

BANGLADESH  
WATER MANAGEMENT SYSTEMS PROJECT  
FINAL REPORT

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## INTRODUCTION

The Water Management Synthesis II Project is a centrally funded AID activity that has as one of its major functions the upgrading of water management expertise in various Missions. By providing short and long term technical assistance through a contract between AID and the Consortium for International Development (Contract DAN-1427-C-00-0086-00) with three lead universities (Colorado State University, Utah State University and Cornell University), AID is able to supplement existing skills in participating Missions, particularly in those countries where AID has not had significant water management experience.

In response to a request from the AID Mission in Bangladesh the Water Management Synthesis II Project agreed to provide technical assistance for the development of a Project Paper entitled "Water Management Systems". The main purpose of this project was to provide support for the pump irrigation sector in Bangladesh, a sector in which AID staff in Bangladesh had little experience. Cornell University was selected as the lead institution for this technical assistance with responsibility for assembling, fielding and administering an appropriate team, and preparing a final report that would form the basis for the proposed Project Paper.

This report details the activities of the Water Management Systems team in Bangladesh between May and October 1983 and provides a summary of the major findings and conclusions. A more detailed evaluation of the overall water management situation in Bangladesh will be prepared at Cornell University that will serve as a starting point for further water management activities by the AID Mission in Dhaka. This report should be completed by the end of 1983.

The team members would like to thank the AID Mission in Bangladesh for their support and assistance during this assignment. Particular thanks are due to Joanne Hale, Latifur Rahman, Steven French, Charles Antholt and the Director, Dr. James Norris.

## Chapter 1

### BACKGROUND TO THE WATER MANAGEMENT SYSTEMS PROJECT

During the past few years there has been increasing interest in the AID Mission to Bangladesh in supporting the irrigation sector. In the latest AID Country Strategy Statement for Bangladesh, population programs and agriculture were identified as the two most important sectors for continued support. With increasing Government support for irrigation, and particularly the pump irrigation sector, it was seen as appropriate that AID should emphasize this sector in its development program.

In developing water management priorities for the Dhaka Mission the Water Management Systems team was guided by previous AID experiences in irrigation and water management in Bangladesh. Four projects had already been approved by AID, three of which are still in progress. The team wished to utilize this experience in designing a new project as well as ensuring that there was no overlap or duplication of effort between existing and proposed activities.

The first significant effort by the Dhaka Mission was the completed "Small Scale Irrigation Project" that had assisted in the development, manufacture and sale of about 150,000 manually operated shallow tubewells for irrigation. Despite some initial delays, the project was ultimately considered successful for two reasons: 50,000 acres of land were brought under controlled irrigation and local manufacturers developed sufficient expertise and facilities to continue to meet the demand for hand tubewells without additional technical assistance. A major ambition of the Water Management Systems Project was to provide the right environment for similar development in the manufacture of pumps and engines for the minor irrigation sector.

The second project involves support for CARE, a private voluntary organization, which is assisting farmer organizations in improving water management in deep tubewells. The program, entitled the Deep Tubewell Irrigation and Credit Program, provides technical assistance and credit for farmers within selected deep tubewell command areas in cooperation with the official Government agencies charged with providing irrigation services to farmers. Although the number of tubewells included in the project is only about 200 the project has demonstrated that, given adequate support services, it is possible to significantly increase the command area of tubewells and raise agricultural productivity. While recognizing that management inputs provided by CARE were probably higher than could normally be expected by

Government agencies, AID was interested in providing similar support through one or more of these Government agencies.

A third AID activity provides support to a FAO/UNDP project developing water management training capability at the Rural Development Academy at Bogra. FAO/UNDP is providing an interdisciplinary team of consultants who are training faculty at the Rural Development Academy, while AID contributes to the expenses of thana level officers and selected farmer representatives attending training courses in water management. A significant output from this project has been the development of a manual for tubewell Command Area Development for adoption by the Ministry of Local Government, Cooperatives, Rural Development and Religious Affairs. It is expected that AID will continue to support this program over the next few years by providing funds for the month long training courses undertaken by the Academy, while FAO/UNDP will continue to provide technical assistance. During the next four years it is expected that all thana level Subject Matter Officers responsible for providing water management services to farmers, as well as substantial numbers of farmer representatives, will have received training through this program.

The fourth activity is support for the Bangladesh Agricultural Research Council (BARC), including a substantial component specifically aimed at upgrading research into problems of water management. An amendment to the initial project was signed in 1982 that provided \$5 million for research into the water management sector, including support for three full time expatriate advisors and about \$1 million for contract research by participating institutions. The main aims of the water management consultants to BARC are to assist in developing improved pump irrigation techniques, upgrading on-farm water management research and close coordination with Government agencies involved in providing water management services to farmers.

Through its support for these projects, the AID Mission in Dhaka had shown that it was both interested in, and capable of, supporting the small scale irrigation sector in Bangladesh. At the same time, the Mission was not in a position to provide the necessary financial or administrative support required to develop an additional project, nor did it feel that it had the necessary technical expertise to design a project that focussed on irrigation water management. The establishment of the Water Management Synthesis II Project, whereby funds could be made available to requesting Missions for technical support in water management activities, was timely for the Dhaka Mission. On receipt of the request from Dhaka for support, AID/Washington agreed to fund a team under WMS-II to develop the Water Management Systems Project Paper. This was finalized in November 1982 and an initial approach was made to Cornell University to provide the necessary technical assistance.

