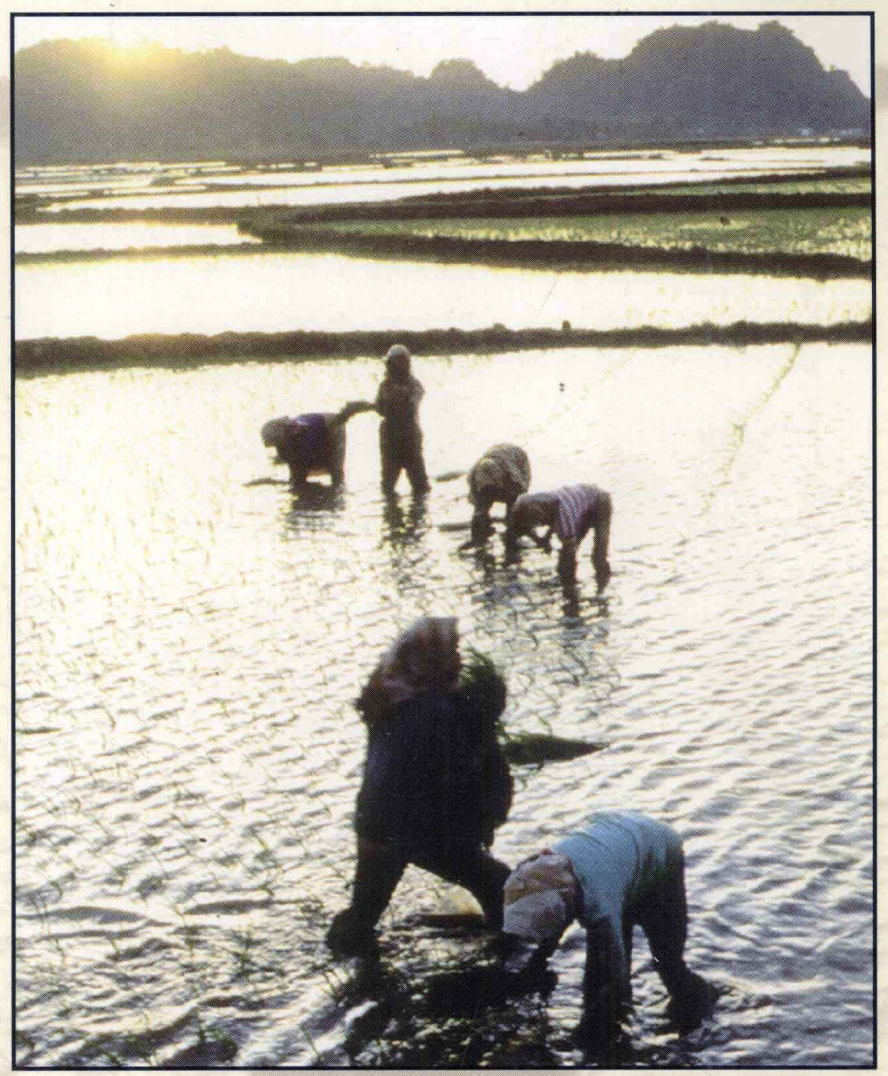
The World Bank and Irrigation



William I. Jones

OED

A World Bank Operations Evaluation Study

The World Bank and Irrigation

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Cover: Planting rice in Indonesia (Java).
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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

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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