

# **Paddy Irrigation and Water Management in Southeast Asia**

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Paddy Irrigation and Water Management in Southeast Asia

E. B. Rice

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Cover: Makeshift repairs of a canal by farmers in the Lampao irrigation scheme, northeast Thailand. Photo by Robert Yoder.

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## Foreword

This Operations Evaluation Department study examines the impact of irrigation investments, operation, and maintenance in Southeast Asia. The review covers six gravity irrigation schemes in Thailand, Myanmar, and Vietnam. To compare the organization and effectiveness of operation and maintenance (O&M) between irrigation and flood control, the study also reviewed the performance audit findings from flood control schemes at three sites in Bangladesh.

The dominant paradigm for government–operated, gravity–fed irrigation schemes in the humid tropics ascribes the low economic returns of irrigation projects to poor O&M and inadequate farmer organizations. Mismanagement by official agencies and anarchic distribution of water, caused by farmers' opportunistic behavior, is also viewed as a threat to sustainability.

Findings from the review contradict this model. To be sure, the six schemes are performing less well than expected at appraisal. But in most of them the performance gap cannot be attributed to decaying infrastructure or

wasteful water distribution. The more important reasons are falling paddy prices, overoptimism about the crop area to be served, and project design faults, including choice of unsuitable technology. Public agencies do a creditable job in operating and maintaining irrigation structures. And farmers, whether or not they are formally organized in water user groups, do cooperate to share water and to get essential maintenance done.

Though the sample is small, the similarity of the findings across the different schemes suggests that the following lessons may have wider application:

Tailor the prescriptions of programs for improving O&M to actual behavior.

Simplify technology.

Emphasize capacity building for effective water distribution associations, including tertiary federations.

Ensure that project engineering takes adequate account of hydrological, topographical, and social factors.

Favor crop diversification and intensification.

The results emphasize the value of co-production involving pragmatic approaches to operation and maintenance that bring together public irriga-

tion agencies, local authorities, and farmers to address specific problems and strengthen appropriate incentives.

ROBERT PICCIOTTO  
DIRECTOR GENERAL  
OPERATIONS EVALUATION

## Preface

This review of gravity-fed irrigation schemes supported by the World Bank in Thailand, Myanmar, and Vietnam was issued as an unpublished study in June 1996. A flood control and drainage project in Bangladesh was included for comparison. The evaluation team visited farmers and officials at the scheme sites as well as public irrigation authorities responsible for the schemes. Interactive group and household interviews were arranged in all four countries. Project completion reports, performance audit reports, and an earlier impact evaluation report provided a substantial baseline for the review.

The original version of the study included four annexes, the first three of which describe the impact study results in Thailand, Myanmar, and Vietnam. Annex A, which covers Thailand, concentrates on the Lam Pao scheme in the northeast, but brings in corresponding observations from the Maeklong River schemes (in particular, the right bank) west of Bangkok. Annex B, which covers Myanmar, concentrates on the Kinda scheme in the north, but also observes the smaller Kinmundaung and Azin tank sites in the north and southeast respectively. Annex C covers the Dau Tieng scheme near Ho Chi Minh City in Vietnam. Finally, Annex D adapts the summary of the Bangladesh project's performance audit report. These annexes are available from the Bank's Public Information Center.

This review covers only the essential details of the nine scheme sites and concentrates on a discussion of the salient features of the study domain.

## Prólogo

En este estudio del Departamento de Evaluación de Operaciones se examinan los efectos producidos por las inversiones en sistemas de riego, su funcionamiento y actividades de mantenimiento en Asia sudoriental. El examen abarca seis programas de riego por gravedad en Tailandia, Myanmar y Viet Nam. A fin de comparar la organización y eficacia de las actividades de operación y mantenimiento en los planes de riego y en los de control de inundaciones, se examinan también las conclusiones de la evaluación de resultados de algunos programas de control de inundaciones en tres localidades en Bangladesh.

Según el paradigma dominante sobre los programas públicos de riego por gravedad en las zonas tropicales húmedas, la baja rentabilidad económica de dichos sistemas se debe a las deficiencias operacionales y de mantenimiento y a la organización inadecuada de los agricultores. La mala administración por parte de los organismos oficiales y la distribución anárquica del agua —causada por el comportamiento oportunista de los agricultores— se consideran también como una amenaza para la sostenibilidad.

No obstante, las conclusiones del estudio contradicen este paradigma. Ciertamente es que los resultados obtenidos hasta ahora en los seis programas son menos satisfactorios de lo que se había previsto en la evaluación inicial. No obstante, en la mayoría de los casos estas deficiencias no pueden atribuirse al deterioro de la infraestructura o a una distribución dispendiosa del agua. Se deben, sobre todo, a la caída de los precios del arroz, al optimismo excesivo con respecto a las áreas de cultivo a las que debía llegar el riego, y a las deficiencias en la formulación de los proyectos, incluida la selección de tecnología inadecuada. La labor de operación y mantenimiento de los sistemas de riego realizada por los organismos públicos es digna de elogio. Además, los agricultores, ya sea que estén o no oficialmente organizados en grupos de usuarios, cooperan entre sí para compartir el agua y realizar las tareas de mantenimiento esenciales.

Si bien el tamaño de la muestra es reducido, las semejanzas entre los resultados permitirían aplicar con carácter más general las recomendaciones extraídas del estudio, a saber:

Acomodar al comportamiento real de los participantes las disposiciones de los programas para mejorar la operación y el mantenimiento.

Simplificar la tecnología.

Realzar el fortalecimiento de la capacidad a fin de mejorar la eficacia de las asociaciones de distribución de agua, incluidas las federaciones terciarias.

Velar por que se tengan en cuenta en los proyectos los factores hidrológicos, topográficos y sociales.

Promover la diversificación e intensificación de la producción agrícola.

Los resultados del estudio ponen de relieve la importancia de una coproducción caracterizada por la aplicación de enfoques pragmáticos de operación y mantenimiento que permitan la cooperación entre organismos públicos de riego, autoridades locales y agricultores a fin de abordar problemas específicos y mejorar los incentivos correspondientes.

ROBERT PICCIOTTO  
DIRECTOR GENERAL  
EVALUACIÓN DE OPERACIONES

## Prefacio

Esta reseña sobre los programas de riego por gravedad respaldados por el Banco Mundial en Tailandia, Myanmar y Viet Nam fue dada a conocer en forma de estudio inédito en junio de 1996. Para poder disponer de un punto de comparación, se incluyó un proyecto de control de inundaciones y avenamiento en Bangladesh. El equipo de evaluación visitó a los agricultores y funcionarios en las localidades de los proyectos, así como a los cargos públicos encargados de los mismos. Se realizaron entrevistas interactivas por grupos y hogares en los cuatro países. Los informes de terminación de proyectos, los de evaluación *ex post*, y uno anterior de evaluación de los efectos constituyeron un importante punto de referencia para el estudio.

En su versión original, el estudio consta de cuatro anexos. En los tres primeros se describen, respectivamente, los resultados del estudio en Tailandia, Myanmar y Viet Nam. El Anexo A, que se refiere a Tailandia, se centra en el proyecto de Lam Pao, en el noreste del país, aunque también se incluyen algunas observaciones sobre los proyectos del río Maeklong (especialmente en la ribera derecha), situados al oeste de Bangkok. El Anexo B, que está dedicado a Myanmar, se centra en el proyecto de Kinda, en el norte del país, aunque también incluye los proyectos de Kinmundaung y Azin, de menor escala. El Anexo C se refiere al proyecto de Dau Tieng, cerca de Ciudad Ho Chi Minh, en Viet Nam. Finalmente, el Anexo D es una adaptación del informe de evaluación *ex post* del proyecto de Bangladesh. Las personas interesadas pueden solicitar estos anexos al Centro de Información Pública del Banco Mundial.

Esta reseña sólo abarca los aspectos fundamentales de los nueve proyectos y consiste, principalmente, en un examen de los aspectos más sobresalientes del estudio.

## Avant-Propos

La présente étude du Département de l'évaluation des opérations analyse l'impact de l'exploitation et de l'entretien d'équipements d'irrigation en Asie du Sud-Est. Elle porte sur six périmètres d'irrigation par gravité situés en Thaïlande, au Myanmar et au Viet Nam. Aux fins de comparaison de l'organisation et de l'efficacité de l'exploitation et de l'entretien (E&E) entre équipements d'irrigation et de lutte contre les inondations, l'étude a également examiné les conclusions de l'évaluation rétrospective de trois aménagements de lutte contre les inondations, tous situés au Bangladesh.

Le modèle dominant attribue la faible rentabilité économique des projets de périmètres d'irrigation par gravité de zone tropicale humide, gérés par l'état, à la médiocrité de l'exploitation et de l'entretien et aux insuffisances des organisations d'agriculteurs. Une mauvaise gestion de la part des organismes publics et le caractère anarchique de la distribution de l'eau, conséquence d'un comportement opportuniste des agriculteurs, compromettraient aussi la viabilité de ces projets.

Les conclusions de l'étude réfutent ce modèle. Assurément, les six périmètres sont moins performants que prévu à l'évaluation. Mais, dans la plupart des cas, cet écart ne peut être attribué ni à la détérioration des infrastructures ni à des déperditions dans la distribution de l'eau. Il tient surtout à la chute des rendements du riz, à l'optimisme exagéré dont on a fait preuve quant à la superficie cultivée qui serait desservie, et à des défauts dans la conception du projet, y compris le choix de techniques inadaptées. Les organismes publics accomplissent un travail méritoire d'exploitation et d'entretien des ouvrages d'irrigation. Et les agriculteurs, qu'ils soient ou non officiellement organisés en groupements d'usagers de l'eau, coopèrent véritablement, quand il s'agit de partager l'eau et d'effectuer l'entretien indispensable.

Bien que l'échantillon soit modeste, la similarité des conclusions pour les différents périmètres laisse à penser que les enseignements énumérés ci-dessus ont une portée générale:

Il faut adapter les recommandations d'amélioration de l'E&E figurant dans les programmes aux comportements constatés.

Il faut employer des techniques plus simples.

Il faut renforcer les capacités dans une perspective de mise en place d'associations de distribution efficaces, y compris de fédérations d'usagers tertiaires.

Il faut faire en sorte que la conception technique du projet prenne correctement en compte les facteurs hydrologiques, topographiques et sociaux.

Il faut favoriser la diversification et l'intensification des cultures.

Les résultats mettent avant tout en évidence la valeur de partenariats faisant appel à des conceptions pragmatiques de l'exploitation et de l'entretien qui associent organismes publics d'irrigation, collectivités locales, et agriculteurs à la solution de problèmes précis et renforcent les incitations appropriées.

ROBERT PICCIOTTO  
DIRECTEUR GÉNÉRAL  
ÉVALUATION DES OPÉRATIONS

### Préface

Le présent examen de périmètres d'irrigation par gravité financés par la Banque mondiale en Thaïlande, au Myanmar, et au Viet Nam a été diffusé officieusement en juin 1996. Un projet de drainage et de lutte contre les inondations situé au Bangladesh y était traité à titre de comparaison. L'équipe d'évaluation a rencontré agriculteurs et responsables locaux sur les sites des périmètres, ainsi que les fonctionnaires des organismes publics en charge de ces périmètres. Des entretiens interactifs avec des groupes et des ménages ont été organisés dans les quatre pays. Les rapports de fin d'exécution des projets, les rapports d'évaluation rétrospective et un précédent rapport d'évaluation d'impact ont fourni à l'étude une documentation de référence substantielle.

La version initiale de l'étude comportait quatre annexes, dont les trois premières décrivaient, respectivement, les résultats de l'étude d'impact en Thaïlande, au Myanmar et au Viet Nam. L'Annexe A, relative à la Thaïlande, porte surtout sur le périmètre de Lam Pao, au Nord-Est, mais comporte, en parallèle, des observations sur les périmètres de la rivière Maeklong (en particulier celui de la rive droite), à l'ouest de Bangkok. L'Annexe B, relative au Myanmar, porte surtout sur le périmètre de Kinda, dans le Nord, mais traite aussi des sites de superficie réduite (Kinmundaung et Azin) alimentés par réservoir, dans le Nord et le Sud-Est. L'Annexe C porte sur le périmètre de Dau Tieng, proche d'Hô Chi Minh-Ville au Viet Nam. Enfin, l'Annexe D est une adaptation du résumé du rapport d'évaluation rétrospective du projet du Bangladesh. On peut se procurer ces annexes auprès du Centre d'information du public de la Banque mondiale.

La présente étude ne couvre que les aspects essentiels des six périmètres et est axée sur la discussion des aspects marquants du domaine étudié.

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## Abbreviations and Acronyms

BWDB	Bangladesh Water Development Board
ERR	Economic rate of return
FCD	Flood control and drainage
ID	Irrigation Department (Myanmar)
IIMI	International Irrigation Management Institute
NEWMASIP	North–East Water Management and System Improvement Project
O&M	Operation and maintenance
OED	Operations Evaluation Department
PAR	Performance audit report
PCR	Project completion report
RID	Royal Irrigation Department (Thailand)
SAR	Staff appraisal report
WASAM	Water allocation scheduling and monitoring program
WDR	World Development Report
WUG	Water user group

## Summary

The objective of this study is to assess the agro–economic impacts of investments in gravity–fed irrigation schemes in the paddylands of Southeast Asia, and to determine whether and how the quality of operation and maintenance (O&M) services influences the sustainability of those impacts. The study team selected six gravity–fed irrigation schemes with reservoirs for water storage in Thailand, Myanmar, and Vietnam. Four were large schemes—at least 40,000 hectares—and the other two were small tanks of about 1,000 hectares. [1](#) The six

schemes, which were widely dispersed across the region, were chosen for their variety and not their representativeness. Nevertheless, the findings were similar at all sites, which suggests that the lessons learned have wider application. The study included an audit of a flood control and drainage project at three sites in Bangladesh to identify differences in O&M organization and effectiveness between irrigation and flood control. Map 1 shows all nine scheme sites.

Field work was carried out in three phases in late 1994 and early 1995. An Operations Evaluation Department (OED) impact study team comprising Bank staff and international and local consultants visited farmers and officials at the scheme sites and pertinent public irrigation authorities. The field work had a participatory orientation, as the team arranged interactive group and household interviews in all four countries. The field work was also carried out rapidly: on average the team spent one-and-a-half weeks at each site.

### **O&M Performance: The Current Model**

With few exceptions, O&M performance by both agencies and irrigators on the large, government-operated, gravity-fed irrigation schemes in Southeast Asia is dismal. This conclusion confirms, but goes beyond, the frequent reports of degraded public infrastructure in developing countries, particularly irrigation structures. Measures to reverse the problem of "rusting, crumbling infrastructure" were central concerns of the World Bank's *World Development Report 1994: Infrastructure for Development* (World Bank 1994, 4).

Poor O&M and lowered benefits from irrigation investments are causally linked. A recent report (Jones 1995) reviewed not only the Bank's record, but experience in similar non-Bank projects throughout the world. The review looked in particular at the problems of paddy irrigation O&M in the humid tropics of Asia. It focused on alarming behavioral patterns that suggest that unusually intense irrigator resistance to O&M design standards degenerates into anarchy and chaos.

Social scientists have paid increasing attention to the role of formal and informal associations of beneficiaries of public assets. Nowhere is this more evi-

*The literature suggests that O&M performance on the large, government operated, gravity-fed irrigation schemes in Southeast Asia is dismal ...*

dent than in the literature on irrigation, where researchers have attempted to define the characteristics of association that promote improved O&M. Elinor Ostrom's seminal publication, *Crafting Institutions for Self-Governing Irrigation Systems* (Ostrom 1992), offers eight design principles. Researchers both within and outside the Bank have prepared other lists of conditions for success. In the vanguard is the International Irrigation Management Institute, established in Colombo, Sri Lanka, in 1984 with international funds and a mandate to study all aspects of irrigation organization and management. The institute has led the way in promoting the *transfer* of certain O&M responsibilities by public agencies to water user groups (WUGs). Whereas the literature conveys a sense of hope that O&M will improve with greater participation by farmers, it is less optimistic in its assessments of the prospects for public agency performance. Observers generally believe that deep-seated cultural features of irrigation bureaucracies inhibit effective O&M work.

In short, the dominant model is one of incompetent bureaucracies combined with nonexistent or weak irrigator associations struggling, largely without success, to impose a sophisticated O&M routine upon opportunistic farmers, with the result that production benefits attributable to the irrigation are far below their potential. Inevitably, this model guided the design of the impact study.

### **Agro–Economic Impacts of the Six Schemes**

The predominant crop in all the schemes is paddy, and they have many other similarities. The most important distinguishing factor is the degree of water abundance or scarcity at the reservoir level compared with the area to be irrigated. Four of the schemes have more water than they use. The other two, located in the central dry zone of Myanmar, have much less than planned.

At four of the six sites, including three of the large ones, the areas supplied by the irrigation systems are significantly less than planned. Overoptimism, engineering errors, lower than normal rainfall, and failure to extend the tertiary canals are the leading explanations, but vary in importance from site to site. Cropping intensities are also substantially lower than expected at three sites and are falling at a fourth. Without a high level of water recapture by small private pumps on fields beyond reach of the canals at Dau Tieng in Vietnam, that scheme would also show much lower average cropping intensities than projected. Only one scheme—a tank in Myanmar—has attained both its area and intensity targets. Paddy yields vary widely—between schemes and in comparison with expectations—but a weighted average for the wet and dry seasons at all the schemes is about 3.3 tons, or 85 percent of appraisal projections. However, even where soil conditions permit a shift to other field and specialty crops, farmers have not diversified out of paddy. Indeed, the concentration on paddy has increased.

Re–estimates of total scheme production of paddy and of a few other major crops at the two schemes where paddy is not completely dominant show that output is between 32 and 73 percent of appraisal estimates for five schemes (four of them are below 50 percent). The Myanmar tank is again the exception, but accounts for only 1,200 hectares out of a total of 207,000 hectares served by all six schemes. These production shortfalls undermine the economic rate of return for each scheme. The returns have also been driven down by the decline of the international price of rice between 1981 and 1986. Rice prices projected by the Bank in early 1995 for the mid– and late–1990s were only 30 percent of the prices projected when these projects

were appraised. The small upturn in late 1995 had little effect on the outcome. Together, the production shortfalls and lower prices result in rates of return at or below 7 percent for all schemes and a negative rate for one scheme.

### **Welfare Impacts**

Smallholder irrigated paddy can no longer provide the basis for a growing, or even stable, household economy. Farmers' incremental and total financial incomes from average size holdings range from about \$600 to \$2,000 per year. For Vietnam and Thailand, actual incomes are only 10 to 30 percent of appraisal estimates. The gap is lower in Myanmar, but mostly because appraisal projections were less ambitious. The implications vary; for example, the accelerating rate of outmigration from the two Thailand schemes contrasts with the stability of farm communities in Myanmar. However, as economies expand, irrigated paddy will not be able to compete with the incomes to be had from other employment opportunities.

### **O&M Performance: In Practice**

The field surveys concentrated on assessing agencies' and irrigators' performance in operating and maintaining the schemes. Team members noted the condition of canals and control structures; agency activity in allocating, distributing, and maintaining the flow of water; and the strengths and weaknesses of farmer O&M, especially as managed through informal associations, WUGs, and the few higher level federations of WUGs encountered. Overall, agency and irrigator performance appears to be substantially better than the image presented in the depressing model described earlier, and runs counter to allegations about farmers' disinterest in maintaining the irrigation assets that serve them, about feuds over water supplies that tend toward anarchy, and about an insurmountable bias against O&M among agency engineers.

*... but this study finds that O&M performance by agencies and irrigators is better than expected ...*

Even in the two schemes short of water and on the ends of the distributary canals in the other schemes where periodic water deficits appear despite an overall abundance of water, relationships between headenders and tailenders are more civil, accommodating, and fair than the model suggests. Advantaged irrigators do use their advantages and other irrigators do complain, but nowhere is the level of agitation alarming. The absence of a significant yield differential between the heads and tails of the watercourses underlies this low level of conflict, but it also suggests that water is reaching the tailenders.