## Chapter 2

### INITIAL PROJECT ACTIVITIES

The request for technical assistance from AID/Dhaka proposed that a five person team be sent to Bangladesh for a period of three months, during which time they would undertake a review of existing water management activities within Bangladesh, identify the major issues that could be addressed by a project, and write a report that would be the first draft of a Project Paper. The Water Management Synthesis II team at Cornell University felt, for a number of reasons, that this was not the best format for designing a water management project in Bangladesh. Unlike many other Asian countries, there is a general lack of experienced expatriate consultants who are familiar with conditions in Bangladesh, and it would therefore be difficult for a team to be fully productive in the first few weeks of an assignment. With the very rapid growth of the minor irrigation sector in a physical environment rather different from the rest of South or Southeast Asia, it was considered unlikely that experience from other countries could be readily transferred to Bangladesh.

Cornell University proposed that it would, in the long run, be more productive to send a team leader who would be resident in Bangladesh for several months, and then provide short term technical assistance in two phases. The first phase, early on in the project activity, would enable short term consultants to identify the major concerns that could be addressed by the project and to indicate where more information and data were required before a Project Paper paper could be developed. The second phase, following the compilation of the requested information, would involve the preparation of the Project Paper itself. In agreeing to these proposals, the Mission in Dhaka indicated that time pressure was not a major factor in developing the Project Paper, and that they would be prepared to accept some delay if it meant that a better end product would result.

The Mission also agreed that the start of the project be delayed until the designated team leader, Dr. Hammond Murray-Rust, was able to come to Bangladesh in late May 1983. However, in order not to lose the momentum of Mission support for the project prior to Dr. Murray-Rust's arrival, it was agreed to support a short term consultancy by Dr. Martin Hanratty, previously with the Ford Foundation in Dhaka, that would provide a baseline assessment of water management issues in Bangladesh for use by the Cornell University team. This report would also serve as the first of the periodic reviews required by the Mission that would evaluate the desirability of developing a water management project.

## Chapter 3

### MAJOR PROJECT ACTIVITIES

The submission of Dr. Hanratty's report to the AID Mission in Dhaka in April 1983 represented the first phase of project activities. In his report Dr. Hanratty reviewed the development of the irrigation sector in Bangladesh with particular emphasis on pump irrigation. His overall conclusions were that pump irrigation was likely to become the single most important component of the irrigation sector and would probably enable the Bangladesh Government to fulfill its objective of foodgrain self-sufficiency during the next few years. The evidence available to him indicated that investment in pump irrigation was an appropriate strategy for the Government to pursue, but that greater management of the infrastructure would be required to maintain long term food self-sufficiency. Rather than duplicating the activities of other donor agencies who have largely supported irrigation development by providing funds for purchase of new irrigation equipment from overseas, Dr. Hanratty reiterated the notion that AID could play a useful role in supporting greater emphasis on management without coming into conflict with these other donors. He indicated a number of areas where AID support could be most beneficial, including support for equipment manufacture, sales and service, provision of better spare part manufacture and distribution, training of mechanics, training of operators of equipment, support for water management services for farmers and continued research into water management problems in Bangladesh. While not going into the specifics of such a project, the overall conclusion was that AID had identified an important area that had been neglected by other donors, and full support should be given to the project team in developing a Project Paper.

The main project activities commenced when the team leader, Dr. Hammond Murray-Rust, arrived in Dhaka on 29 May 1983. During the next two and half months five short term consultants participated in the project and each wrote a detailed report of their findings. A full list of team members is presented in Appendix A and an index of project reports is provided in Appendix B.

In addressing the Scope of Work provided by the Mission (Appendix C) the team investigated a wide range of activities that could be included in a Project Paper. Although each team member represented a different discipline there was considerable overlap in their trip reports, and it is convenient to identify five main areas within which to summarize the findings of the team.

### 3.1 Water Resource Planning and Development

The pump irrigation sector in Bangladesh is comparatively recent, with the first tubewells and low lift pumps being installed only in the late 1960s. Initially, tubewell development was concentrated in the northwestern part of Bangladesh with the sinking of about 3,000 deep tubewells, and it was only in the mid-1970s that any significant installation of tubewells occurred in the rest of the country. The first phase of development consisted almost entirely of deep tubewells, with shallow tubewells only becoming important since the early 1970s.[1]

The Bangladesh Government decided that during the Second Five Year Plan (1980 - 1985) there should be a massive expansion of shallow tubewell development as part of the overall program to achieve foodgrain self-sufficiency. The Plan aims at installation of some 200,000 shallow tubewells in addition to modest growth in the numbers of low lift pumps[2] and deep tubewells. By the end of the Plan period, a high proportion of groundwater resources will be tapped for irrigation purposes. The desire of the Government to achieve foodgrain self-sufficiency as rapidly as possible has tended to overshadow the need to plan optimal exploitation of groundwater resources: there are already signs that in some areas the water table may be experiencing permanent drawdown while in others there is clearly interference among adjacent tubewells.

The two main planning objectives for optimal groundwater exploitation are to extract only the renewable or rechargeable portion of groundwater (i.e. avoidance of groundwater mining), and the spacing of wells to avoid problems of competition between adjacent wells for the same groundwater. It was clear to the team that most, if not all, tubewell installation has proceeded without any prior evaluation of groundwater potential and the extent of local or regional limitations for groundwater extraction. The same conditions appear to be true for exploitation of surface water resources, for there has been no detailed inventory of surface water reserves during the past decade. It is in the long term interest of the country to develop proper planning

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1. The difference between deep and shallow tubewells is not so much the depth of the well, more the location of the pump. Deep tubewells have turbine pumps that are submerged in the well tube, while shallow tubewells have centrifugal pumps installed at the ground surface. Shallow tubewells can, therefore, only pump water which is within 25 feet of the ground surface, while deep tubewells are capable of pumping water from much greater depths.

2. Low lift pumps are surface mounted centrifugal pumps that draw water from surface bodies such as rivers and ponds. No well tube is involved.

procedures for sustainable exploitation of water resources, thereby avoiding any crises in the years ahead.

