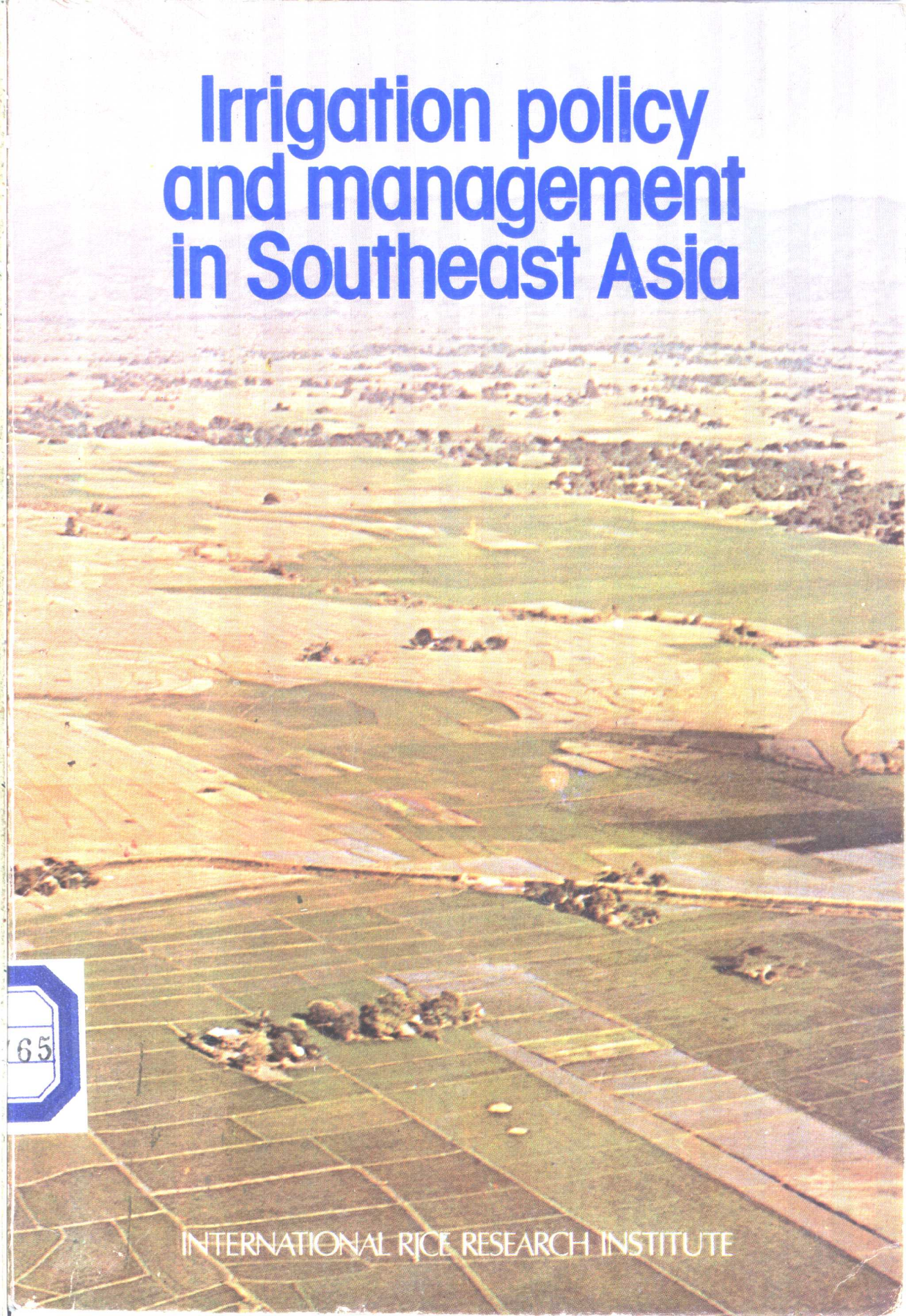
Irrigation policy and management in Southeast Asia



INTERNATIONAL RICE RESEARCH INSTITUTE

Irrigation policy and management in Southeast Asia

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The full responsibility for all aspects of this publication rests with the International Rice Research Institute.

