Performance Measurement in Farmer-Managed Irrigation Systems: Case Studies of Tubewells in a Selected Area of Bangladesh

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ABSTRACT

THE PERFORMANCE OF farmer-managed tubewells (TW) is of great importance to Bangladesh given the country's preponderance of groundwater technologies among its irrigation systems and given the pace of turnover of agency wells to farmer groups. This study examines farmer-management involvement in performance measurement in a sample of deep tubewells (DTW) in the Rajshahi Region of western Bangladesh. DTWs were found to be often underutilized in relation to reasonable expectations of command area and service to farmers. If farmer managers of DTW FMIS are to be able to effectively manage their wells and improve their performance, they must have access to relevant measures of output, impact and management process attainments. While FMIS managers in the study do keep some basic records they are aware that there is scope for the use of a number of additional types of measures. Further, there is some confusion as to what might constitute appropriate standards of performance for various measurement indicators. Irrigation agencies (or other organizations) could usefully contribute to the performance of farmer-managed TWs by providing training and information in regard to various performance measures and standards. In addition, agencies could collect and disseminate information on some types of technical indicators (evapo-transpiration, water table changes, etc.) that would be difficult for farmer-managers to acquire on their own.

INTRODUCTION

Bangladesh, with a very high land/man ratio estimated at 766 persons per square kilometer in 1989, is among the ten most densely populated countries in the world. The most pressing development problems of the country include a) chronic food shortage, b) massive unemployment and under-employment, c) widespread and severe poverty and d) inequity in the distribution of assets and incomes. The Government of Bangladesh has identified the creation and expansion of irrigation facilities as a key strategy in dealing with these problems and irrigation now covers about 25 percent of the total cultivable land in the country. Of the total irrigated area about 90 percent is

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covered by modern methods and the rest by traditional technologies. The irrigation sector is dominated by small-scale irrigation systems, which include primarily shallow tubewells (STWs), deep tubewells (DTWs), and low lift pumps (LLPs).

Farmer-Managed Irrigation Systems (FMIS) in Bangladesh

Although in Bangladesh farmer-managed modern irrigation systems were introduced in the late sixties, the country has a very long history of farmers managing irrigation with traditional methods. The traditional methods include individually owned one-farm *dhones* (pivoted boat-like devices discharging 0.04 cusec), and swing baskets (discharging up to .06 cusec) which use surface water and dug-wells capable of irrigating 0.2 to 0.3 acres of rice. More modern small-scale methods such as DTWs and LLPs were initiated and installed by the government and then handed over to farmers for their use and management under various arrangements — rent, sale or (with more agency involvement) for a fee. The present government policy is to turn over to the private sector all tubewells (TW) and pumps. The rental system is still prevalent, however, particularly for DTWs.

FMIS include both government-developed modern methods as well as traditional technologies of minor irrigation. Such systems irrigate 2.23 million hectares which is over 90 percent of the total irrigated area in the country. These systems are managed variously by farmer cooperatives, informal groups of farmers, and individuals. Compared with surface irrigation FMIS in other countries, farmer-managed TW and LLP irrigation systems in Bangladesh are smaller in scale, more cash-oriented and enjoy a greater degree of control over the source of their water (Parker 1991). As with major agency-operated irrigation projects, however, there is a growing concern in the country over the performance of these farmer-managed systems. Irrigated command area is often small in relation to technical capacity and water access by tenants and small farmers is seldom secure.

Issues in Performance Measurement

To address the issue of performance of these farmer-managed pump irrigation systems, it is necessary to examine the bases of performance concepts for FMIS and the constraints of performance measurements. Against whose goals is performance to be measured? Are they the goals of the tenant cultivator(?), the large farmer(?), the system manager(?), an irrigation agency(?), a donor(?) Or are they to be a composite of the goals of all of these parties? Performance measurement indicators may well differ by these differing perceptions of performance. Related to these issues of goals and measurements is that of the standards against which indicators are to be compared in performance measurement. Are standards used by researchers based on some theory, notion or experience with which the users of a farmer-managed system are unfamiliar? Do farmers agree with these standards? As farmers are the primary actors in these systems such agreement is essential if progress is to be made in attaining given standards of performance.