This civility and relatively fair sharing of water has been accomplished even though the WUGs—which are present on all schemes—are not functioning at expected standards. The one exception is the internationally assisted sections of the scheme at Lam Pao, Thailand, where both the WUGs and the federated groups of WUGs organized along some of the distributaries meet the criteria laid down in Ostrom (1992) and clearly illustrate the improvements in the system and on the farms that follow effective organization. However, that level of organizational performance is unique among the schemes studied. Elsewhere at Lam Pao the WUGs accomplish their basic purpose, which is to keep the tertiary canals and watercourses open and to assemble labor to help the agency keep the larger canals clear, but they do not bring about any larger group cohesion or participatory activity. In Myanmar the WUGs are subordinate to the village councils and do not seek or achieve any higher

purpose. In Vietnam the WUGs are barely more than arms of the provincial irrigation authority. In short, strong WUGs are not a primary cause of the relatively successful O&M activity observed in the schemes studied. Farmers cooperate to achieve at least basic O&M objectives regardless of the level of maturity of the formal organization.

The contrast with the flood control schemes is instructive. In Bangladesh no attempt was made to form user groups associated with the flood control structures. The character of these structures and the benefits they provide are such that the beneficiaries do not even associate spontaneously to take care of them. The rate of degradation of the embankments, sluices, and other equipment is much more alarming than on the irrigation schemes. Moreover, with no official stimulus to promote farmer association to protect scheme assets, even the small irrigation inlets that were installed in the embankments at two of the three sites were, for the most part, neglected. Flood control O&M fits the model better than irrigation O&M.

*Poor O&M has a negligible impact on irrigated production ...*

### **O&M Influence on Agro–Economic Impacts**

Do the lapses and failures of operation and maintenance that the study team observed at all the sites contribute to lower production on the five poorly performing schemes? Again, the answers are unexpected. The study reveals no substantial negative constraints on irrigated production attributable to poor performance in O&M. Those O&M operations that are essential to keep sufficient supplies of water flowing to the great majority of the fields are adequately carried out. Yet it was the assumption that such a negative relationship did exist that prompted the study. In many other countries and on many other schemes the record is undoubtedly worse. However, the study suggests that a more discriminating analysis of O&M is warranted.

Clearly some components of O&M are under control and others are not. This report discusses four parts of an O&M matrix: agency operations, agency maintenance, irrigator operations, and irrigator maintenance. Common weaknesses are agencies' inability to keep some of the larger distributaries clean of silt and weeds throughout the cropping season and farmers' indifference to and neglect and destruction of tertiary gates. These failures are not systemic, however, and budget constraints, scheduling problems, and farm–level disincentives that require tailored and well–crafted solutions can usually explain them.

### Other Issues

The study covers a number of other issues, including the following:

The dismantling of complex technological control systems imported in the 1980s by foreign consultants. The schemes in Thailand and Myanmar had adopted a computerized water allocation scheduling and monitoring program (WASAM), but it proved to be too demanding on agency staff, and the protocol and measuring devices have been abandoned.

The ongoing attempt by a group of consultants in Thailand to modernize the control system by simplifying WASAM and substituting weirs and gates that require less human intervention. The modifications are of two types: fixed structures that have no adjustments and structures that ad-

just automatically to changes in water levels, each of which has its particular advantages.

The rejection by farmers of both rotations and gates. Rotations do occur, but they tend to break down under conditions of shortage, which is when they are most needed. The biggest problem is not the sharing of water within a tertiary system but among tertiaries.

The ability of one country's agencye—supported by the local administration—to bypass rotations altogether by simply cutting off tailend tertiaries. The irrigation agency informs the farmers in advance which of them cannot be supplied. In other parts of the world, shortages are usually shared equally.

The different degrees of success in mobilizing free irrigator labor to clean the larger canals. In Myanmar the authorities can gather large numbers of irrigating and nonirrigating farmers. Group work on distributaries is rooted in Burmese irrigation traditions.

### Findings and Recommendations

The finding that dominates the study has little to do with O&M. Given that they offer poor economics and low incomes, these paddy irrigation schemes face an uncertain future. Improved O&M performance will not rescue them. In fact, the study finds that this causality is being reversed. As the lack of competitiveness of paddy farming drives younger family members off the farms and the older members who stay behind concentrate on basic subsistence crops, social capital will erode and O&M standards are likely to suffer.

*... and even with improved O&M, irrigated paddy schemes face an uncertain future*

Based on the six schemes studied, the team has come up with a dozen recommendations grouped into four sets of proposals:

*Sharpen the response to O&M failures* by disaggregating O&M; identifying the poorly performing components; and dealing with disincentives specific to each, such as the tertiary gates that farmers below consider unfriendly.

*Simplify the infrastructure and operations technology* by converting to fixed and automatic controls that need less human intervention and by supporting authorities who plan with the farmers to abandon equitable rotations by rationing water during emergencies.

*Promote the transfer of management to farmers and their WUGs judiciously* by recognizing that organizing user groups pays off, but also accepting that immature WUGs cannot handle some management responsibilities.

*Improve household earnings* by diversifying cropping systems and supporting research, extension, and marketing services keyed to specialty crops and integrated, high-value farming.

The relevance of these recommendations beyond the schemes studied is uncertain, because they depend on cultural and institutional parameters that may be country specific and on engineering and agronomic considerations that may be project specific. For example, readers who commented on a draft of this report were concerned that the findings were both too rough on and too forgiving of O&M performance in the region. For the moment, these rec-

ommendations are better viewed as hypotheses. Additional empirical work is needed to validate the range of countries and projects within or outside the region for which these recommendations are appropriate. OED has proposed holding a regional workshop where validation would be one of the principal objectives.

### Note

1. Thailand: Lam Pao scheme in the northeast serving 50,000 hectares, Maeklong right bank scheme serving 40,000 hectares. Myanmar: Kinda scheme in the central dry zone serving 71,000 hectares, Kinmundaung tank in the central dry zone serving 1,000 hectares, Azin tank in the south serving 1,200 hectares. Vietnam: Dau Tieng scheme northwest of Ho Chi Minh City serving 45,000 hectares.

## Resumen

El objetivo de este estudio es evaluar los efectos agroeconómicos de las inversiones en sistemas de riego por gravedad en los arrozales de Asia sudoriental, así como determinar si la calidad de los servicios de explotación y mantenimiento influye, y de qué modo, en la sostenibilidad de esos efectos. El grupo de estudio escogió seis sistemas de riego por gravedad con embalses para el almacenamiento de agua en Tailandia, Myanmar y Vietnam. Cuatro de ellos eran sistemas extensos de 40.000 hectáreas como mínimo—y los otros dos eran embalses pequeños que abarcaban una superficie de alrededor de 1.000 hectáreas<sup>1</sup>. Los seis sistemas, que estaban muy dispersos por la región, se escogieron en razón de su variedad, no porque fueran representativos. Sin embargo, las conclusiones fueron similares en todos los emplazamientos, lo que sugiere que las enseñanzas extraídas son de más amplia aplicación. El estudio incluyó una evaluación de un proyecto de control de crecidas y drenaje en tres emplazamientos en Bangladesh con objeto de establecer las diferencias entre planes de riego y proyectos de control de crecidas en cuanto a la organización de la explotación y el mantenimiento y a la eficacia. En el mapa 1 se muestran los emplazamientos de los nueve sistemas.

El trabajo en el terreno se llevó a cabo en tres etapas a finales de 1994 y comienzos de 1995. Un grupo del Departamento de Evaluación de Operaciones de estudio de los resultados, compuesto por funcionarios del Banco Mundial y consultores internacionales y locales, visitó a agricultores y funcionarios en las zonas de los sistemas y a autoridades públicas competentes en materia de riego. El trabajo en el terreno se abordó mediante un enfoque participativo, ya que el grupo de estudio organizó entrevistas interactivas con familias y agrupaciones en los cuatro países. Dicho trabajo se realizó asimismo con rapidez: el grupo de estudio pasó un promedio de una semana y media en cada emplazamiento.

### Resultados De Los Mecanismos De Explotación Y Mantenimiento: Modelo Actual

Con contadas excepciones, los resultados obtenidos, tanto por organismos interesados como por los regantes, en materia de explotación y mantenimiento de los planes de riego por gravedad de gran extensión gestionados por el

gobierno en Asia sudoriental son pésimos. Esta conclusión confirma en forma aún más contundente los frecuentes informes relativos al deterioro de la infraestructura pública en los países en desarrollo, en especial de las estructuras de riego. Uno de los temas principales del *Informe sobre el Desarrollo Mundial 1994—Infraestructura y Desarrollo* (Banco Mundial 1994, 4) era la aplicación de medidas para combatir el problema de las infraestructuras mal conservadas y en decadencia.

Hay una relación de causa y efecto entre la explotación y el mantenimiento inadecuados y la disminución de los beneficios de las inversiones en sistemas de riego. En un reciente informe (Jones 1995) se examinó no sólo la experiencia del Banco, sino también la derivada de otros proyectos similares en todo el mundo en los que no participa el Banco. El examen prestó especial atención a los problemas relacionados con la explotación y el mantenimiento de planes de riego de arrozales en zonas tropicales húmedas en Asia. Se centró en pautas de comportamiento alarmantes que indican una resistencia poco común de los regantes a normas de diseño en materia de explotación y mantenimiento que degenera en la anarquía y el caos.

Los especialistas en ciencias sociales prestan cada vez mayor atención al papel de las asociaciones formales e informales de beneficiarios de bienes públicos. Esta tendencia es más evidente en los estudios sobre riego que en otras esferas; en dichos estudios los investigadores han tratado de definir las características de las asociaciones que promueven mejoras de la explotación y el mantenimiento. Elinor Ostrom, en su publicación *Crafting Institutions for Self-Governing Irrigation Systems* (Ostrom 1992), de fundamental importancia, presenta ocho principios de organización. Investigadores del Banco y ajenos a éste han preparado otras listas de condiciones para lograr resultados satisfactorios. A la vanguardia de este empeño está el Instituto Internacional de Ordenación del Riego, establecido con recursos internacionales en Colombo (Sri Lanka) en 1984, cuyo mandato consiste en estudiar todos los aspectos de la organización y ordenación del riego. El instituto ha llevado la iniciativa en lo relativo a la promoción de la transferencia de organismos públicos a las asociaciones de regantes de determinadas funciones de explotación y mantenimiento. Si bien los estudios transmiten la esperanza de que la explotación y el mantenimiento mejoren gracias a una mayor participación de los agricultores, son menos optimistas en sus evaluaciones de las posibilidades de que los organismos públicos funcionen con eficacia. Por lo general, los observadores consideran que ciertas características culturales profundamente arraigadas de las burocracias encargadas de la ordenación del riego impiden la explotación y el mantenimiento eficaces.

En síntesis, el modelo dominante está basado en burocracias incompetentes combinadas con la falta de asociaciones de regantes, o la existencia de asociaciones endebles de este tipo, que se esfuerzan, normalmente sin éxito, por importar prácticas avanzadas de explotación y mantenimiento a agricultores oportunistas, con el resultado de que el aumento de la producción debido al riego es mucho menor de lo que sería posible. Inevitablemente, este modelo guió la elaboración del estudio de los efectos.

### **Efectos Agroeconómicos De Los Seis Planes De Riego**

El arroz con cáscara es el cultivo predominante en todos los planes de riego, que son similares en muchos otros sentidos. El factor distintivo más importante es el grado de abundancia o escasez de agua de los embalses en relación con la superficie de regadío. Cuatro de los planes disponen de más agua de la que se utiliza. Los otros dos, ubicados en la zona seca central de Myanmar, tienen mucho menos agua de lo proyectado.

En cuatro de los seis emplazamientos, incluidos tres de gran tamaño, las superficies servidas por los sistemas son considerablemente menores de lo previsto. Un exceso de optimismo, errores técnicos, precipitaciones más escasas de lo normal y la insuficiente ampliación de los canales terciarios son las explicaciones principales de ese hecho, aunque la importancia de cada una

de ellas varía de uno a otro emplazamiento. La intensidad de cultivo es asimismo considerablemente inferior a lo esperado en tres de los planes y está disminuyendo en otro de ellos. De no ser por el elevado nivel de agua recuperada mediante pequeñas bombas privadas en campos fuera del alcance de los canales del sistema de riego de Dau Tieng, en Vietnam, la intensidad media de cultivo de ese plan sería también mucho menor de lo proyectado. Tan sólo un sistema de riego —uno de los embalses en Myanmar— ha alcanzado sus objetivos relativos a la superficie e intensidad. Los rendimientos del arroz con cáscara varían mucho tanto de un plan a otro como en comparación con las previsiones, pero la media ponderada de la estación de lluvias y la estación seca para todos los planes asciende a unas 3,3 toneladas, es decir, el 85 por ciento de las proyecciones iniciales. Sin embargo, incluso en los lugares donde las condiciones del suelo permiten adoptar otros cultivos especializados y de campo, los agricultores no han diversificado su producción. Por el contrario, la concentración de arroz con cáscara ha aumentado.

Según las estimaciones revisadas, la producción total de arroz con cáscara y de otros pocos cultivos importantes en los dos planes en donde el arroz no es el cultivo predominante es de entre 32 por ciento y 73 por ciento de las estimaciones iniciales en cinco de ellos (y en cuatro de los planes es inferior a 50 por ciento). El embalse en Myanmar constituye una vez más la excepción, pero sirve únicamente a 1.200 hectáreas, de las 207.000 hectáreas servidas en total por los seis planes. Esa insuficiencia de la producción afecta adversamente la tasa de rendimiento económico de cada plan. Los rendimientos han disminuido asimismo a causa del descenso del precio internacional del arroz con cáscara entre 1981 y 1986. Las proyecciones de precios del arroz durante la segunda mitad de los años noventa realizadas por el Banco a comienzos de 1995 representaban únicamente el 30 por ciento de los precios previstos cuando se evaluaron inicialmente los planes de riego. El pequeño aumento que se produjo a fines de 1995 no afecta mucho los resultados. La insuficiencia de la producción, unida a la baja de los precios, tiene como consecuencia tasas de rendimiento del 7 por ciento o menos en todos los planes y una tasa negativa en uno de ellos.

### **Efectos En El Bienestar**

La producción de arroz de regadío en pequeñas explotaciones no puede seguir proporcionando la base de una economía familiar en crecimiento, ni tan siquiera estable. Los ingresos incrementales y los ingresos financieros totales de los agricultores con establecimientos de tamaño medio oscilan entre US\$600 y US\$2.000 anuales. En los casos de Vietnam y Tailandia, los ingresos reales ascienden a tan sólo entre el 10 por ciento y el 30 por ciento de las estimaciones iniciales. La diferencia es menor en Myanmar, pero ello se debe principalmente a que las proyecciones iniciales eran menos ambiciosas. Las consecuencias de esta situación varían: por ejemplo, la creciente tasa de emigración de las zonas de los dos planes de riego en Tailandia contrasta con la estabilidad de las comunidades agrícolas de Myanmar. Sin embargo, a medida que las economías crezcan, la producción de arroz de regadío no podrá competir con los ingresos que proporcionarán otras oportunidades de empleo.

### **Resultados De La Explotación Y El Mantenimiento En La Práctica**

Las encuestas sobre el terreno se concentraron en la evaluación de los resultados logrados por los organismos y los regantes en la explotación y el man-

tenimiento. Los integrantes del grupo de estudio observaron las condiciones de los canales y las obras de regulación; las actividades de los organismos en las esferas de asignación, distribución y mantenimiento del caudal de agua; y las ventajas y los inconvenientes de que la explotación y el mantenimiento sean gestionados por los agricultores, especialmente por medio de asociaciones informales, asociaciones de regantes y las pocas federaciones de mayor nivel de asociaciones de regantes encontradas. En general, al parecer los resultados de los organismos y regantes son considerablemente mejores de lo que el deprimente modelo descrito antes permitiría esperar y esto contradice las observaciones sobre el desinterés de los agricultores en relación con el mantenimiento de las obras de riego de las que se benefician, a los desacuerdos relacionados con el surninistro de

agua que lindan con la anarquía, y a la oposición inquebrantable de los ingenieros de los organismos a los mecanismos de explotación y mantenimiento.

Incluso en los dos planes de riego con déficit de agua y en los tramos de cola de los canales secundarios del resto de los planes, donde periódicamente hay escasez de agua a pesar de la abundancia habitual, las relaciones entre los usuarios de los tramos de cabecera y los de los tramos de cola son más corteses, conciliatorias y equitativas de lo que revela el modelo. Los regantes más favorecidos aprovechan sus ventajas y otros regantes se lamentan, pero el nivel de malestar no es alarmante en ningún lugar. La falta de diferencias significativas de rendimiento entre los tramos de cabecera y los de cola de las acequias explica ese reducido nivel de conflictos y revela además que el agua llega a los tramos de cola.

Esa urbanidad y el reparto relativamente equitativo del agua se han logrado pese a que el funcionamiento de las asociaciones de regantes, que existen en todos los planes de riego, no está a la altura de lo esperado. La única excepción son las secciones del plan de riego de Lam Pao (Tailandia) que reciben asistencia internacional, en las que tanto las asociaciones de regantes como los grupos federados de asociaciones de regantes organizados en torno a algunos de los canales secundarios cumplen los criterios expuestos en la obra de Ostrom (1992) e ilustran con claridad las mejoras en el sistema y en las explotaciones que una organización eficaz permite lograr. Sin embargo, ese nivel de organización es único entre todos los planes analizados. En otros puntos del sistema de Lam Pao, las asociaciones de regantes cumplen su objetivo fundamental, que consiste en mantener expeditos los canales terciarios y las acequias y en proporcionar mano de obra para ayudar al organismo competente a mantener despejados los canales mayores, pero no dan lugar a una mayor cohesión entre el grupo o a otras actividades participativas. En Myanmar las asociaciones de regantes están subordinadas a los consejos vecinales y no buscan ni alcanzan ningún objetivo de más trascendencia. En Vietnam las asociaciones de regantes son poco más que un instrumento de las autoridades provinciales en materia de riego. En resumen, la solidez de las asociaciones de regantes no es la causa primordial de los resultados relativamente buenos de las actividades de explotación y mantenimiento observados en los planes analizados. Los agricultores colaboran a fin de alcanzar al menos los objetivos básicos en el ámbito de la explotación y el mantenimiento, prescindiendo del nivel de madurez de la organización formal.

El contraste con los sistemas de control de crecidas es revelador. En Bangladesh no se hizo ninguna tentativa de formar grupos de usuarios en conexión con las estructuras de control de crecidas. El carácter de esas estructuras y los beneficios que proporcionan son tales que los beneficiarios no se asocian ni siquiera de forma espontánea con miras a su mantenimiento. El nivel de deterioro de los diques, canales de desagüe rápido y otros equipos es mucho

más alarmante que en los sistemas de riego. Además, a causa de la falta de estímulo oficial para promover asociaciones de agricultores encaminadas a conservar las obras del sistema, incluso las pequeñas tomas de agua que se instalaron en los diques en dos de los tres sistemas fueron desatendidas por lo general. Los mecanismos de explotación y mantenimiento de los sistemas de control de crecidas se ajustan en mayor medida al modelo que los mecanismos de explotación y mantenimiento de los sistemas de riego.

### **Influencia De Las Pautas De Explotación Y Mantenimiento En Los Efectos Agroeconómicos**

¿Contribuyen las deficiencias y los defectos de la explotación y el mantenimiento observados por el grupo de estudio en todas las zonas a reducir la producción en los cinco planes cuyos resultados son insatisfactorios? Una vez más, las respuestas son inesperadas. El estudio revela que no pueden atribuirse a los malos resultados en materia de explotación y mantenimiento limitaciones sustanciales de la producción agrícola de regadío. Las operaciones de explotación y mantenimiento esenciales para que la gran mayoría de las tierras reciba suministros suficientes de agua se llevan a cabo de forma adecuada. Sin embargo, fue la presunción de que tal relación negativa existía lo que inspiró el estudio. En muchos otros países y en muchos otros planes las consecuencias son indudablemente peores. No obstante, el estudio sugiere que se justifica hacer un análisis más exhaustivo de las

operaciones de explotación y mantenimiento.

