Irrigation Management for Rice-Based Farming Systems in Indonesia, Bangladesh, and the Philippines: A Synthesis of Findings under the IIMI-IRRI Collaborative Project

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INTRODUCTION

IRRIGATION IS A major factor in the strategy of developing countries to support agricultural production. However, the success in rice production which has enabled a number of countries in Asia to attain self-sufficiency has also resulted in a reduction in economic returns from irrigated rice lands.

Theoretically, there are, at least, three ways in which this problem could be addressed: a) by increasing the economic yield of rice; b) by increasing the area served by scarce water resources through more effective and efficient irrigation system management; and c) by introducing crops of higher value than rice into the irrigated rice farming systems. In July 1987, the Rockefeller Foundation provided a grant to the International Irrigation Management Institute (IIMI) and the International Rice Research Institute (IRRI), for the two organizations, with their complementary strengths, to conduct a joint study of the three options. IRRI clearly has interest in the first option. The second is part of IIMI's mandate to improve irrigation system management. Both institutes are concerned with the third option of getting higher economic and more equitable social returns from the water and its associated land. In addressing the three options, the project attempted to look at the problem from a comprehensive point of view to include agronomic, socioeconomic and institutional issues related to rice and nonrice crops in irrigated rice-based farming systems. This paper presents a synthesis of the findings of the studies conducted under the project.

The IIMI-IRRI Collaborative Project covers three countries, namely, Bangladesh. Indonesia, and the Philippines, which are all in the humid tropics of Asia. Sixteen separate studies were conducted in Bangladesh, and eleven each in Indonesia and the Philippines. The six broad objectives of the project are:

1. To characterize the factors influencing the options for changes in rice-based farming systems, and to identify the more important options in selected geographic locations.
2. To determine the degree to which different levels of irrigation system performance influence the ability to incorporate changes in the farming systems effectively.
3. To develop efficient and economical methods for managing irrigation water delivery and use of post-rice residual water for rice-based systems in which nonrice crops are grown, with special reference to implications for agronomic practice and for institutional performance and change.
4. To transmit and interpret the research findings to agricultural and irrigation system managers, planners and policymakers to encourage informed and better decision making.
5. To enhance the development of trained professionals in the area of irrigation problems through provision of graduate research opportunities.
6. To provide an opportunity for IRRI and IIMI staff to interact in a variety of collaborative activities which would permit the development of an effective and mutually supportive long-term relationship.

PROJECT IMPLEMENTATION PROCESS

While the broad project objectives were defined early on, the different implementing activities covering problem area identification, research sites selection and various modes of interaction between the two institutes and national agencies were done on a country-to-country basis.

Setting Country Specific Objectives

Bangladesh

In Bangladesh, limited consultations were held in Dhaka with senior staff of the Bangladesh Water Development Board (BWDB), Bangladesh Rice Research Institute (BRRI), the Bangladesh Agricultural Research Council (BARC), the Bangladesh Agricultural Development Corporation (BADC), the Bangladesh Agricultural University (BAU), etc. As suggested in the grant document, the work in Bangladesh had to take into account the following: a) the need for rice production in the country to continue at a level sufficient to maintain the basic economic value of rice production in irrigation systems -- thus, the objective was to increase the efficiency and equity of rice production; b) the agricultural and irrigation techniques already proven successful in increasing rice productivity could be extended more widely in the government irrigation systems, with adaptation to site-specific conditions; and c) organizational and institutional modifications might be needed for the implementation and maintenance of revised irrigation procedures. It was recommended that the Project build on the results obtained so far in the ongoing BRRI/BWDB/IRRI collaboration with IIMI's interest on main system management complementing the on-farm mandate of IRRI.

Indonesia

In Indonesia, planning meetings were held in June and October, 1987 and March, 1988 with the Directorate General for Water Resources Development (DGWRD), the Agency for Agricultural Research and Development (AARD) and the University of Gadjah Mada (UGM).

The primary objective of the project in Indonesia is to develop and test irrigation system management strategies that take into account variations in the physical environment, crop management, water availability, and fanners' crop decision making. Current irrigation system management practices, largely based on the *pasten* system (an index to relate the quantity of available water to the irrigated area) or derivatives thereof, already respond to certain aspects of demand and supply but are relatively insensitive to variations in physical conditions. Through the Irrigation Committee, seasonal cropping plans are drawn up based on previous experience but it is clear that there are significant deviations from this plan during each season. Biweekly estimates of planted area and average water demand are obtained and compared with estimates of water availability during the same time period. As long as supply exceeds demand, the systems operate largely on a continuous flow basis to all parts of the irrigated area, leaving fanners to make local adjustments where needed. When supplies are inadequate, rotational irrigation is implemented between tertiary blocks along a secondary canal and, under more severe conditions, between secondary canals.