In any water management program it is desirable to have some clear coordination among the various agencies responsible for installation of new equipment, and the team looked at both the current position and future prospects for such coordination. The overall opinion of the team members was that while there were some positive moves towards planning for water resource exploitation these were still at a preliminary stage.

The two main agencies responsible for water resource development are the Bangladesh Water Development Board (WDB) and the Bangladesh Agricultural Development Corporation (BADC). Although these agencies are now both within the Ministry of Agriculture (WDB was previously part of the Water and Power Development Authority) there is still little evidence of cooperation between them. WDB has responsibility for exploiting surface water resources, drainage and flood control. In addition to constructing and operating all major (large scale gravity) irrigation schemes, they have responsibility for most of the currently installed low lift pumps. They also have responsibility for monitoring water levels in rivers, and estimating surface water resource potential. BADC was established to provide agricultural inputs to farmers, including fertilizers, seeds and pesticides. When tubewell development started it was decided to give responsibility for their installation and operation to BADC rather than to WDB. The vast majority of tubewells therefore come under the aegis of BADC, which also has the responsibility for monitoring groundwater level fluctuations and evaluating groundwater reserves. There has been a long history of competition between WDB and BADC, which has resulted in a lack of coordination of their activities. Further, BADC was organized to treat deep and shallow tubewell development completely independently, and there are many cases where BADC has installed deep tubewells in areas where shallow tubewells already existed, thereby creating competition for the same groundwater.

The team did not feel that donor agencies who were involved in providing irrigation hardware have been sufficiently responsive to these planning requirements: the desire to provide loans for the purchase of large numbers of new tubewells appears to outweighed the need to have national and local planning of their siting, spacing and viability. In promoting better management of groundwater resources, the AID Mission could come into conflict with those donors who are largely interested in short-term installation of new irrigation infrastructure rather than in their long term viability, as well as with Government agencies who have vested interests in installation of pumpsets as opposed to their management.

From a more positive viewpoint, there are a few initiatives toward improved groundwater management. In a consultancy for AID through the Agricultural Research II Project Dr. George Radosevich worked with officials of the Ministry of Agriculture in developing an Ordinance controlling the installation, siting, spacing and operation of tubewells. During this consultancy Dr. Radosevich emphasized the need to develop regulations that could accommodate local and regional variability in groundwater and aquifer

conditions rather than developing a uniform set of regulations that would apply throughout the country regardless of the actual conditions present in any given area. In this respect, Dr. Radosevich was concerned more with the process by which than a level officials could regulate groundwater development rather than the specifics of the regulations themselves. However, it was generally recognized that a major constraint was a general lack of detailed information on groundwater resources, and that this would not be remedied within the time frame of the current Government program of expansion of the minor irrigation sector.

A second positive aspect was the creation of the Master Planning Organization (MPO) within the Ministry of Agriculture to develop the water component of the Third Five Year Plan for the Planning Commission. One of the tasks of the MPO is to develop a complete inventory of surface water, groundwater and aquifer conditions in Bangladesh to facilitate optimal planning for tubewell and low lift pump development. The MPO, which is supported by UNDP, is able to draw on the work of a previous UNDP activity that resulted in the first nationwide survey of groundwater and aquifer conditions. However, a potential weakness of the MPO is that it is only a clearing house for information, and it does not have the resources to undertake any long term monitoring. It is precisely this lack of baseline information that inhibits the development of rational groundwater planning, and the team was of the opinion that establishment of a groundwater monitoring program should be of major priority in any AID water management project. Until better information is available on groundwater conditions, the numbers of tubewells and pumps, the rate of groundwater extraction and potential levels of development, it is unlikely that long term sustainable water resource exploitation can be achieved.

The team was of the opinion that during the next five years there will be considerably greater interest on the behalf of the Government to manage water resources more effectively. The current phase of development was seen largely as one of obtaining access to water resources for future productive use, and that when this initial phase was over, greater attention would have to be paid to management. Despite some reports of permanent drops in the groundwater table, the team did not feel that this was a major problem. With the large potential recharge during the monsoon rains it was thought unlikely that the current emphasis on shallow tubewell development would create a situation where water tables could be permanently lowered over wide areas. By supporting a monitoring program at this stage, AID would be preparing the ground for more rational use of water resource development during the next decade.

### 3.2 Irrigation Equipment Manufacture

At present, the majority of equipment used in the minor irrigation sector is imported, largely through the assistance of aid programs that provide

credits for financing equipment purchase. The only products that are manufactured locally in adequate quantities are cast iron centrifugal pumps for shallow tubewells and low lift pumps. While this is understandable given the relative infancy of the pump irrigation sector, it is not desirable from the perspective of long term self-sufficiency in irrigation.

The Bangladesh Government has indicated its desire to develop local engine manufacturing capacity by issuing licenses for the production of diesel engines and has supported some domestic manufacture of electric motors. However, it has not modified import policies that existed prior to the growth of the pump irrigation sector. As a consequence local industries face untoward competition from imported products. The most anomalous situation is in the duties levied on raw materials compared to duties levied on finished products, be they for agricultural or industrial use. Raw materials have been subject to duties of close to 100%, while finished agricultural products have only been subject to a 15 - 25% duty. In addition, some donor agencies have imposed conditions on the Bangladesh Government in the form of tied aid, obliging the Government to buy assembled equipment from overseas. The net result of these policies has been that of the five licensees for diesel engine manufacture, only one has significant domestic production. The other four licensees are content to continue to act as importing agents rather than make the transition to manufacturing concerns.