Es evidente que algunos componentes de las operaciones de explotación y mantenimiento están bajo control y otros no. En el estudio se examinan cuatro aspectos de un modelo de explotación y mantenimiento: la explotación por los organismos, el mantenimiento por los organismos, la explotación por los regantes, y el mantenimiento por los regantes. Las deficiencias comunes son la incapacidad de los organismos para mantener algunos de los principales canales secundarios limpios de limo y maleza a lo largo de la campaña agrícola y la indiferencia de los agricultores hacia las compuertas terciarias, la falta de atención a esas compuertas y su destrucción. Con todo, esas deficiencias no son sistémicas y suelen poder explicarse por las limitaciones pre-supuestarias, problemas de programación y desincentivos a nivel de las explotaciones que exigen soluciones específicas y bien concebidas.

### Otras Cuestiones

El estudio abarca otras varias cuestiones, incluidas las siguientes:

El desmantelamiento de complejos sistemas de control tecnológico importados en los años ochenta por consultores extranjeros. Los planes de Tailandia y Myanmar habían adoptado un programa computadorizado de programación y supervisión de la asignación de agua, denominado WASAM, que resultó una carga demasiado pesada para el personal de los organismos, por lo que el plan y los dispositivos de medición se han abandonado.

Un intento, que está realizando actualmente un grupo de consultores en Tailandia, con objeto de modernizar el sistema de control mediante la simplificación del programa WASAM y su sustitución por presas de derivación y compuertas que precisan una menor intervención humana. Las modificaciones son de dos tipos: estructuras fijas que no pueden

regularse y estructuras que se ajustan automáticamente a los cambios en los niveles de agua. Ambos tipos de estructuras ofrecen ventajas particulares.

El rechazo por los agricultores tanto de la distribución por rotación como de las compuertas. Existen sistemas de distribución por rotación, pero tienden a fracasar en condiciones de escasez, que es cuando resultan más necesarios. El mayor problema no es el reparto de agua dentro de un sistema terciario, sino entre diversos sistemas terciarios.

La capacidad del organismo de un país —con el apoyo del gobierno local— para evitar los turnos de rotación por completo interrumpiendo sencillamente el flujo a los sistemas terciarios del tramo de cola. El organismo de riego comunica con antelación a los agricultores cuáles de ellos se quedarán sin suministro. En otras partes del mundo, los efectos de la escasez se reparten generalmente por igual.

Los diferentes grados de éxito en la movilización de mano de obra no remunerada aportada por los regantes con miras a limpiar los canales mayores. En Myanmar las autoridades pueden reunir gran número de agricultores de regadío y de secano. El trabajo colectivo en los canales secundarios tiene raíces en los sistemas tradicionales de riego del país.

### Conclusiones Y Recomendaciones

La conclusión principal del estudio guarda poca relación con las operaciones de explotación y mantenimiento. Habida cuenta del escaso valor económico y los bajos ingresos que proporcionan, estos sistemas de riego de arroz con cáscara encaran un futuro incierto. La mejora de los resultados de su explotación y mantenimiento no los salvarán. De hecho, el estudio muestra que esa relación causal se está invirtiendo. A medida que la falta de competitividad de la producción de arroz con áscara hace que los miembros más jóvenes de las familias

abandonen las fincas y los miembros de mayor edad que permanecen en ellas se concentren en cultivos básicos de subsistencia, el capital social se irá erosionando y el nivel de las operaciones de explotación y mantenimiento tal vez se vea afectado.

Sobre la base de los seis planes estudiados, el equipo ha formulado una docena de recomendaciones agrupadas en cuatro conjuntos de propuestas:

*Perfeccionar la respuesta a las deficiencias en materia de explotación y mantenimiento* desagregando esas operaciones; determinando los componentes que no producen buenos resultados; y haciendo frente a los desincentivos específicos a cada uno de ellos, como las compuertas terciarias que suscitan la oposición de los agricultores.

*Simplificar la infraestructura y la tecnología de las operaciones* instalando controles fijos y automáticos que requieren una menor intervención humana y prestando apoyo a las autoridades que conciertan con los agricultores el abandono de turnos de rotación equitativos mediante el racionamiento del agua durante las situaciones de emergencia.

*Promover la transferencia de modo sensato de la capacidad de ordenación a agricultores y sus asociaciones de regantes*, y reconocer que la organización de grupos de usuarios es ventajosa pero reconocer también que las aso-

ciaciones de regantes poco maduras no pueden hacer frente a determinadas responsabilidades de ordenación.

*Aumentar los ingresos familiares* por medio de la diversificación de los sistemas de cultivo y la prestación de apoyo a los servicios de investigación, extensión y comercialización dirigidos a cultivos especializados y la producción agrícola integrada de alto valor.

La pertinencia de esas recomendaciones para otros sistemas aparte de los estudiados no es segura, ya que dependen de parámetros culturales e institucionales que pueden ser específicos de cada país, así como de consideraciones técnicas y agronómicas que pueden ser específicas de cada proyecto. Por ejemplo, algunas personas que leyeron un borrador del presente informe e hicieron observaciones al respecto opinaron que las conclusiones eran demasiado críticas de los mecanismos de explotación y mantenimiento de la región; otras opinaron que las conclusiones eran demasiado benévolas. Por el momento, sería más apropiado considerar esas recomendaciones como hipótesis. Son necesarios estudios empíricos adicionales para determinar el conjunto de países y proyectos, tanto en esa región como en otras zonas, a los que son aplicables estas recomendaciones. El Departamento de Evaluación de Operaciones ha propuesto la celebración de un seminario regional que tenga como uno de sus objetivos principales la convalidación de dichas recomendaciones.

### Nota

1. Tailandia: plan de riego de Lam Pao, en el nordeste, que sirve una superficie de 50.000 hectáreas; plan de riego de la margen derecha del Maeklong, que sirve una superficie de 40.000 hectáreas. Myanmar: plan de riego de Kinda, en la zona seca central, que sirve una superficie de 71.000 hectáreas; embalse de Kimmundaung, en la zona seca central, que sirve una superficie de 1.000 hectáreas; embalse de Azin, en la zona meridional, que sirve una superficie de 1.200 hectáreas. Vietnam: plan de riego de Dau Tieng, al noroeste de Ciudad Ho Chi Minh, que sirve una superficie de 45.000 hectáreas.

## Résumé

La présente étude a pour objet d'évaluer l'impact agro-économique d'investissements réalisés dans des périmètres irrigués par gravité des rizières d'Asie du Sud, et d'établir si la qualité des services d'exploitation et d'entretien (E&E) influe sur la pérennité de cet impact, et dans quelle mesure. L'équipe chargée de l'étude a choisi six périmètres d'irrigation par gravité alimentés par des retenues de stockage de l'eau en Thaïlande, au Myanmar et au Vietnam, dont quatre grands périmètres, couvrant au moins 40.000 hectares, et deux petits, d'environ 1.000 hectares<sup>1</sup>, alimentés par des réservoirs. Les six périmètres, qui étaient largement dispersés dans toute la région, avaient été choisis non pour leur représentativité mais pour leur diversité. Il n'en reste pas moins que les résultats ont partout été analogues, ce qui laisse à penser que les enseignements tirés ont une portée générale. L'étude comportait aussi un audit d'un projet de drainage et de lutte contre les inondations sur trois sites du Bangladesh, pour établir les différences existant dans l'organisation et l'efficacité de l'exploitation et de l'entretien dans le cadre de l'irrigation et dans celui de la lutte contre les inondations. Les neuf sites sont indiqués sur la Carte 1.

Les travaux sur le terrain se sont déroulés en trois étapes, à la fin de 1994 et au début de 1995. Une équipe d'étude d'impact du Département de l'évaluation des opérations, composée d'agents de la Banque et de consultants locaux et internationaux, a rencontré agriculteurs et responsables locaux sur le site des périmètres, ainsi que les fonctionnaires en charge de l'irrigation concernés. Le travail sur le terrain avait un caractère participatif, puisque l'équipe a organisé des entretiens interactifs avec des groupes et des ménages dans les quatre pays. Il a aussi été effectué rapidement: en moyenne, l'équipe a passé une semaine et demie sur chaque site.

### Performance De L'exploitation Et De L'entretien: Le Modèle En Vigueur

À de rares exceptions près, dans les grands périmètres d'irrigation par gravité de l'Asie du Sud gérés par l'état, la performance des organismes en charge comme des irrigants, est atterrante pour ce qui est de l'E&E. Cette constatation fait plus que confirmer les fréquents rapports faisant état de la dégradation des infrastructures publiques en général, et des ouvrages d'irrigation en particulier, dans les pays en développement. Les mesures à prendre pour enrayer la détérioration d'infrastructures qui rouillent et s'écroulent comptaient parmi les préoccupations centrales du *Rapport sur le développement dans le monde 1994 de la Banque mondiale—Une infrastructure pour le développement* (Banque mondiale 1994,4).

Médiocrité de l'E&E et baisse des avantages générés par les investissements d'irrigation ont un lien de causalité. Un rapport récent (Jones 1995) a non

seulement dressé le bilan de l'expérience de la Banque dans ce secteur, mais aussi celui de projets analogues, extérieurs à la Banque, partout dans le monde. L'étude s'est en particulier intéressée aux problèmes d'E&E de l'irrigation du paddy dans les zones tropicales humides de l'Asie. Elle a appelé l'attention sur des modes de comportement inquiétants qui semblent dénoter, de la part des irrigants, une résistance aux normes d'exploitation et d'entretien d'une vigueur inhabituelle telle qu'elle aboutit à l'anarchie et au chaos.

Les théoriciens des sciences sociales s'intéressent de plus en plus au rôle joué par les associations, informelles et structurées de bénéficiaires de biens publics. La manifestation la plus éclatante de cet intérêt, ce sont les travaux publiés sur l'irrigation, où les chercheurs se sont efforcés de définir les caractéristiques qui, dans une association, favorisent l'amélioration de l'E&E. L'étude originale d'Elinor Ostrom « *Crafting Institutions for Self-Governing Irrigation Systems* » (Ostrom, 1992) propose huit principes en vue de l'organisation de ces institutions. Tant à la Banque qu'en dehors, des chercheurs ont établi d'autres listes de conditions de réussite. À l'avant-garde de ces recherches se trouve l'Institut international de l'irrigation, créé à Colombo (Sri Lanka), en 1984, grâce à un financement international, avec pour mission d'étudier tous les aspects de l'organisation et de la gestion de l'irrigation. Il a joué un rôle moteur dans le transfert de certaines responsabilités d'E&E d'organismes publics à des

groupements d'usagers de l'eau (GUE). Si la documentation publiée inspire l'espoir que l'exploitation et l'entretien s'amélioreront si on y associe davantage les agriculteurs, elle évalue de manière moins optimiste les perspectives d'efficacité d'organismes publics. Pour la majorité des observateurs, les bureaucraties chargées de l'irrigation ont des caractéristiques culturelles profondément enracinées qui les empêchent d'assurer efficacement E&E.

En bref, le modèle dominant, c'est celui de bureaucraties incompétentes, allant de pair avec des associations d'irrigants faibles ou inexistantes s'efforçant à grand-peine d'imposer, le plus souvent sans succès, un programme d'E&E complexe à des agriculteurs opportunistes, d'où un impact positif de l'irrigation sur la production bien inférieur à son potentiel. Inévitablement, c'est ce modèle qui a présidé à la conception de l'étude d'impact.

### **Impact Agro-Économique Des Six Périmètres**

Si dans tous les cas la culture dominante c'est le paddy, les périmètres ont bien d'autres points communs. Ce qui les distingue, avant tout, c'est l'abondance ou la faiblesse des ressources en eau provenant de la retenue par rapport à la superficie à irriguer. Quatre des périmètres disposent de davantage d'eau qu'ils n'en utilisent. Les deux autres, situés dans la zone sèche centrale du Myanmar, ont beaucoup moins d'eau que prévu.

Sur quatre des six sites, y compris trois des grands périmètres, les superficies alimentées par les réseaux d'irrigation sont bien inférieures à ce qui était prévu. Excès d'optimisme, erreurs de conception technique, pluviosité inférieure à la normale et non-prolongation des canaux tertiaires en sont les principales explications, mais dans des proportions diverses selon les cas. L'intensité de culture est aussi sensiblement inférieure aux prévisions sur trois sites et elle est en diminution sur un quatrième. Si des petites pompes privées ne permettaient pas de récupérer beaucoup d'eau dans les champs non desservis par les canaux à Dau Tieng au Vietnam, ce périmètre afficherait aussi une intensité de culture moyenne bien inférieure aux prévisions.

Un seul périmètre—alimenté par un réservoir au Myanmar—a révisé ses objectifs, tant d'intensité de culture que de superficie irriguée. Les rendements du paddy sont très variables—entre périmètres et par rapport aux attentes—mais la moyenne pondérée pour la saison sèche et la saison humide de tous les périmètres est d'environ 3,3 tonnes, soit 85 pour cent des prévisions à l'évaluation. Toutefois, même lorsque les conditions pédologiques permettent l'adoption de nouvelles cultures de plein champ ou de cultures spéciales, les agriculteurs n'ont pas diversifié leur production. En fait, ils produisent même une plus forte proportion de paddy.

Après réestimation, pour l'ensemble des périmètres, de la production de paddy et de quelques autres grandes cultures dans les périmètres où le paddy ne domine pas de manière absolue, on arrive à des chiffres représentant entre 32 et 73 pour cent des estimations à l'évaluation pour cinq périmètres (quatre d'entre eux produisent moins de la moitié de ce qui était prévu). Le périmètre alimenté par un réservoir au Myanmar est encore une fois l'exception, mais il ne représente que 1.200 hectares sur les 207.000 desservis par les six périmètres. Ces déficits de production compromettent le taux de rentabilité de chacun des périmètres. La rentabilité a également été affaiblie par la baisse des cours internationaux du riz entre 1981 et 1986. Les projections de prix du riz établies par la Banque au début de 1995 pour le milieu et la fin des années 90 ne s'établissaient qu'à 30 pour cent des prix prévus lors de l'évaluation de ces projets. La légère remontée enregistrée à la fin de 1995 n'a guère eu d'effet sur les résultats. À eux deux, le déficit de production et la baisse des cours aboutissent à des taux de rentabilité de 7 pour cent ou moins pour l'ensemble des périmètres et à un taux négatif pour l'un d'entre eux.

### **Impact Sur Les Conditions De Vie**

Le production de paddy irrigué sur petite exploitation ne peut plus assurer un revenu croissant ni même stable à une famille. Le revenu financier total et additionnel des exploitants d'une superficie moyenne représente entre 600 et 2.000 dollars par an. Pour le Vietnam et la Thaïlande, les revenus effectifs s'élèvent seulement à 10 à 30 pour cent des prévisions de l'évaluation. L'écart est moindre au Myanmar, mais essentiellement parce que les

projections de l'évaluation étaient moins ambitieuses. Les conséquences varient: ainsi, l'accélération du taux de départ des deux périmètres de Thaïlande s'oppose à la stabilité des communautés agricoles du Myanmar. Toutefois, à mesure que les économies croissent, la culture irriguée du paddy ne pourra plus soutenir la comparaison avec les revenus que peuvent procurer d'autres emplois.

### **L'efficacité De L'Exploitation Et De L'Entretien: La Réalité**

Les enquêtes sur le terrain se sont attachées avant tout à évaluer la performance des organismes et des irrigants en matière d'exploitation et d'entretien des périmètres. Les membres de l'équipe ont pris note de l'état des canaux et des ouvrages de régulation de l'eau; de l'activité de l'organisme en matière de répartition, distribution et maintien de l'écoulement de l'eau; et des points forts et points faibles de l'exploitation et de l'entretien par les agriculteurs, en distinguant les cas de gestion par des associations informelles, des groupements d'usagers de l'eau et les quelques cas de fédérations à un niveau plus élevé de groupements d'usagers rencontrés. Darts l'ensemble, la performance des organismes et des irrigants apparaît sensiblement supérieure à l'image

qui ressort du modèle déprimant décrit plus haut et contredit les allégations relatives au manque d'intérêt que manifesterait les agriculteurs vis-à-vis de l'entretien des actifs de l'irrigation dont ils sont les bénéficiaires, aux querelles défavorables sur l'utilisation des ressources en eau qui tourneraient à l'anarchie et à la prévention insurmontable contre l'exploitation et l'entretien qu'on constaterait chez les ingénieurs de l'organisme d'irrigation.

Même dans les deux périmètres qui manquent d'eau et aux extrémités des canaux secondaires dans les autres périmètres où l'eau manque périodiquement malgré son abondance habituelle, les relations entre les exploitants d'amont et ceux d'aval sont plus civiles, plus conciliantes et plus loyales que le modèle ne l'indique. Les irrigants avantagés tirent effectivement parti de la situation, tandis que les autres se plaignent, mais nulle part ces remous n'atteignent un niveau alarmant. L'absence de différentiel de rendement significatif entre l'amont et l'aval des rigoles ou conduites de distribution explique que les relations soient peu conflictuelles, mais laisse aussi à penser que l'eau atteint bien les exploitants d'aval.

On constate ces relations civiles et ce partage assez équitable de l'eau bien que les groupements d'usagers de l'eau—qui existent dans tous les périmètres—ne fonctionnent pas aussi bien qu'on l'avait prévu. On note une seule exception: les zones du périmètre de Lam Pao (Thaïlande) qui bénéficient d'une aide internationale, où les groupements d'usagers et les fédérations de ces groupements organisés le long de certains des canaux secondaires satisfont aux critères énoncés dans l'étude d'Ostrom (1992) et où ils témoignent de manière évidente des améliorations que la mise en place d'une organisation efficace produit au niveau du périmètre et des exploitations. Toutefois, ce degré d'efficacité organisationnelle est sans pareil dans tous les périmètres étudiés. Dans les autres zones du périmètre de Lam Pao, les groupements d'usagers remplissent leur fonction principale, qui est de maintenir l'écoulement de l'eau dans les canaux tertiaires et les rigoles et d'assembler la main-d'oeuvre nécessaire pour aider l'organisme à maintenir dégagés les canaux principaux, mais ils n'entraînent pas de cohésion à un niveau plus large, pas plus qu'ils ne suscitent d'activité participative. Au Myanmar, les groupements d'usagers sont placés sous l'autorité des conseils villageois et ne cherchent ni ne parviennent à jouer un rôle plus important. Au Vietnam, ils ne sont guère plus que des agents de l'office provincial de l'irrigation. En bref, l'existence de groupements d'usagers solides n'explique pas au premier chef le caractère assez satisfaisant de l'exploitation et de l'entretien constaté dans les périmètres étudiés. Les exploitants coopèrent à la réalisation des objectifs minimums d'E&E quel que soit le degré de maturité de l'organisation officielle.

Le contraste avec les dispositifs de lutte contre les inondations est instructif. Au Bangladesh, on n'a rien fait pour essayer de former des groupements d'usagers en rapport avec les ouvrages de lutte contre les inondations. La nature de ces ouvrages et les avantages qu'ils procurent n'amènent même pas les bénéficiaires à s'associer spontanément pour les entretenir. Le rythme de détérioration des digues, écluses et autres matériels est beaucoup plus inquiétant que celui des dispositifs d'irrigation. En outre, en l'absence d'incitation publique à la formation

d'associations d'exploitants pour protéger les actifs du périmètre, même les petites prises d'eau d'irrigation installées dans les digues de deux des trois sites étaient, pour l'essentiel, négligées. L'exploitation et l'entretien des ouvrages de lutte contre les inondations correspondent mieux au modèle que l'E&E des périmètres d'irrigation.

### **Influence De L'Exploitation Et De L'Entretien Sur L'Impact Agro-Économique**

Les lacunes et échecs de l'exploitation et de l'entretien que l'équipe chargée de l'étude a pu constater sur tous les sites contribuent-ils à l'affaiblissement de la production dans les cinq périmètres aux résultats médiocres? Encore une fois, la réponse à cette question est inattendue. L'étude ne révèle pas que la médiocre performance de l'exploitation et de l'entretien nuise sensiblement à la production irriguée. Les activités d'exploitation et d'entretien qui sont indispensables pour acheminer suffisamment d'eau jusqu'à la grande majorité des parcelles sont effectuées correctement. Or, c'est l'hypothèse qu'il existait une relation de corrélation négative à cet égard qui est à l'origine de l'étude. Dans beaucoup d'autres pays et dans beaucoup d'autres périmètres, le bilan est assurément pire; mais l'étude semble indiquer qu'une analyse plus discriminante de l'exploitation et de l'entretien s'impose.

