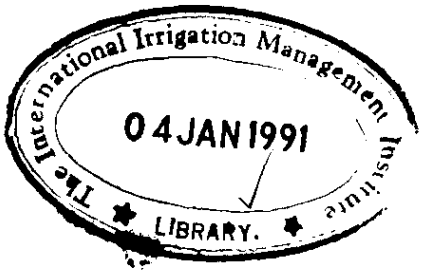

Design Issues in Farmer-Managed Irrigation Systems

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Small-Scale Irrigation in South Asia: Some Preliminary Findings from Case Studies

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THERE IS NO uniform definition or criterion for small-scale irrigation in South Asia. In Bangladesh, small-scale irrigation includes low lift pumps, deep tube wells, shallow tube wells, and a few indigenous gravity-irrigation and lift-irrigation schemes. In India, minor irrigation includes those schemes having cultivable command areas up to 2,000 hectares (ha). In Pakistan, dug and tube well systems, low lift pumps, tanks, and small irrigation dams are considered small-scale irrigation systems. In Nepal, small-scale irrigation covers systems up to 50 ha in the hills and 2,000 ha in the plains. In Sri Lanka, a minor irrigation scheme covers up to 80 ha of agricultural land.

Small-scale irrigation schemes play an important role in national food production and in particular, in the direct food requirements of subsistence farm communities that undertake this type of irrigation.

Various studies of small-scale irrigation systems in Asia suggest that the peasant organization is an important adapting mechanism for management of irrigation (Coward 1984). There is a growing realization that the success of an irrigation project depends largely on the active participation of the individual farmers, and there have been growing efforts to involve farmers in the management of irrigation, at least at the field level. In late 1987 CIRDAP launched an interdisciplinary study in five of its member countries in South Asia (Bangladesh, India, Nepal, Pakistan, and Sri Lanka) to analyze the impact of small-scale irrigation on the rural poor. The interaction of design, implementation, and management issues of small-scale irrigation schemes is highlighted here.

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In each of the five countries two cases were selected for in-depth study at the field level: one small-scale irrigation system with high intervention from an outside agency, and the other with no (or low) intervention from an outside agency. The second category is similar to farmer-managed irrigation systems. However, intervention in some form or other is present in almost all types of small-scale irrigation systems in Asia.

DESIGNS OF SOME SMALL-SCALE IRRIGATION SYSTEMS

In most of the irrigation projects in South Asia the design is done by engineers without much reference to other disciplines such as agronomy, social science, and economics. The most underrated and forgotten "dimension" or agent in large-scale irrigation is the farmer. In analyzing the five country situations, the comparison between high and low intervention cases will bring out the extent of the use of local skill and information on irrigation practices and participation of the beneficiaries in design, implementation, and management of small-scale irrigation systems. The hypothesis of this paper is that "the structures and systems designed for small-scale irrigation will create facilities and procedures that reduce the dependency of the system on an external agency, and the impact of the scheme will be high on the rural poor if local knowledge, skill, and people are utilized to the maximum."

Bangladesh. In Bangladesh, two deep tube wells in Comilla District were studied, one owned by a village agricultural cooperative society and the other by a few enterprising farmers with reasonable land and access to financial resources. The design for the village agricultural cooperative society's deep tube well was drawn up as prescribed by the Bangladesh Academy for Rural Development and the design for the other tube wells was similar to it. The members of the village agricultural cooperative society designed the construction of the water courses to different plots. The slope, materials used (cement, brick, mud) and the length and width of the water courses were decided in meetings and consultations with the cooperative members. A water distributor was appointed by the cooperative to oversee the distribution of water.

India. In India, two bore wells in Ranga Reddy District in Andhra Pradesh were chosen as case-study locations. The one with high intervention was implemented, managed, and operated by the Andhra Pradesh Small-Scale Irrigation Development Corporation. For purposes of day-to-day management and maintenance, the corporation has placed an operator for every 30 wells. The second bore well was installed by the Andhra Pradesh State Dairy Development Cooperation which handed over the operation and management of the well to the farmers of the command area. In both cases, the design process did not involve beneficiaries much, but in the second one, there was involvement of the beneficiaries in the operation and management of the scheme.

Pakistan. In Pakistan, one small dam in Khasala in Rawalpindi District, and one irrigation scheme in the hilly areas of Gilgit were taken as examples of intervention and nonintervention schemes, respectively. The intervention scheme was constructed and managed by the Small Dam Organization of Pakistan. The nonintervention scheme was constructed by local initiative under the motivation of a nongovernmental organization. In the intervention scheme the actual release

of water is far less than the design releases mainly because the water courses are not properly maintained. It was found that at the tail end the elevation of the farmers' fields was greater than that of the water courses. This is a design fault which could be corrected through construction of suitable water courses in that zone. In the Gilgit area, the farmers were consulted before the installation of the scheme and maintenance of the scheme was entrusted upon the representatives of the farmers. The motivation of the farmers in the Gilgit case was high and as such the impact on the rural poor was much higher in the nonintervention case.