Foreword

The supply of water — more than any other single factor — controls the production of field crops in the tropics. Year-round cropping systems are generally possible in areas where water supply is dependable and controllable — a condition found only where irrigation systems are well-conceived and efficiently managed. But too often, deficiencies in the conceptualization and management of irrigation systems preclude the realization of full food-production potential within their command areas. Means to remove such deficiencies must be found and implemented so that crop production can be increased to its biological limits.

Scientists and engineers in national irrigation planning and management programs collaborate with counterparts in regional and international institutions to identify shortcomings in existing irrigation distribution systems and to devise workable schemes to improve them. Scientists in such international organizations also work with irrigation planners to incorporate efficient management methods into the operation of future irrigation systems.

The International Rice Research Institute (IRRI), the Agricultural Development Council (ADC), and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) jointly sponsored the International Seminar on Irrigation Policy and Management in Southeast Asia. These international organizations support research and management efforts to achieve potential agricultural productivity through improved irrigation planning and implementation. This seminar highlights such efforts, which are essential to the effective utilization of biological breakthroughs. New plant varieties and better soil and crop management schemes can be fully exploited only with effective water-management practices. The seminar should help achieve such a goal.

The Institute extends appreciation to the cooperating researchers and others who participated in the seminar, and to Dr. T.H. Wickham of IRRI and Dr. D.C. Taylor of the Agricultural Development Council, Singapore, who served as joint technical editors for the published proceedings.

N. C. Brady
Director General

March 1978

Preface

A research seminar on Irrigation Systems in Southeast Asia was held 22 to 25 June 1976 at Los Baños, Laguna, Philippines. It was sponsored by the Agricultural Development Council (ADC), the International Rice Research Institute (IRRI), and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). Those agencies also supported the publication of this volume.

The seminar was held to

1. Provide a forum for the presentation of recent research results on irrigation policy and the management of irrigation systems;

2. Offer researchers and irrigation agency staff an opportunity to interact and exchange ideas;

3. Plan directions for future research that is relevant to the needs of professionals in the field of irrigation policy and water management; and

4. Augment the scarce literature now available to students and professionals involved in irrigation research and management in Southeast Asia.

The geographic focus of the seminar was Indonesia, Malaysia, the Philippines, and Thailand. Seminar participants included researchers (many of whom had recently completed the reported research as part of graduate study programs), senior irrigation policy makers, and irrigation system managers.

An editorial board reviewed the seminar papers and decided which to include in this volume for wider circulation. IRRI's Office of Information Services helped the board edit the papers. Some changes in format and style were made on the original manuscripts to make them more consistent for joint publication.

Part I of the volume is the interpretative summary, which identifies the main themes that emerged from the seminar and highlights the most important issues discussed.

Part II includes four papers that describe selected strategies being followed by various Southeast Asian countries in planning and designing irrigation infrastructure.

Part III deals with the management, operation, and maintenance of irrigation systems. Four of the papers report research results and one describes a training program for water management personnel.

Part IV comprises six papers that cover economic issues in irrigation. The papers include analyses of the economic performance of various types of irrigation projects and assessments of policies for securing repayment of irrigation investment.

Part V deals with irrigation organization and farmers' behavior. The content of three of the papers is primarily sociologic or anthropologic and the fourth is socioeconomic.

Most of the papers have common characteristics that make the collection a unique contribution to the literature on irrigation and water management:

1. The research papers are primarily empirical, rather than speculative or theoretical. Most are based on local research, some of which involved case studies. The authors point out the limitations of their papers and the implications of their findings for policy and

managerial decisions and for further research.

2. The nature of irrigation varies greatly from country to country, and even from region to region within individual countries. Furthermore, quite different aspects of irrigation are emphasized in different papers. The differences are highlighted in the abstracts and are elaborated in text. Readers are urged to note such differences when interpreting the findings presented.

3. Most of the research papers are authored by young professionals. Their analyses are straightforward and should interest a wide range of readers, including undergraduate and graduate students and practitioners in the field.

One of the most significant aspects of the irrigation seminar was the effective communication between irrigation field staff and policy makers, and research workers. Both groups clearly responded to the opportunity provided by the affiliation of the participants and sought out new ideas to make their work more complete.

We are grateful to the authors for their time and attention in writing the papers, to IRRI's Office of Information Services for editing them, to Ms. Cheng Bolton for painstakingly organizing them, and to Ms. Leila Hernandez for typing several drafts of each manuscript.