À l'évidence, certaines composantes de l'exploitation et de l'entretien sont maîtrisées, tandis que d'autres ne le sont pas. Le présent rapport examine quatre éléments d'une matrice d'exploitation et d'entretien: l'exploitation de l'organisme responsable de l'irrigation, l'entretien assuré par lui, l'exploitation des irrigants et l'entretien assuré par les irrigants. Les faiblesses communes tiennent à l'incapacité des organismes de débarrasser les principaux canaux secondaires de limon et d'herbes pendant la saison de culture, et à l'indifférence et à la négligence font font preuve les agriculteurs vis-à-vis des vannes tertiaires et à leur destruction. Ces échecs ne sont cependant pas systémiques et ils sont généralement attribuables à des contraintes budgétaires, des problèmes de calendrier, et, à l'échelle de l'exploitation, à des facteurs dissuasifs qui demandent des solutions bien pensées et adaptées.

### **Autres Problèmes**

L'étude aborde un certain nombre d'autres questions, dont:

L'abandon des dispositifs de commande technique complexes importés dans les années 80 par des consultants étrangers. Les périmètres de Thaïlande et du Myanmar avaient adopté un programme informatisé de planning et de suivi de l'affectation de l'eau (WASAM), qui s'est avéré trop exigeant pour le personnel de l'organisme, et le protocole et les instruments de mesure ont été abandonnés.

L'entreprise de modernisation du dispositif de commande engagée par un groupe de consultants en Thaïlande, qui consiste à simplifier le WASAM et à installer des déversoirs et vannes demandant une moindre intervention humaine. Les modifications sont de deux types: ouvrages fixes ne permettant pas d'ajustements et ouvrages s'adaptant automatiquement aux modifications du niveau de l'eau, chacun ayant ses avantages propres.

Le refus par les agriculteurs de la distribution par rotation et des vannes. La distribution par de l'eau à l'intérieur d'un réseau tertiaire, mais entre réseaux tertiaires rotation existe, mais elle tend à être abandonnée en cas de pénuries, lorsqu'elle est le plus nécessaire. Le plus gros problème, ce n'est pas le partage de l'eau à l'intérieur d'un réseau tertiaire, mais entre réseaux tertiaires.

L'aptitude de l'organisme d'un des pays—appuyé par l'administration locale—à se passer entièrement de rotations en interrompant purement

et simplement la distribution aux canaux tertiaires d'aval. L'organisme d'irrigation indique à l'avance aux agriculteurs lesquels d'entre eux ne seront pas alimentés en eau. Dans d'autres parties du monde, les pénuries sont en général partagées également.

Le degré de succès inégal remporté quand il s'agit d'obtenir des irrigants qu'ils participent bénévolement au nettoyage des canaux principaux. Au Myanmar, les autorités parviennent à mobiliser de nombreux agriculteurs irrigants et non irrigants, le travail collectif dans les canaux secondaires faisant partie de la tradition de l'irrigation birmane.

### Conclusions Et Recommandations

La conclusion majeure de l'étude n'a pas grand-chose à voir avec l'exploitation et l'entretien. Vu la médiocrité de leurs perspectives économiques et la faiblesse des revenus qu'ils assurent, ces périmètres d'irrigation ont un avenir qui s'annonce incertain. Améliorer la performance de l'exploitation et de l'entretien ne les sauvera pas. En fait, l'étude conclut à un renversement de ce lien de causalité. À mesure que le manque de compétitivité de la culture du paddy amène les jeunes à quitter l'exploitation familiale et que les générations plus âgées restées sur place se concentrent sur les cultures de subsistance de base, le capital social s'amenuisera et les normes d'E&E risquent fort de s'en ressentir.

S'appuyant sur l'étude des six périmètres, l'équipe a émis une douzaine de recommandations, regroupées en quatre séries de propositions:

*Affiner la réaction aux échecs de l'exploitation et de l'entretien* en décomposant l'E&E; en identifiant les composantes peu performantes; et en traitant les facteurs dissuasifs propres à chacune, tels que les vannes tertiaires auxquelles les agriculteurs sont hostiles.

*Simplifier l'infrastructure et la technique d'exploitation* en passant à des commandes fixes et automatiques faisant moins appel à l'intervention humaine et en apportant un appui aux instances compétentes qui prévoient avec les agriculteurs de passer de la distribution par rotation équitable au rationnement de l'eau en cas d'urgence.

*Promouvoir un transfert judicieux de la gestion aux agriculteurs et à leurs groupements d'usagers de l'eau* en étant conscient qu'organiser des groupements est valable, mais en acceptant aussi que les groupements naissants ne soient pas à même d'assumer certaines responsabilités de gestion.

*Élever les revenus des ménages* en diversifiant les systèmes d'exploitation et en apportant un appui à la recherche, à la vulgarisation et aux services de commercialisation axés sur les cultures spéciales et l'agriculture intégrée à forte valeur ajoutée.

Il n'est pas encore certain que ces recommandations soient applicables au-delà des périmètres étudiés, car elles sont fonction de paramètres culturels et institutionnels qui peuvent être propres à un pays, et de considérations techniques et agronomiques qui peuvent être propres à un projet. Ainsi, ceux qui ont émis des observations sur une version préliminaire du présent rapport s'inquiétaient que les conclusions sur la performance de l'E&E dans la région soient à la fois trop rudes et trop indulgentes. Pour le moment, il vaut donc mieux considérer ces recommandations comme des hypothèses. Il faudra

d'autres; travaux empiriques pour établir la gamme des pays et des projets, dans; la région et en dehors, auxquels ces recommandations sont applicables. Le Département de l'évaluation des opérations a proposé qu'un atelier régional soit organisé qui aurait pour principal objectif cette validation des recommandations.

### Note

1. Thaïlande: le périmètre de Lam Pao dans le nord-est, desservant 50.000 hectares, le périmètre de la rive droite du MaeKlong, desservant 40.000 hectares. Myanmar: le périmètre de Kinda dans la zone sèche centrale desservant

71.000 hectares, le bassin de Kinmundaung dans la zone sèche centrale desservant 1.000 hectares, le bassin d'Azin dans le sud desservant 1.200 hectares. Vietnam: le périmètre de Dau Tieng au nordouest de Ho Chi Minh City desservant 45.000 hectares.

### 1.— Introduction and Background

The objective of this study is to assess the agro-economic impacts of investments in gravity-fed irrigation schemes in the paddylands of Southeast Asia, and to determine whether and how the quality of operation and maintenance (O&M) services influences the sustainability of those impacts. The study was prompted in part by an expanding field of academic inquiry into the high rate of deterioration of public irrigation infrastructure everywhere in the developing world as a result of inadequate O&M by agencies and farmers (see Chapter 2). It was also prompted by the Operations Evaluation Department's (OED's) recent study of irrigation programs worldwide (Jones 1995), which highlighted the special characteristics of irrigation in the humid tropics and the failings of O&M services as two separate subjects that warranted additional review. This study assesses both subjects for six gravity-fed irrigation schemes with reservoirs for water storage in Thailand, Myanmar, and Vietnam.

The World Bank participated in only three such schemes in Myanmar and only one in Vietnam; all four are reviewed. The other two schemes selected were in Thailand, where the Bank has an older and larger portfolio of irrigation projects. The two chosen in Thailand are outside the river basin where most Bank investments were concentrated, but were the subject of two earlier OED reports that provide a foundation for follow-up research. The criterion for selecting schemes was that the investments had been completed at least five years ago. The three countries constitute a sample of experience in the region, but not a sample drawn purposefully to include a range of pre-identified levels of impact and O&M. The six schemes, which are widely dispersed in the targeted region (Map 1), were chosen for variety without guaranteeing representativeness. Nevertheless, the fact that the findings were relatively similar at all sites suggests that the lessons learned may have wider application.

An audit of a flood control and drainage project (FCD) at three sites in Bangladesh was included in the field work for the study. Irrigation was a minor component at two of the sites and not involved in the third. The purpose of including the audit was to help identify any obvious differences from and similarities in O&M organization and effectiveness in *protecting against excess water* and O&M aimed at *managing limited water supplies*.

Field work was carried out in three phases in late 1994 and early 1995. An impact study team that comprised Bank staff and international and local consultants visited farmers and officials at the scheme sites and pertinent public irrigation authorities. Government representatives assisted the team everywhere, and in Thailand and Bangladesh, foreign and local staff of two donor-supported technical assistance programs helped the team.

The field work had a participatory orientation, in the sense that the team arranged group and household interviews in all four countries in such a way that they exploited interactive interview design as much as possible. At all irrigation schemes (other than Azin in Myanmar) the team selected four to six sites that ostensibly covered a tertiary or small group of tertiaries based on hypotheses about representativeness appropriate to each scheme. The team organized group sessions with assistance from irrigation agencies and local governments, which helped to ensure that leaders, headenders, tailenders, men, women, and other characteristic irrigators were present. Participants at these sessions crafted wall maps of all homes, canals, difficult maintenance sections, and major gates. The maps gave shape to the discussion, during which the facilitators encouraged participants to seek agreement on important issues. These sessions, which lasted up to five hours, drew on participatory rural appraisal techniques. Rides and walks along distributaries, tertiaries, and field channels; conversations with farmers and

families in their fields and households; and contact with as broad a range of key informants as time allowed supplemented the group meetings.

The field work was carried out rapidly. On average, the team allocated one-and-a-half weeks to each major site, testing the effectiveness of rapid rural appraisal methodology in shortcutting the more extensive survey designs characteristic of earlier impact studies. The study does not include any control cases, and many of the statements about impact are based on comparison with appraisal projections, not with farmers' original conditions.

The study differs from standard impact study design in one other important respect. Whereas the standard model covers the whole range of welfare impacts, including a full discussion of social, institutional, and environmental change, this study is confined to agro-economic impacts. Within that limitation, it explores in some depth the key intermediate objective that ensures the sustainability of all the improvements: operation and maintenance. Subsequent reviews of impact will be strengthened by a better understanding of the processes that underpin satisfactory O&M performance. Nevertheless, the neglect of social and other noneconomic impacts limits the study's relevance.

This report focuses on the essential details of the six scheme sites and the Bangladesh flood control and drainage project and on discussion of the findings. As irrigation canal terminology differs from country to country, it adopts a common nomenclature that distinguishes the main canals; the primary and secondary distributaries; the tertiary canal systems below the tertiary turnouts (below as used here means behind, or served from, the tertiary turnout, not further down the distributary); and the networks of smaller channels that reach or nearly reach the farmers' fields. Where the distributaries discharge into small terminal command areas, distinguishing between tertiaries and field channels can be hard.

## 2.—

### Operation and Maintenance: Summary of the Literature

#### O&M Performance

The literature suggests that O&M performance by both agencies and irrigators on the large, government-operated, gravity-fed irrigation schemes in Southeast Asia is, with few exceptions, dismal. This conclusion is consistent with the alarming reports of degrading public infrastructure of all categories in developing countries, and of irrigation structures in particular.

An expanding body of literature is available on the causes of and solutions for communities' failure to maintain structures that governments have installed to serve them. This phenomenon is not unique to rural areas, but the case studies that have examined it have been concentrated there.<sup>1</sup> In the opening sentences of a recent book (Ostrom, Schroeder, and Wynne 1993, xv) on infrastructure policy, Elinor Ostrom, the dean of this school of inquiry, captures the pervasive nature of this problem:

As indicated by our subtitle [*Infrastructure Policies in Perspective* ], this volume addresses a practical, yet extremely complex, public policy issue confronting nearly all developing countries—the problem of insufficient maintenance of rural infrastructure facilities. Where maintenance is inadequate, public investments deteriorate long before their expected useful lives are completed. This premature deterioration in capital assets results in a further drain on the already scarce resources of low-income countries.

Measures to reverse this problem of "rusting, crumbling infrastructure" are also a central concern of the *World Development Report 1994—Infrastructure for Development* (World Bank 1994, 4), which begins its search for solutions with the statement:

Inadequate maintenance has been an almost universal (and costly) failure of infrastructure providers in developing countries.

The 1994 *World Development Report* (WDR 1994) looks at all infrastructure—power, telecommunications, and potable water supplies—as well as irrigation. Other Bank evaluation studies confined to the irrigation portfolio repeat the critique of O&M performance. Two other reports on management issues in irrigation make the same point, in both cases on the first page. A 1981 internal Bank document notes that overall, water management received inadequate attention in the irrigation projects reviewed. Insufficient provision for O&M had been made at appraisal and insufficient action had been taken during implementation. The second report (Bottrall 1981, i) points out that:

There are immense opportunities for improvements in the performance of irrigation projects through management reform and better water distribution.

A more recent OED review of the Bank's entire irrigation portfolio (Jones 1995) articulates a causal link between poor O&M and lowered benefits attributable to the irrigation investments. The review examined not only the Bank's record, but reports on experience with similar projects worldwide. It concludes:

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

(Jones 1995, 56).

The review looks in particular at the problems of irrigation O&M on paddy projects in the humid tropics of Asia, a subset of the Bank's portfolio that has attracted special interest in the last decade. The review's discussion of this regional record focuses on alarming behavioral patterns that suggest that these paddy projects face unusually intense irrigator resistance to O&M design standards. In the following quote, the review refers to the highly reticulated, gated systems popular in the region and common to all the irrigation schemes studied in this, subsequent, impact study:

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

(Jones 1995, 116).

*The literature contends that in the humid tropics, project designers should not only anticipate but should expect antisocial behavior from farmers ...*

The concepts of chaos and anarchy in the context of such systems have their roots in a paper by Robert Repetto (1986), one of the first to examine the impact of rent-seeking behavior on irrigation system performance. His discussion of opportunistic behavior by agency staff, as well as by farmers, matches other reports on rural public infrastructure of all types, including Ostrom's seminal works. Repetto refers to free riding (by farmers within the effective irrigation perimeter who do not participate in O&M, but cannot be excluded from receiving water), shirking (by farmers who do participate, but contribute less than they promised and expect to get away with it), moral hazard (of farmers who neglect maintenance routines because accelerated deterioration will prompt earlier government intervention), and corruption. (For a good discussion of moral hazards in maintenance in the study area see Bruns 1993, especially pp. 184-345.)

For paddy irrigation schemes in the humid tropics a special set of circumstances dictates that project designers should not only anticipate antisocial behavior, but should expect it to prevail. The argument is that these paddy farmers plant their wet season crop in the expectation of adequate rainfall, unlike their neighbors in the drylands of South Asia who depend on irrigation for planting in any season, and thus restrict their plantings to coincide with expected deliveries of canal water. When the rains fail, as they often do for periods during the wet season, the paddy farmers take desperate individual or group action to defend their standing crops; for example, they may "vandalize" the gates and other structures that stand between them and the limited canal supplies. Several recent reports by Bank staff (Berkoff 1990; Burns 1993) have convincingly described this anarchy model of wet season behavior, and Jones (1995) covers it exhaustively. These publications take the characterization of behavior with common public assets—such as free-riding—one step further.

In short, this model was the basis of both the justification for and the initial design of the impact study, whose objective was to review a set of large scale, gravity-fed irrigation projects in Southeast Asia to try to assess the inadequacy of O&M performance, the reasons for it, and the implications for production.

### Institutions

*...while also claiming that these very farmers, rather than public agencies, may hold the key to better O&M*

In response to the concern about the degradation of public infrastructure, social scientists have paid increasing attention to the role of formal and informal associations of beneficiaries in reversing that trend. This has been especially evident in the literature on irrigation, where researchers have been trying to define the characteristics of association that promote improved O&M by irrigators. This line of research has expanded rapidly only in the last decade. An experimental program undertaken by the Philippine National Irrigation Authority in the mid-1970s to prepare farmers to take over smaller schemes that it could no longer afford to manage is usually cited as the first deliberate government attempt to involve irrigators in a major way (see especially Korten and Siy 1988). Yet even in 1981, an internal Bank report on irrigation management issues failed to recognize the future importance of this developing field of social engineering; the report casually introduced the subject of farmer participation, noting that farmers *may* play a useful role in operating irrigation systems. Today, the universal assumption is that farmers *have to play* a central role in operation, as well as in management, or the irrigation scheme will not progress.

The study of the successes and failures of water user groups (WUGs) and the incentives and conditions that determine effective, collective farmer participation has attracted scholars and practitioners from across the globe. Ostrom's (1992) popular booklet suggests eight design principles. Her work is paralleled by other lists of explanations or conditions for success constructed by researchers inside and outside the Bank (see, for example, Cernea and Meizen-Dick 1992; Yoder 1994). The International Irrigation Management Institute (IIMI), established in Colombo, Sri Lanka, in 1984 with international funds to study all aspects of irrigation organization and management, including the roles of both irrigators and agencies, has taken the lead in such investigations.

IIMI has also led the way in promoting the *transfer* of certain O&M responsibilities from agencies to WUGs where conditions are appropriate, up to full turnover of the entire scheme (*turnover* as used here involves the transfer of responsibility for all assets, including the reservoir and headworks). Turnover is usually confined to smaller schemes, although it reached its fullest expression to date in the thus far successful turnover of the major public schemes in northwest Mexico. IIMI helped organize the International Conference on Irrigation Management Transfer in Wuhan, China, in September 1994. In the context of this impact study, transfer refers to both individual tertiary systems and collections of tertiary systems along a distributary. An alternative route to farmer participation in O&M is through *cost recovery*. A common institutional arrangement for recovering costs is to transfer full responsibility for irrigation facilities behind the tertiary turnout to the farmers, and to require farmers to contribute cash and/or labor to cover agency costs of operating and maintaining the rest of the system.

Whereas the literature conveys a sense of hope for improved O&M from greater farmer participation, assessments of public agency performance and

prospects for improvement are invariably grim. This judgment stems from cultural features of irrigation bureaucracies that observers see as inhibiting dedicated O&M work by agency managers and staff. Central government irrigation officials are usually engineers, and the literature—such as reports by the technical assistance team working on the Bangladesh Water Development Board's systems rehabilitation project—commonly describes them as more interested in building new systems than in maintaining existing ones. The task of overturning these preferences is described as daunting. Nevertheless, the WDR 1994 (World Bank 1994, 3233) highlights this situation as one where change is essential if infrastructure is to be sustained:

Where infrastructure is operated inefficiently and delivers poor service, the solution cannot be simply to tell suppliers to do more maintenance and to consult users. The weaknesses in infrastructure provision are inherent in the *incentives* built into current institutional and organizational arrangements, in which outputs and inputs are not closely measured, monitored, or managed, and suppliers do not depend on user satisfaction for reward.

The latter comment refers to infrastructure broadly. Jones (1995) cites a background study carried out for the WDR 1994 that compared incentive structures in irrigation agencies in India and the Republic of Korea and found a stark contrast: the Indian organization had virtually no incentives for conscientious work, while the Korean one was full of both individual and collective incentives. World Bank and other reports on irrigation agencies in Southeast Asia (Berkoff 1990; Bottrall 1981; Burns 1993; Murray–Rust and Vermillion 1989) describe institutions whose poor O&M performance reflects the absence of any strong incentives for improvement, much closer to the Indian than the Korean example.

*The literature also suggests that factors such as unreliable water supply and inappropriate technology act as disincentives to good farmer O&M*

The rapid research style of the impact study did not permit detailed examination of WUGs' incentives and norms of agency activity. Nevertheless, it was essential for the team to make a rough assessment of the quality of performance by both farmers' associations and scheme authorities. As Chapter 6 shows, the observations were structured in a four–cell matrix that treats agency and irrigator performance in both operation and maintenance separately. The initial hypotheses were that the individual impact case studies would reveal the same characteristics that are alleged to prevail throughout the region. This implies performance levels below standards that guarantee adequate O&M and reasonably efficient use of irrigation water. The team also assessed the status of and progress with transfer and cost recovery.