Another measurement issue concerns the availability and usability of data with which to assess performance. If irrigation performance measures are to be useful tools for farmer managers, the supporting information or data must be easily gathered and easily understood. How can the use of such data be promoted among farmers and others concerned? Are the farmers convinced of the need of the data and of the indicators supported by the data?

Objectives of the Paper

The broad objective of this paper is to contribute to the development of an approach to performance measurement that is appropriate to the attainment of the goals of FMIS. The specific objectives are to address some of the issues mentioned above, particularly in the context of samples of DTWs located in the western part of Bangladesh falling under three categorizations of group management/ownership. These categorizations include: a) private groups owning wells; b) groups renting TWs from a government agency; and c) groups managing wells in an agency project. The specific objectives may be detailed as: i) to identify the goals of farmer-managed irrigation systems (under varying situations) as distinct from the goals of agency-managed systems; ii) to determine and categorize a set of relevant indicators to measure FMIS performance; iii) to identify standards against which some of the indicators may be compared; and iv) to examine farmer-manager use of performance measures and to explore ways to promote the use of relevant indicators among farmers and others.

The objectives of the paper were pursued mainly through case studies of groups of farmer-managed DTWs distributed among the three categories of management/ownership noted above. These types of tubewell management form a significant portion of the FMIS in Bangladesh, covering 0.56 million hectares. Three groups of 15 DTWs (private, rental and agency-coordinated fee-based) were chosen for study in the Rajshahi area of western Bangladesh. In each group of 15, three were chosen for interviews with farmers and managers while information on irrigation coverage, costs, yield, etc., was gathered from all of the wells. The data generated from the case studies were supplemented by information from various sources such as agency reports, project documents, evaluation reports, field studies and monographs, and farmer records.

DISCUSSION AND FINDINGS

Objectives of Tubewell FMIS in Bangladesh

FMIS using motor-driven pumps in Bangladesh were originally introduced (and generally installed) by such government agencies as the Bangladesh Agricultural Development Corporation (BADC) and the Bangladesh Water Development Board (BWDB). In the initial years of rental FMIS, the agencies provided repair and maintenance services. This is also true in the present agency-coordinated fee-based systems. In its present policy of turning over (selling) DTWs to private groups for ownership and management, the government is providing a fairly substantial level of subsidy. Given these government inputs as well as the government's general development aims, one view of appropriate FMIS objectives might be that such goals should be the same as those of government-managed irrigation systems — which seem generally to be subscribed to by international development agencies. Broadly, these objectives include a) increasing farm production, especially of food grains, b) increasing incomes of all categories of farmers, c) creating additional employment opportunities for farmers and landless laborers, and d) reducing, or at least arresting, inequity in the distribution of income and assets. These impact objectives are expected to be achieved through the realization of such output objectives as increasing the technical efficiency of the systems as reflected in increased irrigated area, ensuring water supplies in sufficient quantities in a timely and predictable manner, and ensuring equity through the provision of access to irrigation water to all categories of farms.

The farmers who are managers and owners of the DTWs under study would seem to be in general agreement with these broad objectives. Among the 9 TWs (under 3 types of farmer management) surveyed, the managers stated that with the help of irrigation they would like to increase their farm production as well as the incomes and employment of their fellow farmers in the village. In respect to equity, the managers also declared that every farmer should get equal access to water as long as he paid his irrigation fee/charge. There is, of course, skepticism in Bangladesh (and elsewhere) about the motivations of larger and more influential farmers in respect to their less-advantaged neighbors, and the statements of the tubewell managers on equity goals might be open to some doubt. The 3 owner-managers in the sample, however, identified maximization of the return on their investment as one of their important management objectives and noted that irrigation investment return-maximization requires providing efficient irrigation services to the maximum number of farmers and irrigated area. In many areas the development of water markets seems to act as a deterrent to the monopoly pricing of water. As a result, area coverage increases are the remaining route to increased returns. Where returns to the manager's system (as opposed to the manager's own farm or influence) is not the prime concern, of course, the equity goals of managers may differ from those stated here. Such a difference might be expected in some surface systems but is less likely for farmer-managed TWs in which some level of financial return (after O&M costs) can be extracted from users.