D.C. Taylor T.H. Wickham

December 15, 1977

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ECONOMIC ANALYSES OF IRRIGATION

ORGANIZATION OF IRRIGATION ACTIVITIES AND BEHAVIOR OF IRRIGATORS

Irrigation policy and management issues: an interpretive seminar summary

R.C. LAZARO, D.C. TAYLOR, and T.H. WICKHAM

This interpretive summary reviews the observations and impressions of the authors from a seminar on Policy and Management Issues in Irrigation Systems in Southeast Asia.[1] The summary identifies the main themes that emerged from the presentation and discussion of the seminar papers and highlights the most important issues discussed.

The summary deals conceptually with each issue covered. The names of the authors responsible for specific ideas are shown in parentheses, but no attempt is made to document sources of ideas that emerged in the seminar discussions. The conceptual presentations are followed by summaries of relevant empirical findings and suggestions of issues deserving further study.

R.C. Lazaro, Director for Agriculture, Agriculture Department, Special Projects Office, National Irrigation Administration, Quezon City, Philippines: *D.C. Taylor,* Agricultural Development Council Associate and Visiting Professor of Agricultural Economics, Malaysian Agricultural University, Serdang, Malaysia: *T.H. Wickham,* Agricultural Engineer, Department of Irrigation and Water Management. The International Rice Research Institute, Los Baños, Philippines.

[1] While the authors have attempted to reflect the content and spirit of the seminar's deliberations, they accept responsibility for any omissions or errors in what is reported.

Main Themes

Three basic issues in expanding and making more equitable irrigated agricultural production in Southeast Asia were identified.

1. *Alternative strategies to develop irrigation infrastructure* were considered. They include investment strategies in constructing new projects, rehabilitating old systems, and intensifying the terminal facilities of existing systems. The seminar participants gave explicit attention to large-scale vs. small-scale irrigation infrastructure.

2. *Alternative approaches to improve the operations and maintenance (O&M) of irrigation systems* were discussed. They include the advisability of separating operational tasks from maintenance tasks, and of emphasizing the

improvement of either the main-system or terminal-system O&M, or both; the relative value of rotational vs. continuous irrigation; and means for securing greater farmer participation in terminal O&M.

3. *Specific policy options.* This third set of issues deals more directly with the social sciences. It includes the possibility of achieving income redistribution through irrigation development, the prospects for securing repayment of the costs of providing irrigation, the need for greater attention to manpower development in irrigation, the feasibility of evaluation studies that can provide insights into improved policy and management decisions, and the need for and possibility of achieving greater integration of nonengineering issues in irrigation development.

Each of the three main themes is discussed more fully below.

Alternative strategies to develop irrigation infrastructure

Constructing new irrigation projects. Irrigation projects aim to expand a country's potential for agricultural production by exploiting new sources of water. Depending on hydrologic and other technical considerations, new projects may involve pumping,[2] river diversion, or reservoir storage. Diversion projects are usually less dependable, especially during the dry season, but their financial, ecological, and social costs are usually less than those of storage projects, which involve elaborate infrastructure, the displacement of people, and the disturbance of natural habitats through reservoir flooding.

An advantage of allocating irrigation investment to new projects, rather than to rehabilitating or intensifying terminal infrastructure in old systems, is that the benefits of new projects reach out to encompass new people. If these people are relatively poor, desired redistribution effects can be realized at the same time that production potentials are raised.

Indonesia's program of small-scale *sederhana* or simple irrigation development in the Outer Islands is of interest in this connection (Oesman). The projects involve up to 2,000 ha each and usually serve rather remotely located pockets of farmers with access to modest amounts of river water. The program broadens the geographic spread of government developmental efforts, since the irrigation infrastructure in the projects is technically simple to design and construct, and the gestation period between project construction and realization of irrigated production is relatively short (less than 2 years). The close link between farmers and irrigation development, which is feasible with small-scale projects, may also increase the willingness of farmers to participate in the operation of the completed systems.

Small-scale irrigation projects were the primary form of early irrigation in most countries of the region. Because of the recent renewed interest in small-scale irrigation, it would seem useful to undertake more research to document its performance. Such research could, for example, examine whether small-scale projects actually have more favorable impacts on income distribution and shorter gestation periods, and encourage greater degrees of farmer participation than large schemes. Other questions to which such research could find answers are:

1. Do the per-hectare costs of small-scale irrigation infrastructure and O&M generally differ from those of large-scale systems?