### **Contributing Factors**

The initial model that governed the design of the impact study was of disinterested bureaucracies combined with nonexistent or weak irrigator associations struggling, largely without success, to impose a sophisticated O&M routine upon opportunistic farmers, with the result that production benefits attributable to the distributed irrigation waters are far below their potential. That model had to be adjusted to reflect three other factors discussed in the literature—the unreliability of the main supply, the use of inappropriate technology along with faulty construction, and the declining profitability of irrigated farming—that can help depress farmer O&M performance. This impact study tries to examine the strength of each of these factors in determining both the quality of O&M and the influence of O&M on production.

### **Unreliability of the Main Supply**

Anthony Bottrall's (1981) report on the management and organization of irrigation projects emphasizes repeatedly that farmer follow through on O&M below the tertiary turnout is highly dependent on the quality of the service the agency provides at the turnout, that is, whether farmers can rely on it to provide the allocated water supplies. The report claims that the first condition for successful group action is for farmers to anticipate the benefits of a collective good that would otherwise be withdrawn, in particular, a predictable water delivery schedule. Agency inefficiency reflected in a variable water supply destroys farmers' confidence and weakens their commitment to O&M.

### **Inappropriate Technology and Faulty Construction**

Inappropriate technology and faulty construction are two other factors that explain poor O&M performance and that work independently of the chaos paradigm. On the one hand, critics allege that the reticulated gated structures under manual control that Bank-financed schemes in the humid tropics have normally installed to control water levels and water flows are ill-suited to the demands of small farmer paddy irrigation in either the wet season or the dry season. This has been a recurring theme in critiques by the Bank's own staff of the Bank's traditional design (see, for example, Plusquellec, Burt, and Wolter 1994). On the other hand, as noted in an internal Bank report following an earlier OED study of the Lam Pao scheme, the canals, structures, or both have often been badly constructed, usually because contractors have shortcut the design specifications with the connivance or indifference of the supervising agency. In either case, the system performs poorly, and no amount of O&M can fully restore the scheme's potential. Farmers respond to these faults by circumventing the inappropriate structures and reducing their commitment to maintenance.

### **Declining Profitability of Irrigated Farming**

The declining profitability of irrigated, especially paddy, farming has been increasingly prominent in the literature since the early 1980s. Unfortunately, the implications have not been incorporated into the discussions of O&M, transfer, and cost recovery. Some of OED's recent reports have followed this trend of reduced profitability. A good example is an internal document on the Thailand Irrigation XI and XII projects, which, according to Burns (1993, 783), who used the document as a source for his article, calls into question the "increasingly implausible assumptions about net impact." Jones (1995) returns to this subject frequently, highlighting the need to diversify out of rice in a world of low rice prices. A report by staff of the International Food Policy Research Institute (Rosegrant and Svendsen) referred to a series of econometric studies that attempted to explain the trend of public irrigation investments in four countries of South and Southeast Asia (Indonesia, the Philippines, Sri Lanka, and Thailand), and concluded that the most important causes of shrinking investments were the decline in the world rice price and the increasing costs per hectare of new irrigation development (see Rosegrant and Svendsen 1994).

### **Influence of O&M Performance on Production**

The literature refers often to the depressing effects of inadequate O&M on production. Many of the publications take for granted the causal and posi-

tive relationship between improved O&M and improved production, a reasonable assumption given that the operative variable—the supply of water—is usually in short supply, and the more that can be channeled to farmers' fields, the better the harvest. Nevertheless, the reports that Jones (1995) examined on O&M, WUGs, transfer, and improved technology do not provide any quantitative evidence of the impact of varying levels and qualities of O&M. What is missing is an anatomy of O&M that identifies which components are likely to have the greatest effect—in the short and long term—when agency and irrigator performance falls short.

*The literature assumes that better O&M leads to greater output, but does not back this belief with quantitative evidence*

In the absence of any guidelines for examining the relationship, the study team set up a hypothetical list of six patterns of suboptimal O&M behavior that could be depressing total irrigated crop production, namely:

Inappropriate and erratic rotation practices at all levels of turnout to subsidiary channels. This includes a concern about agencies' failure to continue whatever sophisticated control system had been installed.

Overuse of water on the fields, particularly, but not exclusively, on paddy.

Inadequate maintenance of irrigation structures—regulators, gates, and other controls—resulting in inefficient distribution of available water.

Inadequate repair of irrigation canals, resulting in excessive losses in conveyance.

Insufficient cleaning of canals and watercourses, also resulting in losses in conveyance to the fields.

Support of inefficient cropping patterns, especially by supplying water to paddy in seasons and fields where crops with lower water requirements could otherwise be cultivated.

Chapter 6 refers to these factors in trying to arrive at an assessment of the overall impact of O&M performance.

### **Note**

1. The original studies that anticipated this growing field of research dealt with the village commons and speculated on the conditions under which villagers could agree to collective action to prevent overstocking of livestock, and thus preserve common pastures and woodlands for the collective benefit of individual households. Clifford Hardin's (1968) article, "The Tragedy of the Commons," did the most to stimulate the subsequent debate. Ostrom (1996), in a paper presented at the World Bank's annual conference on development economics, provides a partial listing of more recent studies of the incentives that govern private and institutional treatment of public infrastructure.

### **3.— Scheme Sites and Infrastructure**

This chapter describes the schemes in each of the four countries.

#### **Thailand**

The *Lam Pao Scheme* in northeast Thailand covers about 50,000 hectares supplied from east and west bank main canals below a reservoir on the Lam Pao River, about 90 kilometers east of the regional center of Khon Kaen. The Royal Irrigation Department (RID) manages the scheme. The Bank participated in two projects, approved in fiscal 1974 and fiscal 1979, for stages I and II of the irrigation works (not the dam). The loans, for \$7.0 million and \$17.5 million, each covered several sites in the northeast, of which Lam Pao was the principal operation. Stage II was completed in 1986. Paddy still dominates everywhere; the pace of crop diversification has been disappointing. The reservoir capacity exceeds design requirements, and the designed tertiary grid is complete. Nevertheless, structural limitations and inefficiencies in delivery cause some tailend shortages. OED issued a

performance audit report (PAR) on Stage I in 1982 and an impact evaluation study of the whole scheme in 1990. The North–East Water Management and System Improvement Project (NEWMASIP), a technical assistance project for irrigation infrastructure rehabilitation financed by the European Community and based in Khon Kaen, currently supports Lam Pao. The assistance NEWMASIP provided to the impact study team allowed the team to test its field methodology at Lam Pao at the start of the study.

*This study looks at irrigation schemes in four countries*

The *Maeklong Right Bank Scheme* covers about 40,000 hectares supplied from two main canals on the right bank of the Maeklong River below a diversion weir just south of Kanchanaburi. An initial Bank–supported project financed the diversion dam and some construction on the west bank. Subsequent projects financed construction of two multipurpose dams in the Maeklong headwaters. The project under review, approved in fiscal 1979 for \$80 million, financed the extension of distributaries that the RID had already built with government funds on the east bank and the intensification of tertiary and on–farm work. This project (Thailand Irrigation Project XI) was completed in 1986. The system is fed from the river by the diversion weir with little storage, and flows are controlled at the two dams. Paddy dominates everywhere, as expected. Water supplies in the reservoirs are well above scheme demand, although releases from the dams are determined by electricity demand, and water shortages for irrigation occasionally occur. In 1990, OED issued a PAR on the project, which also discusses the development of the portfolio of Bank–supported irrigated projects in Thailand.

### Myanmar

The *Kinda Irrigation Scheme* was incorporated into a multipurpose project that financed a dam, a power plant, a transmission line, and canal construction to cover 79,000 hectares below the reservoir 90 kilometers south of Mandalay. The Irrigation Department (ID) manages the scheme. The project strengthened existing run–of–the–river diversion schemes originally built 1,000 years ago in the central dry zone, and extended the scheme on the west bank to former drylands. The project was approved in fiscal 1980 for \$90 million, and was completed in 1991. Paddyland dominates everywhere, even in the extension, which was planned for cotton and other irrigated field crops. The expanded irrigation infrastructure is overdimensioned with respect to reservoir supplies, and about 8,000 hectares of the design command area—all in the west bank extension—will probably never be adequately served. OED has not carried out an audit, but issued a project completion report (PCR) that covered the multipurpose project in 1991.

The *Kinmundaung* and *Azin tanks* were the only two works financed by the Bank's Tank Irrigation Project, which was intended to initiate a series of Bank–supported, multiple tank projects, but was never repeated. The Bank approved the project in fiscal 1993, the ID executed it, and it was completed, after long delays at Azin, in 1990. The Kinmundaung tank was designed to provide supplementary wet season supply to all 2,000 hectares in nominal command and dry season supply to more than half the 2,000 hectares. The irrigation works are overdimensioned in relation to inflows from the watershed to the tank, and the proportion of nominal command that will never be served is larger than at Kinda. Paddy still dominates in both seasons, despite plans for cotton and other field crops in the dry period. The Azin tank was designed to provide dry season irrigation to 350 hectares of upland orchards and 800 hectares of lowland paddy. Monsoon crops have adequate rainfall and did not need supplementary supplies. The tank is properly dimensioned and cropping targets have been reached. A water supply component for the town of Mudon near the Azin scheme was also completed, but consumer demand has grown slowly, and currently amounts to only 15 percent of appraisal projections. The Bank issued a PCR in 1991, and OED released its PAR in 1996.

### Vietnam

The *Dau Tieng Scheme* covers 60,000 hectares on the right bank of the Saigon River, immediately below a dam 65 kilometers northwest of Ho Chi Minh City. The Bank's credit for \$60 million was approved in fiscal 1979, and funded construction of the dam and the first phase of irrigation infrastructure. This phase was completed in 1986, and subsequent government investments have expanded the distributary grid from the east and west main canals to cover the 60,000-hectare nominal command area. Agencies of the central Ministry of Water Resources and the irrigation management companies of Tay Ninh and Ho Chi Minh City provinces shared responsibility for implementing the project and managing the scheme. Construction of tertiaries is well behind schedule, and only 45,000 hectares are actually supplied with water. Paddy dominates, although groundnut is an important second crop. As elsewhere, the pace of diversification into other crops has been disappointing. The reservoir supply is larger than required for the existing scheme, but other indirect uses downstream from Dau Tieng add to the benefits attributable to investment in the dam. OED issued a PAR on the project in 1991.

### Bangladesh

The flood control and drainage project in Bangladesh was the second in a series of four projects supported by the Bank as part of its investments in medium-scale flood control schemes. The three sites are scattered across the country, one each in the northwest (*Chalan Beel*, 38,000 hectares), the southwest (*Satla Bagda*, 21,000 hectares), and the northeast (*Hail Haor*, 19,000 hectares). The first two subprojects were traditional polders. The third was intended to provide protection against certain flood threats to crops grown around the permanent lake in the depression (the *haor*), but the works were later recognized to be poorly located, and the subproject will never serve its original purpose. The project was approved in fiscal 1981 for \$27 million equivalent and completed in 1989. It was implemented by the Bangladesh Water Development Board (BWDB), which is responsible for all public FCD and irrigation schemes in the country. As noted previously, OED's intent in incorporating this project in the review was to observe the behavior of officials and irrigators in the operation and maintenance of embankments and flood control structures (at Chalan Beel and Satla Bagda). The Bank issued a PCR in 1991, and OED completed its PAR in 1996.

## 4.—

### Operation and Maintenance: Systems and Performance

#### Agency Level

The *operational systems* for water allocation managed by public agencies depend in the first instance on the adequacy of water supply. Of the six irrigation sites in the study, two of the Myanmar sites experience continuing deficits. There, the ID cuts off farmers it cannot supply. It makes no attempt to allocate water equally to all farms through rotations. Elsewhere, the agencies allocate water proportionally to areas under command and try to meet the expected requirements of the prevailing cropping pattern.

*How well do the public irrigation agencies operate and maintain irrigation schemes?*

Measured against the allocation plan, the *operational performance* of public agencies on the mains and distributaries is acceptable. Because the agencies have handed over rotations below the tertiary turnouts and responsibility for dealing with localized scarcity to the irrigators at all the sites studied, the agencies avoid most claims of unfair treatment. In addition, as most schemes have adequate water, this position—once removed from decisions on distribution within the terminal command areas—has not reflected poorly on agency performance. Incidents of occasional discrimination against a tertiary group were reported at group sessions, but the team found

no evidence of pervasive discontent or of arbitrary and discriminatory rule. Distinguishing between performance against annual plans and against the original appraisal design is important. The lack of effective canal command over the entire area originally expected to receive water in four of the six sites means that the agencies will never be able to catch up with appraisal targets, even if water use is made more efficient. In two cases this is due to error in estimating inflows to the reservoirs, and in two cases to social factors that inhibit completion of the tertiary systems.

The study team had no opportunity to observe how the agencies in Thailand and Vietnam would react to conditions of severe water shortage, but they would probably enforce rationing when necessary. The Royal Irrigation Department's instructions to all field staff at Lam Pao to limit water applications to household uses and fish ponds during the 1993/94 dry season is an example. Other evidence from the same year's drought in Thailand—in the Chao Phraya basin—when RID pressed paddy and orchard farmers to take responsibility for dealing with unavoidable cuts imposed by RID in releases from the river, suggests that these government agencies do intervene in emergencies.

The prevailing *maintenance systems* the agencies provide are similar in scope and operate down to the tertiary turnout. Ambiguity about responsibility for the structures at those turnouts may explain a disturbingly high level of negligence in maintaining the tertiary gates. Dau Tieng is different. There the central (headworks and mains) and provincial (distributaries) irrigation

companies share responsibility. Everywhere, maintenance programs down to, but not including, the tertiary gates seem to be responsibly designed and organized. The MaeKlong scheme's maintenance program is less impressive, although there, as at the other sites, water users help the agency carry out essential cleaning. Kinmundaung is a special case, because the maintenance program is tailored only to the areas that are expected to receive water: the water deficit drives all water and work decisions. In contrast with these irrigation sites, the maintenance program of the BWDB for its flood control and drainage schemes is unimpressive, the structures are in poor condition, and the O&M budget is seriously underfunded.

*Agency maintenance performance* on irrigation structures is good everywhere, at least when evaluated against requirements for carrying out the operational plan. Dams, main canals, and cross-check and gated structures are in good order, except that most measurement devices have been removed or allowed to deteriorate.

The agencies' record as concerns cleaning canals they are responsible for is compromised by problems peculiar to each of the three primary schemes (Lam Pao, Kinda, and Dau Tieng). Silt and weed build-up is not adequately handled in certain sections of each of these sites, deficiencies that are partly attributable to design flaws that prevent easy solutions, such as insufficient gradients, and hence low water velocities in the canals. The weed problem at Kinda is the most serious, although this disadvantage is partly offset by the Irrigation Department's exceptional capability to mobilize village labor. Cleaning is less of a problem on the MaeKlong right bank, and is not of concern at the two tanks in Myanmar.

*The agencies' canal cleaning record is compromised by problems such as design flaws, but overall performance is acceptable*

The sustainability of O&M performance at all three major sites must be qualified. At Lam Pao, good performance can be attributed to the simultaneous arrival of an activist, senior RID project manager and an expatriate technical assistance team in the early 1990s. Conditions on the older, unassisted sections of the Lam Pao scheme are worse. At Kinda, the ID's routine maintenance is undermined by its inability to eliminate illegal uses of and cuts through the embankments, despite the tight controls of the state administration. The team observed several serious breaches. At Dau Tieng, when the central and provincial governments cut the prevailing subsidies on O&M—a likely prospect given the present cost-cutting drive in all public authorities—the provincial companies will have

to curtail services. Offsetting budget cuts with farmer contributions will be difficult, because of the lack of effective irrigator associations.

This said, the BWDB's maintenance performance on the Bangladesh polders is much worse than at all other sites. There, serious deterioration of embankments and some of the regulators and sluices is visible, prompting dire predictions about failing structures not heard elsewhere. The problem is attributable partly to the professional incentives at BWDB, which favor civil engineering skills over water management skills. It is also attributable to the greater difficulty of organizing beneficiary participation for protecting flood control structures, because the returns to cooperation are less evident than in irrigation.

Donors have grappled with O&M in both Thailand and Myanmar, and through consultancy arrangements have sought to establish sophisticated measurement and control systems for allocating and distributing water. The water allocation scheduling and monitoring computerized program (WASAM), a Dutch consultant's system, was introduced first in Thailand at

Maeklong and later at Lam Pao. The same program was introduced at Kinda. The full model has been abandoned at all three sites. NEWMASIP is currently perfecting a much less ambitious model at Lam Pao, with calibration, measurement, and tailored releases limited to the mains and their gates. The long-term viability of these control systems, even after all operators have advanced on the learning curves, is still in doubt, however. The failure of *romijn* gates and of the automated maintenance planning process at Maeklong may be warnings of widespread rejection of sophisticated gated control systems. Chapter 7 returns to this subject.

Despite these failings, the overall impression of agencies' systems and performance on the irrigation schemes is mixed, but is substantially better than conveyed in the literature. The team's impressions contradict allegations about the relatively low priorities agency management and staff attach to O&M as a whole and the pervasive and corrupting engineers' bias toward construction and rehabilitation.

### **Irrigator Level**

The analysis of irrigators' O&M performance must distinguish not only between operation and maintenance, but also between canals and gates. In short, farmers show themselves to be competent to maintain their canals at all sites—that is, they can keep water moving—when needed. However, farmer operation, maintenance, and protection of gated structures is deficient in many stretches of the canal grid.

Tertiary and watercourse canals usually disappoint observers looking for mint conditions. However, farmers seem keenly aware of the limits beyond which weed growth, siltation, and injury to canal walls reduce water flow, and are prepared to work collectively, either when organized or spontaneously, to do cleaning and repair work when serious shortages threaten. What looks like a weed-choked canal at the end of the premonsoon cropping season may be totally transformed by manual cleaning and reshaping immediately before transplanting or broadcasting rice for the rainy season. Thus field observations refute the notion that irrigators are not prepared to maintain canals at serviceable standards.

*Farmers show themselves competent to maintain canals when needed*

One factor that would mar this satisfying picture is continuous, conspicuous, uncontrolled, and excessive exploitation of the water supply by advantaged irrigators, especially headenders. Although complaints by the disadvantaged can be heard at all sites (except Azin), nowhere was the level of hostility so high as to suggest that headenders are disposed to or allowed to exploit their positions excessively. Complaints are often calendar specific, that is, around holidays or other special days when irrigation supplies are abnormally, but predictably, affected by reduced releases from the reservoirs. In some situations the disadvantaged are blocked from full

participation anyway by being situated away from the canal infrastructure (Dau Tieng) or by being at tailends of mains where supplies are clearly deficient (Kinda, Kinmundaung). The tailenders' acceptance of the disadvantages of inferior access caused by physical location reduces the potential for dispute. Custom honored thresholds that headenders will not violate—in the common interest—do seem to exist.

Again, Bangladesh is an exception. At Satla. Bagda, where 450 irrigation inlets have been installed in the polder embankments, the gradient is so shallow that headender irrigation on the watercourses results in tailend flooding.

There is no equitable solution for all farmers in this case, and outright headender action to let water in can lead to violence. The usual outcome, however, is for the irrigation inlets to be disabled or abandoned. Once again, this suggests that social pressures prevent headenders from taking undue advantage of their position.

*The image of anarchy is overstated; social pressures prevent headenders from taking undue advantage of their position*

The defining visual characteristic at all but one of the schemes (Azin) is the poor condition of the gates installed by the project at and below the tertiary turnout. However, this is not the result of the usual reasons cited for lowlevel maintenance—inadequate budgets, lack and ignorance of mechanical skills, moral hazard, or simply an indifference to timely maintenance. The poor condition of the tertiary gates, and indeed, of most of the masonry gates on the field channels below the tertiary turnout, reflects operational decisions by farmers not to use them for their design purpose, that is, to ration water to the users below the gates. A gate is rarely friendly to such users, especially in paddylands where flooding is preferred. The gates were installed to serve users elsewhere along the supplying canal. Without human intervention to protect that goal—either by enlightened and disciplined farmer association or by dedicated and respected officials—the gates and their function degenerate.