For the irrigation management system to be effective, two different time frames should be taken into account: within season system operation and seasonal planning.

Within Season System Operation. Initially, research was concentrated on responses to existing irrigation management practices before moving on to innovations later in the project. The following specific objectives were identified:

1. To determine optimal rotational irrigation schedules to be adopted when water supplies are inadequate to meet demand through continuous and simultaneous deliveries to all tertiary blocks. The institutional arrangements and supporting information flows required to implement alternative water delivery practices including modifications to rotational irrigation need to be evaluated.

2. To evaluate the relationships between irrigation system operation and groundwater fluctuations that may be detrimental or beneficial to nonrice crops and to develop methods for the productive use of residual soil moisture and the prevention of overirrigation during periods of abundant water supply that may lead to untoward buildup of groundwater that inhibits cultivation of nonrice crops in subsequent seasons.

Annual Planning of Irrigation Schedules. Since the Annual Crop Plan involves several components relating to the assessment of water supplies based on ten-year moving records, soil and crop water demand, allocation of cropping patterns within the system, and development of a set of operational plans to accommodate variations in both supply and demand, the following objectives were pursued:

1. To develop methods of assessing water availability bener, from both rainfall and rivers throughoutthe year, with particular emphasis onsimplemethods ofpredicting periodicity and intensity of water deficit during the dry season.
2. To obtain bener estimations ofprobable cropping decisions to be made annually by farmers which can be integrated into seasonal cropping plans, lo evaluate cropping choices by fanners and assessment of the constraints to cropping practices or crop establishment and to develop alternative cropping patterns that bener suit variations in physical conditions.
3. To improve procedures for dry-season allocation of area to be irrigated and the crops to be grown, based on predictions of water availability at the system level and assessment of field-level demand.
4. To develop plans for operationalizing system management from the Annual Crop Plan to accommodate anticipated demand and probablewatersupplies to the system, and assess the capability of the system to accommodate alternative rotational irrigation practices.
5. To propose modification of the annual and seasonal planning process that incorporates more site-specific information and which includes feedback from performance in previous seasons.

Philippines

In the Philippines, consultation meetings were held in October, 1987 with the National Irrigation Administration (NIA), the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD), the University of the Philippines at Los Banos (UPLB), the Central Luzon State University (CLSU), the Bureau of Soils and Water Management (BSWM), the Bureau of Agricultural Research (BAR) and the Philippine Rice Research Institute (PhilRice). It was decided that IIMI and IRRI, either separately or together, take major responsibility for developing and facilitating research with collaborating national agencies in the following areas:

1. Documentation and analysis of the management procedures of irrigation systems with rice-based cropping (IIMI). The analysis should include an assessment of

factors that influence the management and decision-making process of systems manages, central office staff, and fanners as well as policymakers. The analysis should also focus on the changes that may have to be introduced in the systems designed for monocropping of rice.

2. Assessment of the physical characteristics and design of the irrigation system for suitability for rice-based farming systems, with the possibility of introducing modifications in the present design to support mixed cropping (IIMI/IRRI).
3. Exploration of strategies and recommendations for irrigation managers, fanners, and policymakers on how to manage irrigation systems for crop diversification efficiently and effectively (IIMI/IRRI). These include water resource augmentation to extend the dry-season irrigated area in different types of systems and opportunities for alternative water allocation toestablish higher efficiency of water use andgreater equity among farmers (rice and nonrice). The results will help formulate policy recommendations that will support the government's effort in both maintaining self-sufficiency in rice and enhancing farmers' income from the use of ricelands through crop diversification.
4. Identification of the physical infrastructural requirements for effective water control at the farm level to support mixed cropping after wet-season rice, and the methods for their optimal use (IRRI).
5. Determination and analysis of the factors influencing farmers' decision making in crop selection and management during the dry season within the context of the household socioeconomic situation (IRRI). Factors such as water supply, soil type. farm location, profitability of various crops, availability of off-farm employment, input supply, credit availability, markets, and irrigation service fees for different crops will be investigated.
6. Assessment of the status and behavior of dry-season groundwater regimes in nonirrigated areas, particularly in areas adjacent to irrigated rice (IRRI/IIMI). The problems and opportunities that these regimes present for production of nonrice crops should be evaluated. Soil and crop management and irrigation inputs that can maximize the benefits of both metric and groundwater reserves for nonrice crops should be identified.
7. Assessment of drainage options for rice and upland crops under different hydropedological, topographical, and local cropping environments and their implications for system design and management (IRRI/IIMI). Benefits and costs of investments in drainage facilities should also be addressed.

