cofinanced by IDA Credit 1765, approved March 1987, and by others), which is reminiscent of the integrated rural development projects of the late 1970s. Designed for the semi-arid slopes of the highlands east of Rift, 36 percent of this project's funds are earmarked for rehabilitation or new construction of small irrigation schemes, 18 percent for support for the national and zonal public irrigation bureaucracy, 23 percent for training-and-visit agricultural extension, 8 percent for other agricultural support, 12 percent for soil conservation, and 3 percent for women's programs. Local participation is to be important; for irrigation, beneficiaries are to contribute all unskilled labor and level their own land. The project, in short, embodies all of the popular themes of the 1990s. Only time will tell whether it encounters the problem that haunted so many of the "integrated" rural development projects of the 1970s and 1980s: the impracticability of managing implementation of a complex project with so many components dispersed over a wide area.

Some of these new loans are what they claim to be—sectorwide loans with focus on institution building and policy conditionality. Indonesia's Irrigation Subsector II (O&M) Project (ISSP-II) (Loan 3392, approved July 1991) covers only part of the borrower's investment program over four years. It does, however, contain considerable policy conditionality on sectorwide O&M and cost recovery in support of the borrower's 10–15 year reform program. Mexico's Irrigation and Drainage Sector Project (Loan 3419 for $400 million, approved December 1991, plus Interamerican Development Bank financing) is even closer to the ideal. It finances a slice of the borrower's 1991–94 irrigation investment program. The loan's major conditionalities are not as onerous as they might appear because they covenant reforms that the borrower had already decided to carry out and, in some cases, was already carrying out, whether independently or as a result of sector dialogue with the World and Interamerican Banks.

Institution building

AGR's annual irrigation reports also highlight an increase in institutional strengthening. Since a number of different activities can be classified as institutional development, the extent of this trend, like the trend from discrete projects to sector loans, can only be guessed. The two are no doubt related to each other and also to the desire to support socially useful irrigation in the face of objections from external critics of water storage, resettlement, and big projects in general. Taking a national or regional approach and supporting government institutions rather than specific civil works disarms would-be critics. Specific investments displace specific people, animals, and plants and replace them with others. With dams, rivers cease to be free-flowing, as specific interest groups like them to be. Institutional-strengthening investments are more difficult to attack. For example, consider the following institutional development component:

> *It would finance three complementary sets of activities. The first would support project startup and management assistance, including staff training, for the 11 State Coordinating Entities (ECEs) and other cooperating state and federal agencies. The second would furnish longer-term organizational development, planning systems design and operating procedures to build the ECEs into effective state-level irrigation organizations. The third set would finance programs to build public support for irrigation, educate farmers about the production economics of irrigation, and sponsor long-term planning and research on production, resource conservation, and environmental, organizational and legal issues. These mutually reinforcing activities would foster the creation of a sound long-term policy and institutional framework for the continued expansion of private irrigation.*[3]

It is difficult to see who would be hurt by this proposed expenditure of $20 million on institutional strengthening. The connection to beneficiaries is less obvious too.[4] In institutional-strengthening components, the Bank finances studies, vehicles, offices and office equipment, training, technical assistance, and sometimes incremental salaries. The specific benefits of such expenditures are not always specified.

Not all institution building targets public sector agencies. For instance, the Philippines' Irrigation Operations' Support Project (Loan 2948, approved June 1988) projected 75 percent of its expenditures to finance deferred maintenance and 25 percent for institutional strengthening. Of this quarter, 24 percent was earmarked for the National Irrigation Administration and 1 percent ($ 0.7 million) for strengthening and extending NIA's pioneering irrigators' association development program.

Irrigators' participation

The trend in lending to strengthen public irrigation institutions is counterbalanced by a trend to circumscribe their role. It comes from a growing recognition that it may be better if public irrigation bureaucracies do not try to do everything. Cornell University's first study in irrigation[5] argues that the rapid expansion of public irrigation *hardware* in the second half of the Twentieth Century has not been sufficiently accompanied by the *software* needed to make it work, much of it in the form of social conventions, institutional arrangements, and operating traditions. Since it was the public sector that took the lead in developing irrigation-development during this period,[6] it is not surprising that the public sector tried to fill the software gaps.

Surface irrigation

At the height of its irrigation lending, Bank-financed *surface irrigation* projects characteristically focused on expanding the public-sector role. In South Asia, when distributaries were built in previously rainfed farming areas and farmers failed to complete field channels and land leveling to make canal irrigation work properly, the standard approach was for public authorities to do it. For example, when irrigation lending resumed in the 1970s in India, the Bank's largest irrigation borrower,[7] "command area development" was the watchword.[8] Command area development authorities contracted for construction of field channels and land leveling on behalf of farmers, who were obliged to take loans to finance these expenditures. The Bank's policy dialogue helped convince many Indian states to reduce the size of the "chak"—the block to which public canal projects deliver water and the interface between public and private—from 20 to eight hectares. In India and elsewhere, the Bank fostered the expansion and further reticulation of public irrigation facilities. But actions taken because of Bank urging were only part of a much larger trend of public encroachment upon irrigation activities that had previously been community or privately run.[9]

The first hint of this transition from government takeover to government turnover was the 1974 initiatives of Philippine NIA Administrator Benjamin Bagadion and his colleagues, referred to in Box 7.1 above. As that box describes, the Bank supported first the turnover of generally smaller "communal" systems to irrigator management through the Communal Irrigation Development Project (Loan 2173, approved June 1982) and its successors, and then the Management Turnover Program for generally larger "national" systems.[10] The Bank first supported a similar turnover in neighboring Indonesia through the Irrigation Subsector Project (Loan 2880, approved October 1987). As deferred maintenance was completed on technically simpler, smaller systems and users' associations were formed, these systems were to be devolved to the irrigators. This was not

a major feature of the project in money terms; it accounted for $2.8 million, less than 1 percent of projected base costs. Turnover of 2,304 small systems covering 185,309 hectares was to be completed by October 1993. These small systems constituted nearly half of Indonesia's irrigation systems under 500 hectares. While a great many irrigators' associations have been formed, all but a few are "belum berfungsi"—not yet functional—at present, so that actual irrigator management is still rare.

The most prominent instance of turnover to irrigators has taken place in Mexico. In its 1983 irrigation sector survey,[11] the Bank recognized what Mexicans had long known—that large government owned and operated irrigation districts did not operate as well as smaller irrigation units in which irrigators were more heavily involved. The Mexican government, also mindful of major fiscal losses in the districts where water charges were far from covering O&M costs, embarked on a program of transferring responsibility for irrigation-district O&M to irrigators. In the process, irrigators would absorb government losses on O&M. While the program was implemented vigorously prior to Bank involvement, it was an integral part of Mexico's Irrigation and Drainage Sector Project (Loan 3419, approved December 1991) in support of the 1991–94 investment program. This project envisaged rehabilitation, modernization, and transfer to the users of 21 of Mexico's 77 irrigation districts covering over half the area irrigated by these districts.[12]

The effects of Mexico's program of empowering irrigators are poignantly apparent in developments on the Rio Fuerte/Rio Sinaloa Irrigation Project (Loan 1706, approved May 1979; PCR currently under review). This project was meant to rescue the large Rio Fuerte command, which was going out of production due to insufficient maintenance and salinization resulting from insufficient drainage, and to complete the Rio Sinaloa command.[13] After surviving a catastrophic flood and massive implementation problems, this project appeared to be heading for disaster all over again from the government's failure to maintain the works. In 1992, the government transferred the O&M functions to the water users' associations of the Rio Fuerte and Rio Sinaloa districts. As the PCR reports, "As a result, cost recovery from the collection of water fees jumped from about 30 percent in 1991 to 100 percent in 1993 in both districts. Since then O&M improved substantially, confirming the appropriateness of the strategy to assure sustainability conditions for the project, which were jeopardized by the previous shortage of O&M funds."[14]