Some evidence in the study area indicated that the incidence of gates broken by farmers at and below the tertiary turnout was higher in the wet season. But nowhere was the concentration of abuse during that season so high as to lend conclusive weight to the anarchy model described in Chapter 2. The image of anarchy—every family for itself—is overstated. In all the schemes studied, the social penalties associated with individualistic behavior are not substantiated, partly because water is usually not so scarce that such behavior creates major discomfort for other participants. Thus headenders refrain from egregious exploitation and tailenders do not resort to physical retaliation. This is as true for the farmers in the two Myanmar schemes with an overall absolute shortage (relative to design) as it is in the so-called surplus schemes. Anarchy is a useful concept to explain some of the influences on irrigator behavior. But in the study domain, it is not the dominant pattern. Rather, a loose kind of cooperation exists, under which minor infractions are tolerated and substantial latitude is offered to headenders—within bounds.

Another, milder form of the anarchy model applies to relationships *between* tertiary units. Agency performance in distributing water *through* the distributaries is generally good, as is farmer performance with distributions *within* the tertiary systems. However, a gap exists in the allocation of water supplies from the secondary distributaries to the tertiaries. That interface does not seem to be well, or at least consistently, managed in the schemes under review. Neighborhood cohesion and the other social forces that ensure reasonable cooperation within the tertiary system are too weak to guarantee equitable water sharing arrangements between tertiary units. In this context the public agencies, to the extent they have removed themselves from this level of administration, have left a void.

Several reasons account for this situation. First, the harmony within a tertiary group, whereby cooperation is seen to be in every member's self-interest, does not embrace neighboring groups. Second, in all the schemes in the study, the public irrigation agency is formally responsible for operating the tertiary gates, but has either turned management of the gates over to the WUGs or shares it with them. As formal irrigator associations above the individual tertiary WUG normally do not exist, the discipline that the agency should, in principle, provide to

ensure equitable treatment is miss—

ing, except where strong local officials are determined to enforce it. The more common case is for agency field staff to avoid imposing rotations unless the water shortage is so severe that they cannot avoid taking action. Because most of the schemes have surplus water, rotations between tertiary systems do not normally provoke conflict and the issue becomes less important. A broken gate at one tertiary turnout does not invite retaliation by other tertiary groups. Myanmar reaches the same point even in the face of water scarcity by cutting off the lower reaches of the schemes and ensuring adequate water for the rest. However, when the collective interests of neighboring tertiary units are challenged, the systems in this sample cannot respond as well as in countries where higher-level water users' institutions are formally organized.

### Water User Groups

Nominal WUGs exist in the command areas of all six schemes. Everywhere they are responsible for managing O&M below the tertiary turnout, while the public agencies retain ultimate responsibility for operating and maintaining the tertiary gates. However, these jobs are usually shared under formal or informal arrangements with the WUG. In principle, *transfer* is not an issue at the WUG level.

Recent experience in those parts of Lam Pao under technical assistance programs and comparable results in parts of the Maeklong scheme and along the older Kinda canals seem to support the claim that well-administered, well-supported water user groups can be effective in improving the general level and distribution of benefits among members. But they are the exceptions. The study encountered a number of newer schemes or extensions of older schemes where WUGs play only a minor role in determining the rules of water sharing and rotations. In this sense, transfer is by no means complete.

At Dau Tieng the WUGs are not much more than the local arm of the provincial irrigation authorities. They are not organizations that represent irrigators' interests, and the provincial authorities carry out the infrequent rotations that occur. Farmers at Dau Tieng showed little interest in or experience with taking collective action to secure mutual benefits, except for clearing the watercourses. The fact that many of the farmers in this scheme are relatively recent arrivals, come from different parts of the country, and speak different dialects helps explain the lack of cohesion. In addition, Dau Tieng has never received any external assistance aimed at consolidating participatory action by farmers within a tertiary perimeter on common irrigation problems.

Group action is also weak in the tertiary systems in Lam Pao, which have not received technical support from either of the two recent donor-assisted programs. The state of decay of all structures in these nonassisted systems contrasts strongly with the structures in assisted systems, and group discussions revealed the same indifference to mutual support—apart from group canal cleaning crusades—that was evident at Dau Tieng.

At Kinda and Kinmundaung in Myanmar, the two sites with permanent water shortage, the Irrigation Department, backed up by the state agriculture supervisory committees and the village tract law and order restoration committees, imposes a rationing system that guarantees supply to most farmers, but cuts off the rest, and seemingly cannot be subverted. This example of heavy-handed hierarchical behavior seems to be—at least on irrigation schemes—the manifestation of the traditional rural social order, which dates

back to the Burmese dynasties. Unlike in Vietnam, the WUGs in Myanmar do represent the farmers, but at these two sites, when water scarcity becomes critical, the authorities have already taken the major decisions on water distribution and the WUGs only get involved in local issues.

The only examples in the study of formal federated activity above the WUG level are in the assisted areas of Lam Pao. This is where the NEWMASIP team of local and international consultants, Royal Irrigation Department staff, and local community assistants has been able to create a successful framework for collaborative farmer action along the secondary distributory canals. Similarly enlightened action by irrigators' cooperative associations that embrace many WUGs distinguishes some areas at Maeklong. At Kinda watercourse leaders along some of the tertiaries select one of themselves to take leadership along the whole of the tertiary. This arrangement has proven to be effective, especially on the longer canals of the old right bank scheme, and is the first step toward formal association.

*Associations work best when all members share an objective that benefits everyone*

An interesting example of informal federated action is on the longer distributaries of the right main canal system at Kinda, where WUGs combine to protect their mutual interests. Groups of WUGs on the lower half of the distributary contribute to a common fund to pay about 50 guards to police the upper half tertiary turnouts when these gates are supposed to be shut during the dry season on an upper/lower rotation. This illustrates the point made by participation experts: that associations—and WUGs themselves—work best when all members share an objective that benefits everyone. Groups whose only purpose is to ration fixed water supplies among members, some of whom have advantaged positions, are harder to sustain.

In short, despite the relative youth of most of the groups associated with the schemes, their weakness in relation to public authorities, and the absence of federative associations, the team rated farmers' O&M performance in keeping their parts of schemes running as satisfactory. This implies that viable organizational models are available for implementing plans for water allocation other than improved WUGs. Farmers in this sample of schemes have proven themselves competent to assemble when necessary to take care of their canals, irrespective of the maturity and independence of their "group."

One other feature of the Myanmar cases that distinguishes them from the other schemes is the authorities' ability to mobilize labor for campaigns to clean the larger canals. The proliferation of a hitherto insignificant weed species along the left main canal at Kinda has resulted in a serious weeding problem. The large number of people the ID has been able to muster to assist in weed removal without pay has enabled the agency to keep most of the left bank canals full of water. The example is of broader interest to the study, because it supports the case for federating WUGs to tackle common problems. Thailand's Royal Irrigation Department could not organize farmer participation on the same scale without paying for their services. Federated WUGs could.

### **Cost Recovery**

Cost recovery plays a minor role in the study domain. In Thailand, despite decades of discussion and agreements with the World Bank and the Asian Development Bank to impose water charges on irrigators, the government continues to operate a free water policy. Farmers at Lam Pao and Maeklong currently pay nothing for the use of water, and at Lam Pao they pay nothing

for the facilities. Elsewhere in Thailand where irrigators were part of a land consolidation scheme that reorganized farm boundaries to install an intensive network of canals, the farmers do pay for part of the capital costs. The Maeklong right bank project was constructed after less intensive consolidation, and the farmers there pay a smaller capital charge.

In Myanmar irrigators pay both a water tax and a land tax based on the acreage farmed. All farmers pay the land tax. However, the rates of both taxes are so low—\$10.0 per acre per year for the water tax and \$2.50 per acre per year for the land tax—that they serve little purpose in revenue generation and no purpose in water rationing. The government argued and the World Bank accepted that a compulsory crop requisition program at below market

prices served the purpose of cost recovery. Nevertheless, there is no direct relationship between the tax implicit in the crop requisition program and the costs of the irrigation scheme, the link the World Bank and Asian Development Bank had intended.

At Dau Tieng, as throughout Vietnam, farmers are obliged to pay for contracts with the irrigation authorities for water promised and delivered, that is, for water actually received. In principle, all irrigators sign contracts. However, because the two provincial irrigation companies operative at Dau Tieng cannot guarantee delivery, the WUGs are seen more as tax collectors than as farmer representatives and have no moral authority over members, and because many farmers are still not connected to the tertiary grid, most water users pay nothing. During the 1995/96 dry season only 15,000 of 45,000 hectares benefiting from scheme water were covered by contract. Farmers are not required to repay capital costs at Dau Tieng.

### Comparisons with Flood Control

The review of O&M conditions on two Bangladesh flood control subprojects revealed several interesting differences between FCD and gravity irrigation investments. These differences may be country specific (see Chapter 6). Some informants in Bangladesh claimed that the strong patron/client relationship that exists at all levels of society has conditioned farmers to wait for government intervention. However, the nature of the findings suggests a wider relevance.

*Losers cannot be expected to come together with winners to protect a public asset*

To begin with, flood control maintenance standards and performance by the agency and the farmers are lower than on the irrigation schemes covered by the study. As already noted, irrigating farmers gather more readily if the objectives are shared by all. Proper maintenance of the regulators, sluices, drains, and embankments on FCD polder schemes usually benefits all members, yet in these cases collective farmer action does not materialize. This may be because the benefits of cooperation are less tangible and certain. They are reaped only during floods and they are not equally shared. In such circumstances, hierarchy must fill the void left by inadequate participation.

Unfortunately, until recently the Bangladesh Water Development Board made no effort to organize farmer groups to provide maintenance. The board does organize water user groups on the *irrigation* schemes it builds and manages. But on its *FCD* schemes, which are much more numerous than its irrigation schemes, it has ignored the potential of farmer institutions. A technical assistance team working under the umbrella of the ongoing, Bank-supported Systems Rehabilitation Project has initiated the formation of farmer groups for O&M on pilot schemes included for rehabilitation, with good results. Else—

where on polder schemes, such groups do not exist. With gravity-fed irrigation in the other three countries, the groups have varying levels of effectiveness, but exist everywhere. The Bangladesh experience provides a good example of unsatisfactory O&M in the absence of both formal farmer participation and effective public sector management.

In addition, where irrigation inlets are installed in the FCD embankments at the Satla Bagda polder, groups have not formed spontaneously to organize the sharing of irrigation waters. In this case, however, opening the inlets to help the headenders causes flooding on the lower reaches. This is the opposite of the typical headender problem in an irrigation scheme, where tailenders are deprived. The outcome is much the same, however: winners and losers cannot be expected to come together to protect a public asset. And when headenders' gains lead to actual losses by tailenders, the investment is not used, or may even be destroyed, even though on average it is a productive asset.

## 5.— Agro–Economic Impacts

The following paragraphs briefly compare appraised and actual irrigated areas, cropping intensities, cropping patterns, yields, and incremental production on the six gravity–fed irrigation schemes in the three countries studied. They present estimates of the representative irrigator's incremental and total financial income from the irrigated fields to assess the benefits of participation to farm families. They also present recalculated economic rates of return (ERRs) and compare them with those calculated in the appraisal models to determine any shortfall from original projections. The staff appraisal report (SAR) and impact ERR re–estimates are limited to the costs associated with the Bank's projects. They do not purport to represent in all cases returns to investments in the entire scheme, including the attributable costs of headworks and reservoirs that the Bank did not finance under the projects.<sup>1</sup>

The prevailing cropping pattern is paddy, and there is substantial correspondence between the case studies. The sample of six schemes presents a consistent pattern for most factors, so that a "story" of paddy–based irrigation schemes in the humid tropics of Southeast Asia emerges.

### Agricultural Impacts

#### Irrigated Area

*Four of the six irrigation schemes receive significantly less water than planned*

At four of the six schemes, the area supplied by the irrigation system is significantly less than the design area (Table 5.1). While both Kinda and Kinmundaung have suffered from a substantial shortage in rainfall during the last decade, the record also points to overoptimism during the design stage about inflows to the reservoirs. The projections were particularly off the mark at Kinmundaung, where the actual area supplied is half that planned. Dau Tieng and Maeklong fall short for other reasons. At Dau Tieng, construction of the tertiary network has stalled and the area effectively watered is 63 percent of the design area. On the Maeklong right bank, 20,000 of the 66,000 hectares targeted for the consolidation program were denied project investments after the farmers voted against it. A substantial part of the area where farmers voted "no" to consolidation now receives water, but without guarantee, and only from the older distributaries by field–to–field flooding or pumping. These farmers are not included in RID scheme estimates. Another 6,000 hectares were dropped from the irrigation program altogether for other reasons and receive no water.

At all four sites, the project completion reports assumed that the design area would eventually be reached and that in all cases this would occur before 1996. This review has had to reduce those projections sharply. Dau Tieng is

TABLE 5.1: IRRIGATION AREA, INTENSITY, YIELDS, AND PRODUCTION

Country and scheme	Area		Intensity <sup>a</sup>		Average paddy yields			
	SAR	Actual	SAR	Actual	Wet season		Dry season	
	(ha)	(ha)	(%)	(%)	SAR	Actual	SAR	Actual
<i>Thailand</i>								
Lam Pao	49,000	49,500	160	150	3.8	3.0	4.0	3.0

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Maeklong	66,000	39,500	200	160	3.5	3.9	4.2	3.9
<i>Myanmar</i>								
Kinda	79,000	71,000	160	117	4.0	3.6	3.6	3.1
Kinmundaung	2,000	11000	150	122	4.2	3.6	n.a.	3.1
Azin	1,150	1,150	100	100	—	—	4.4	4.2
<i>Vietnam</i>								
Dau Tieng	72,000	45,000	226	250	3.8	2.6	4.2	3.2

— Not applicable. n.a. not available. ha Hectares.

a. Using the actual command area as the denominator.

b. Tons of paddy production or, in Dau Tieng and Kinda, paddy plus weighted paddy equivalents of other major crops. The production estimate is not derived from "Area," "Intensity," and "Average paddy yields" because of shortfalls in nonpaddy

*Source:* SARs and the study team's research.

the only site where expecting some further, though slow, expansion is reasonable. However, the current area irrigated of 45,000 hectares is retained in the analysis of benefits.

### Cropping Intensities

Cropping intensities have also fallen substantially short of appraisal projections at three schemes (Table 5.1). At Dau Tieng the smaller area effectively irrigated results in intensities that are higher than planned. Part of that good performance is attributable to unexpected, and increasing, recapture of water in fields distant from the canals. At Lam Pao the cropping intensity came close to the SAR target of 160 percent, but has recently declined, and some observers expect it to decline further. Azin is the only scheme that meets area and intensity targets.

### Cropping Pattern

*Farmers have not only failed to diversify out of paddy, they have tended to increase the amount of land devoted to paddy ...*

On almost all of the Maeklong right bank (the rest was in sugar) and in the Azin lowlands, project appraisers expected paddy to approach 100 percent of plantings in the dry as well as in the wet seasons. Elsewhere, they expected paddy to dominate both seasons only in the lowlands. In the sandier, better drained uplands under scheme command, even during the monsoon season, other traditional field crops, like groundnuts, cotton, and sesame, predominated. Project appraisers also anticipated diversification into specialty crops such as chilies, watermelon, and baby corn.<sup>2</sup>

Diversification out of paddy failed to occur at any scheme. Indeed, in recent years farmers have tended to increase the proportion of land dedicated to paddy. At Dau Tieng farmers have shifted from groundnuts to paddy, on the Maeklong right bank the few sugar growers have been uprooting the cane and substituting paddy, and at Kinda the cotton area on the previously irrigated right main canal has declined without any compensating cotton planting on the left main canal. At Kinmundaung project appraisers did not plan paddy for any of the expected 3,500 hectares of dry season plantings. Yet of the approximately 500 hectares that the Irrigation Department has managed to supply in the dry season, most has been assigned to farmers who agreed to plant paddy in support of the government's rice export campaign.

### Yields

Paddy yields are below projections at all but one site (Table 5.1). The study team computed a weighted average based on scheme size to provide a yield estimate representative of all the study sites. Compared with 3.86 tons per hectare projected at appraisal, only 85 percent of the expected yield, 3.34 tons per hectare, were actually reported. As concerns other crop yields, at Dau Tieng groundnut production is greater than the staff appraisal report anticipated, and at Azin the fruit trees are maturing well, although reliable production estimates are not yet available.

### Production

Table 5.1 also shows the ratio of actual and appraised estimates of paddy production for the six sites. In the cases of Dau Tieng and Kinda, production figures include paddy plus weighted paddy equivalents of other major crops. Except for Azin, actual production is well below SAR values, reflecting shortfalls from appraisal plans for either area commanded, intensities, or both. For Kinda and Kinmundaung, the actual production is 40 percent or

less of the appraisal figures. Some field crops and all specialty crops were not incorporated in the analysis because of lack of data.<sup>3</sup>

### Farmers' Financial Benefits

For most of the schemes the team assessed both incremental and total net incomes from the irrigated fields, based on the average size of farmers' holdings. The analysis is cued to paddy, but for Dau Tieng and Kinda also includes paddy equivalents of some other irrigated crops. The analysis again omitted specialty crops, which means that farmers who have concentrated on chilies and watermelon at Lam Pao, for example, and may be benefiting substantially by occupying those market niches, are not represented in the analysis. Off-farm and nonfarm incomes are excluded. Thus, the analysis does not capture families' overall financial position. Nevertheless, as paddy was and remains the basic activity for most farmers at all the sites, the analysis gives a good idea of the size of household earnings.

*...even though paddy incomes, in most cases, are well below appraisal estimates*

Table 5.2 shows the total net income from irrigated paddy, not the incremental income over preproject rainfed paddy income. This is done to emphasize the point that in most cases, the paddy incomes are not only well below appraisal estimates, but so low as to defeat one of the key, implicit objectives of the project, which was to create a viable, attractive household economy that could compete with other job opportunities.

Table 5.2, which is supported by the annex, summarizes the results of the analyses. As the size of average holdings varies by site—ranging from 1.0 hectare at Dau Tieng to 3.5 hectares at Maeklong—the table shows per hectare as well as total farm incomes. The table also shows SAR estimates of family incomes from irrigated farming on farms of a size considered average at that time. The SAR estimates have been inflated to 1995 financial prices, expressed in US dollars.

TABLE 5.2: ANNUAL TOTAL IRRIGATED PADDY INCOMES PER FARM AND PER HECTARE (1995 US dollars)

<i>Country and scheme</i>	<i>SAR</i>	<i>Actual</i>	
	<i>per farm a</i>	<i>Per farm a</i>	<i>Per hectare</i>
<i>Thailand</i>			
Lam Pao	2,055	590	270
Maeklong	6,100	1,750	500
<i>Myanmar</i>			
Kindab	2,965	2,010	670
Kinmundaung	1,975	670	670
Azin	1,320	1,580	790
<i>Vietnam</i>			
<i>Dau Tieng</i>			
Lowland	5,645	570	570
Uplandb	5,875	1,050c	1,050

a. SAR and actual farm sizes may differ. See Annex, including footnotes.

b. Paddy and paddy equivalents.

c. Incremental, not total farm income. The difference is small.

*Source:* Annex.

At both sites in Thailand, households currently earn less than one-third of projected income from their irrigated plots, including home consumption valued at farmgate prices.<sup>4</sup> The SAR projected a net annual family income of about \$2,000 for a 2-hectare diversified farm, while the study team estimates that the typical 2.2-hectare family farm is netting a little less than \$600 per year. During its investigation of the situation at Lam Pao, the study team found that the rapidly industrializing Thai economy has resulted in so-called push and pull forces, which encourage family members to abandon dry season cropping or farming altogether and look for other employment.

*The most dramatic difference between expected and actual incomes is at Dau Tieng*

For Kinda, Table 5.2 and the annex show a net annual income of about \$3,000 at appraisal for a 2-hectare farm, and an actual average of \$2,000 for a 3-hectare farm. That ratio, about two-thirds of expectations, holds for Kinmundaung as well. At Azin, farm incomes are now estimated to exceed SAR projections by about 20 percent. Thus, compared with Thailand and Vietnam, incomes in Myanmar are closer to expectations. That is mostly because appraisal expectations were less ambitious. But it is also due to price relationships: per hectare incomes in Myanmar exceed those in the other two countries, a reflection of the relatively favorable farmgate rice prices and input/output price structure.