2. Which size of system is generally adapted to more intensive farming?

3. What approaches are most effective in organizing the management of widely scattered small-scale projects?

Rehabilitating existing infrastructure. Substantial investments are being made, especially in Indonesia and the Philippines, to rehabilitate irrigation facilities that have deteriorated because of inadequate maintenance. The intention is to restore the infrastructure to its original condition. Rehabilitation consists of repairing diversion dams and expanding their capacities, desilting and lining irrigation and drainage channels, repair-

[2] Pump irrigation was not a major focus of the seminar, and is not discussed in detail here.

ing and replacing water control structures, improving service roads, and providing additional training for O&M personnel.

Several papers examined the impacts of rehabilitation. Two dealt with small-scale systems: a communal system in the Philippines (Dozina et al.) and two systems in Indonesia (Hafid and Hayami). One paper involved a large-scale system, the Pekalen Sampean Irrigation Project in East Java, Indonesia (Taylor).

The small-scale systems were rehabilitated primarily to restore their original diversion capacities. Both studies on the small-scale systems showed not only substantial production and income benefits from the rehabilitation but also high rates of mobilization of local resources, especially labor. The systems studied, however, were relatively successful and not necessarily representative of all small-scale systems in the respective countries.

The rehabilitation of the Pekalen Sampean Irrigation Project emphasized the desilting of channels and the repair of water control structures, rather than the restoration of original water-diversion capacities. The study showed that rehabilitation had no immediate observable impact on production. One explanation is that O&M was more intensive in those irrigation blocks that had deteriorated most, indicating that extra O&M was used to compensate for infrastructural deficiencies. It is also possible that the design of the original system was such that moderate deterioration did not impair minimum water deliveries to farmers' fields. If this reason is valid, the rehabilitation could have precluded possible losses in production in later years.

These findings suggest that the expected impact of rehabilitation depends on the nature of the rehabilitation activities undertaken and on their timing relative to the degree of deterioration. Studies aimed at further elaborating these aspects would provide useful guidelines for future rehabilitation decisions.

Providing more intensive terminal facilities in existing systems.

The intensification of on-farm facilities which began in Taiwan now receives considerable emphasis throughout Southeast Asia. It has been described as the third and most recent phase of long-term irrigation development in Thailand (Trung, Ananda) and Malaysia (Pang). Intensive on-farm terminal facilities are also being introduced in the Philippines' largest storage project, the Upper Pampanga River Project, to permit rotational irrigation among 10-ha units within 50-ha areas (Bagadion et al.).

Terminal facilities extend a system's irrigation and drainage network to provide water directly to individual fields or smaller areas. They make it possible for fields that are difficult to irrigate conventionally to receive a reliable supply of water, and for farmers who formerly depended on irrigation water that moved from plot to plot over other farmers' fields to receive water directly from the additional farm ditches installed in the system. On-farm drainage ditches also alleviate localized deep-water flooding. The development of terminal facilities usually involves the construction of farm service roads and, in some cases, such as in Thailand, land leveling and realignment of field boundaries as well (Ananda).

From a conceptual standpoint, the possibility of expanding irrigated production through more intensive terminal irrigation facilities has considerable appeal. The crucial issue is the actual impact of such facilities on irrigation performance. In other words, to what extent does the introduction of additional terminal facilities in an irrigation system improve the adequacy of water on individual fields and the yields and production levels of the system? Are these production increases great enough to offset the additional costs of constructing, operating, and maintaining the additional facilities?

The only research presented in the seminar that dealt directly with this issue was that done in the Philippines (Wickham and Valera). The study concluded that the performance of irrigation blocks with higher ditch densities was not significantly better. But the introduction of additional ditches may be beneficial under special circumstances, such as when topography is uneven, soils are unusually

permeable, or turnouts are few and widely spaced.

Several seminar participants emphasized the undesirability of adopting uniform densities of terminal facilities in new projects. At issue at one extreme is a strategy of phased irrigation development in which terminal facilities are built over a period of years as shortcomings in existing systems are identified and local action is taken to overcome them. This strategy of gradual evolution of infrastructure is common for communal irrigation systems (de los Reyes). At the other extreme, if quick results and streamlined administrative procedures are to be achieved, standard norms and one-time terminal-improvement projects tend to be emphasized. The seminar brought out the merit of adopting a middle-of-the-road approach that would at the outset identify the problem areas within systems which are brought about by present irrigation or drainage facilities, and then provide additional infrastructure to serve those areas.