Many other countries are in the early stages of increasing irrigator participation. A great variety of arrangements and a great variety of names are involved. Some are called privatization and some are not. Irrigators' financial responsibility for O&M, however, is a common feature. One is Nepal's Farmer Managed Irrigation Schemes, which has evolved with technical assistance from the Philippine institutions involved in Philippine management turnover (MTP): the National Irrigation Administration and the Institute for Philippine Culture.[15] Another is the proposal that India's Haryana, Tamil Nadu, and Orissa states devolve O&M of parts of their irrigation systems to irrigators.[16] In Niger, Irrigation Rehabilitation Project (Credit 1618, approved June 1985) provided for assistance to irrigators' cooperatives to permit self-management and self-reliance. In this case, irrigators' responsibility was to be limited to providing unskilled labor and "if they do not perform the task satisfactorily, ONAHA <the irrigation authority> would do it and charge the ... cooperatives." ONAHA would be responsible for works requiring equipment, "though farmers would have the option of hiring a private contractor."[17]

Groundwater irrigation

In *groundwater irrigation* there is also a trend toward transferring public tubewell irrigation to private hands. This trend was evident earliest in Pakistan, which, because of its intrinsic problems of salting and waterlogging, went farthest in installing public tubewells in its Salinity Control and Reclamation Programme (SCARP). The government was never able to recover more than a small portion of the operating costs of these wells. Operating efficiency has been declining, and average well operation has declined to about half of capacity. In 1986, Pakistan undertook a pilot program with Bank support (SCARP Transition Pilot Project, Credit 1693, approved May 1986) to foster installation of private tubewells in commands with fresh groundwater and then remove the public pumps. The transition pilot has succeeded in keeping groundwater levels stable and passing to farmers expenses formerly borne by government, but it has not yet been demonstrated that the transition improves equity or efficiency.[18] Because of the urgency of the situation, the borrower and the Bank proceeded with a larger sequel (Second SCARP Transition Project, Credit 2257, approved June 1991) before the evaluation results of the pilot were known. A third project is now being processed.

On India's Ganga plain, where waterlogging and salinity are not as severe, a different tack was taken. With design help from FAO, India undertook and the Bank helped finance (Second Uttar Pradesh Public Tubewells Project, Credit 1332, approved March 1983) an attempt to design around the shortcomings of public tubewells. Public wells financed by this project were to assure equity and reliability by looped, underground pipe delivery to each field. Unreliable operators were to be made unnecessary by automating the pumps, and the irregularity of the public power system was to be circumvented by giving each cluster a dedicated power line. Despite these efforts, an OED audit now in progress has found that public tubewells are working less, and less regularly, than anticipated. As a consequence, farmers in the public well commands are installing private wells.[19]

It would be not be realistic to regard irrigator financial responsibility for O&M, and/or the variety of turnover arrangements that frequently accompany it, as a panacea for irrigation's problems. There is enough evidence to document the existence of a trend, but it is far too early to know how far it will go or where it will lead.[20] While the kinds of reforms involved represent a net social gain, there are losers as well as gainers. As Box 7.1 shows, the more mature experience of the Philippines provides a cautionary tale, showing how good intentions can be partially side-tracked. Early evaluation of these developments would be useful as guidance for policymakers.

Rehabilitation or upgrading

AGR's annual irrigation reviews have stressed the trend toward more lending for rehabilitation, particularly low-cost rehabilitation. The FY91 report points out that the FY91 "average investment cost per hectare fell to $390, about a tenth the average cost for developing new areas."[21] The report recognizes that, in the absence of evaluations, it is too early to assess the effects of this trend. However, it is clearly skeptical. "There is ... still little evidence that very low cost interventions can have a meaningful effect on water-use efficiency—and provide an acceptable rate of return."[22]

This study has already noted that few Bank-supported projects are new-area projects, that sorting new construction from rehabilitation, extension, and upgrading is a messy job, and that a substantial portion of lending has always been for "rehabilitation." Nevertheless, the existence of such a trend is beyond doubt. Interpretation of what it means is not.

Some OED irrigation audits have expressed concern that the Bank has become involved in an endless cycle of rehabilitating projects that have run down much more rapidly than they were projected to, simply financing deferred maintenance that should have been the responsibility of irrigators or of their public authorities without solving the problems that caused premature disintegration. Many task managers share this concern and consider it an inappropriate use of Bank resources.

Review of recent appraisals reveals some projects that merely restore systems that ought not to have broken down. Mali's Office du Niger Consolidation Project (Credits 1906 and A-35, approved May 1988) is one such example, yet it contains technical upgrading too. On two canals, it instituted downstream control with automatic gates and made village associations responsible for tertiary water distribution and billing, which is expected to reduce waste and make volumetric water charges possible.

Chapter 4 established a compelling logic for low-cost rehabilitation, about which the 1991 AGR report is skeptical. With food staple prices low and no signs of a secular rise, irrigation investments must be careful of their unit costs. Moreover, low unit costs have been significantly related to good economic returns throughout the evaluation period (see Table 4.2). And yet, financing deferred maintenance does seem an inappropriate use of Bank resources.

In the recent non-new-area projects that are sometimes classified as "rehabilitation" are projects that are *not just rehabilitation*, such as the India National Water Management I Project (Credit 1770, approved March 1987). The project is intelligence-intensive, applying engineering, economic, and sociological analysis to *working* irrigation systems to find ways they can *work better*. The initial idea was to find ways of improving results just by changing operating rules. In practice, however, it proved necessary to change both operating rules (software) and structures (hardware). Although it often involves major changes, the expert solution turns out to have a low unit cost, because massive costs have already been sunk and are embodied in physical investments and in knowledge of local farmers. "Rehabilitation" does not accurately describe this kind of investment. For want of a better name, these engineering and social-science intensive interventions to improve existing systems are called *upgrading*.

Other trends

Review of recent irrigation appraisal reports and interviews with task managers and their chiefs revealed five other trends in irrigation lending.

Cost recovery

As Chapter 2 demonstrated, cost recovery has been a part of Bank thinking about irrigation from the beginning. There is no evidence yet, however, of better cost recovery or of covenant compliance either. Framing the issue as "cost recovery" actually makes it sound, incorrectly, like merely a fiscal issue. It is *making irrigators bear the cost that promotes efficient use of irrigation.*

Where water is not particularly scarce, irrigators have an interest in getting the optimum amount of O&M done at the optimum time and the optimum cost. Chapter 7 has reviewed the evidence that *financial autonomy* is the key. If the irrigators choose government to do the work, as in the new tubewell arrangement in West Bengal (see endnote 19), government cost "recovery" will take place. If the group does the work, it will "recover" the cost from itself. The trend is not in cost recovery but in greater *irrigator participation*. Where water is scarce, cost-bearing for O&M alone will not assure efficient water use. In some water-scarce countries, like Morocco and Cyprus,

irrigators are already paying full O&M costs, and sometimes more. Government is not losing money on O&M. Under these circumstances, the appropriate incentive for water-saving must be stronger than devolving O&M costs to users.

