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EXECUTIVE
SUMMARY

PN-AMT-506

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF LOCAL GOVERNMENT, RURAL
DEVELOPMENT AND COOPERATIVES

RURAL IRRIGATION WORKS STUDY
FINAL REPORT

EXECUTIVE SUMMARY

ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO, U.S.A.

PLANNERS, ENGINEERS AND CONSULTANTS LIMITED
DACCA, BANGLADESH

FEBRUARY 1980

EXECUTIVE SUMMARY

Section 1: Authority

This report on the Rural Irrigation Works Study was prepared for the Ministry of Local Government, Rural Development and Co-operatives (MRD) of Bangladesh, under the terms of an agreement, dated January 28, 1979, between MRD and the joint venture firms, Engineering Consultants, Inc., (ECI) of Englewood, Colorado, and Planners, Engineers & Consultants (PEC) of Dacca.

Section 2: Project Description

A. General Description

The objective of the study was to prepare for implementation a proposed three year AID financed project for constructing and operating small-scale irrigation systems through the Rural Works Program of the Government of Bangladesh. As stated in the contract, "a small-scale irrigation system is...one which delivers irrigation water from a groundwater or surface water source to the field. The system may include but not be limited to lowlift pumps, tube wells, small dams, conveyance systems, and appurtenant structures".

Phase I of using a survey/evaluation questionnaire developed by the Consultant to rank 90 sub-projects from six districts. The Consultant was also responsible for making recommendations for the selection of 30 sub-projects for design and construction. Results of this work are detailed in the Phase I Report submitted to MRD and USAID in June 1979, and are also included in this final report.

Phase II commenced upon review and approval of the 30 sub-projects by USAID and MRD. Total input requirements--including maps, sub-project surveys, design criteria, and a social, economic, and environmental evaluation--were prepared.

The principal objective of the program is to increase agricultural production through flood protection, improved drainage, the provision of irrigation water, or combinations of these engineering schemes.

B. Survey/Evaluation Questionnaire and Sub-Project Selection (Chapter II)

One of the objectives of this study was to develop a survey/evaluation questionnaire for priority ranking of sub-project proposals submitted to the Rural Works Program of MRD. The Consultant developed a questionnaire based on a set of criteria outlined in the contract and summarized in Table S-1. (Tables throughout this report are placed at the end of the chapter to which each belong.) The questionnaire was applied to the 90 sub-projects, of which 30 were selected for design and development. Table S-2 contains a list of the 30 sub-projects approved by MRD and USAID.

The questionnaire is intended to assist MRD personnel in evaluating proposed small irrigation systems by briefly visiting the sub-project areas. The point rating obtained from use of the questionnaire provides a relatively accurate measure of their suitability for design and construction.

Sub-projects to be developed will serve as models of design and operation to MRD engineers and to water users' groups; therefore, economic justifiability was not considered to be a primary factor in the development of the questionnaire. However, the economics of typical sub-projects were evaluated in detail and the results appear below in Section 2, Part H. of this summary.

C. Agriculture (Chapter III)

Because of its importance to the economy of the country, the agricultural sector was carefully analyzed. Crop calendars for typical crops and the main existing cropping patterns were defined and explained in detail.

The Consultant prepared an agronomical analysis of factors influencing cropping patterns, such physical factors as land classes, flood levels, drainage, soil permeabilities, soil moisture-holding capacities, and soil types.

Based upon the different land and soil types, the Consultant prepared a table showing nine traditional cropping patterns and possible improvements for each with irrigation water.

A procedure for evaluating and recommending improved cropping patterns for existing and proposed irrigation sites was outlined in the report. The steps outlined should be followed for each specific sub-project and must be accomplished through interviews with farmers and village and local leaders, through on-site inspections, through crop cut surveys, and through management studies.

The Consultant specified that the improvement of cropping patterns is only a first step towards increased crop production. Management, extension activities, and supply and marketing systems must also be improved. Finally, the Consultant emphasizes that the farmers themselves must select the cropping pattern to be used and that in some instances it may be more successful to propose a gradual change in cropping patterns.