Nepal. The Majhuwater farmer-managed canal system in Dhading District was constructed by traditional canal cutters without any technical consultation with external experts. The beneficiaries were involved from the very beginning and they are very conscious of the status of the system which they maintain through mutual agreement. The government-managed Pipaltar system in Dhading District was constructed by a contractor under the supervision of the Department of Irrigation. There were some design and construction problems which were reflected in a leak that developed due to landslides near the command area. The Pipaltar scheme was constructed with all necessary permanent structures. Although the Majhuwater scheme has no structure high density polyethylene pipe siphons were installed near the command area. The canals of the intervention system were not functioning well compared to those of the nonintervention systems although the design of the government-managed system was more sophisticated. Due to lack of popular participation its maintenance has not been satisfactory.

Sri Lanka. In Sri Lanka, two anicut (weir, or enclosure across a river) minor irrigation systems in Ratnapura District were studied in depth. State support of the high intervention system was mainly restricted to constructing the physical infrastructure and then handing it over to the Department of Agrarian Services for operation and maintenance. In the other system the water users, using coconut and rubber tree trunks, constructed an anicut to raise the water level enough to irrigate 5.5 ha. In this farmer-managed scheme, two social aspects have facilitated operation by the farmers: community property rights over land and water, and the homogenous nature of the community (most of the farmers belong to a single kinship pattern).

IMPACT ON THE RURAL POOR

Irrigation water, if properly utilized, can bring about significant changes in the production and socioeconomic situation of the community concerned. The small-scale schemes covered under the present paper were supposed to benefit the small and subsistence farmers. Next, some selected indicators are discussed to show the direct and indirect impacts of small-scale irrigation. Table 1 presents the cropping intensity and rice yields per acre in the case-study locations.

Cropping Patterns and Intensity

Crop intensities, in general, have increased in all the cases under study. In Bangladesh the respondents were asked about the changes in cropping patterns and the nature of the changes. After the installation of deep tube wells, in both cases, farmers shifted from traditional aus to irrigated boro high yielding variety (HYV). They also grew HYV amon rice. The change in cropping pattern was associated with the changes in sowing system (from broadcasting to transplanting), and increases in the use of fertilizer and modern agricultural tools.

Table 1. Indicators of agricultural productivity.

Country	System studied	Cropping intensity (%)	Rice yield/acre (kg)	Wheat yield/acre (kg)
Bangladesh	Intervention	190	2190	NA
	Noninter-vention	200	2010	NA
India	Intervention	200	1872	NA
	Noninter-vention	158	862	NA
Nepal	Intervention	209	704	319
	Noninter-vention	251	1194	486
Pakistan	Intervention	49*	NA	925
	Noninter-vention	NA	NA	NA
Sri Lanka	Intervention	NA	819	NA
	Noninter-vention	NA	758	NA

Note:* Cropping intensity increased from 18 percent covering 44 ha in 1979 to 74 percent in 1988-89. Planned cropping intensity for 1988-89 was 126 percent.

NA = Not available

In India, in both cases, farmers put more emphasis on crops other than rice, such as tomato, chili, potato, and wheat. This is because these crops are more profitable and consume relatively less water than rice.

In Nepal and Sri Lanka there has been no significant change in the cropping pattern in the sense that rice remains a major crop in the project areas. However, cropping intensity has increased because of irrigation.

In Pakistan, increase in water supply has encouraged the production of vegetables and fodder in the project area coupled with the production of wheat which is the major crop.

In Bangladesh and Nepal the cropping intensity is higher in the nonintervention case than in the intervention case. In India, it is the reverse. In Pakistan the cropping intensity increased from 18 percent in 1979 to about 74 percent in 1989 in the intervention case. Data for the nonintervention case in Pakistan are not available.

Production/Yield

In Bangladesh, the area chosen for the case studies is one with the highest yield of rice per acre in the country. In both the case studies, the yields per acre are well above the national average.

In India, the yield is high for the intervention case compared to the nonintervention case. In the nonintervention case the farmers cultivate a package of crops which yield low return. Consequently, the gross income of farmers from crop production in the area is comparatively lower. The farmers there do some non-crop activities such as livestock rearing.

In Nepal too, the difference between yields in intervention and nonintervention cases is very high. In the nonintervention case, more emphasis is given to the high return crop of that area which is rice.

In Sri Lanka, the average yields of rice in both the cases were lower than those of the national level. There were a few cases where per acre yields of rice were very high (compared with very low return for some households).

In Pakistan, per acre yield of wheat in the intervention case is well above the national average.