There is a trend for dealing with this fact, but it is not found in Bank lending or covenant enforcement. The Bank is increasingly involved in fostering planning exercises to help member countries comprehend all the ramifications of water shortages, present and to come, and to decide how to cope with them. In some cases, the Bank has used its own resources and worked directly with the member country, as in constructing the basin-level simulation and optimization model of China's Yellow River basin.[23] This modeling made transparent the fact that the highest-return investments in the basin would be those that reduced the sediment load by keeping the Loess Plateau's loess on the plateau. Massive Chinese efforts to do so have followed. A Bank-financed credit to support them (Loess Plateau Watershed Rehabilitation Project) is currently under consideration. Often, Bank involvement is more at arms' length, as in the long-term water supply and demand modeling being done by Jordan River riparians and by Cyprus. In these and other cases, the exercises are being done and paid for by the member states themselves and/or by other parties, with the Bank furnishing technical advice. The Bank has set up a special Water Resources Team to foster such activities in a technical department that covers North Africa, the Middle East, Central Asia, and Europe. This trend is fully consistent with the *Water Resources Management Policy Paper.*

Gender

As indicated in Chapter 3, OED's study, *Gender Issues in World Bank Lending,* reveals increasing attention to gender issues in project documents over time. Sometimes this attention leads to concrete actions to help women. The Ethiopian IFAD small-irrigation projects referred to above, also financed by the Bank and others, stipulated support for 370 women's vegetable gardens, a search for other income-generating schemes for women, and support for family nutrition. To back up this support, the project prescribed a dedicated credit line for women and a women's unit, staff, and vehicle. By contrast, the appraisal report for Senegal's Fourth Irrigation Project (Credit 1855, approved December 1987) provides an analysis of the predicament of women in the project area but the specific actions proposed are gender neutral.

Irrigation is often a rising tide that lifts all the boats. As such, it helps women and men. But the distribution of costs and benefits depends on customs and particularly on the sex division of labor in the society. If irrigation itself is more than gender neutral, that is because it usually improves availability of household water, which affects women's lives disproportionately, an effect noted in Chapter 3 above but not counted in OED's *Gender Issues.* Where there are specific women-helping actions, review of recent appraisal reports shows that they are not specific to irrigation, as in the case of the Ethiopian vegetable gardens above.

As with the rest of this chapter, there being as yet no evaluation, results of these initiatives are a matter of speculation. The lessons of experience suggest, however, that there is a strong danger that new-style irrigation project managers will, like the managers of "integrated" rural development projects, concentrate on the larger central components that they consider vital to project implementation—the irrigation components—while neglecting social dimensions.

Catchment improvement

As indicated in Chapter 3, Bank jurisdictional disputes during the period covered by irrigation evaluations sometimes prevented integrated attention to irrigation and to

improvement of the catchment. Since the reorganization of the Bank along country lines in 1987, this jurisdictional problem has been surmounted. Better land husbandry up-catchment from storage reservoirs prolongs their life and reduces the need to desilt canals and drains. Better land husbandry in the irrigated areas themselves improves the use of irrigation water and the returns to irrigation investment. There is a modest trend towards capturing these synergies. The pilot microcatchment schemes in the Santa Lucía River Basin above Montevideo (financed by Uruguay's Natural Resources Management and Irrigation Project, Loan 3697, approved January 1994) aim to integrate soil conservation and irrigation. The prospective financing of Yellow River catchment improvement in China mentioned above, while vastly larger in scale, is another example of an integrated approach. (Of course, there is no need to limit catchment improvement to those catchments where there are irrigation investments.)

Dam safety

Dam safety concerns were discussed above. The governing policy directive, OMS 3.80 of June 1977, is still in effect. However, for the past several years, the requirements of that directive are also being extended to Bank-financed projects where no dam financing is involved but the project depends on an existing dam. Thus, when the Bank finances expansion of the canal network of a surface irrigation project or the upgrading of control structures and/or operating plans, as it increasingly does, any existing dams in these systems are subject to a dam safety assessment and, if appropriate, periodic inspection by a dam safety panel. This de facto extension may be formalized by a Bank Procedure (BP), which is now under discussion. With or without formalization, this extension of Bank policy is significant. Bank financing of dams has always been modest. However, 30 to 35 existing dams come under Bank safety surveillance each year due to Bank financing of other parts of irrigation, hydroelectric, or drinking water systems.

Another part of the trend toward even more attention to dam safety is the appearance of projects specifically for dam safety: Pakistan's Reservoir Maintenance Project (Loan 2247, approved March 1983), India's Dam Safety Project (Credit 2241/Loan 3325, approved May 1991) for four states, and Indonesia's Dam Safety Project, currently under consideration and triggered by concern about the stability of Jatiluhur dam which came to light through dam safety studies that were part of Indonesia's West Tarum Canal Improvement Project (Loan 2560, approved May 1985).

Dams and resettlement

Chapter 3 reviewed the place of dams and of involuntary resettlement in the Bank's irrigation lending. In short, the Bank has financed few dams; its resettlement policy is appropriate, but has frequently not been implemented satisfactorily. Resettlement problems would have been much greater than they have been but for the modest place of dam financing in Bank irrigation lending.

Two instances in which the Bank did finance large dams, in Brazil and in India, attracted major media attention. Since the 1940s, Brazil has been developing the hydroelectric potential and, more recently, the irrigation potential of the Sao Francisco River in the dry northeast. Bank finance has been involved at a number of points, including construction of the large Sobradinho regulating dam in the early 1970s (Fourth Paulo Alfonso Hydroelectric Power Project, Loan 1008, approved June 1974). This dam displaced 70,000 people and greatly changed the farming systems in the lower valley. When considering the loan, the Bank's Board expressed concern over resettlement arrangements. In response, the Bank's president agreed personally to review the required

resettlement plans. Resettlement efforts, while substantial, had mixed results, a fact that was not widely recognized until OED's audit (Report No. 6578, December 1986) pointed out that many of those settled in four new towns and in the rural agrovilas were not reservoir oustees. The plight of these resettlers became something of a cause célèbre. OED's study of Bank approaches to the environment in Brazil concludes in part, "the rural resettlement program was seriously flawed."[24]

The Bank did not finance the second-biggest dam, Itaparica, downstream of Sobradinho, but did finance the elaborate resettlement program (Itaparica Resettlement and Irrigation Project, Loan 2883, approved November 1987). After criticism for underfunding and a cavalier approach to resettlement at Sobradinho, both Brazil and the Bank were thorough at Itaparica. Resettlement has been satisfactory but expensive. The OED study concludes,

> *The final cost of resettlement at Itaparica will be very high, probably exceeding $63,000 per family. This high cost appears to be largely a consequence of the comprehensive nature of the resettlement program adopted—which is consistent with current Bank policy .... This contrasts with the earlier experiences at Sobradinho ... and in the lower valley.*[25]

In India in 1985, when decades of contention between Indian states over rights to Narmada River water were resolved, the Bank agreed to participate in developing that river's hydropower and irrigation potential. Loan 2497 and Credits 1552 and 1553 for $450 million (approved March 1985) were to finance 21 percent of the cost, net of taxes, of the largest dam in the scheme, Sardar Sarovar, and the accompanying powerhouse and most main canals. At appraisal, a rolling, multiyear resettlement plan was accepted. As a result of disputes between states, the borrower fell behind on resettlement plans and implementation. Thanks to delays in dam construction, resettlement delays did not immediately become serious, though they did result in one Bank threat to suspend disbursements. Despite implementation progress, the prospective plight of Sardar Sarovar oustees was the major factor used by opponents of Narmada development to campaign against the dam. After a variety of internal reports that pointed to major problems, external commission reports, and disputes between the Bank and the borrower, the latter decided to end Bank participation in the project, canceling the amount outstanding on the credits. The Bank had earlier stopped processing subsequent Narmada-development loans, notably for Narmada (Indira) Sagar dam, for resettlement, and for catchment improvement.

As a result of these and other experiences, there is a clear trend to avoid investment in water storage. Actual construction of Kedung Ombo, one of the most recent large irrigation dams constructed with Bank finance (Indonesia's Kedung Ombo Multipurpose Dam and Irrigation Project, Loan 2543, approved May 1985) was completed in 1991. Increasingly, the Bank works around storage dams. A recent request from a borrower in Southeast Asia for inclusion of a storage dam in an irrigation project now being processed was met with the advice to exclude this part of its irrigation program from its dealings with the Bank. It is the strong opinion of irrigation staff, mindful of the experiences of the Sao Francisco and Narmada river developments, that Bank resettlement guidelines will cause the borrower major delays or great expense or both. Under the circumstances, the borrowers' wisest solution is to seek dam financing elsewhere. This trend is not as radical as it might seem in view of the Bank's very modest historical role in dam financing. However, it does introduce a distortion in irrigation policymaking where dam construction is technically, financially, and economically justified.