Research Site Selection

The research site selection was greatly influenced by ongoing research conducted by either or both IIMI and IRRI in each of the three countries.

In Bangladesh, the research sites chosen initially were the Ganges-Kobadak lift-cum gravity irrigation system and the North Bangladesh deep Nbewells where IRRI has been conducting collaborative research for a number of years with BWDB and BRRI. Later, BADC deep tubewells in Rajshahi (with the participation of the Rajshabi Krishi Unnayan Bank and Grameen Bank) were added. While IRRI research has resulted in some significant improvements in the management of irrigation water in the two earlier systems as well as in the crop production practices of farmers, the present IIMI-IRRI Collaborative Project is conceived to enhance the process of internalizing the available results and lo generate relevant new information in support of the project objectives.

In Indonesia, two sites were chosen in Cirebon, West Java where IIMI has been conducting research and which were in proximity to the Sukamandi Research Institute for Food Crops of the AARD. The bulk of the fieldwork is done in the Maneungteung Irrigation System which is a run-of-the river diversion. The second diversion system is at Ciwaringin. Because ofresearch done in the past there, IlMI has established a good data base in irrigation management activities at these two sites.

In the Philippines, the research sites chosen, all in Luzon, are the same systems where IIMI conducted studies on irrigationmanagement for crop diversification with funding from the Asian Development Bank. These are the Upper Talavera River Irrigation System (UTRIS), the Laoag-Vintar River Irrigation System (LVRIS), and the San Fabian River Irrigation System (SFRIS), which are all run-of-the river diversion types. Three other sites are used by IRRI to conduct parallel component studies. Most of the work by both IIMI and IRRI is done in UTRIS.

FINDINGS AND RECOMMENDATIONS: A SYNTHESIS

With the Project due for completion by end-1990, final national workshops were held during 13-14, June in Yogyakarta, Java, Indonesia, and during 10-12, September in Los Banos, Laguna, the Philippines to disseminate and receive feedback on the research findings. In Bangladesh, a workshop scheduled for 23-24, September, 1990could not take place because the needed government permit was not obtained.

A culminating activity was an intercountry workshop held during 12-14, November in Colombo to review and integrate the research findings in each country and across the three countries, and to deliberate on the recommended course(s) of future action. The workshop was able to produce a consensus on the findings and recommendations which were categorized into: a) Main irrigation system management for rice-based farming systems; b) Farm-level water management for rice-based farming systems, c) Economics and institutional issues in irrigated rice-based farming systems, and, d) Critical issues discussed. The following questions were used as the guide in sorting out the findings and recommendations of the project:

1. What are the factors that influence the options for changes in rice-based farming systems?
2. What are these options and bow do the different factors affect them?
3. What are the implications of these changes on imgation management both at the system and farm levels?
4. How could these implications be addressed? What are the recommendations already utilizable? Is there a need for further research? What should be done next?

a) Main **irrigation system management for rice-based farming systems**

* Some background issues were considered such as the differences in the types of irrigation systems used as research sites (large gravity direct diversions in the Philippines and Indonesia, and lift and deep tubewell systems in Bangladesh). It was recognized that there were lessons that could be learned from drier environments (Egypt, Morocco, Pakistan, etc.) where diversification is widespread and management issues may be simpler or better understood. The main issue is how the irrigation agency is able lo respond lo diversification once the external environment is encouraging farmers to do so in terms of water allocation and delivery in the main system. It was agreed that changes be introduced in the planning, implementation, monitoring and evaluation procedures being followed by the irrigation agency.

* On water distribution, reliability of timing may be more important than trying to meet adequacy. Rotational irrigation of some form is almost inevitable because of the risk of overirrigation and the need to maintain the hydraulic head, and because rationing by time is easier than rationing by discharge.

* Irrigation systems properly designed and constructed for implementing irrigation for wet-season rice which can meet the land-soaking and land preparation requirements have enough canal capacity for the intermittent flow of water needed for irrigating nonrice crops, although the need for greater canal-water regulation is apparent.