The potential for domestic production is considerable. If the Government is successful in importing and commissioning close to 200,000 new irrigation facilities during the current Five Year Plan, the total installed capacity in 1985 will be close to 250,000 pump and engine sets. With some engines being suitable for other purposes such as powering agricultural equipment or small boats, it is possible that total numbers of engines will exceed this figure. The World Bank in its "Review of the Minor Irrigation Sector" estimates that annual demand for replacement diesel engines could reach close to 70,000 by 1990. If all of these engines are imported it would represent a massive, and continuing drain on the resources of Bangladesh for the foreseeable future.

The experience of the only major domestic manufacturer of diesel engines (Deutz Bangladesh Ltd.) has been that, given good management and a commitment to make long term investments, it is possible to produce good quality engines that are competitive with imported models despite the adverse import duty situation. Given the abundance of cheap labor and the proficiency of local artisans and mechanics it should, given sufficient share of the market and limited short term protection, be possible to manufacture engines at lower cost than imported ones. This alone should be sufficient reason to promote domestic manufacture, but there are a number of supporting reasons that the team felt important.

Because most equipment is imported it is much harder for the Government to ensure that it is appropriate for local conditions. The team was strongly of the opinion that for long term self-sufficiency in pump based irrigation, it was essential that equipment be as appropriate as possible for the type of conditions experienced in Bangladesh. Two different aspects of appropriateness were considered important: the need to have pumps and engines

suited to groundwater conditions, and the need to have equipment that was readily repairable in local workshops.

While Bangladesh is fortunate to have plentiful groundwater close to the surface over much of the country, imported equipment may have been designed for different environmental conditions. The large annual fluctuations in groundwater levels due to monsoonal conditions requires particular pump and engine designs to ensure optimal efficiency during the entire pumping season. However, the team did not find evidence that design of equipment took these conditions into account, nor were government procurement policies geared to the variations in groundwater conditions throughout the country. With few sources of energy in Bangladesh it is obvious that maximizing efficiency of the pump and engine sets would result in the saving of large amounts of foreign exchange. As yet, no studies appear to have been undertaken to ensure that pump and engine sets have been correctly matched to the groundwater and aquifer conditions of Bangladesh.

The second reason to foster local manufacture of pumps and engines is to develop a strong capability to repair and maintain equipment. Reliance on imported equipment does not always lead to development of this capability, and this is particularly true in Bangladesh where local manufacturing industries do not have the technical capability to replicate imported parts or materials. A case in point is the import of large numbers of lightweight alloy engines, for it is very difficult, if not impossible, for local craftsmen to repair this type of equipment. In contrast, there is considerable capacity to repair cast iron engines and pumps. In this respect, local manufacture of irrigation equipment using appropriate materials would not only save foreign exchange but would promote local employment of artisans in the rural areas.

Allied to this, but frequently treated as a separate issue in Bangladesh, is the whole question of spare parts. Present conditions are such that it is difficult for users to be certain that the correct spare parts are readily available, that their quality is adequate and that the price is fair. Support for local manufacture of irrigation equipment would help to overcome these problems, particularly if there were greater private sector involvement in both manufacture and distribution.

With one exception, the team was unable to find objective studies of how installed irrigation equipment is performing in the field. This is partly a consequence of the difficulty in getting agencies responsible for tubewell installation to make objective evaluations of their own performance, and partly because there has been a tendency to focus too much on the use of water once it has been pumped to the ground surface. The few reliable measurements of tubewell discharges appear to indicate that actual discharges are considerably lower than the nominal rated capacity of the pumps, and indication that the lower than expected command areas are attributable to equipment performance as well as inadequate on-farm water management.

The team felt that if for any reason the scope of the project had to be reduced, then support for domestic manufacture of irrigation equipment should

be the highest priority area for AID support. The general success of the "Small Scale Irrigation Project" in fostering local manufacturing capability of hand tubewells, combined with the strong local performance of pump manufacturers, is indicative of the potential for similar progress in the engine manufacturing sector.

### 3.3 Support Services for Irrigation Equipment

Closely allied to the manufacture of irrigation equipment are questions of providing adequate support services to ensure that installed equipment is able to function efficiently and reliably. These services include ensuring that operating inputs are readily available, that spare parts are adequately stocked and of appropriate quality and that there are sufficient mechanics available to undertake both major overhauls and routine maintenance and repairs. The team was firmly of the opinion that the entire support service sector was in need of assistance if long term viability of the pump irrigation sector was to be guaranteed. At the same time it was recognized that there was already some transition in government policy that might lead to improved support services.

The present government has promoted a policy of privatization in several sectors of the national economy, including the sale and service of shallow tubewells and low lift pumps and a more limited sales program for deep tubewells. Prior to 1980 all irrigation equipment was owned by the government and leased out to user groups formed specifically for the purpose of operating the equipment and managing the water within the pump command area. The government agency that has the largest role in this activity is the Bangladesh Agricultural Development Corporation, which has responsibility for providing service to almost all of the publically owned deep and shallow tubewells as well as to some low lift pumps. The Water Development Board has responsibility for the majority low lift pumps.

Neither agency has been particularly efficient, and the government has increasingly been of the opinion that privatization of the minor irrigation sector would likely lead to better services for water users, in the same way that privatization of fertilizer wholesaling and retailing appears to have been more efficient. The team felt that the private sales and service program adopted by the government had not been as successful as it could have been, and would need some substantial modification if it was to serve the true interests of users. Nevertheless, the team maintained support for the privatization program as a long term strategy to encourage more efficient use of irrigation infrastructure.