Notes

1. AGR's irrigation advisers report annually to the director on characteristics of irrigation lending and sector work, OED findings, and compliance with policy initiatives.

2. Notably Rural Electrification Project (Credit 572, approved June 1975), Second Rural Electrification Corporation Project (Credit 911, approved May 1979), and Third Rural Electrification Project (Loan 2165, approved June 1982), the first two audited in 1986 (OED Report No. 6307) and the third currently being audited. The latest audit concludes that the projects were unsuccessful and unsustainable because, inter alia, through subsidies to farmers, they led to wasteful use of resources and contributed to the swinging losses of the state electricity boards. However, they "played a central role in shifting the country's agriculture from monsoon dependent dry farming to irrigated agriculture ...<contributing> to a successful national food security program that has eliminated the risks of widespread distress ..." Thus the projects "made a significant contribution to improving the lives of the poorest of the poor" (Preface). The third project permitted installation of two million electrified tubewells, the program as a whole, eight million. Tubewell irrigation accounted for an estimated 85 percent of electricity consumption from these projects.

3. Brazil's Irrigation Subsector Project, Staff Appraisal Report, May 16, 1988, para. 3.08.

4. In this case, Bank staff counted the institutional development costs in economic analysis but assigned no benefits to them. See SAR, Annex II, p. 2.

5. See Chapter 1, endnote 4. Also see Gilbert Levine, "Hardware and Software: An Engineering Perspective on the Mix for Irrigation Management," unpublished paper presented at the Workshop on Rice Research, Los Baños: IRRI, 1979.

6. See Chapter 1.

7. There is an eight-year gap in Bank irrigation lending to India between the Sone and Purna Irrigation Projects (Credits 21 and 23, approved 1962) and the resumption of lending in 1970 with the Kadana Irrigation Project (Credit 176). In fact, except for Kadana and the 1971 Pochampad Irrigation Project (Credit 268), there was a 12-year hiatus to the first Command Area Development Authority (CADA) projects of 1974. This was a period of disagreement between the Bank and India over procurement rules.

8. The early command area development projects are: in 1974, Rajasthan Canal CADA (Credit 502) and Chambal CADA (Rajasthan, Loan 1011); in 1975, Chambal CADA (Madhya Pradesh, Credit 562); in 1976, Andhra Pradesh Irrigation and CADA (Loan 1251); and subsequent projects implemented by CADAs or with major CADA components, such as, in 1977, Maharashtra Composite Irrigation I (Credit 736) and, in 1978, Karnataka Irrigation (Credit 788).

9. For further information on this process in the Philippines, see Robert Y. Siy Jr., "Rural Organizations for Community Resource Management: Indigenous Irrigation Systems in the Northern Philippines," unpublished PhD dissertation, Ithaca: Cornell, 1981, and also references in Korten and Siy (see Chapter 7, endnote 26 for reference). For Nepal's "assistance" to and takeover of communal systems, see Ujjwal Prasad Pradhan, "Property Rights and State Intervention in Hill Irrigation Systems in Nepal," unpublished PhD dissertation, Ithaca: Cornell, 1990. For government takeover and "improvement" of tank systems in southern India, see Ruth Meinzen-Dick, *Local Management of Tank Irrigation in South India: Organization and Operation*, Cornell Studies in Irrigation No. 3, Ithaca: Cornell, 1984; S. Y. Krishnaswami, *Rural Problems in Madras*, Madras: Government Press, 1947; and John C. Baker, *An Indian Rural Economy 1880-1955: The Tamilnad Countryside*, Delhi: Oxford, 1984.

10. NGO representative Frances Korten argues in Box 7.1 that the Bank actually subverted the Philippine Management Turnover Program, turning it into something that stops far from the original goal of full farmer authority.

11. Mexican Irrigation Subsector Survey—First Stage, 2 vols., July 1983, covered in Chapter 5 analysis.

12. For a recent self-assessment of the progress of this program, see Fernando J. Gonzelez Villarreal, "Mexico's National Water Law: the Implementation of New Approaches to the Country's Water Resources Management and Development," to be published in proceedings of the Bank's Tenth Annual Irrigation and Drainage Seminar, December 1993.

13. Only 28 percent of the projected command could be completed under Mexico's Rio Sinaloa (Loan 970, approved February 1974). This project was nevertheless found to be satisfactory by an OED impact evaluation (OED Report No. 7876, June 1989), with an estimated 9 percent economic IRR. The Loan 1706 PCR estimates the economic IRR for Sinaloa I at 8 percent.

14. Contrast this result with Niger's Irrigation Rehabilitation Project (Credit 1618, approved June 1985). According to the PCR, currently being reviewed, this was a well-conceived project that went bad for want of farmer participation, cost recovery, and turnover of irrigation functions to irrigators.

15. See Richard Reidinger and Upendra Gautam, "Promoting Private Irrigation Development: The Irrigation Sector Program Experience in Nepal," *Irrigation and Drainage: Saving a Threatened Resource—In Search of Solutions*, Ted Enguan (ed.), New York: American Society of Civil Engineers, 1992, pp. 221-226.

16. In India, repair of watercourses is the responsibility of farmers. In Haryana, this stems from the 1873 Northern India Act. But irrigation departments may undertake the work and charge the farmers. Increasingly they have done so, but without fully recovering their costs. Haryana Water Resources Consolidation Project (Credit 2592, approved March 1994) sanctions a schedule by which the government will (a) declare intent of turning over system maintenance to beneficiaries, (b) define the policy details thereof, (c) define the rules and procedures, (d) start training to promote turnover, and (e) do it.

17. Staff Appraisal Report, May 30, 1985, paras. 3.09 and 3.08 respectively. Recent experience in Romania provides an example of what can happen when turnover is attempted before irrigators have organized themselves. After abrupt transition from centrally planned irrigation for state farms to unorganized private holdings, only 15 percent of irrigation systems are reportedly

working at all. In some of the sprinkler systems, farmers have sold the now-useless pipes for the value of their aluminum.

18. An OED audit of this project is currently underway. The baseline and initial follow-up farm-management study conducted in 1989 and 1990 (Shaukat Ali Shahid, Mazhar-ul-Haque, Abdur Rehman and Muhammad Jameel Khan, *Evaluation of SCARP Transition Pilot Project*, Lahore: Punjab Economic Research Institute, 1992) showed a small loss of efficiency in transitioned areas compared to control areas. It also showed a distinct disequity effect as less-poor farmers installed wells but not in sufficient numbers to generate vibrant competition and low prices for water buyers. On the basis of field visits, the audit believes that the disequity effect is lessening over time and that productivity gains have emerged since 1990. To verify this impression, the Bank is arranging for the Punjab Economic Research Institute to re-run its study.

19. Whether planned or unplanned, privatization of groundwater irrigation typically results in installation of three to four times the capacity necessary to serve the command. Against this private and social cost must be weighed the evidence that private groundwater irrigation provides better service. Is there a way of capturing the scale efficiencies of large shared tubewells that generally characterize the public sector without succumbing to the operating problems that have plagued the public sector? The UP Tubewells II experiment did not succeed. However, another experiment in India is promising. In West Bengal, under West Bengal Minor Irrigation (Credit 1619, approved July 1985), the state irrigation department, after consciousness-raising and training, is constructing large-scale tubewells and giving them to village councils. The councils own them and are responsible for O&M. They usually contract with the irrigation department for nonroutine maintenance and pay the full cost of delivering it. Thus, the overinvestment and the inequities associated with small, private well development are avoided. Moreover, with irrigator ownership, the inefficient operation characteristic of public mismanagement is avoided.