FARMER PARTICIPATION IN THE DESIGN PROCESS OF SMALL-SCALE IRRIGATION

In the formulation of small-scale irrigation projects in most countries of the world a great deal of attention is given to the technical aspects. Irrigation planners and designers make a number of decisions on the basis of certain assumptions and choices. These decisions have direct or indirect political, socioeconomic, and cultural consequences. As a result, many small-scale irrigation projects of sound technical design might fail to meet political and socioeconomic goals. The interaction among planning, design, management, and socioeconomic consequences should be

considered by both irrigation engineers and social scientists. Therefore, interdisciplinary irrigation research is a prerequisite for developing comprehensive guidelines for all types of irrigation schemes; large, medium, and small.

The five country studies in South Asia bring a mixed picture of farmers' participation and the use of local information and skill in the planning and management of small-scale irrigation projects.

Table 2. Participation of the farmers in irrigation water management.

	Bangladesh		India		Pakistan		Nepal		Sri Lanka	
	I	NI	I	NI	I	NI	I	NI	I	NI
A. Participation of farmers in the design process										
1. Preliminary idea	H	L	L	L	-	M	-	L	M	H
2. Land/water resources inventory	L	-	-	-	-	M	-	L	M	M
3. Preliminary plan	M	M	-	-	L	M	L	H	-	H
4. Feasibility study	M	-	M	M	L	H	-	H	L	M
5. *Design*										
Hydraulic design	L	-	-	-	-	M	-	M	L	M
Building structure	M	M	-	-	-	M	-	L	L	H
Operation	H	H	-	M	-	H	-	H	L	H
Training of staff	M	-	M	-	-	M	-	-	-	-
B. Farmer management										
1. Use of local information by designer	H	M	L	L	L	M	L	L	L	M
2. Use of local skill by designer	H	H	L	L	-	M	-	H	L	H
3. Users' group formation	H	H	-	-	-	H	-	-	L	H
4. Operation of system	H	-	-	M	-	H	-	H	L	H
5. Repair and maintenance	H	H	-	M	-	M	-	H	L	H
C. Manifestation of design fault										
1. Conflicts among farmers	-	-	L	L	H	-	H	-	M	-
2. Head- versus tail-end inequality	-	-	M	M	H	L	H	-	L	-
3. Marginalization	-	-	-	-	M	-	M	-	-	-
4. Underutilization of system	M	M	-	-	H	-	M	L	M	M

Notes: I = Intervention scheme
NI = Nonintervention scheme
H = High M = Medium L = Low

Table 2 shows a matrix of various important aspects of irrigation water management. The design issues play a crucial role in the success of small-scale irrigation systems. The participation of farmers in the process of design has been divided into five major components (A1-A5), and the participation of farmers in each component has been indicated for each country. Out of the available information for 28 cases for the first four components (A1-A4), only in 6 cases (21 percent) is the farmers' participation high; in about 12 cases (43 percent) it is medium, and in 10 cases (36 percent) the participation is low. If the actual design process (A5) is taken, out of 21 available cases, the farmers' participation is high only in 6 cases (28 percent), and the figure for medium is 10 (48 percent) and for low it is 5 (24 percent). It should be pointed out that many of the blocks in this component are empty implying insufficient information on farmers' participation.

An important issue related to the design process is participation by the farmers in the operation and maintenance of the irrigation facilities. Five major components (B1-B5) have been identified under this and the situations in countries have been depicted in part B of Table 2. Out of 36 cases reported, 17 cases (47 percent) have high incidence of farmer management; seven cases (19 percent) have medium incidence, and the remaining 12 cases (34 percent) have low incidence. The nonintervention schemes performed well in this respect because out of 17 high instances of farmer participation, 12 are for nonintervention schemes. All the 7 medium-incidence cases fall under the nonintervention schemes. Even in the management aspect where farmer participation should have been overwhelmingly high, we observe a low incidence of their participation. Though information on some likely results of design fault is not readily available, we attempted to indicate those in the third broad category of our matrix (C1-C4). Out of the 20 cases reported here, in five cases (25 percent) the incidence of design fault is high; in ten cases (50 percent) it is medium and in five cases (25 percent) the manifestation of fault is low. Due to lack of interaction among the design, implementation, and operation and management issues and due to lack of farmer participation in all phases of water management in small-scale irrigation in the five countries, there has been less impact on the rural poor than envisaged or expected.

CONCLUSION

The evidence presented in the paper relating to the case studies of small-scale irrigation in five South Asian nations somewhat supports our hypothesis: that the impact of small-scale irrigation on the rural poor will be high if local information, knowledge, skill, and commitment are blended in the design and management processes of small-scale irrigation systems; and that there is a need to design small-scale irrigation to reduce dependency of the system on an external agency. A participatory design process should be adopted by the agency responsible for implementation of a project. Intervention by a government agency or nongovernment organization should be accompanied by organizational/institutional development at the local level. What is needed most in the design stage, to use the language of computer technology, is the "user-friendly" design.

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