* It is important that rotation plans be known by all concerned. Irrigation system managers should have different plans for different levels of water deficit. The level of rotation which can be below or at the tertiary, secondary, or along sections of the primary canal, depending upon the nature and severity of the water shortage, needs further rationalizing lo improve reliability and equity. The not-quite-satisfactory weekly rotation being implemented in Indonesia and the Philippines and the 9-10 day rotation in the G-K Project in Bangladesh are indications in this regard. It was understood that developing new rotational plans is a gradual process involving negotiation and testing. The selection of alternative rotation plans is a contract between the irrigation agency and the fanners. The activities should be based on suitability for farmers (time of delivery/nondelivery), manageability by agency (staff, number ofgates, etc.), and technical feasibility (conveyance capacity, cross-regulation provision).

* There should be an early warning in case of a change in the rotational plan, and this should be done with concerted communication effort between and among the agency staff and farmers.

* The information management required should include the monitoring of the dynamic situation at the intake (available river flow and diverted flow to the

system), and the overall implementation of the plan. Regular meetings between the irrigation staff and farmers or their representatives during the implementation of the plan such as after water rotational delivery, should be held to serve as a means for monitoring the operations of the system. The meetings could provide the needed feedback mechanism to make the schedule more realistic and to settle conflicts in water distribution.

* The involvement of fanners and farmer participation as early as during the planning stage (annual seasonal planning) is implied and should be institutionalized to minimize problems during implementation. Active participation of farmers in decision making and in managing the system increases their awareness of the system's capabilities by helping them understand the plan better and the reasons for actions taken.

* The objectives of the plan (whether they are productivity, equity, sustainability, etc.) should be clear to all concerned and translated into clear operating rules.

* Water availability prediction must he good. If water available is less than the demand, rotation between years (i.e., 2-3 yearsplanning cycle, not 1 year) may be more appropriate.

h) Farm-level water management for rice-based farming systems

* Although there are several factors influencing the options for changes in rice-based farming systems such as availability of adequate water, land suitability, climatic condition, availability of management technology, time constraint caused hy the presence of rice crop, fanners' preference, resource base, influence of neighboring farmers or extension agents and land tenure status, income stability was identified as the major consideration that influences the farmers to diversify or not.

* In responding to the changes, it is implied that farmers must assume greater responsibility in water sharing to effect the desired changes in water management. Some checking facilities may have to be added to provide the hydraulic head required at certain points to implement the flush basin flooding method for irrigating a number of crops such as onion, tobacco, etc. Additional facilities during the dry season in the form of extra field channels (some already temporarily built by fanners) to facilitate the distribution, application and removal of excess water for nonrice crops are needed. The resulting density of the field channels can be more than three times those being retained for rice cultivation during the wet season.

* The use of groundwater to supplement canal supplies in the dry season was significant and economically attractive in both the Indonesian and Philippine sites. The same result is expected in similar groundwater use for Rabi (dry) season cropping in the Ganges-Kobadak Irrigation System (GKIS) area in Bangladesh.

* The use of residual soil water is significant in Bangladesh for growing wheat, onion, garlic and legumes after the Aman (wet) season in the GKIS area. While the potential is present in Indonesia and the Philippines, the use of residual soil moisture, especially for mungbean, has not been systematically documented.

* The challenge of managing a high water table resulting from seepage from adjacent unlined canals and surrounding fields was addressed in the Upper Talavera Irrigation System (UTRIS) site in the Philippines by establishing a properly designed interception-cum-drainage channel around and across the average size fields to convert an unsuitable area to effectively produce maize of 7.3 to/ha, compared with 3.3 to/ha in the control area.

* It was found that a cropping pattern of rice-mungbean-maize replacing rice-rice-nonrice has higher productivity than rice-maize-mungbeao for systems without adequate irrigation. In Bangladesh, green manure-rice-legume is recommended to replace rice-rice.

* Optimal yields for nonrice crops are obtained if soil moisture depletion is not allowed to go beyond 40 percent available soil moisture.

c) Economics nnd institutional issues in irrigated rice-based farming systems

* Different cropping options were identified which the fanners may consider during the dry season. These include leaving the land fallow, planting nonrice crops alone, growing combinations of nonrice crops or rice and nonrice crops, and planting dry-season rice crops. These options are influenced by a variety of factors such as crop scheduling/timing, tenurial status, prices of inputs, product (market) prices, land suitability, drainage constraints, farmer experiencelattitudes, agency staff skills, labor/farm power, farmer's ability to control water, availability and access to technology. government policies and existence of residual soil moisture.