20. Unlike annual AGR irrigation reports, the study finds no water users' associations trend in recent Bank irrigation lending. First, while irrigation appraisal reports are paying increasing attention to irrigators groups over time, as discussed in Chapter 7, there is no evaluation or other evidence that appraisal intentions are realized in the field. In any case, what matters is not the existence of groups or their legal registration. They are almost always there. What matters is the conditions in which they operate—conditions that give the irrigator-members scope for improving their lot through group action. Secondly, associations are but a facet in irrigator participation, which is not an end in itself but a means for improving beneficiaries livelihood through better O&M and, eventually, better system design.

21. "Irrigation and Drainage," internal AGR review document, September 6, 1991, p. 1.

22. Ibid.

23. For a description of the process and the model, see Daniel Gunaratnam, Gary Kutcher, and Stephen McGurk, "Application of a Basin-level Model to the Yellow River," *Water Policy and Water Markets*, Guy LeMoigne, William Easter, Walter Ochs, and Sandra Giltner, eds., selected papers and proceedings from the Ninth Annual Irrigation and Drainage Seminar, Washington: World Bank, 1994, pp. 17-29.

24. " World Bank Approaches to the Environment in Brazil: A Review of Selected Projects," vol. I, p. 19, para. 2.30. This five-volume study reviews the Sao Francisco Valley developments, among others.

25. Ibid., pp. 21-22, para. 2.39. Staff in the Bank's operating division now estimate that the cost was much higher still.

9. Findings and recommendations

Irrigation is a large and very complex subject. Therefore, it is hardly surprising that findings and recommendations from this analysis of irrigation's evaluation record are many and diverse. The major ones can be clustered under seven headings.

The appropriate role of the Bank

In the past, Bank irrigation lending has risen and fallen in tandem with world irrigation investment. Although irrigation generates new jobs, improves household access to water, and helps hold down food prices—matters of great importance to the poor—irrigation investments are primarily justified by irrigation's primary benefits: production of more food and fiber. The primary reason for retrenchment in world, and Bank, irrigation investment is today's historically low prices for the food staples grown with the help of irrigation, and perhaps unwarranted confidence that those prices will stay low. As a result, developing country irrigation investment as a whole, and public sector investment in particular, have fallen. The rate of growth of irrigated area has dropped.

The complacency generated by low staple food prices, however, may well lead to underinvestment in agriculture, the result being another world food crisis. World population growth is slowing and the income elasticity of demand for staple foods is low, but both are still positive. A long-term view shows the importance of counter-cyclical investment, particularly because the stakes are high. A sudden sharp rise in the price of grains would have a far more serious impact on the world's poor than a similar rise in the price of anything else.

The bulk of future world agricultural growth will come from intensification of output on existing farmlands. Much recent growth has come from the synergy between plant-breeding advances, increased use of fertilizers, and irrigation. If, as some argue, the returns to plant breeding and incremental fertilizer use are declining,[1] the main burden of intensification will fall on irrigation.

Overall, the experience of Bank irrigation lending has been relatively good, with 67 percent of evaluated irrigation projects being rated satisfactory. When projects are weighted by size of area served, 84 percent are rated satisfactory. The average evaluation economic rate of return is 15 percent per project and 25 percent per area served. Nevertheless, there is ample room for improvement, both in the one-third of projects with unsatisfactory outcomes and in the two-thirds judged satisfactory.

Perhaps the greatest single benefit from Bank irrigation investments has been the effect of increased food production in keeping food

prices down and making food more affordable for the poor. But this benefit, like the benefit of additional agricultural employment, is difficult to measure. The Bank usually limits itself to measuring the benefits of irrigation projects to participating farm operators. These benefits have been distributed very equitably. The median size of beneficiary farms was 2.1 hectares. Irrigation was a service to small private farmers. It is estimated that about 16 million farm families were primary beneficiaries from the 208 evaluated irrigation projects. Hence, the 365 Bank projects where more than half of project costs were spent on irrigation, evaluated or not, assisted about 28 million farm families. This means there were well over 150 million beneficiaries on farms and countless other millions who benefited as laborers, as consumers of food, household water, or electric power, or as construction contractors and civil servants. In short, the benefits of irrigation investments have been widely distributed.

The problems caused by Bank irrigation lending—failed projects, successful projects that failed to live up to expectations, projects that turned sour because of poor O&M or failure to implement the drainage component, successful projects where oustees were not treated fairly—are the exceptions that confirm the rule. Overall, Bank irrigation lending has been good for the borrowers and constitutes a strong case for continued Bank irrigation lending, informed by the knowledge gained from past mistakes.

The next six headings summarize the main findings and recommendations that emerge from this study of Bank and other irrigation evaluations, and of other sources of information.

The case for upgrading

Farmers and irrigation-system operators will be facing more and more competition in the future for water from aquifers, streams, and lakes. Irrigators account for at least 70 percent of the water withdrawn from these sources today, but water almost invariably has a higher marginal value product for competing users, especially people who drink it and wash with it, and power companies that use it to generate electricity. Competition for water is already intense in the Middle East, in Central Asia, in North Africa, in growing parts of South, Southeast, and East Asia, and in Europe, and in western South and Meso-America.

Meanwhile, prospective sources of new irrigation water are becoming fewer. In general, the best dam and pumping sites have already been developed. Prospective sites for new dams, weirs, and pumps have become less attractive in economic terms. This means that larger dams and longer canals are needed per unit of water and per unit of land irrigated. Deeper drilling for pumping over greater vertical distances also becomes necessary. Like plant breeding and fertilizer use, irrigation faces the law of diminishing returns.

At the same time, prices of the foods and fibers that irrigation helps to produce are at historic lows.

This new environment is considerably different from that of the 1960s and early 1970s. Therefore, *future emphasis should be on upgrading existing irrigation,* a process that uses engineering and social science intensively to improve irrigation service to people, lower unit costs, and conserve water where it is scarce.

This does not mean simply rehabilitating irrigation systems to standards designed for an environment that no longer exists. This approach recognizes that irrigation serves a changing world. This growing emphasis, a challenge for engineers, agriculturalists, economists, and other social scientists, is consistent with the thrust of the *Water Resources Management Policy Paper.*

Evaluation criteria and methods

As noted, the Bank usually limits itself to assessing only the agricultural production benefits of irrigation. But irrigation also has multiplier effects—externalities that are missed by partial analysis. Incremental employment, a benefit in some senses, is a cost in economic analysis. Such benefits may be disproportionately large in irrigation. These effects are treated consistently in Bank project analysis. A change in project analysis methods is not recommended. However, it is appropriate to cite the irrigation benefits that partial analysis misses in project appraisals.

Irrigation suffers by comparison to other types of projects because benefit calculations miss its other direct benefits, such as better health, household water, improved dam safety, and catchment effects. *The Bank should devise and use simple performance indicators for quantifying health, household water, dam safety, and catchment improvement benefits.* Better project monitoring and evaluation would generate the technical and economic information that would make it possible to devise such rules of thumb. Moreover, it would greatly facilitate ex-post evaluation. Therefore, *system monitoring and project evaluation should be strengthened.*

The environmental costs of waterlogging and salinity, which are the offspring of inadequate drainage, have always been recognized. Earlier Bank-financed projects did not pay enough attention to the environmental costs of reservoir flooding and involuntary resettlement, but recent projects do.

The *"optimism gap"*—the difference between appraisal projections of economic returns and evaluation assessments—is not significantly different for irrigation than it is for other Bank-financed projects. The two principal factors that explain the divergence from expectations are unexpected changes in output prices and cropping intensities (Box 4.1).