A sample of 70 cultivators in the study TWs were also interviewed in regard to their views of irrigation system objectives. Again, their objectives seemed compatible with those of the government and the tubewell managers. In other words, for the types of pump-irrigated FMIS examined in this study, there is a fairly high degree of agreement on irrigation goals between users, managers, government agencies and aid donors.

Indicators of Performance

Performance indicators might be classified as measuring progress toward: a) output objectives (directly related to the provision of irrigation); b) impact objectives (related more to irrigation's longer-term or indirect results); and c) process objectives (dealing with management processes). Irrigation agencies and outside researchers have interests in all three types of performance indicators — both to rate the progress of an irrigation project and to identify ways to improve the system. Farmer-managers would appear to be more interested in the attainment (through whatever means) of their direct output objectives rather than in the more diffuse impact types of objectives. The performance of tubewell FMIS in Bangladesh has, in the past, been evaluated primarily by international aid agencies and government departments through sponsored research by consultants, universities or institutes. The emphasis would seem to have been on project performance rather than on the use of performance measures by farmer-managers. As a result, there has been little focus on making performance indicators user-friendly at the FMIS management level. Farmer-managers have seldom been consulted when measures were selected nor have they usually been instructed in the use of the indicators as the measurements have been seen as evaluative tools rather than management ones.

Even as primarily project evaluation tools many of the performance indicators utilized in studies of tubewell irrigation in Bangladesh have had a number of problems of design, coverage, quality of data and lack of comparability, etc. (Bottrall 1983, Sadeque and Hakim 1989). There has, at times, been confusion between measures of output, impact and process attainments and a lack of explicit linkages between these various types of measures. Measures have sometimes been inappropriate and others have not been clearly defined. For example, a measure of area irrigated

is not useful unless there is some definition of what constitutes an irrigated crop. A crop receiving one irrigation turn (when more turns are needed) is in a very different category than a crop which receives water when required. Yet area-irrigated measures have seldom made that distinction.

From the literature already cited some performance indicators might be listed that have been identified as being particularly appropriate for the analysis and/or management of pump FMIS in Bangladesh.

Output indicators:

* Area irrigated effectively.
* Total volume of water made available in a particular season.
* Attainment of start-up time best suited to a chosen cropping pattern.
* Adequacy of water in relation to crop water needs.
* Equity of water supply by field location and farm category.
* Reliability of water supply.
* Participating farmers as a proportion of potential command area irrigators.
* Return on irrigation system investment by farmers.

Impact indicators:

* Yield increments due to the irrigation provided.
* Cropping intensity increases due to irrigation.
* Cropping pattern changes due to irrigation.
* Changes in costs of cultivation due to the provision of irrigation.
* Impacts on local employment, particularly of women and disadvantaged groups such as landless labor.
* Sustainability of yield, income and employment increases due to irrigation.
* Impacts on the environment and on social systems.
* Irrigation-related crop income gaps of farms by field location, farm size and tenurial class.
* Levels of technical efficiency of input use.
* Return on outside (i.e., government or donor) investments in pump FMIS.

Process indicators:

* Nature of farmer organization in FMIS
* Nature of organization of irrigation management functions.
* Nature and practice of irrigation planning.
* Adequacy of irrigation budgeting.
* Adequacy of accounting system.
* Degree of mobilization of farmer participants for repair, construction, and maintenance of irrigation channels.

* Regularity of repair and maintenance functions (pump and channels).
* Costs of operation and maintenance per hectare.
* Irrigation fee collection efficiency.
* Loan repayment rates if institutional credit is used.
* Nature of contacts with government irrigation and agricultural support agencies.
* Quality of monitoring systems.