* The implications of changes on irrigation management, as earlier indicated, include the need for better coordination among farmers, between farmers and agency staff, and among agency staff, to increase the reliability of irrigation delivery. Conjunctive use of surface water and groundwater need to be enhanced and drainage information should be considered.

* These implications could be addressed through a pilot-testing of management changes and an assessment of successful cases. These would involve the agency, farmers and researchers interarting with each other for fine-tuning of management procedures in the internalization process while the participation of the researchers is gradually phased out. The budget implications of the new management changes need to be assessed.

d) Critical issues discussed

Irrigation service fees. Policies on irrigation service fees should be reviewed in relation to the differences in managing the system for rice as against nonrice. Consideration should be given to farmers who are using water more efficiently, or who practice water conservation measures such as mulching and water augmentation. It was suggested, however, that the review may also look at strategies to encourage the farmers to pay irrigation fees.

Tenurial status. The status of land tenure has some implications on farmers' attitudes to improving land productivity. Not owning the land somehow deters farmers from using the recommended technologies to improve land productivity. Landlord-tenant arrangements also do not provide clear indications as regards membership in irrigators' associations, and the payment of irrigation service fees. Who is responsible? The tenant or land owner? The present situation does not provide any mechanism to address the problem, more so to improving land productivity through crop diversification.

Farmers' decision to diversify. As the report indicates, a number of factors influence the decision of the farmers to plant rice or nonrice, and they should be given some degree of flexibility. However, this flexibility should consider not solely the farmer's own advantage but its influence on other farmers and the flexibility of the irrigation system itself. What may be done is for the irrigation agency and other support services to be ready with options to match the requirement of not one farmer but the larger group of farmers. Likewise, the agency should also have some kind of mechanism lo influence the farmers.

Farmer's organizations. Organizing farmers is not an absolute necessity for effective irrigation management In Pakistan, the farmers use the water as they see fit. This cannot happen in the Philippines, Indonesia and Bangladesh where farmers have no fixed water rights. Somehow there is a need for sharing of responsibility between the farmers and the agency. It thus depends on the sociopolitical situation existing in the area where the system is located.

PLANS FOR THE IMMEDIATE FUTURE

A modest proposal has been submitted to the current donor to wind up the work in Bangladesh. The work will consist mostly of pilot-testing promising irrigation management innovations over one cropping season with the active participation of concerned irrigation agency staff and farmers. The period from November, 1990 to June, 1991, which covers the drier part of the year (from the beginning of the dry-season until the start of the wet season) when water becomes scarce is the most critical in fine-tuning the pilot-testing process and in determining the actual operational requirements for the methodical transfer and institutionalization of management innovations.

RECOMMENDATIONS FOR FUTURE ACTION/RESEARCH

The project may be completed but a lot of things remain to be done. Useful information and technologies which are expected to enhance irrigation management have emerged from the findings but these need to he further evaluated through some kind of piloting. It is anticipated that a gradual internalization process is required for the impact of the recommended innovations to be really felt.

There should be action plans to put into reality and operation the findings made so far. Stronger and more active participation of the irrigation agency and the farmers are envisioned. Other agencies involved in agriculture (from production to marketing) should likewise be included.

The outstanding or unresolved issues like the following may be addressed in future research:

* Is the design of the irrigation system flexible for crop diversification or is it complex?

* How can assessment and matching of both available water supply and water demand be improved to match the under-diversified cropping conditions?

* Should the government get involved directly through such mechanisms as crop plans?

* How should the agency and farmers cope with different soil/drainage environments, considering zoning and water requirements?

* For both rice and nonrice production, how should better techniques for improving water use efficiency and productivity be developed?

In addition, studies on drainage seem to be underplayed. Basic drainage facilities are necessary, particularly for upland crops. An in-depth study of the motivation of fanners to participale in irrigation management is more important than their need to form associations. Agency-farmer relationship is an integral component of diversification. This still has a long way to go. This has to be related to reliability of water delivery and variability, which cannot be controlled. A measure of reliability is still to be developed. Market forces and postharvest facilities should also be given due consideration.

Three years of activities under the IIMI-IRRI Collaborative Project have addressed important and comprehensive issues of irrigation management for nonrice crops in rice-based systems. The next step is to evolve strategies to operationalize the recommendations that have come out of the present findings, and to disseminate the information as widely as possible to irrigation and agricultural agency officials. The Research Network on Irrigation Management for Crop Diversification (IMCD) will be very useful for this purpose.

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