How to devise better projects

Analysis of irrigation evaluations generated many findings, some of which lead to recommendations for devising better irrigation projects in the future. Eight of these are summarized here.[2]

Project size is strongly associated with results. That is, the bigger the command area, the higher the likely economic returns. This fact is statistically independent of other variables tested. It is true of surface projects and of decentralized groundwater projects. It is also true when sub-Saharan African projects, most of which are small and most of which are unsuccessful, are excluded. Big projects do better than small projects in sub-Saharan Africa too. These economies of scale stem from engineering efficiencies (bigger canal systems, pumps, wells, storage dams) and from management efficiencies (bigger projects attract better managers and get more effective government attention). In view of their better average results, *the Bank should continue to finance irrigation projects with large command areas.*

Low unit costs (investment costs per irrigated hectare) are significantly related to project success. Upgrading design with expensive facilities may pay in individual circumstances, but the general common-sense rule to cut costs and avoid "gold-plating" applies.

As expected, certain *macroeconomic distortions* prejudice the success of irrigation projects, except that irrigation projects did better in a somewhat restricted foreign trade environment than they did in either a nonrestricted or a highly restricted one. *The Bank should avoid irrigation investments where such distortions are serious and the probability of their removal is slim.*

Irrigation-related health initiatives have been so successful that *the Bank should consider expanding health initiatives,* either as part of irrigation projects or independently.

Assuring *construction quality* is an important implementation problem (Table 6.2) with a significant bearing on results. *Land acquisition* problems frequently cause implementation lags. *Bank irrigation supervision should focus more intensively on them.*

Implementation problems were particularly prevalent in rehabilitation projects, in surface water projects, in rice projects, in projects in the sub-Saharan African, Latin American, and East Asian regions, and, above all, in projects rated unsatisfactory.

Dams and involuntary resettlement. The Bank has financed few dams. Due to external criticism, dam financing by the Bank is now even less likely. Bank policy on dam safety has been effective. This policy is being applied not only to dams the Bank finances but also to those with which the Bank is peripherally involved. The Bank's involuntary resettlement policy is sound, but its application has sometimes been unsatisfactory. When the policy has been applied insufficiently, people obliged to resettle through no fault of their own have suffered unjustly. When applied fully, Bank policy can lead to complications that provide borrowers with an incentive not to seek Bank financing for dams. *The Bank should continue to apply its policy on involuntary resettlement and to assist borrowers in dealing with the social consequences of irrigation investment* when judging irrigation projects to achieve equity for both the oustees and society. However, the tendency of borrowers to forego Bank financing for dam construction that is technically, financially, and economically justified is an area of concern.

Catchment improvement. Irrigation projects only occasionally cause catchment degradation problems but are frequently the victims of them. They may also provide a means of attacking them. The Bank had a jurisdictional problem that impeded the synergy of joint irrigation and catchment development in certain regions before 1987, but this problem has been solved. Where possible, *Bank projects should exploit the potential synergy between irrigation and catchment improvement.*

Toward improved sustainability

Poor quality of project design and planning are big problems, but poor operation and maintenance is a bigger one. Shortage of public funds is only one of the reasons. There are two reasons why the Bank's standard tactic for dealing with poor O&M—raising water charges—does not work: (a) covenants to raise water charges and thus pay for "adequate" O&M are rarely respected, and (b) revenue from water charges is usually returned to the general treasury instead of being allocated to O&M. Since raising water charges does not normally improve O&M, *operational directives should be rewritten to remove the suggestion that O&M improvement is a reason for greater cost recovery.*

Satisfactory O&M is usually associated with financial autonomy. Either the users are fully responsible for it, or there are public water service units dependent on users for funding. Therefore, *whether public or private entities provide O&M, wherever feasible, they should receive their funding directly from irrigators.*

Devolution of responsibility for O&M presumes irrigators' groups are working satisfactorily. Despite the increasing attention paid to irrigators' groups in Bank-financed projects, however, most of them have not worked satisfactorily. This is true even though governments frequently organize irrigators groups and give them legal recognition.

The circumstances that encourage irrigators to create durable and useful groups are known. Durable, effective irrigators' groups have

clear geographical and jurisdictional boundaries. Member financial contributions are proportional to benefits. Members are represented in decisions on water allocation and financial contributions. Auditors are accountable to irrigators. Rule violators' punishments fit their crimes. Disputes are resolved locally and cheaply. Governments do not challenge the groups. Primary and higher-level groups are "nested," each with appropriate responsibilities.

Small primary groups have an easier time organizing themselves and working effectively. Bank evaluations show that irrigator groups in groundwater projects are twice as likely to be operating satisfactorily as they are in surface projects. Groundwater projects are, on average, smaller than surface projects. More importantly, large groundwater projects are subdivided into small units composed of users of individual pumps. By using a similar sort of subdivision, surface projects could achieve improved O&M without sacrificing economies of scale.

In lieu of loan covenants that require borrowers to form irrigators' groups, the Bank and its borrowers should foster the conditions associated with the formation of durable groups (for example, through experimentation and piloting prior to large scale funding).

The benefits of increased user participation in operating, maintaining, and designing irrigation systems are large. Irrigation professionals are usually wary of such participation, however, because they know it will lengthen the implementation period and may prejudice project results. However, evaluation has shown that neither implementation time nor implementation delay has had any significant effect on project outcome, while there are examples of inadequate designs and disruptions in implementation due to inadequate participation.

Design in the humid tropics

In view of the concentration of Bank irrigation lending in the humid tropics, particularly in Asia and for rice production, the study concentrated on the problems of these systems, particularly public surface systems. Private groundwater systems have fared better than public groundwater systems, but Bank lending for public groundwater systems has virtually stopped. The public surface irrigation systems of the humid tropics suffer from some special problems of their own and present some special opportunities. The most obvious is the operational chaos that prevails in many large systems that are supposed to make flexible water deliveries to individual farmers in response to their demands. The study's findings are:

- In Asian rice deltas, the Bank has often supported surface irrigation design more appropriate to drier conditions and to other crops while neglecting the potential benefits of local, low-lift pumping.

- Most of Asia's large, highly reticulated surface schemes designed to provide water on demand are operating chaotically. There is no consensus on the solution, except that discipline and simplicity are desirable.

- High water charges are one way to ration water supply, but there are other ways, such as designing systems to deliver less water than farmers demand.

- Surface systems without storage capacity have failed to generate benefits except where community cohesion is greatly enhanced by irrigator ownership, involvement in design, and operational responsibility.

Especially in the humid tropics, *the Bank should pay special heed to fostering discipline and simplicity, to integrating small-scale low-lift pumps into*

surface system design, and to promoting greater user involvement in all aspects of irrigation.

Where water conservation is called for, since it is unlikely that water charges will be raised enough to achieve the desired conservation, *the Bank and its borrowers should seek other ways to foster more efficient water use, including irrigation systems designed to furnish less water than demanded.*

The drainage conundrum

Bank irrigation policy has focused on drainage, but without much success except when lending has been devoted specifically to drainage. In view of the environmental problems caused by poor drainage, *the Bank should continue to stress drainage and finance it. The Bank should not insist on construction of drainage works before drainage is needed and before appropriate technical solutions are found and promising institutional arrangements are in place so as to ensure sustainability. Instead the Bank should sponsor experimentation and piloting of drainage schemes to identify adapted solutions —prior to large-scale construction.*

Notes

1. Ian Carruthers, "The Economic Case for Sustainable Irrigation Development," unpublished paper, Ashford (UK): Wye College, 1994.