The relative lack of success of the privatization of the minor irrigation sector was attributed largely to the lack of incentives given to private dealers to develop long term commitment to the sector. The sales program has been structured in such a way as to foster indiscriminate selling of

equipment with no post-sales responsibility for dealers: manufacturers have not provided warranties on equipment, dealers do not have to ensure that well siting and spacing guidelines are being followed, there is no monitoring program to ensure that dealers correctly sink wells (and in some cases make users sink the wells themselves even though this is included in the purchase price), nor is there any mechanism to check that dealers employ mechanics and keep adequate stocks of spare parts so as to be able to carry out the eighteen months of free service required under the conditions of the contract signed with the government or banking sector. Despite these inefficiencies, the team was of the opinion that private sector sales program was no worse than the sales program of government agencies, and that some modifications in the contractual agreements of dealers could result in improved services.

The strength of private sector initiative was best observed in the increasing number of private mechanics serving both private and leased tubewells. Although users leasing a tubewell or low lift pump are supposed only to use mechanics provided by BADC, in reality it is only by going to private mechanics that many farmers can obtain the necessary services. The team recognized that private mechanics were most numerous close to the major urban centers, while government mechanics still undertook most maintenance in more remote areas. This was seen as evidence that when the number of pieces of equipment in any given area reached a critical level, then there was sufficient market to encourage private mechanics to move in and take on the responsibilities nominally reserved for government mechanics. There has been no reduction of government mechanics in areas where private sector mechanics have taken over, nor has there been any relocation to the more remote areas.

The same pattern appeared to be true for the spare parts sector. In major urban areas, notably Bogra and Comilla, there has been a large increase in the number of private workshops manufacturing spare parts and undertaking repairs to equipment brought in from the field. While there are real concerns over the quality of some of these spare parts compared to original equipment manufacture spares provided by manufacturing companies or import agents, the prices are generally significantly lower and their local origin makes them far more readily available than those which have to be distributed to rural areas from Dhaka or Chittagong.

The private sector has also become involved to some extent in the supply of operating inputs (diesel, oil and lubricants) although these are still largely handled by government agencies, with BADC again having the largest involvement. While there were reports of a number of local shortages of operating inputs in the past, these shortages seem to have diminished in recent years and there does not seem to be the same degree of concern at the present time. The only exception to this is in the supply of electricity to rural areas, and this will gradually ameliorate with the on-going AID supported Rural Electrification Program and the development of greater generating capacity using local sources of natural gas. While electrically operated irrigation equipment appears more attractive to many farmers, both in terms of cost and ease of operation, there are great fluctuations in voltage and frequent disruptions to supply. Greater cooperation between the Power Development Board, the Rural Electrification Board and the Ministry

of Agriculture would be desirable, and some consideration should be given to prioritization of electricity installations in those Districts where there is a large market for electrically operated irrigation equipment.

The major question the team had to consider in defining the role of the private sector in providing support services for irrigation equipment was the extent to which the private sector would respond to market forces. If the private sector was able to respond rapidly to market forces then the team felt that there was little need to provide further incentives to encourage private sector participation. If, on the other hand, the private sector was not prepared to respond to market forces because of uncertainties of whether how the Government was going to introduce regulation, provision of incentives could lead to a situation which was no more efficient than the existing government structure. The team felt constrained by any detailed evaluation of the performance of the private sector, and were conscious of having to rely on anecdotal evidence, particularly from government officers who may have vested interests in maintaining large public sector involvement. The team was also aware that interventions into a private sector as complex as that of Bangladesh would not be easy, and that too much intervention would undermine the whole purpose of private sector participation.

In identifying the type of activities that would be appropriate for AID support, the team recognized a number of difficulties. As far as providing more mechanics was concerned, three sets of activities already exist. Private companies involved in engine manufacture already run a number of training courses, initially to meet their own requirements but with significant contribution to the private sector once mechanics move into their business on their own. In supporting domestic manufacture of equipment, the team felt that companies could be expected to continue to run these types of training programs and in so doing would contribute to the overall pool of mechanics capable of undertaking major engine overhauls.

Secondly, the government has supported the development of thana level workshops and has received some assistance from other donors, notably the World Bank. The World Bank is of the opinion that with their current support for mechanic training programs there will be no shortages of mechanics once the current programs are complete. While the team disputed this, both because the program envisages a rather higher number of pumpsets to be serviced by a single mechanic and because it assumes uniformity in the distribution of mechanics throughout the country, the team felt that it might be hard for AID to propose to the Government additional training programs that appeared initially to be redundant.

The third activity is the training of mechanics through apprenticing, a system that has been well established within the private sector for a long time. The team had no way of knowing the effectiveness of this type of training, the numbers involved, or the prospects for growth, and merely assumed that mechanics trained in this fashion would be additional to those trained through more formal programs. Because of these uncertainties it would require a lot more investigation into both the supply and demand of mechanics before AID could safely invest in training on a large scale. One

option open to serious consideration, however, was the continued or increased support for private voluntary agencies and non-governmental organizations who already have technical training programs. An attraction of these programs is that a number of them specifically aim at assisting the poor, the unemployed and the homeless.

### 3.4 Support Services for Farmers

A major component of the original Scope of Work for the team was to investigate ways in which farmers could be given improved support in undertaking better water management within the command areas of tubewells and low lift pumps. Much of the available literature on water management in Bangladesh, as well as the prevailing conventional wisdom, focusses on the inefficient use of water by farmers once it has been pumped to the ground surface. As a result the team was initially guided towards stressing support for water management services to farmers along the lines already taken in the Command Area Development program.

After the first round of short term consultancies the team members were not convinced that this was the best approach that AID could adopt under present conditions. The general paucity of good quality, detailed observations of present farmer practices and behavior made it difficult to formulate a program that had a realistic chance of improving field level water management. Moreover, the team members unanimously agreed that farmers were probably adopting the most rational practices under prevailing conditions and with the external incentives currently available. The apparent inefficiencies in water use resulting in lower than expected command areas were seen by the team as a reflection of overoptimistic assumptions of commandable areas rather than as a genuine reflection of farmer performance in water management.