Standards and Performance

Performance measures become useful as management tools when employed in relation to some standard of attainment. Where past records exist, comparisons with previous performance can be made. For tubewell FMIS comparison with other TWs is useful for the creation of realistic expectations of performance. In Bangladesh, there is little agreement on standards for key performance variables for tubewell systems of similar technology. Of course, there are regional differences in agro-ecological conditions and in the socioeconomic contexts within which pump FMIS operate. Even on a regional basis, however, the definition of such a basic measure as potential irrigable area for DTWs has been termed an "elusive quality" (Murshid 1985) by at least one researcher.

This lack of agreement is not just on the part of researchers. From interviews and discussions with officials, tubewell managers and farmers in the study area there would appear to be wide differences in expectations. In Table 1 it can be seen that standards for irrigated area and rice yield vary markedly by category of respondent.

An attempt was made, using data from research area TWs, to calculate a few possible standards for irrigated area, number of farmers served and rice yield during the irrigated boro rice season. These figures are shown in Table 2 along with average actual attainments per tubewell. It can be seen that actual performance in regard to irrigated area is somewhat below the rather moderate calculated potential for rental and private wells and is roughly half the potential for the agency FMIS TWs. At least part of the area shortfall is due to operating hours. While it is technically feasible to run the pumps for much longer periods, the sample wells operated an average of 8.8 (agency FMIS), 9.5 (private) and 10.4 (rental) hours per day during the boro rice season. For the agency FMIS wells it would also appear that much more water was utilized per hectare than would seem necessary given characteristics of rainfall, evapotranspiration, seepage and percolation. Some of that extra water could have been used to irrigate an additional acreage.

Table 1. Stated standards of irrigated area and boro rice yield by agency officials and by DTW FMIS farmers and managers.

Type of FMIS	Irrigable hectares per cusec			Yield in tons per hectare		
	Farmer stated	Manager stated	Official stated	Farmer stated	Manager stated	Official stated
Rental	15.7	20.2	12.2	6.9	6.1	4.6
Private	15.8	24.1	12.2	6.9	6.1	4.6
Agency FMIS	9.7	10.4	12.2	5.5	7.1	5.5

Table 2. Selected indicators for case study DTWs[1].

Type of FMIS	Irrigated area (ha)		No. Farmers (per TW)		Yield (ha),	
	Potential[2]	Actual	Potential[3]	Actual	Potential[4]	Actual[5]
Rental	19.9	15.6	116	91	6.0	4.6
Private	20.2	17.9	118	105	6.0	5.6
Agency FMIS	16.6	8.4	55	28	6.0	4.6

1 Information derived from 45 DTWs — 15 in each category.

2 Potential irrigated area calculated from average measured TWs discharge, an assumption of 12 hours per day pump operation, 67 operating days for rental and private wells and 82 days for agency wells (due to a different rice variety), and 1991 irrigation needs for boro rice based on measured evapotranspiration, seepage/percolation and rainfall.

3 Potential farmers are based on the number of farmers per hectare for actual irrigated area extrapolated to the potential irrigated area.

4 Yield is assumed to be 6 tons per hectare when using prescribed amounts of inputs including adequate irrigation water.

5 Actual yield estimates are based on crop cuts.

Operating and maintenance costs, fee revenue, net tubewell returns and farmer returns are shown in Table 3. Calculated standards have not been determined for these items as significant parts of O&M costs cannot be expected to be linearly related to hectares irrigated. Some economies of scale might occur as irrigated acreage expands. This would indicate that net returns to the sample TWs are substantially below their attainable level if the calculated potential irrigation coverage were to be achieved.

Table 3. Returns for case study DTWs.[1]

Type OF fmis	O&M[2]		Fee Revenue		Net TW Return[3]		Farmer Return[4] ha
	TW	ha	TW	ha	TW	ha	
Rental	51,592	3,307	62,564	4,011	10,972	704	12,262
Private	62,534	3,494	119,244	6,662	56,710	3,108	15,454
Agency FMIS	41,050	4,887	60,944	7,255	19,894	2,368	9,739

1 Information derived from 45 DTWs — 15 in each category.

2 O&M costs include all repair and maintenance to pumps and channels, all salaries and honoraria, fuel and miscellaneous expenditures.