2. A large number of other findings about evaluated Bank irrigation lending not recapitulated here include: the impacts on project outcome of unexpected prices and crop yields; absence of impact on project outcome of cropping intensity, implementation time, and delay; groundwater projects do slightly better than surface projects despite their smaller size; results of irrigation projects in arid areas are not better than those in humid areas, as had been expected; attention to gender is modest but growing in irrigation and sector work, but specific gender actions are not common; and professional assessments of irrigation problems revealed large areas of agreement, with differences stemming from the stage at which professionals deal with the project, not from their professional background.

Supplement

Introductory note

Feedback of evaluation results within the World Bank

Each study by the Bank's independent Operations Evaluation Department is reviewed by the Bank's management before being discussed by a committee of the board of executive directors. Management provides a detailed response to the recommendations outlined in the study. This response is discussed by the committee and, together with a record of actions promised and taken, is recorded in a "policy ledger" accessible to all Bank staff. The Bank's executive directors have requested that all published studies by the Operations Evaluation Department include a record of the management response and a synopsis of the committee's findings.

Management response

1. We consider the OED study to be a rich source of valuable insights into what makes irrigation projects succeed, or not. The report contains important lessons learned from completed projects that need to be taken into account in the implementation of ongoing projects and in the design of new projects. Many of these lessons have already been taken into account in recent or upcoming operations, as indicated in the attached matrix of our responses and actions proposed with respect to the OED ledger of recommendations. Particular emphasis has been put on building beneficiary participation into project design and implementation.

2. One reason for the early application of results of the OED study is the existence in the Bank of a long-standing network of irrigation and drainage professionals, not just engineers, but also economists, financial analysts, sociologists and management specialists. These people interact frequently, culminating in an annual December Seminar, recently expanded from irrigation and drainage to water resources management more generally. The preliminary results of the OED study were presented to the December 1993 seminar, and were received in the collegial spirit that has for long permeated the Bank's irrigation and drainage "community". Indeed, this community reaches beyond the Bank and includes the irrigation advisers to the main donor agencies, and key people in the irrigation agencies in the world's main irrigation countries. All of these people are striving to make irrigation investments even more effective than the impressive record of the last 50 years that has been so well documented in the OED report.

3. As indicated in the attached matrix, we agree with all of the recommendations in the OED report, although with some qualifications. On most of the recommendations the Bank has already taken action and we envisage corresponding follow-up actions on all the other recommendations. These actions do not entail any change in Bank policy (with one minor exception) nor any significant change in how the Bank carries out its work in irrigation and drainage. It is largely a matter of "doing more and better" in directions that are generally agreed. Borrowing countries do, however, differ considerably in their perceptions of how far and fast they can go in the desired directions. This calls for more concerted efforts of three kinds: (a) wider dissemination of best practice guidelines and other analytical work, including this OED report; (b) continued improvement of EDI seminars by highlighting success stories; and (c) further organization of inter-country study tours whereby those who may be hesitant to change can learn first hand from those who have changed.

OED Ledger
The World Bank and Irrigation

OED Recommendation	Management Response	Action Promised
1. To improve design and preparation of irrigation projects, good practice guides should incorporate the following study findings:		
(a) Future emphasis should be not on mere rehabilitation but on upgrading existing irrigation.	Agreed. The emphasis in irrigation lending is already switching from mere rehabilitation to upgrading, as demonstrated in the recent Indonesia Java Irrigation and Water Resource Management, Iran Irrigation Improvement, and Mexico Irrigation Sector Loan projects. Beyond the need to conserve water where it is scarce, (text, Ch. 9), beneficiary participation in project design indicates a strongly perceived need for upgrading. But upgrading to what (new) standard, at what cost and with what benefit? Consideration of the options will be part of the art of project design, using willingness to pay as one of the guiding principles. The options are spelled out in the May 1994 Technical Paper No. 246, *Modern Water Control in Irrigation.*	Project preparation will continue to examine upgrading options, based on the recent best practice guide. The guide has been widely disseminated in the Bank, in professional associations, and in other donor agencies, and will be further disseminated in borrowing countries.
(b) Continue to finance irrigation projects with large command areas.	Agreed. Small can be beautiful but large is not ugly. Continued financing of irrigation projects with large command areas is manifest in recent projects such as China Sichuan Agricultural Development, India Haryana Water Resources Consolidation, and Morocco Second Large-Scale Irrigation Improvement, and is envisaged in projects under preparation such as China Yangtse Basin Water Resources, Egypt Irrigation Improvement, and India Andhra Pradesh Irrigation III. Beneficiary participation in project design may, however, require that large command areas are disaggregated into smaller units for (for instance) upgraded rehabilitation if the perceived needs of different user groups are different.	Maintain current practice, with command area size to be determined by local characteristics, with no *a priori* bias for or against any particular size (although subject to differences in perceived needs of different beneficiaries).
(c) Avoid irrigation investments where macroeconomic distortions are serious and their removal improbable.	Agreed.	Maintain current practice of determining lending programs in country assistance strategies taking into account macroeconomic policy management.
(d) Consider expanding irrigation-related and independent health initiatives.	Agreed. A new finding in the report is that irrigation-related health initiatives have been more successful than is often acknowledged.	Follow up the December 1993 Water Seminar with further dissemination of this finding. Encourage Country Teams to examine explicitly whether irrigation-related health initiatives are better undertaken as part of irrigation projects or independently.

OED Recommendation	Management Response	Action Promised
(e) Exploit the potential synergy between irrigation and catchment improvement.	Agreed. The synergy between irrigation and catchment improvement is increasingly being sought in more "integrated" projects such as Brazil Ceara Water Resources, Ecuador Guayas, and Uruguay Irrigation and Natural Resources Management. Particularly large-scale applications of the synergy between irrigation and catchment improvement will be sought in the Aral Sea program, and in the Mexico Water Resources Management Project.	The text (Ch. 9) notes that a jurisdictional problem that impeded the synergy of joint irrigation and catchment development in certain regions prior to 1987 has been solved. Nonetheless, a similar jurisdictional problem remains in many borrowing countries, which Country Teams will attempt to address by advocating the river basin approach to water (and management of related natural resources) that is proposed in the September 1993 *Water Resources Management Policy Paper.*
(f) Whether public or private entities provide O&M, wherever feasible, they should receive their funding directly from irrigators.	Agreed. Satisfactory O&M is usually associated with financial autonomy. This is increasingly being sought and achieved, where the funding and execution of O&M is vested in effective water users associations, as demonstrated in Mexico and Senegal. O&M of major headworks or conveyance works that exceeds the domain of individual associations will require management by a federation of associations or a public entity, although in both cases the actual execution of the work could be contracted out. In both cases, direct funding from irrigators will improve the likelihood of success, as is being demonstrated in Mali and Mexico and is being sought in Indonesia and Vietnam.	Continue efforts to obtain direct funding by irrigators to entities responsible for O&M. Organize inter-country study tours between those who practice direct funding and those who do not. Maintain the direct funding theme in EDI seminars (see g).
(g) In lieu of covenants binding Borrowers to form irrigators' groups, foster the conditions associated with the formation of durable groups.	Agreed. This lesson has been learned, although there is still much debate about the sufficient conditions associated with the formation of durable groups; experimentation and piloting may be required. Such piloting has been successfully carried out in projects in the Dominican Republic, Mali and Senegal. Elsewhere, borrowers solved the problem themselves (Mexico) or are endeavoring through projects to apply such good practices to their own circumstances (Estonia and Turkey).	A Best Practices Paper on Water User Associations is under way for completion in FY96. A progress report on interim findings will be a main feature of the December 1994 Water Seminar. This work is a collaborative effort with CGIAR centers and, unlike much earlier work on this subject, pays special attention to the financial and legal conditions necessary for durable associations. Initial findings from this work have already been incorporated in EDI seminars in India and Pakistan in 1994. Next steps include an international seminar in Mexico in February 1995, and a national seminar in Morocco in March 1995.