The most dramatic difference between expected and actual incomes is at Dau Tieng, where the lowland paddy farmer with 1 hectare of irrigated land earns a net income of less than 10 percent of the amount projected at appraisal. This is due to a number of factors, of which the most important is inflated appraisal projections. The appraisal report for a new Bank-supported irrigation project for Vietnam—one component of which will

complete another scheme on the Saigon River 30 kilometers downriver from the tailend of the Dau Tieng scheme—has departed radically from the inflated coefficients of the 1978 SAR for Dau Tieng. It projects average incremental earnings on 1 hectare of \$400 per family, roughly the same as the study team's ex post calculation. The push and pull forces are weaker in southern Vietnam than in northeast Thailand. But given these low family earnings, industrialization is likely to be as much a threat to the sustainability of irrigation schemes on the Saigon River as it is at Lam Pao unless the value added on the scheme can be substantially increased.

These financial analyses are based on 1995 farmgate prices of paddy and other important crops quoted by World Bank agricultural and irrigation staff. Thus, differences in family incomes emerge in part both because of varying physical performance and because of different levels of real farmgate prices. The study team estimated some comparator price ratios to see whether substantial differences in the level at which the local economy rewarded its paddy producers did, indeed, exist. In particular, the team computed the ratios of the paddy price per ton to the costs of (a) a ton of urea, and (b) the average daily wage for field labor. The variation in the ratio of output to input prices across the three countries is one indicator of the incentives facing progressive paddy planters. The real rural wage is so different in the three economies that the paddy/wage price ratio is certain to have a different impact on farmers' decisions to plant different crops, to recruit labor, or to find work off their own farms.<sup>5</sup> Table 5.3 shows that the ratios are significantly higher for Myanmar than for Vietnam and Thailand. This finding is consistent with Myanmar's superior position in net paddy incomes as shown in Table 5.2.

TABLE 5.3: OUTPUT–INPUT PRICE RATIOS

<i>Country</i>	<i>Paddy/area</i>	<i>Paddy/wage</i>
Thailand	0.51	39/1
Myanmar	0.82	263/1
Vietnam	0.49	110/1

*Source:* The study team's research.

### **Economic Rates of Return**

The re–estimated ERRs are low for all six schemes, and in one case the ERR is negative. Five of them are affected by the decline in the international price of rice since the late 1970s and early 1980s when the appraisal farm plans were prepared (Figure 5.1) and lower than expected production (except at Azin).

Table 5.4 compares appraisal estimates of ERRs with the team's re–estimates.<sup>6</sup> Actual figures not only fall short of SAR projections by substantial margins, but are all well below 10 percent. Kinmundaung's ERR is below zero because the project could not supply half its design command area.

Figure 5.1 illustrates the decline in prices for rice. It shows that forecasts throughout the period of these five project appraisals (1978–82) were excessively optimistic, with the first major jolt hitting during that last year, 1982. The ratio of the 1980 projections and 1995 mid–year estimates for the 1995 rice price (both in 1990 dollars) is exactly three to one.<sup>7</sup> By 1987, not only had the rice price projections bottomed out, but the optimism had disappeared.

At the end of 1995 rice prices showed a small upturn, but not enough to rescue the economic rating of the original investments. The Bank's end–of–year rice price projection for 1995 was 17 percent above the 1995 price projected at

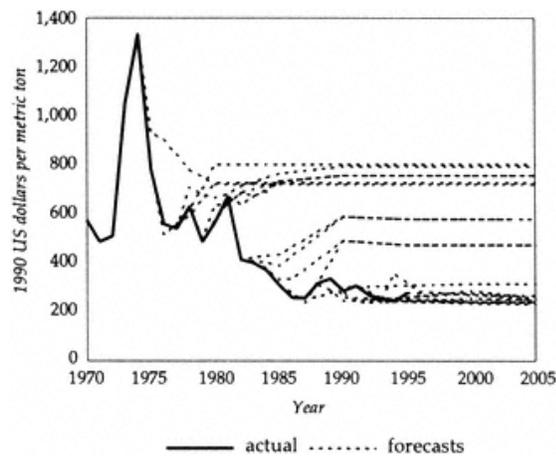


Figure 5.1:  
International rice prices: actual and Bank forecasts, 1970-2005

TABLE 5.4: ECONOMIC RATES OF RETURN

<i>Country and scheme</i>	<i>SAR</i>	<i>PCR</i>	<i>Actual</i>
<i>Thailand</i>			
Lam Pao	26.0	12.0	7.0
Maeklong	35.0	8.2	3.6
<i>Myanmar</i>			
Kinda	21.3	14.0	7.4
Kinmundaung	13.6	12.3	Negative
Azin	12.3	7.3	6.0
<i>Vietnam</i>			
Dau Tieng	17.0	4.9	3.6

*Notes:* Lam Pao: Stages I and II Consolidated; Maeklong: Right Bank (Irrigation XI); Kinda: includes power component (24 percent of actual project costs); Azin: includes Mudon town water supply (28 percent of actual subproject costs); Dau Tieng: Stage I—the PCR text says 4 percent, but the PCR table produces 4.9 percent.

*Source:* SARs, PCRs, and the study team's research.

the beginning of the year. The Bank's Commodity Price and Analysis Unit expects that rise to settle back within two years to a level only about 2 percent above the earlier long-term projection.

The viability of most of the investments under review was profoundly damaged twice. The declines in production and prices were each enough to drive the ERRs to low levels. For example, for Dau Tieng the PAR, which was issued in 1991, showed that substituting the SAR's rice prices for actual prices lifted the ERR re-estimated for the PCR from 5 percent to only 6 percent. Substituting the SAR's production projections for actual production while retaining actual rice prices lifts the PCR's re-estimates from 5 to 8 percent. The undiluted effect of the rice price decline is indicated by the Azin estimates, where the ERR slipped from 12.3 percent at appraisal to 6.0 percent in

1995, despite good performance in production. Chapter 7 addresses the implications of these low ERRs for the sustainability of this sample of paddy irrigation projects.

### Notes

1. This omission affects the two Thailand schemes, for which the costs of the storage dams are excluded and the water supply at the scheme headworks is not costed. The economic rates of return (ERRs) are therefore inflated. The Bank does not have data on the costs of the dam at Lam Pao.
2. These were not best guesses: in most appraisal farm plans these nonpaddy crops were essential to the economic justification. They generally provided higher net margins and were needed to rescue the poor returns, calculated at appraisal, to most paddy plantings. For example, cotton was introduced in appraisal plans as a major crop on the left main canal at Kinda to bring the ERR well above 10 percent. The Bank's Agriculture and Rural Development Department was suspicious of these introductions, especially the large scale of the plans in areas where the resident farmers were unfamiliar with the crops. But they were nevertheless made in the farm plans.
3. This omission results in a more favorable comparison of actual achievements with appraisal projections, because the shortfall in production from the projections for these other crops was even larger than for paddy.
4. Assuming per capita annual consumption of 250 kilograms of rice, a household of six persons would withhold 2.5 tons of paddy (the equivalent of 1.5 tons of rice) each year based on calculations contained in an internal World Bank report.
5. Average daily wages in 1995 were \$3.75 in the vicinity of Lam Pao, Thailand; \$1.20 around Dau Tieng, Vietnam; and \$0.50 around Kinda, Myanmar.
6. The ERR re-estimates are not based on a full reconstruction of project costs, farm models, and price relationships. Instead, they use the ERR structure presented either in the SAR (Myanmar), PCR (Dau Tieng), or impact evaluation report (Lam Pao). Where the projects included power (Kinda) and water supply (Azin) components, PCR re-estimates for these components were retained. The basic procedure was to adjust the cost and benefit streams by known changes in the values of the major variables in the analysis, such as areas, yields, costs, and so on.
7. For example, the Kinda projection, made in 1980, for rice prices in 1990 and thereafter, converted to 1990 dollars, is \$700 per ton. The actual mid-year 1995 price, also in 1990 dollars, is \$237 per ton.

### 6.—

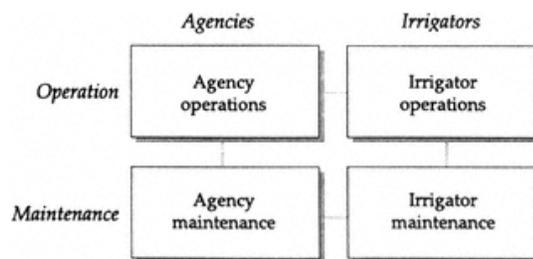
## Influence of O&M Performance on Agro-Economic Impacts

This study of a group of six irrigation schemes does not reveal any substantial, areawide, negative constraint on irrigated production attributable to poor performance in O&M by either agencies or irrigators. The assumption that such a relationship did exist is what prompted the study in the first place: to identify the problem and try to

explain it. As Chapter 2 indicated, the literature on degrading structures under public ownership in developing countries is impressive, and suggests that in many countries, or at least in many irrigation schemes, the record is worse than the study's findings.

The only serious examples of degraded structures that depressed production that the study team found were in the two flood control polders in Bangladesh, where the public authority's O&M standards are inadequate, the beneficiaries behind the embankments do not participate in O&M, and the physical structures' rate of decay is visible and alarming. Inadequate maintenance reduces the effectiveness of the regulators and drainage sluices that penetrate the embankments at Chalan Beel and Satla Bagda, resulting in a negative impact on farms located in the shadow of these structures because of reduced drainage and flood congestion. Inadequate cleaning of the natural drains traversing the polders has the same effect. The loss in integrity of the embankments themselves increases the risk of a breach or larger failure with advancing age or another overwhelming flood. However, this singular experience in Bangladesh does not provide any basis from which to generalize to the rest of the study area.

The favorable judgment about O&M based on the study sample can be defended for each of the four components analyzed in the study. This two by two matrix consists of agency maintenance, agency operations, irrigator maintenance, and irrigator operations.



### Agency Maintenance

*Despite adequate agency maintenance, canal blockages do occur. But most of the sites still have water surpluses and the effect on production is therefore low*

The study team judged the agencies' maintenance performance on dams, major canals, regulating structures, and gates down to, but not including, the tertiary turnouts to be adequate at all six sites—the most impressive finding of the review. This judgment is necessarily based on a limited number of observations at each scheme, but the consistency of the observations was clear. Despite low budgets in all three countries, the engineers and their field staffs appear to be keeping up with minimum requirements. The exception is the silt and weed problems that have overwhelmed the agencies at certain stretches of the main and primary distributaries at Dau Tieng, Lam Pao, Maeklong, and Kinda. The agencies are attacking these problems—there is no evidence of indifference or lack of concern—but the downtime for desilting and deweeding in the middle of the irrigation season is not free of costs, and the agencies have yet to find methods to gain control within their limited budgets. The blockages do have an impact on downstream water supplies, but given the prevailing surpluses at three of these four sites, the effect on production is small. The Kinda left main canal weed problem is especially severe, but low flows through that canal are a result of water shortage at the reservoir and do not result in a net loss to irrigation.

### Agency Operations

Public agencies' operational plans and performance for the reservoirs and for water distribution through the main and distributary canals are acceptable at each site. This judgment is based on the area under effective command. It does not penalize present performance for overdimensioning the schemes at inception. The failure to adopt WASAM's demanding technical standards and other sophisticated measurement and allocation protocols also

does not reverse the conclusion. The one area of weakness is in enforcing rotations through the tertiary turnouts organized by irrigators.

### **Irrigator Maintenance**

Irrigator performance varies according to whether one is examining the channels or the gates. There is no evidence that irrigators fail to keep their supply canals (tertiaries, watercourses, ditches) open when they need water. Formal and informal group and individual action is taken as necessary to permit adequate flow. Although tailenders appear to contribute more time to the tertiary and watercourses than headenders—as expected, given that they benefit more than headenders—the local rules and controls function well enough and headenders do join the groups. This cooperative response to cleaning and minor repair requirements is combined with significant rent-seeking behavior in exploiting access to water. Larger, expensive repairs to the canals are handled less easily, but in such cases the public agencies usually intervene.

The major problem is with irrigator maintenance of the gates. But as already mentioned and discussed next, this is not a result of a failure, but an unwillingness, to maintain. It reflects operational decisions, not ignorance about or indifference to keeping beneficial physical assets in working condition.

### **Irrigator Operations**

The main problems of O&M performance are concentrated in irrigator operations, that is, irrigators' behavior in regulating and/or assisting with the allocation and distribution of water agencies make available in the secondary distributaries for the channels below the tertiary turnouts. Rotations organized by farmers have not worked well, even during periods of water stress, when they are most needed to ensure equitable access. The stronger WUGs, for example, the ones NEWMASIP assists, have a better record in preventing overuse by headenders. However, a pattern of abuse is apparent at five of the six sites—Azin excepted—and whether the scheme's overall water supply is plentiful or scarce does not seem to matter.

*Nor does improper allocation of water by farmers have any obvious impact on production*

The issue, however, is not whether the rotations do not work, but whether their failure reduces total production. The equity question should be set aside at this point. At all five sites, there is no compelling evidence that the failure to arrange rotations to allocate available supplies—in proportion to the requirements of the cropping systems on each farm, in proportion to land holdings, or in equal amounts per family—has reduced production to a substantial degree over the entire scheme. The most interesting case is Dau Tieng, where headender extravagance is widely admitted, but where tailenders are compensated by their ability to recapture drainage and the level of complaints is low. At Lam Pao overall supplies are adequate to serve most tailenders as well as "overusing" headenders. There are exceptions, but these are pockets with special geographical or topographical limitations and have little influence on overall system performance. At Maeklong the exceptions and complaints are even fewer. At all three schemes in Thailand and Vietnam, the yields farmers and agency staff report on tailenders' paddy fields are almost the same, and in one case higher, than on headenders' fields, strong evidence that the water is getting through despite the failure of formal rotations. In Vietnam this applies even to tailenders without access to groundwater.

The two schemes in Myanmar that lack sufficient water also fail to demonstrate that the absence of rotations controlled by farmers has significantly constrained production. At Kinda and Kinmundaung water rationing imposed by the ID has substituted for farmer rotations during periods of water stress. The agency limits available supplies to sections on the upper reaches of the schemes for which the ID has determined supplies are adequate. The study sample does not include cases representing behavior and impacts under conditions of severe stress, where the agency has been unwilling or unable to impose a solution and permitted anarchy to reign at and below

the tertiary turnouts. Even if it had, whether such a free-for-all would diminish total production is not at all certain.

What is probable is that paddy cultivation by headenders and tailenders alike, in the uplands as well as in the lowlands, uses more water than financial or economic conditions can justify in relation to alternatives. This is the first and only one of the six plausible patterns of suboptimal O&M behavior listed in Chapter 2 that the study team confirmed in the field. If the headenders at Dau Tieng, on the left main canal at Kinda, or the favored blocks on the right canal at Kinmundaung could be induced to diversify away from paddy in the dry season, larger areas of other field crops could be irrigated instead, with a potentially large, positive effect on the value of total production.<sup>1</sup> A partial exception is Lam Pao, where soils are marginal and the yields of most other field crops are low. Thus, the economics of O&M may be inextricably linked to prospects for diversification.

### Conclusion

*In short, poor O&M does not result in major or sustained losses of production*

In short, none of the four elements in the matrix of O&M shows a pattern of poor performance that results in major and sustained losses of production. There is even a possibility that the imposition of planned rotations, especially if they enforced equal allocations, would have a detrimental effect. Such sharing of water among all farms within the design command areas of Kinda and Kinmundaung would certainly do so. Reducing the flows to headenders at Dau Tieng would not mean that the savings would automatically go to tailenders. Because of canal configurations, some of those savings would flow to the end of the main canals and distributaries and be lost to the scheme altogether (though not to the river basin as a whole). Discharges from the Maeklong main canals limited by WASAM formulas to strict requirements of standing crops would have the same effect: water would pass through the mains to the end of the scheme.

One can challenge the very concept of headender "waste" on two grounds. First, overuse of water defined in terms of an excess over the standing crops' requirements for evapotranspiration ignores the other legitimate reasons for flooding paddy, especially weed control, and thus reduced labor costs. Second, water overused at the headend may reappear lower in the scheme or basin, and is thus not wasted.

### Note

1. Unless rice prices rise to the levels expected in the late 1970s for the mid-1980s (see Figure 5.1).

## 7.— Findings and Recommendations

### Findings

The findings were unexpected. The study team's intent had been to determine whether lower than desirable standards of O&M performance—which was an operating hypothesis driving the study—had had an appreciable effect in driving benefits downward, and thus jeopardizing farmers' incomes as well as the investments' rates of return. Three significant findings upset that hypothesis, namely (1) that O&M performance is better than expected; (2) that weaknesses in O&M have had no appreciable impact on production to date; and (3) that the schemes' financial and economic impacts have been seriously eroded by production and price shortfalls, to the extent that the schemes' sustainability is jeopardized by factors that have nothing to do with O&M.

As these schemes evolve, O&M is likely to be the dependent variable. The sustainability of O&M performance will depend more on improved scheme returns resulting from diversification than from O&M. This may already be the situation in Thailand.

The six irrigation schemes display similar patterns of O&M behavior and irrigation impact. Although the schemes' representativeness across the region cannot be assumed, the relative uniformity of patterns across the sample suggests that the lessons learned have broader applications.

### **Operation and Maintenance**

*O&M performance by public agencies is at least adequate, and in some cases, good*

O&M performance by the public agencies that manage the schemes is at least adequate, and in some cases, good. The knowledge and hands-on involvement of field engineers from the two provincial irrigation services at Dau Tieng, the aggressive reforms RID's new project manager has promoted at Lam Pao supported by a European Community technical assistance team, and the intelligent management of scarce supplies by the ID at Kinda are impressive. Weed control in the mains and distributaries is not as good as it should be for optimal effectiveness, but the authorities are aware of this problem and are struggling to overcome it. Low budgets prevent large-scale use of hired labor. As cooperative behavior already ensures a modicum of maintenance when most needed, further progress can be expected as efforts to promote association bear fruit.

In Thailand and Myanmar the agencies did not adopt WASAM, the high-tech water measurement and allocation program promoted by consultants. Also, an unfamiliar overshot gate that required excellent controls upstream (romijn gate) introduced at Maeklong on a pilot basis was not used elsewhere. The demands imposed on agency staff and irrigators to collect data, calibrate de-

VICES, and control flows proved beyond their capabilities and interests. With hindsight, the outcome appears to have been inevitable, raising a question about the realism of the foreign consultants' plans and the Bank's support for them. These experiences give the impression of donors and technical assistance teams using the region as a testing ground to try out new designs, with encouragement from agency headquarters, but without a realistic assessment of local management capacities or irrigators' incentives. Especially in an age when governments are reducing their involvement in irrigation management, project designers should give more consideration to technologies that require little management attention. WASAM has been scaled back at Lam Pao in an attempt to reorganize around the manageable components—an attempt that appears to be succeeding.

*Farmers at the sites examined do not display the anarchic, antisocial behavior described by the literature*

Sophisticated water delivery systems that depend on centralized calculations of irrigation targets based on an assessment of crop water requirements, as reported in Thailand, tend to lack complete information to derive accurate targets. The information that is most often lacking or inaccurate is data about variable seepage and percolation, return flows, alternative water sources for some blocks, spatially variable rainfall, and variations in plant requirements at different stages of growth. Where the inability to take such factors into account renders irrigation targets unacceptably inaccurate, water is distributed based on qualitative judgments by field staff or interference by farmers. This makes the water delivery system uncertain and hampers the ability to monitor actual distribution performance. The best becomes the enemy of the good.

Foreign experts tend to recommend control structures designed for stable water levels but for environments where frequent fluctuations of discharge at the intake are amplified down through the irrigation system as water passes more and more adjustable gates. Thus, the gates do not function as intended. This was the case at Maeklong, where WASAM was mounted in combination with the *romijn* gates, to the detriment of both.

There is no evidence at any of the six sites that the quality of the original construction was so poor as to frustrate subsequent maintenance programs. Design engineering errors did occur, especially at Lam Pao Dau Tieng, but many were spotted and corrected before construction and the rest are being dealt with gradually. Some of the original works at Lam Pao suggest that initial construction was of low quality, but the agency and two consecutive technical assistance teams have been busy rehabilitating them.