High priority research seems justified to identify inadequacies in existing irrigation performance and to determine the contributions that additional facilities could be expected to make toward overcoming such inadequacies. Research on alternative types of water distribution channels, such as fiberglass-reinforced polyester flumes vs. earth channels reported in Malaysia (Pang), would be useful. An analysis of different levels of intensity in terminal irrigation facilities and management practices is another example of research needed to guide future irrigation policies.

Alternative approaches to improve the operations and maintenance of irrigation systems

Operations deal with the allocation of water supplies and the handling of drainage runoff. Maintenance refers to the upkeep of structures and embankments and the removal of silt and vegetation from canals and channels.

Separating operations and maintenance tasks. Although a certain degree of coordination between operations and maintenance is important to the smooth functioning of each, several seminar participants stressed fundamental distinctions between the two (Duncan, Pasandaran). Operations is an everyday activity involving systems' personnel as well as farmers. Maintenance, on the other hand, takes place only periodically and may or may not directly involve farmers. The skills required to perform operations differ from those required for maintenance. It appears that the two activities are usually combined chiefly for convenience and efficiency, since both require substantial field forces.

Improving main system vs. terminal system O&M. The greatest potential for improved water management in irrigation systems in Southeast Asia is often said to be at the farm level. That is because irrigation infrastructure is generally more fully developed in main systems than in terminal systems, and because on-farm O&M involves many people, including farmers, most of whom have only modest or no professional training. While such views may be valid in some circumstances, the seminar papers dealing with this question provide counterevidence.

Several research projects on water management in the Philippines show that problems of water distribution are greater in lateral and sublateral canals than at the farm level (Wickham and Valera). In typical Central Luzon topography and system layout, the on-farm movement of water was found to be relatively efficient and its distribution equitable. Similar findings were reported for a Philippine communal system, where water flow in its main system was irregular and unpredictable (delos Reyes). The authors conclude that a prerequisite for further improvement in terminal-level O&M is the equitable and dependable flow of water in the main system, which requires greater O&M attention at that level.

The Pekalen Sampean Irrigation Project study in East Java (Taylor) provides indirect evidence of a similar nature. The study shows O&M expenditures in terminal systems (involving tertiary and quaternary canals and on-farm ditches) to be three to five times greater than those in main systems (irrigation headworks and primary and secondary canals).

While terminal-level O&M is possibly less efficient and therefore costs more than main-system O&M, the latter is clearly in greater need of increased support.

In view of these findings, it would seem quite important that more research be undertaken to determine exactly where within irrigation systems are problems of water distribution greatest (Tabbal and Wickham).

Adopting rotational vs. continuous irrigation. Traditional irrigation systems involve continuous or simultaneous water flow throughout their distribution network. Forms of rotational irrigation, on the other hand, involve concentrated irrigation flows through portions of the networks at certain scheduled times. Systems of rotation vary, depending on the level within the system at which rotation takes place.

One interpretation of rotation is the prescribing of successive crops to be grown in various sections of a command area. An example is the *golongan* system in East Java, in which planting dates are staggered among irrigation blocks within an irrigation system. Each year the sequence of planting is rotated. For example, the last block planted in one year is planted first the following year. Similar forms of rotation are also reported for the Philippines (Wickham and Valera). This practice is followed to achieve equity in water distribution over time since risks of water shortage tend to be lower and yields higher on the earlier planted blocks (Pasandaran).

Another type of irrigation rotation in East Java is the *giliran* system (Pasandaran). Used during periods of unexpected water scarcity after crops are planted, it results in rotated water use among channels or parcels. The more severe the water shortage, the further down in the system (more decentralized) is the level at which rotation takes place. The rationale for the procedure is that limited water must be concentrated in a few canals for the water to flow efficiently and command the land. Other possible reasons are the farmers' feeling of social responsibility to share water with others in their communities during periods of acute shortage, and the reduced risk of on-farm water wastage with decentralized rotational irrigation.

The most common meaning of rotational irrigation in Southeast Asia is the sequential application of water to small parcels of land within larger continuously supplied blocks. This farm-level rotation may be among individual farms (Thailand), or approximately 10-ha units within 50-ha blocks (Philippines). Rotational irrigation is believed to promote savings in the amount of water required, to permit more equitable distribution during times of scarcity, and sometimes to increase yields.