The desire of the Bangladesh Government to maximize production through efficient use of water may, at least in the initial stages of development of the irrigation sector, be in conflict with the desires and needs of individuals served by each of the nearly 200,000 independent pump based irrigation schemes. By introducing greater access to water through the provision of irrigation facilities, the government is essentially overcoming the major constraint to increased production. Before mechanized irrigation facilities were available, water could only be obtained by manual lifting methods, and this placed a finite limit on the area irrigable. Dry season irrigation could only take place where surface water supplies were present throughout the year, and thus most farmers could not expect any dry season crop. The traditional cropping pattern reflects this, insofar as most areas of the country have relied on two mousoon crops.

With the introduction of tubewells and low lift pumps there have been significant changes in cropping patterns, with large areas now supporting a dry season rice or wheat. Because these dry season crops are invariably higher yielding varieties, many farmers do not need to rely so much on the wet season cropping pattern, and in some areas have shifted to a single monsoon rice crop. With supplementary irrigation possible in the monsoon season, either through mechanized or manual facilities, total yields from the dry season and single monsoon season are likely to exceed yields from two traditional variety monsoon crops.

From the perspective of the user with access to improved irrigation facilities there may be little incentive to grow a third crop or to maximize the area cropped if family food requirements can be met with fewer inputs: farmers have to bear the full cost of operating and maintaining pumpsets, involving payment in advance for fuel. As many farmers appear to be only partially within the cash economy there may be no direct financial incentive to maximize income by growing as many crops as possible. The team felt that considerably more information was required on the actual economic motivations of farmers under a number of different conditions before it would be possible to understand why pumpsets were being operated as they are. In the long term, however, population growth may well bring greater pressure on farmers to increase their cropped area, thus bringing cropping intensities and productivity closer to the levels anticipated by government agencies and planners.

A second economic reason for relatively small command areas may be that the government lease and rental programs of irrigation equipment do not necessarily favor full utilization of equipment. If it is assumed that the life length of equipment is directly related to the area irrigated, then there may be less economic incentive to maximize the irrigated area: areal increases will be reflected in increased annual replacement costs of the pumpset. With increased conveyance losses associated with larger command areas it is possible that it is less than economically optimal to irrigate command areas of the size assumed optimal by national level planners.

A third economic reason for farmers not to maximize command areas may lie in the sales and subsidy program of the government, for in many cases it is just as attractive, if not more so, for farmers to purchase their own tubewells than to rely on buying water from a neighbor's well. Insofar as the seller of water is likely to charge enough to cover all his own costs and make a profit, it is perfectly rational for a farmer to consider purchasing his own tubewell if he has more than a minimal land holding. That the government, both directly and through the nationalized banking sector, is promoting the ready availability of credit and being somewhat flexible in loan collection provides additional indirect subsidies for tubewell purchase, further lessening the prospects of maximizing the utilization of existing wells.

There are strong technical grounds for farmers not to maximize command areas. There is no doubt that on-farm conveyance losses in some areas of Bangladesh are high: as command areas increase the stream of water reaching

tail end areas will suffer excessive losses through seepage and percolation. While channel lining has been viewed as one way of overcoming this problem, the cost of channel lining is generally high, and it may be cheaper to install more tubewells than to invest in cement and bricks.

As long as there are uncertainties in farmers' minds over the supply of operating inputs and spare parts, it is not unreasonable to expect farmers to be conservative in the number of hours a pumpset is operated, thereby allowing makeup opportunities if repairs takes several days to be arranged. The expectation of planners has been that pumpsets should be operated for twenty or more hours per day, an operational mode that leaves little scope for reintroducing issue schedules following interruptions in pumping due equipment failure or lack of operating inputs.

There are a number of social aspects that need to be considered in assessing the capability of farmer organizations to irrigate large command areas. Bangladesh is typified by small landholdings, many of which are fragmented. This dictates that water allocation and distribution will be complex if all farmers served by a single pumpset are to receive approximately equal volumes of water, particularly towards the tail end when streams of water become small and experience high conveyance losses. This is particularly true for deep tubewells, although there is some evidence that shallow tubewells also face serious organizational problems.

Planners have assumed, purely on technical grounds and with efficient water management, that 100 acres could be irrigated from a deep tubewell with a nominal discharge of 2 cubic feet per second. This would entail well over two hundred separate plots and well over one hundred farmers. This contrasts with experiences from other parts of Asia where it appears that organizational requirements for arranging for proper allocation and distribution of water becomes a difficult task if there are more than thirty or forty farmers in the smallest irrigation unit in any system: to expect good cooperation with over one hundred individuals is optimistic. This is even more true when there has been little time for farmers to develop their own mechanisms for allocation and distribution of water.

Organizational problems do not appear to be so severe for shallow tubewells which have command areas of between ten and twenty acres. However, there is some evidence that it is economic for individuals to purchase their own tubewells and irrigate far less than this without having to supply water to other farmers. This suggests that even among relatively small groups of farmers transactional costs may be sufficiently high to discourage maximization of shallow tubewell command areas.

There has been little expectation on behalf of government agencies that farmers should develop their own mechanisms for managing tubewells as they desire. In both the installation phase and in providing subsequent extension support, there has been a natural tendency for government officers to apply a single package. To be eligible for a tubewell farmers have to form an organization that includes all those with land in the potential command area of the tubewell, and have to have a chairman, secretary and operator of the

organization. In most cases it appears that these positions have always gone to more influential farmers, thereby reinforcing existing power structures at the local level. By contrast, there are very few instances where farmer organizations have been established before the installation of the tubewell so that design and operational decisions can be made before commissioning of the well and pumpset. These few instances appear to be confined to those tubewell groups receiving assistance from private voluntary agencies such as PROSHIKA and BRAC.