OED Recommendation	Management Response	Action Promised
(h) Pay special heed to fostering irrigator discipline and design simplicity, to integrating small-scale, low-lift pumps into surface system design, and to promoting greater user involvement.	Agreed, although as noted in the text (Ch. 9), there is no consensus on the solution to the chaotic operation of large, highly-reticulated surface systems in the humid tropics other than that irrigator discipline and design simplicity are desirable. Progress can be expected as greater user involvement is sought in all aspects of irrigation, such as in the Indonesia Java Irrigation Improvement and Water Resource Management and Philippines Second Irrigation Operations Support projects. Simplicity of operations (not necessarily of design) should be sought, as demonstrated since many years in Iraq, Morocco and Tunisia, more recently in Egypt and Mexico and, in the more humid tropics, in projects such as India National Water Management and Malaysia Kenubu. Integration of small-scale, low-lift pumps into surface system design is being sought in the Egypt Irrigation Improvement, Indonesia Ground Water and Nigeria National Fadama projects.	Beyond seeking greater user involvement in all aspects of irrigation, including through wide dissemination of the Best Practices Paper on Water Users Associations, consideration of the options for fostering discipline and simplicity will be part of the art of project design. Integration of small-scale, low-lift pumps into surface system design will increasingly be sought in project preparation, where appropriate.
(i) New OPs and BPs should make it clear that O&M improvement is not a reason for greater irrigation cost recovery.	Agreed, although the practice for many years has been to seek greater irrigation cost recovery for reasons other than O&M improvement. This broader approach to irrigation pricing was highlighted in the *Water Resource Management Policy Paper*, which underscored the growing importance of pricing of increasingly scarce water in light of the returns to use in activities other than irrigation.	The forthcoming OP 6.00, *Cost Recovery and the Pricing of Public Goods*, will make it clear that O&M improvement is not a reason for greater irrigation cost recovery.
(j) Where water conservation is called for and water charges are unlikely to be raised enough to achieve it, seek other ways to foster more efficient water use.	Water conservation will be called for where water is scarce, and water scarcity will be a powerful motive to raise water charges to induce more efficient water use, as well as the adoption of economically viable technologies for water saving.	Rather than acquiesce in the view that water charges are unlikely to be raised enough to achieve water conservation, continue to seek to apply principles stated in the *Water Resources Management Policy Paper*.
2. Drainage warrants a separate handbook of good practices, which should emphasize that: (a) The Bank should continue to stress drainage and finance it.	Agreed. Although the difficulty is frequently one of convincing borrowing countries of the need for drainage investments. Nonetheless, projects approved during FY93 and FY94 include 10 operations with significant drainage components including two projects in both China and India, and projects in Chile, Indonesia, Iran, Mexico, Morocco and Pakistan. Projects under preparation with significant drainage components include China Yangtse Basin Water Resources, Estonia Agriculture and Forestry, and Pakistan National Drainage.	The December 1992 Technical Paper, No. 195, *Drainage Guidelines*, is a handbook of good practices in drainage techniques and how to make the often difficult choice among technical options. This paper has been widely disseminated in the Bank, in professional associations, and in other donor agencies, and will be further disseminated in borrowing countries. Bank staff are currently collaborating with the International Commission for Irrigation and Drainage on preparation of *Guidelines on Drainage and Environment*.

OED Recommendation	Management Response	Action Promised
(b) The Bank should not insist on construction of drainage before it is needed, before demand is demonstrated, or before institutional arrangement to ensure sustainability.	Agreed, although waiting "until demand is demonstrated" for subsurface drainage can be dangerous since costly remedial works may then be required. The formulation in the text (Ch. 8), which omits reference to demand having been demonstrated, is preferable. Surface drainage works are needed at the time of construction of irrigation systems.	Before construction of subsurface drainage works is envisaged on a large scale, institutional arrangements to ensure sustainability should be tested.
(c) The Bank should sponsor experimentation to identify solutions prior to large scale construction.	Agreed. Recognizing the lack of interest of many borrowing countries in technology research in irrigation and drainage, the Bank succeeded in establishing an international program in this area in 1991. The program has three main themes of which one—salinity control—is directly relevant to drainage in the arid tropics and another—maintenance—is indirectly relevant to drainage generally. The program's primary task is to persuade borrowers of the need and then help obtain financing for applied research. So far, funding commitments (from several sources) have attained $56 million, with a further $50 million in the pipeline.	The Bank will continue to seek funding for the International Program for Technology Research in Irrigation and Drainage.
3. To improve appraisal selection of irrigation projects: (a) Devise and use simple performance indicators for quantifying health, household water, dam safety, and catchment improvement benefits.	Agreed that such performance indicators be devised and used, although the benefit will come in improved project design rather than improved appraisal selection per se—in the sense of improving the prospects for selection of irrigation projects in comparison with other projects (as the text implies Ch. 9). Already, irrigation projects are subject to rigorous environmental assessment, with the emphasis on identifying possible negative effects and mitigating measures to be built into project design. Performance indicators would help reinforce efforts to "do no harm", but could also underscore win-win outcomes.	Define performance indicators for human health, household water, dam safety, and catchment improvement benefits of irrigation projects as part of the Next Steps Program on portfolio management, and refine indicators periodically. Urge project authorities to monitor such indicators and argue that it will be in their own interest, since such indicators will generally reveal unappreciated benefits of irrigation projects.
4. To improve implementation: (a) Supervision should focus more on irrigation construction quality and land acquisition.	The focus on construction quality and land acquisition will be enhanced when the circumstances require it. Construction quality supervision will require specialized knowledge that would not normally be available to supervision missions. Such specialized supervision input would cost $2.5 million/year (at 5sw/project, $5,000/sw including travel, for 100 projects). This is insignificant in absolute terms or when expressed as a percentage of total construction cost, but is not insignificant when expressed as an increment to the typical supervision budget for an irrigation project. By contrast, land acquisition will be a diminishing problem as projects increasingly deal with rehabilitation rather than development of new irrigated lands. This does not mean that rehabilitation entails no land acquisition, since realignment of canals or drains can entail significant land use changes, but the scale of the problem will be quite different in comparison with development of new irrigated land.	The focus of supervision activities will continue to be determined by Country Departments on a case-by-case basis. This will entail consideration of the importance of construction with respect to total project costs, and of reliability of in-country supervising engineers in ensuring that construction quality standards are met. Similarly recourse to specialized supervision of land acquisition will entail consideration of the relative magnitude of land acquisition in total project activities, and of the dependability of in-country expertise in ensuring that land acquisition problems are properly handled.

Committee on Development Effectiveness (CODE) response

The Committee on Development Effectiveness of the Bank's board of executive directors endorsed the OED report. Members noted that impact evaluations showed irrigation projects to be performing much less well than appeared from evaluations done at the completion of disbursements, and agreed on the need for more impact evaluations. While noting the correlation found between project size and economic return, they advised that the size of irrigation command areas should be determined case by case, according to local characteristics. Discussing the problem of excess demand for irrigation water, they were persuaded by arguments against rationing that were cited by Management at the Committee meeting, and noted that staff would continue applying the principles embodied in the Bank's Water Resources Management Policy Paper. On cost recovery, members emphasized that the amount of money collected was less important than how it was used; maintenance was often much better when financed and organized by irrigator groups. On drainage, the Committee noted the need for more pilot testing and monitoring and evaluation of pilot projects; it was important to set up local organizations or other approaches to effective O&M, to ensure drainage arrangements were sustainable. Several speakers called for greater beneficiary participation early in project preparation. Looking to the future, the Committee noted that the Bank's policy now took a more integrated approach to water management and use than was taken when most of the evaluated projects were approved. It noted statements by the DGO that this policy would enable the Bank to help countries improve their responses to environmental and social issues and to appreciate fiscal aspects; water projects might be smaller and the number might even decline, but this could lead to better quality.

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