Counterbalancing the possible advantages of rotational irrigation are the additional costs of the terminal infrastructure necessary to control and allocate water to separate parcels of land according to rotation schedules, and the added management, labor, and materials needed to operate and maintain the infrastructure (Miranda and Levine, Wickham and Valera). Furthermore, farmers may prefer continuous (simultaneous) irrigation flows as insurance against possible water shortages later on, and as a means of weed control.

A paper analyzing pilot rotational irrigation projects in the Angat, Peñaranda, and Santa Cruz River Irrigation Systems in the Philippines dealt with this question (Miranda and Levine). The results of the research were mixed, although there was evidence of higher rates of adoption of new technology and of higher water-use efficiency in the dry season with rotational irrigation.

Relatively large-scale field comparisons of rotational and continuous irrigation during the 1974 dry season in the Philippines Upper Pampanga Irrigation Project did not show significant differences between rotational and continuous irrigation in either yields per hectare or output per unit of water applied (Wickham and Valera). The cost of infrastructure for the rotational areas was somewhat higher, however, and that of the rotational O&M, though not empirically measured, was believed to be considerably higher than the corresponding cost for continuous irrigation.

These findings raise questions about the suitability of rotational irrigation. Many factors

can strongly influence the outcome of on-farm rotational irrigation, and further empirical studies to evaluate its suitability for specific situations are needed. In such studies, attention should be given to managerial and training requirements; the costs of O&M; levels of agricultural output and water-use efficiency; physical parameters such as soils, topography, and water source; and equity of water distribution.

Achieving greater farmer participation in O&M. There is growing interest in Southeast Asia in greater farmer participation in irrigation O&M and in an expanded role for water-user associations in irrigation development. However, attempts to achieve both have generally given only mixed results at best.

Four types of increased farmer participation were recommended during the seminar: 1) taking responsibility to pay more for irrigation, 2) assuming more responsibility to organize and perform O&M tasks, 3) giving more feedback to irrigation offices on the field performance of systems, and 4) exerting greater influence in decisions on water allocation and scheduling.

Greater farmer participation is desired to reduce the administrative and logistic burdens of irrigation, to make better day-to-day decisions on water distribution, and to provide water users with greater incentives to use water carefully. Sometimes the belief that greater farmer participation is needed is based on more philosophical grounds, namely, that the democratic approach to achieving desired discipline and control in irrigation is superior to the authoritarian alternative, and that well-organized farmers can bring modernizing pressure to bear in areas such as irrigation.

The seminar discussions led to three general conclusions on strategies to enlist greater farmer participation in irrigation:

1. *It is unrealistic to expect farmers to participate in irrigation activities, as individuals or as members of groups, unless they believe their participation will benefit them.* The two studies of small-scale rehabilitation provided illustrations of farmers who could envision the rehabilitation contributing substantially to irrigation development (Dozina et al., Hafid and Hayami). In other circumstances, farmers were reported as unwilling to participate in proposed irrigation activities because they did not believe the activities would benefit them (Duncan, de los Reyes).The studies suggest the importance of soliciting farmers' views on irrigation needs, and of bearing in mind the farm-level impact of possible changes in irrigation.

2. *The assumption that improved water management requires greater participation of farmers in irrigation needs to be double-checked.* Several authors drew attention to cases where farmers were reluctant to participate in proposed on-farm water management activities because the main irrigation systems serving them were not providing dependable water supplies (Wickham and Valera, Duncan). Under such circumstances, the government must participate more actively in O&M before farmers can be expected to do likewise. This finding suggests the importance of empirical research aimed at answering the following questions:

a. What are the current water management practices in both main and terminal systems?

b. Where are the problems in water management most severe, and what are their effects on farmers and the systems?

c. What is the most reasonable sharing of roles and functions among the government, farmers as individuals, and farmers as members of groups in solving irrigation problems?

3. *National strategies to introduce widespread, uniform water-user associations may not be advisable.* Great variation in local irrigation environments — physical, institutional, cultural, economic implies that high-priority needs may not be the same in all locations. Development-oriented leadership may be more readily available in some areas than in others, and existing organizations in

particular localities may influence the ways in which local group activities ought to be institutionalized in those areas (Hutapea et al.).