The team was concerned that reports of widespread emergence of "water lords" (influential farmers who obtain control over tubewells and then charge exorbitant rates for water to other farmers) may be exaggerated, in the sense that such inequities existed prior to irrigation equipment installation. While there are undoubtedly many cases where water lords have exploited their new resource, it is not strictly fair to blame irrigation for this problem. Further, because organizations are frequently nominal and are not subject to any outside monitoring, the administrative arrangements for providing tubewells is as much to blame for the types of equity problems that are apparent.

Extension advice, either through the Ministry of Agriculture's Directorate of Extension and Management or the Bangladesh Rural Development Board, is largely along the lines recommended through the Command Area Development program. While the objectives of this program are laudable, there is little inherent flexibility in the advice. The main thrust of both these extension programs is to "motivate" farmers to accept the arrangements proposed in the program, rather than to foster farmer capability to develop their own solutions to the specific difficulties they encounter. Reluctance to accept the standard package and a lack of alternative options may well be a reason for lower than expected areas in tubewells covered by the Command Area Development program.

The general inflexibility of the agencies, combined with a lack of coordination among them, who are supposed provide water management services to farmers was seen as a major constraint by the team members which, combined with a lack of detailed knowledge of local conditions (and perhaps an unwillingness to learn more), led the team to the conclusion that, while there were undoubtedly serious problems at the local level, it would be difficult to base a program on provision of support for on-farm water management activities. The team felt that because farmers were likely to eventually develop their own solutions, widespread intervention at local level would be difficult and might not be very productive.

### 3.5 Administrative Aspects

A major consideration in project design and implementation is the nature of the host country institutional arrangements. Because of the rapid

development of the pump irrigation sector in Bangladesh it has been standard practice to assign responsibilities to existing government agencies rather than to create new or modified administrative structures. In this respect Bangladesh is probably not particularly different from many other countries that have experienced growth in a new sector, but it makes the implementation of projects more difficult than if a single purpose agency exists.

The breaking up of the Water and Power Development Authority which involved the transfer of BWDB into the Ministry of Agriculture theoretically provides for greater coordination of activities between BWDB, BADC, the Agricultural Research Council and the Directorate of Extension and Management, but it does not appear that there has yet been better planning through the Ministry. In addition, all training in water management for thana level Subject Matter Officers has been shifted to the Bangladesh Rural Development Board which comes under the Ministry of Local Government, Rural Development, Cooperatives and Religious Affairs. Responsibility for coordinating and regulating the manufacture of pump and engines coming under the Directorate of Industries, and it is likely to be difficult to transfer information on groundwater and aquifer conditions from the Ministry of Agriculture into the manufacturing sector to facilitate improvements in pump and engine design.

In addition to these divisions of responsibilities, which are not untypical of civil services modeled on the British Colonial Civil Service, three other institutional problems in Bangladesh may affect the implementation of water management projects:

(1) there has been little effort made to ensure that the responsibilities of different agencies are clearly defined. The net result is that there are many instances of overlap in agency roles with significant chance for duplication of effort or provision of conflicting advice for users. Any effort to implement a broadly focussed water management project would have to deal with several agencies simultaneously and make efforts to clarify the status of the various agencies involved. It is likely that such efforts would run into some resistance from certain agencies who do not want to see their responsibilities reduced or redefined. Nevertheless, the recent formation of an inter-ministerial committee to look at irrigation problems indicates that there is some concern at national level of these coordination problems. As yet this committee has not played any significant role in getting greater cooperation either within Ministries or among them, but it can be presumed that it will eventually begin to play this role.

(2) many of the agencies involved in one or more aspects of pump irrigation development have little experience of the type of problems they have to deal with on a daily basis. This is true both for the more technically oriented agencies such as the Bangladesh Agricultural Development Corporation and the Water Development Board, and for extension and training agencies dealing with management of water once it has been pumped to the ground surface.

The lack of formal training in pump based irrigation in the Universities and professional training institutes means that almost none of the engineers in either BADC or BWDB have a sound understanding of the principles of either

pump and engine operation or of well hydrology. One immediate consequence is that it is hard for these agencies to know whether they are purchasing the most appropriate equipment for local conditions. Admittedly, this situation is gradually improving, but it will be some time before either of the organizations is capable of providing sound technical advice on purchasing, installing and operating minor irrigation equipment.

(3) finally there is the potential effect, perhaps only temporary, of current efforts to decentralize some government power to districts and thanas by the end of 1984. The current upgrading of thanas not only provides for greater local control over decision making but, for the first time, makes local level government officers responsible to elected officials rather than to their superiors in line agencies. This means that performance of local level officers can be judged by non-specialists, an area of particular concern to the more technically oriented agencies such as BADC and BWDB. As thana level officers will inevitably be responsible for most decisions about well siting and spacing, provision of extension advice and enforcement of regulations concerning minor irrigation, it is likely that there will be great variation in the decisions made among different thanas.

The team felt that, in line with stated AID objectives, it would be useful for any water management project to address the whole question of developing coherent national policy towards irrigation development. By developing a project that had some policy changes built into the conditions precedent it might be possible to resolve or alleviate some of the issues discussed above. To achieve this, however, the team was of the opinion that the project should be kept relatively simple, and be seen to be addressing a few key issues rather than attempting to simultaneously tackle all aspects of water management.

## Chapter 4

### PROJECT RECOMMENDATIONS

In September 1983, following the first round of short term project consultancies, the team leader and AID staff discussed the direction in which it was thought project development should continue. AID staff reiterated their position that they wanted to have a relatively simple project but one that could support the overall objectives of supporting agricultural development and promoting private sector involvement in national development. They were also concerned that the project should involve sufficient funds to enable AID to have enough influence on government thinking about the minor irrigation sector.