3 Net TW returns are net of O&M costs but not capital costs.

4 Farmer returns are calculated after all costs of production including irrigation fees.

Use of Performance Measures by DTW FMIS

As noted earlier, most studies of TWs in Bangladesh have been made from the perspective of the outside evaluator (researcher or agency official). The intent has generally been to analyze performance so as to recommend irrigation agency or NGO (nongovernmental organization) solutions to identified problems. A variety of performance indicators and standards have been used for this purpose. But what of the farmer managers in DTW FMIS? They, too, have needs for performance measures and standards for use as direct management tools. What measures do they use and how might additional useful measures be made more accessible to farmer managers?

The focus of farmer-managers in tubewell FMIS might be expected to be on only a subset of the issues identified earlier under output, impact and process indicators. Among the sample TWs in this study, the FMIS managers make records of a limited number of items: a) area irrigated; b) the number of farmers getting irrigation water; c) operation and maintenance costs; d) collection of irrigation fees; and e) return over O&M costs. Where fees are collected in kind, some record of yield is also maintained. These fall primarily under the output indicator category but also include some process measures. The methods of recordkeeping are fairly crude. While area irrigated and the names of farmer-irrigators are generally registered in a log book, other information is kept in rough note books or loose sheets of paper. These notes are generally discarded after their immediate seasonal purpose is served and, as a result, changes over time are difficult to trace.

There is an awareness among farmers and tubewell farmer-managers that various additional measures would be useful. For example, among other items, managers identified a need for knowing whether they were supplying a sufficient amount of water to the crops. They also wanted to know more about changes in the water table. Farmers wanted to be able to compare the performance of their tubewells with that of other wells with the intent to find ways to improve the working of their own DTWs. Farmers' interest in the profit or loss of their wells would indicate a concern for the accountability of the tubewell managers. They were also interested in the level of farmer participation in irrigation affairs in comparison with other systems.

While some additional useful measures may be known to farmers and farmer-managers, others are not. In addition, the collection or interpretation of certain types of information may be difficult for the managers of FMIS. For example, water table monitoring and the efficient satisfaction of crop water needs require measurements and technical knowledge that are possibly beyond the means or expertise of most farmer-managers. There is scope for irrigation agencies to make available to farmer-managers localized information on water table performance, rainfall, evapotranspiration, seepage/percolation of certain types of soils, etc.

In addition, farmer-managers could be trained usefully in the making of various types of measurements and in the use of additional performance indicators in their management functions. When interviewed, farmer-managers mentioned the need for brochures or other information on various performance measures and standards as well as a need for suitable recordkeeping forms. Again, irrigation agencies or other rural development groups could provide training or otherwise disseminate information or measurement aids. To allow farmer-managers and their clients to compare performance with other wells, the compilation and distribution of regional tubewell performance records and suggested standards could also be useful to farmers.

CONCLUSIONS

The performance of farmer-managed TWs is of great importance to Bangladesh given the country's preponderance of groundwater technologies among its irrigation systems and given the pace of turnover of agency wells to farmer groups. DTWs are often underutilized in relation to reasonable expectations of command area and service to farmers. If farmer-managers of DTW FMIS are to be able to effectively manage their wells and improve their performance, they must have access to relevant measures of output, impact and management process attainments. While FMIS managers do keep some basic records there is scope for the use of a number of additional types of measures. Further, there is some confusion as to what might constitute appropriate standards of performance for various measurement indicators. Irrigation agencies (or other organizations) could usefully contribute to the performance of farmer-managed TWs by providing training and information in regard to various performance measures and standards. In addition, agencies could collect and disseminate information on some types of the technical indicators (evapotranspiration, water table changes, etc.) that would be difficult for farmer-managers to acquire on their own.

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