These findings suggest that a strategy of tailoring water-user associations to local needs and initiating them on a phased basis, beginning with situations in which the chances of success are greatest, may be more productive in the long run than the commonly advocated attempts in some countries for widespread and immediate introduction of associations. For either strategy, however, research can help identify the nature of local needs and determine which needs might be met most effectively through group action.

Substitutability of O&M and physical structures. The discussion thus far has treated the design and construction of irrigation infrastructure more or less independently of O&M. In reality, of course, this is an over-simplification.

The seminar brought out two ways in which infrastructure may replace O&M. First, additional investments may be made to mechanize certain parts of the infrastructure and thus reduce the need for operations. Examples are the electronic monitoring of water flows and push-button gate controls. Second, more substantial infrastructure — such as lined channels — that requires less maintenance may be constructed. Alternatively, management can be substituted for infrastructure: more and better trained O&M personnel can make a deteriorated system function more effectively.

Some of the liveliest discussions during the seminar concerned this topic. Some participants stressed the need to improve infrastructure in existing systems and minimized the possibility of improved system performance through greater management attention. Others took the opposite view, emphasizing instances in which improved management had compensated for structural inadequacies of the systems.

Although the controversy was not resolved, it seems that certain elements are critical in determining the possibilities for substituting infrastructure for O&M, and vice versa. Perhaps most important are the relative completeness and condition of existing infrastructure, the costs and relative availability of capital material items vs labor, and the attitudes and experience of managers in allocating time and effort to training and supervising field staff.

A second relationship between infrastructure and O&M concerns the possibility of deferring current maintenance expenditures and later absorbing the costs as rehabilitation investments. Almost all participants agreed that basic expenditures on maintenance should be made to enable a system to deliver minimum assured water supplies. But for levels beyond this, there was some question. Those who suggested the possibility of allowing some maintenance functions to be accumulated as rehabilitation drew attention to the fact that at present money for rehabilitation is quite readily available and on favorable terms. Under these conditions, a country may be well advised not to concentrate its scarce annual operating budget on recurring maintenance, but to take advantage of periodic cheap sources of credit for rehabilitation. This view, of course, assumes that such sources will continue to be available. Finally, the seminar brought out the importance of research studies that would examine economic and technical trade offs between rehabilitation and maintenance.

Specific policy options

A wide range of policy options extending beyond infrastructure and O&M is now covered.

Promoting more egalitarian income redistribution through irrigation development. Several participants emphasized that irrigation development usually exaggerates differences in income among different groups of people, because new projects are usually built in low-lying areas where agricultural production potentials are greatest. New irrigation development greatly enhances the value of project lands. Since large-scale systems are almost always heavily subsidized, landowners receive substantial windfall gains from the infrastructure. Such gains are often reinforced by subsidized O&M. Unless the landowners were

initially from the poorest economic strata, irrigation development aggravates existing problems of income distribution. Once investment funds are committed, they are not immediately available for projects to aid more disadvantaged people such as farmers with small rainfed holdings, and unskilled laborers.

Some evidence indicated that the rural elite use irrigation to reinforce their relative advantage by strongly influencing decisions on how scarce water is allocated (Hutapea et al.) and how turnouts are relocated to better serve their land (de los Reyes). There are also instances of owners with large holdings exercising their economic power by buying irrigated land from farmers with smaller holdings — especially land that is favorably located relative to the water source.

No economic development program can simultaneously serve all groups of people equally well. The tendencies cited above are not, therefore, a clear indictment against irrigation. The more important issue would seem to be to search for elements in strategies for irrigation development giving explicit attention to relatively disadvantaged farmers.

The seminar participants agreed that identifying and pursuing equity as well as productivity objectives will require deliberate attention in the formulation of irrigation policies. The following approaches emerged from the discussion:

1. *Concentrating new irrigation development in areas where holdings are small and farmers poor.* An irrigation policy that gives priority to the poorest farmers would be one means of promoting income redistribution. A strategy that emphasizes small-scale irrigation development would seem to contribute toward this end. Small-scale projects are usually found in rather remote areas where economic differences among farmers tend to be small and where economic development efforts usually receive low national priority. Indonesia's program of small-scale *sederhana* irrigation is a contemporary example of such an approach (Oesman).