In light of the various consultants' findings, the team considered that the logical starting place for a comparatively straightforward project dealing with the minor irrigation sector would be in assisting stronger domestic manufacture of irrigation equipment and spare parts. In evaluating the activities of other donor agencies it was clear that little attention had been paid to upgrading this capability despite the fact that reliable operation of irrigation equipment was essential to the long term success of pump irrigation in Bangladesh. By focusing on this aspect, AID would not only be implementing a project in which it had had some prior experience in Bangladesh but would be in a strong position to influence government policy. If, on the other hand, the project overlapped with a number of other donor programs it would be far more difficult to get the desired policy changes implemented.

The team also felt that, in light of the experiences of the AID sponsored Agricultural Research II Project that supports the Bangladesh Agricultural Research Council, it was premature to develop a project that was aimed primarily at on-farm water management. While acknowledging that in the future this type of support would be valuable, there was insufficient information at present to adequately design a project that would address the critical issues. Involvement in supporting manufacture of irrigation equipment at this stage in the development of Bangladeshi irrigation would by no means preclude support for more agriculturally oriented water management activities in the future, and might be beneficial if there were more reliable and more appropriate irrigation installations as a result of the improvements in manufacturing capability.

The team leader prepared a set of recommendations for consideration by AID proposing that, at the present time,

- AID should not pursue further the component concerned with provision of water management services to farmers,
- AID should not get involved in promoting additional training courses for mechanics, as there were likely to be sufficient mechanics trained in current and proposed programs,
- the proposed project should focus on the domestic manufacture of pumps, engines and spare parts, together with improved sales, distribution and servicing, and
- the terms of reference for the team be altered to reflect these changes.

AID staff accepted these arguments and agreed to modify the terms of reference of the Water Management Systems Project team. The major change was that, because the team members did not have appropriate backgrounds in equipment manufacture, the team would not be expected to write the basis of a Project Paper, but would instead prepare a draft Project Identification Document that outlined the major components of a new project to be called "Irrigation Equipment Improvement".

The intention of the Irrigation Equipment Improvement project would be to foster greater local manufacturing capability by addressing four main issues, each of which is briefly described below.

1. Tariff Support: The project should have as a primary goal the modification of existing tariff structures that make it cheaper to import assembled equipment and finished spare parts than to import raw materials for processing and manufacture. Until such changes are made it is unlikely that domestic manufacturers will have any incentive to invest in local production, and will merely act as import agents of finished or partially finished products.
2. Licensing: The project should aim at getting a review of existing licensing arrangements. Currently five manufacturers have been awarded licenses to produce diesel engines, but only one has any significant local production. Licensing should be reviewed periodically to permit other manufacturers to enter the market if existing licensees do not start manufacturing, and to enable the government to introduce greater standardization of makes, models and quality.
3. Equipment Pricing: Existing subsidy programs should be modified to make manufactured equipment at least competitive with imported products, and in the short run it may be necessary to provide some price support for domestic manufacturers to allow them to build up production to a point where they can compete with imported products.

4. Production Concerns: The project should provide technical assistance to manufacturers to enable them to improve the reliability of equipment, to make equipment of materials that can be readily repaired in rural areas, to improve operational efficiency by matching pumps and engines to groundwater and aquifer conditions in different parts of Bangladesh and to provide greater information in groundwater conditions in conjunction with the Water Master Planning Organization. In developing these production objectives, it is highly desirable, if not essential, that the project supports a field monitoring program of pumpset performance, including monitoring groundwater levels and fluctuations, pump discharges, efficiency of operation, reliability of makes and models of equipment and evaluation of spare part and operating inputs availability and quality.

These proposals were presented to AID in mid-October by the team leader in the form of a draft Project Identification Document. It was suggested that the project be structured around a credit of about \$50 million, including \$2 million for technical assistance, that would be made available over a five year period in the form of a development bank for irrigation equipment manufacturers. By releasing funds to the government contingent on certain policy adjustments and changes, AID would have some ability to ensure that overall development of the irrigation sector proceeded in the best interests of both manufacturers and users.

With the acceptance of these proposals by the Mission and the agreement to bring out a team of suitable consultants using other sources of funding, the technical assistance under the Water Management Synthesis-II project was terminated for the Water Management System Project.

**Appendix A**  
**PROJECT PARTICIPANTS**

Dr. Hammond Murray-Rust	Irrigation Engineer (Team Leader) Cornell University	May 29 - October 18
Dr. Leslie Small	Agricultural Economist Rutgers University	June 24 - July 15
Mr. Joe Campbell	Pump Specialist Cornell University	June 25 - July 15
Ms. Susan Turnquist	Organizational Specialist Cornell University	July 1 - August 16
Dr. Harry Blair	Institutional Specialist Bucknell University	July 29 - August 19
Dr. Hamidur Khan	Agricultural Engineer Private Consultant	June 15 - October 19 (part-time)

## Appendix B

### PROJECT REPORTS

Dr. Martin Hanratty	Minor Irrigation Development in Bangladesh (April 1983)
Dr. Leslie Small	Economic Aspects of Minor Pump Irrigation in Bangladesh (July 1983)
Mr. Joe Campbell	Report of three week study in Bangladesh for the Cornell University/USAID Water Management Systems Project (July 1983)
Ms. Susan Turnquist	Local Organization for Irrigation in Bangladesh (August 1983)
Dr. Harry Blair	Institutional Aspects of Water Management in Bangladesh (August 1983)
Dr. Hamidur Khan	Consultancy Report: Water Management Systems Design (October 1983)
Dr. Hammond Murray-Rust	Water Management Systems Project: Interim Report (October 1983)
Dr. Hammond Murray-Rust	Irrigation Equipment Improvement: Draft Project Identification Document (October 1983)