O&M performance by irrigators can be evaluated at two levels. Assessed against engineering design, it rates poorly. The irrigators at all sites demonstrate a willingness and capacity to keep the channels below the tertiary turnout clean enough and in a good enough state of repair to keep water supplies moving. However, they have allowed the calibrated gated structures—essential for measuring discharges under controlled delivery—to degenerate, opting instead for unobstructed flow. Nevertheless, when assessed against irrigators' collective self-interest, irrigation system performance is high. The tendency to engage in destructive anarchy reported in the literature was not evident in this sample of schemes. The degeneration of gates below the distributaries on these schemes is not the result of poor maintenance standards, but of operational decisions to let that function lapse. This is also the case in Bangladesh, where limited use of structures is related to their utter lack of social feasibility.

Social pressures along the channels within a tertiary system appear sufficiently effective in this sample to guarantee headenders' participation in canal cleaning and prevent them from exploiting their advantageous locations for taking too much water. Farmers complained about abuse at all the schemes except Azin, but their complaints were usually not the sort to hint at violence. The fact that water was abundant in four of the six schemes means that most farmers along the watercourses were benefiting from the projects, and explains why they tolerate the absence of gates and rotations above their own turnouts. For the two schemes suffering from water scarcity, both in Myanmar, the agency steps in when necessary to enforce rationing.

*Weak water user groups do not always condemn irrigation schemes to inefficiency, especially when public agencies intervene in an intelligent manner*

Water distribution has been relatively fair and the schemes have avoided serious disputes within their tertiary systems. This is reflected in paddy yields that do not seem to have been affected by lack of rotation. Yields at the tail are everywhere reported to be at least close to, if not equal to or above, those at the head, even where groundwater is not available. Other evidence that water management is working rather well is provided by the high efficiency ratings for water use the study team calculated for the three major schemes: the two stages at Lam Pao (dry season only), for which the rating is 43 percent; both the right and left main canals at Kinda, with a rating of 52 percent; and the east main canal at Dau Tieng, whose rating was 44 percent. These are good scores. The report by the International Food Policy Research Institute referred to in Chapter 2 (Rosegrant and Svendsen 1994, 416) states that, "Overall system hydrologic efficiencies in surface irrigation systems in less-developed Asia are estimated to range between 25 and 40 percent in most cases."

The study samples includes several types of water user associations with different levels of effectiveness. At Dau Tieng the WUGs are little more than extensions of the provincial agencies and participation is low. At the other extreme, the associations sponsored by the consultants at Lam Pao are fully participative and increasingly effective. There and at other sites evidence indicates that WUGs with broad participation and strong leadership enhance the efficiency of water distribution and use, and that weak WUGs are associated with poorer O&M performance. The unassisted associations at Lam Pao are examples of the latter.

Weak WUGs, however, do not always condemn schemes to inefficiency. Intelligent interventions by public agencies to ration water according to availability, combined with cooperative action by farmers everywhere, inside or outside formal associations, to keep channels open, compensate for relatively ineffective associations. Dau Tieng and the left main canal at Kinda are examples of two different approaches to effective government

intervention: in the first by provincial irrigation authorities exercising full control, and in the second by a national irrigation agency backed up by formidable local offices of the central government.

The study shows that equitable treatment is less evident on the longer tertiaries and among tertiary systems on the same distributary. Headend command areas, rather than headend farmers, present the greatest challenge to fair distribution. At this level, associations and formal federations of primary WUGs can make a substantial difference. Note that at Lam Pao, as the associations of water user groups sharing the same secondary canals gain strength, the functions and prominence of the watercourse WUGs tend to diminish. This is predictable, because once the association of WUG leaders has determined an appropriate formula for sharing water or a cleaning schedule, meetings at the lower level can be dispensed with. The turnover of O&M

responsibility from agencies to irrigators in coming years will have to focus on these *systems* of tertiaries. At the Myanmar and Vietnamese sites, irrigators are already responsible for the tertiaries, but the turnover of higher-level systems is not yet under discussion.

Governments should encourage WUGs and their associations to become farmer organizations with broader mandates than simply irrigation O&M. Such organizations require a wider financing base and a broader set of services to induce farmers to support them than can be done within a sole focus on O&M. Members have to see the WUG as offering otherwise inaccessible collective goods. Where a dependable supply of water is provided at the tertiary turnout regardless of WUG activity, participation is less likely to flourish.

The tendency—best illustrated at Dau Tieng—is for foreign experts first to design and construct irrigation systems, next for donors and governments to finance them, and only then for attempts to be made to try to organize farmers to assist with tertiary development. Experience elsewhere confirms that this is an ineffective way to organize farmers to take over responsibility for financing and developing tertiary networks or managing irrigation, and leaves farmers without a sense of ownership of or responsibility for the system.<sup>1</sup> Farmers should be organized first, or at least brought into the design and implementation processes, and then persuaded to enter into agreements for partial financing, approval of designs, participation in construction, and management after completion of the construction.

The government's failure to involve farmers in project design has had disastrous consequences in Bangladesh. Similar consequences are seen at Dau Tieng. First, the development of the tertiary systems by the provincial authorities has practically stalled, and there is no organized protest group to represent those farmers who remain unserved to exert pressure on the agencies to complete the job, to persuade village authorities to cede land essential for water passage, or to take over construction. Second, farmers in advantageous locations get early access to irrigation, which gives them the perception of an abundant supply. Although they gain important experience with irrigated agriculture, it is based on an unrealistic supply situation. This fosters habits, perceptions, and relationships with officials that have hindered expansion of the irrigated area.

### **Agro-Economic Impacts**

Command areas and/or cropping intensities are well below appraisal projections at five of the six schemes. The exception is Azin, which at 1,000 hectares is the smallest scheme. Paddy yields are also below projections at five of the schemes, but only by about 15 percent, on average, for monsoon and dry seasons taken together. While continued improvements can be expected, the interval between project completion and this study corresponds to the interval before full development in appraisal terminology, and thus the comparisons of actual impact with projections at appraisal are valid. Total production falls commensurably with areas, intensities, and yields. For Lam Pao, Dau Tieng, and Kinda actual production of paddy (and paddy equivalents of groundnut and other field crops) is, respectively, 73, 47, and 36 percent of SAR projections.

Production losses are compounded in the economic analysis by the collapse in the price of rice since the early 1980s, after all the projects had been appraised. In constant prices, the price of rice in 1995 was two-thirds less than

the price projected in 1980. The decline in the price of rice could have been more easily absorbed if farmers had adopted the diversified cropping patterns planned for four of the schemes. Instead, they grew more paddy. Table 5.4 showed the recomputed ERRs for the six Bank-supported components of the schemes. They all are below 8 percent, and one is negative.

### *Weaknesses in O&M have no appreciable impact on production*

Thus, for the Bank these have been uneconomic investments. The main explanation is the smaller than projected increase in value added. Even if the 1980 projections of the price of rice had been realized, a combination of lower than expected production and lack of diversification would nevertheless have undermined the economic viability of the investments.

For the borrowers, however, ERRs between 4 and 7 percent are acceptable, given the visible signs of substantial improvement in intensification and yields over large areas that had previously been rainfed and the external regional and social benefits of the investments not captured by rate of return estimates. The governments involved are satisfied that the projects are successful, with the possible exception of Kinmundaung; they are clearly committed to sustaining all of them.

The most serious threat to all the schemes comes from their modest impact on projected family income. As Table 5-2 showed, net annual household incomes from irrigation on average size farms range from about \$600 to \$2,000, depending on the size of the farm, local market prices for paddy, and the extent of diversification out of paddy. Farms in poorly drained lowlands constrained to a paddy-paddy rotation have net incomes at the lower end of that range. Such incomes may not be attractive enough to keep families, and especially young people, committed to farming. The industrialization of the Thai economy and the modernization of its society are reducing the incentives for people to stay on their two- to four-hectare holdings at both Lam Pao and Maeklong. To date, Dau Tieng has not been subjected to push and pull forces of the same intensity, but as the economic pole based on Ho Chi Minh City continues to expand, this scheme's irrigators will also start to migrate. Economic conditions in Myanmar are less advanced than in the other two countries, and without alternative employment opportunities, the irrigators must accept whatever their farms can provide. However, as input/output price ratios are more favorable than in the other two countries, this eases their position somewhat.

What is the future of these paddy-based irrigation schemes in Southeast Asia that are supported by stored water? Do new starts, or even the rehabilitation of old schemes, make sense? The answers depend mainly on whether the country exports or imports rice and is likely to continue to do so. There is more justification for importing countries to encourage production, provided costs are relatively low. There is less justification for exporting countries to continue to promote paddy farming. The objective must be to diversify irrigated farms away from double-cropped paddy. Thailand is the largest rice exporter in the world. The NEWMASIP team in northeast Thailand has concluded that as long as paddy predominates, only the most basic expenditures on rehabilitation can be justified at Lam Pao, and has recommended cutting back on institutional development costs. The relationship between low paddy prices and rising wages (Table 5.3) suggests that the trend is irreversible. NEWMASIP maintains that only after a major shift in farm activity toward integrated, high-value cropping systems can household enterprises achieve incomes competitive with nonfarm employment. Myanmar and Vietnam are also rice exporters, and will face the same adverse out-

put/input price trends as Thailand in the near future (Dau Tieng) and distant future (Myanmar).

### **Relationship between O&M and Impacts**

As discussed in Chapter 6, the study team discovered no significant negative influence of suboptimal O&M performance on agricultural production in the schemes examined. The study was originally conceived to examine the hypothesis that such a negative relationship did exist. But the team found that O&M performance is quite good, and that whatever the weaknesses in O&M on the schemes, they are not such as to depress overall production and family earnings.

The one exception is the failure to achieve diversification out of paddy. By concentrating available water on paddy when diversification to other crops with lower moisture requirements would have permitted irrigation of a larger area—often with higher value crops—irrigators have maintained traditional farming systems at the economy's expense. This report attributes these losses to public policy, and not to poor operational performance.

#### *Production and price shortfalls, rather than poor O&M, eroded the schemes' sustainability*

The decline in the competitiveness of irrigated paddy farming is bound to affect farmers' commitment to O&M. Evidence from the water-short Myanmar schemes indicates that farmers within the design command area who do not get enough water reduce their contributions to collective cleaning and repair. The same result can be expected if family members seek alternative employment and turn away from double cropping. At Lam Pao farmers who let their land lie fallow in the dry season do not join the working groups. Even families that continue to farm must contend with husbands and young adults leaving the fields and wives and older family members taking up the slack. Such trends imply a shift back to subsistence production and less interest in or ability to do good O&M. These changes will be most serious for dry season production, but the monsoon labor profile is also changing, and with it attitudes toward O&M. This is why the beginning of this chapter noted that O&M's influence on production now seems less important than production's influence on O&M.

### **Conclusion**

The Thailand examples provide a preview of the future of the other schemes, and NEWMASIP's lead in speculating how these changes will materialize is worth following. Paddy-paddy rotations are likely to persist in the three countries only as a basis for household subsistence. Diversification, especially on the better drained lands, can restore incentives for many of the farms, not solely in the direction of substitute grains and other field crops, but for integrated farming systems that feature small stock and fish as well as specialty crops. However, unless governments intervene with effective extension and marketing services, the likely outcome is that ribbons of modern, all-season farming will develop along the major distributary canals, while the hinterland will be used intensively for monsoon paddy and be left fallow in the dry season. Some families will leave farming in any case. In this connection, the extension services should not consist of broad-based, poorly informed squadrons of undermotivated high school graduates. Rather they must have staff competent to deal with integrated systems, specialty crops, and other niches that market surveys identify.

### **Recommendations**

Despite the sample's limitations, the following dozen recommendations may have operational relevance.

*But current practice of operating and maintaining irrigation schemes is wanting nonetheless*

#### **Sharpen the Response to O&M Failures**

O&M is often viewed as an indivisible set of agency and irrigator activities that are carried out poorly and require concerted remedial actions. This study suggests that performance across the set of activities is not uniform; that

agencies and irrigators perform certain functions well and fail on others; and that systemic disincentives explain some of those failings more readily than anarchy, moral hazards, bureaucratic disinterest, or other features of the popular model. For example, an examination of irrigator O&M on other projects is likely to support the study's finding that farmers usually maintain local channels well and gates poorly, and that efforts to exhort them to rise to a higher level of O&M by keeping the gates in working order are unlikely to succeed. Hence the first recommendation is to

*Disaggregate O&M, identify the poorly performing components, and deal with specific disincentives .* Exhortations to agencies and irrigator groups to take O&M seriously should be replaced by tailor-made prescriptions based on intensive local consultation with farmers and officials.

### **Simplify Infrastructure and Operations Technology**

Highly reticulated, gated water distribution systems that offer reliable rotations should be simplified whenever an opportunity for modernization exists. Agency and irrigator attraction to, tolerance of, and ability to administer complex systems is limited. Ideal distribution formulas, flow measurements, and democratic rotations sometimes have to give way to second-best solutions, for example:

*Convert to "modern" control structures .* These would include, where appropriate, either fixed or automatic weirs, gates and regulators.

*Ration water supplies to specified distributaries during seasons of acute shortage .* This would be a more efficient alternative than reliance on voluntary intertertiary rotations. Farmers may have to agree to an annual operational plan that includes carefully crafted contingent language satisfactory to tailenders in the event of a shortage. Trying to maintain voluntary systems in times of stress is an invitation to anarchy, at least in immature irrigation societies.

*Withhold water from recalcitrant WUGs .* Most agencies claim authority to prevent release of water to a tertiary system or subsystem pending completion of pre-season cleaning and other O&M responsibilities. While they rarely use this weapon, it is effective and easily defended. Again, prior agreement with farmers may be required, and can be reached by means of intelligent participatory discussion. The threat creates a collective good that only groups can acquire and prompts farmers to organize and participate. The Bank should take a proactive position in recommending the use of this weapon, because it eases WUGs' decisions as to whether they should complete their assignments.

### **Promote Management Transfer to WUGs Judiciously**

Simplistic and politically correct assumptions about the inefficiency of public agencies and the presumed benefits of beneficiary participation should not drive decisions on the transfer of management responsibilities to WUGs. This study suggests that transfer is likely to have different levels of impact depending upon whether the assets and responsibilities transferred are within the tertiary system, at the tertiary gate, or along a section of the distributary with all its tertiary turnouts. In paddy irrigation schemes where responsibilities for channel cleaning and minor repair are already in the hands of farmers, but the WUGs are weak or nonexistent, the payoff to investing in institution building limited to O&M of the tertiary system alone is uncertain. That cannot be said of highly diversified, irrigated cropping systems, which require micro-control of water distribution. Transfer of O&M specifically for the tertiary gates is likely to be frustrated, because paddy farmers below the gates do not want them. Better O&M at the tertiary gates is more likely to follow the association of tertiary WUGs along a distributary. These points translate into four more recommendations, namely:

*Specific measures—such as transferring part of scheme management to associations of water user groups—could be taken to improve irrigation O&M*

*Transfer the responsibility for cleaning, routine maintenance, and minor repair of tertiary canals, channels, and associated structures to farmers where this has not yet been done . They will handle these jobs collectively with a modicum of encouragement and support.*

*Do not transfer O&M of tertiary gates to irrigators in the absence of other measures to improve paddy farmers' incentives to participate in closing gates to restrict their own water supplies . Agencies soon tire of installing new gates that disappear after several months. Agencies are likely to find that policing farmers' performance is as demanding as O&M.*

*Concentrate institution building on organizing federations of associated WUGs, where it is likely to have a high payoff . Associated water user groups can administer rotations from the distributary canals, overriding the selfish behavior of individual WUGs. This will also simplify the groups' work.*

*Focus on flood control and drainage schemes where purposeful development of user associations and transfer of functions have been ignored as prime candidates . Initially, the institution building program should be centered on the structures that offer local farmers immediate and recognizable benefits: smaller sluices, the inlets, and so on.*

### **Improve Household Earnings**

The collapse of incomes from paddy farming threatens both household and scheme economies. A recovery in international rice prices and government willingness to subsidize local market prices are both unlikely. Measures must be taken to elevate irrigated farm technology to increase productivity and household incomes, including the following:

*Promote diversification systematically and aggressively . This may include restructuring channel architecture to permit mixed cropping.*

*Support the development of research, extension, and marketing services oriented toward diversified cropping, including specialty crops and integrated on-farm systems . For the paddylands studied, investments in institutions that provide such services can have a higher payoff than investments in*

narrowly focused WUGs. Ideally, WUGs should expand to incorporate extension and marketing functions.

*Remove restrictions that prevent people intent on modernizing the business from acquiring the rights to farm . This includes removing controls on the rental and sale of irrigation properties, on contract work, or on produce sales. Governments should anticipate that many present scheme occupants will eventually want to migrate, and sooner than that may try to rent their fields in the dry season.*

*Abandon cost recovery . The farmers who agreed to the terms of these schemes at startup are now paying substantial penalties because of the collapse of international and local rice prices. Their losses are reflected in consumer surpluses far larger than even full recovery of capital, as well as O&M costs, would provide. Imposing cost recovery on these paddy farmers is more likely to drive them out of farming than into diversification, especially those with few or no cropping options.*

## Conclusion

The relevance of these recommendations beyond the selected schemes is uncertain, because they depend on cultural and institutional factors that may be country specific and on engineering and agronomic considerations that may be project specific. For example, some of those who commented on a draft of this report were concerned that the findings were at once both too rough on and too forgiving of O&M performance in the region. For the moment, these recommendations are better viewed as hypotheses. Additional empirical work is needed to validate the range of countries and projects inside or outside the region for which these recommendations are appropriate. OED has proposed holding a regional workshop where validation would be one of the principal objectives.

## Note

1. A much studied example is the Bank-supported Narayani scheme in Nepal (Narayani Zone Irrigation Development Project, Stage II). An example of good practice, where participation was encouraged from the beginning, is the Gal Oya scheme in Sri Lanka, which is supported by the U.S. Agency for International Development.

## Annex: Incremental and Total Paddy Incomes Per Farm and Per Hectare

### INCREMENTAL AND TOTAL PADDY INCOMES PER FARM AND PER HECTARE (financial prices in 1995 US dollars)

Country and scheme	<i>Actual (1995)</i>		Paddy incomes		<i>Actual (1995)</i>		Total Per farm
	Average farm size (ha)	Intensity of Irrigated crop (ratio)	SAR (total) SAR prices	1995 prices	Incremental Per farm	Per ha	
<i>Thailand</i>							
Lampao	2.2	1.5	1,120	2,055	n.a.	n.a.	590
Maeklong	3.5	1.6	3,695	6,100	n.a.	n.a.	1,750
<i>Myanmar</i>							
Kinda	3.0	2.0	1,945	2,965	1,815	605	2,010
Kinmundaung	2.0	2.0	1,220	1,975	890	440	1,340
Azin	2.0	1.0	815	1,320	840	420	1,580
<i>Vietnam</i>							
Dau Tieng							
Lowland	1.0	3.0	3,075	5,645	415	415	570
Upland	1.0	3.0	3,200	5,875	1,050	1,050	n.a.

ha Hectares. n.a. "Without" project conditions poorly defined.

*Notes:* Lam Pao: SAR (1978): 2–hectare diversified farm. Study: typical farm, two paddy crops, 50 percent dry season intensity. Maeklong: SAR (1979): 4–hectare paddy farm. Study: typical farm, two paddy crops, 60 percent dry season intensity. Kin (1980): 2–hectare diversified left main canal farm. Study: left main canal farm, two paddy crops, formerly one rainfed paddy. Kinmundaung: SAR (1982): 2–hectare paddy farm. Study: privileged farm, two paddy crops, formerly one rainfed paddy. SAR (1982): 2–hectare paddy farm, one irrigated crop. Study: typical paddy farm, two crops, one irrigated; formerly one rainfed crop (rainfed yield of 3.7 tons/hectare taken from the SAR). Dau Tieng: Lowland: SAR (1978): 150–hectare cooperative with three paddy crops. Study: privileged farm with three paddy crops, formerly with one rainfed paddy crop. Upland: SAR: 150–hectare cooperative with three groundnut crops. Study: privileged farm with two groundnut crops plus one paddy crop, formerly with one rainfed crop.

*Source:* SARs and the study team's research.

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