2. *Ensuring that the views of disadvantaged irrigators receive recognition in irrigation decision making.* Certain irrigators are inherently handicapped in gaining access to assured water supplies, because of either their remoteness from a system's source of water or their relatively low social and economic position. A precise identification of the most disadvantaged farmers, and exploring ways of guaranteeing their rights in decisions on the design of further infrastructure or allocation of scarce water would help ensure greater equity in water distribution.

3. *Analyzing the distribution of benefits from alternative irrigation strategies.* Relatively little emphasis seems to have been given to examining the effects of irrigation development on income distribution. Since these effects are of growing national concern in Southeast Asia, their empirical examination should receive high priority. Certain strategies have probably been more conducive than others to the wide diffusion of irrigation benefits.

One seminar paper that partitioned the benefits of rehabilitating a Philippine communal irrigation system showed significant absolute benefits to laborers, farm operators, and landowners, with the greatest relative benefit going to laborers (Dozina et al.). That finding, together with initial experience from the *sederhana* program in Indonesia, indicates that the equity implications of small-scale irrigation development may be more favorable than those from large-scale development. This hypothesis should be further tested, however, along with other underlying elements that may contribute to a wider diffusion of irrigation benefits.

Securing repayment for irrigation. Both national governments and international lending agencies participating in irrigation development are deeply concerned about policies for financing that development. The seminar papers dealing with irrigation repayment led to the following general conclusions:

1. *Official rates of irrigation assessments*

may not accurately reflect actual payments made for water. Discrepancies between the two may arise because indicated nominal water rates are not collected in full (Tagarino and Torres, de los Reyes), or because some payments for water are indirect or informal. Examples of indirect payments for water are a differential land tax for dry land vs. irrigated land (Taylor) and contributions by farmers of cooperative labor for canal maintenance (delos Reyes, Taylor). Examples of informal payments are gifts to ditch tenders and payments to neighboring farmers for farm-ditch rights-of-way through their fields (de los Reyes).

2. *Water rates should be considered in the context of overall financial policies for development.* This point follows from the first, since payments for water do not necessarily have to be in the form of water rates. Furthermore, charges for water cannot be considered meaningfully outside the overall perspective of a country's development goals and strategies. For example, national development strategies on the desired direction of wealth and income transfers between the agricultural and non-agricultural sectors are integrally connected with decisions on water rates, as are other issues such as efficiency of resource use and equity of income distribution.

3. *Policies for financing irrigation infrastructure and services should consider the full range of irrigation beneficiaries.* Direct beneficiaries of irrigation are landowners whose land increases in value because of its access to water, and farm operators who produce more because of more assured water supplies. Indirect beneficiaries include government and the general food-consuming public, as well as manufacturers, agricultural businessmen, retail business merchants, and laborers. The indirect benefits arise because of generally expanded economic activity induced by irrigation and the larger volume of food which sells at lower prices than it would have sold without irrigation.

The extent of benefit to each group of beneficiaries should be estimated, and the possibility considered of taxing part of the benefit to finance further irrigation development. Papers dealing systematically with this issue were not presented in the seminar; however, the study of the Pekalen Sampean Irrigation Project in East Java showed that irrigation led to a several-fold increase in production, and in requirements for hired labor (Taylor). Discussions of that study and others during the seminar suggested the following hypotheses:

a. Although the first farmers to receive irrigation usually derive income benefits, the competitive nature of agriculture makes it unlikely that they can sustain the surplus profits over time. Thus, conventional strategies for securing irrigation repayment, which focus exclusively on farm operators, should be reexamined.

b. Of the direct beneficiaries of irrigation, landowners are perhaps the most important potential source of repayment because of the several-fold increase in land values commonly associated with the introduction of irrigation. A graduated system of betterment levies implemented upon project completion is one means of extracting part of the windfall gain in land values. Implementing such a system would undoubtedly require considerable administrative discipline, but the necessary resources for enforcement could be justified if the economic case for this approach were strong.

c. It would be difficult to charge indirect beneficiaries whose volumes of business increase because of irrigation, but an increment in taxes assessed against rice millers, for example, might be feasible. Even if indirect beneficiaries could not be taxed directly for irrigation, knowing the extent of their benefits relative to that of direct beneficiaries would help clear up possible misunderstandings, such as the interpretation that farmers are being subsidized whenever they fail to pay the full costs of irrigation.

4. *Higher water charges cannot be expected to provide incentive for more efficient water use unless they are assessed in*