D. Engineering (Chapter IV)

The engineering section of the report is divided into two main parts: The first concerns on-farm distribution system criteria; the second presents the designs and engineering cost estimates for the sub-projects. The report's three appendixes were also prepared as complements of this chapter: Appendix A contains general specifications; Appendix B is the Design Manual; Appendix C is the Operation and Maintenance Manual.

Development of the on-farm design criteria includes detailed description, justification, tables, figures, and examples. It was intended to provide for command areas to be increased to the optimum acreage, taking into consideration agronomic, engineering, economic, and social factors.

Engineering designs and cost estimates were prepared for 24 of the 30 sub-projects approved by MRD and USAID and submitted to the Consultant. Because they were not feasible from the engineering and/or economic point of view, the remaining six sub-projects were not designed. Of the 24 sub-projects designed, the Consultant recommended early implementation of 23. The other sub-project was designed upon MRD request, and its implementation was not recommended by the Consultant.

A complete engineering design was made for each of the 24 sub-projects. The report shows all steps and reference material used in arriving at specific designs. Each sub-project design includes topographic maps showing land parcels, location of pumps, wells, dams, channels, and/or appurtenant structures.

Distribution systems were designed for LLP and DTW sub-projects. A map showing the recommended crop rotation for specific areas was also prepared for these sub-projects.

For sub-projects whose proposed works will affect a large area, only designs for hydraulic structures (i.e. sluice gates, drainage channels, dams) were prepared.

Detailed cost estimates were prepared. Table S-3 summarizes costs for the 23 recommended sub-projects. The total construction cost (FAR) is Tk 25,020,000, of which Tk 8,382,000 is for sub-projects to be constructed during the first year and Tk 9,239,000 and Tk 7,399,000 for the second and third years of construction, respectively. These cost estimates are at the December 1979 price level.

E. General Specifications (Appendix A)

Appendix A, which consists of general specifications for construction of the sub-projects, includes the following sections: Instructions to Tenderers, Tender, Bill of Quantities, Farms, General and Special Conditions, and Technical Specifications. General specifications are defined as tender documents that do not contain information about any particular sub-project but which can be readily adapted to tender documents for construction of several sub-projects under one contract. The technical specifications cover every item of work required for construction of sub-projects and were prepared to enable use of either local materials and local or international contractors.

F. Operation and Maintenance Manual (Appendix B)

The Operation and Maintenance Manual, which constitutes Appendix B, presents examples of irrigation scheduling; procedures for maintenance of distribution systems; operation, maintenance, and costs for LLPs and DTWs; pump performance and pumping time; examples of daily and monthly allocation of water; pump house modifications, and khal maintenance costs. The manual was prepared in draft form and should be expanded and updated during the construction phase. Furthermore, one manual should be prepared for each sub-project as built.

G. Design Manual (Appendix C)

The Design Manual, presented in Appendix C, contains standards and procedures for engineering design of two types of sub-projects: the first for design of distribution systems for irrigation from LLPs and DTWs; the second for design of reexcavation of khals and construction of sluice gates.

The manual is applicable to relatively small engineering schemes. It presumes that field data, maps, river hydrographic records, and agricultural requirement data are available.

H. Economic and Financial Evaluation (Chapter V)

To determine the profitability of sub-project development, seven sub-projects were selected for economic and financial analysis.

The economic evaluation was based on the traditional approach of comparison of future situations with and without sub-project development. To accomplish this, farm budgets were developed to represent farming conditions at different sub-project areas and for the different situations. Costs and benefits were computed for each sub-project. Subsequently, internal rates of return (IRR) and benefit-cost ratios (B/C) were computed. Table S-4 summarizes the results of this evaluation. All sub-projects have a B/C ratio greater than 1 at 12- and 16-percent rates, and only Sub-project No. 27 has a B/C of less than 1 at the 20-percent rate. Sub-project No. 19 had the highest IRR, 76.6 percent. Sub-project No. 27 had the lowest IRR, 17.9 percent.

In general, the results of the economic evaluation are encouraging and the implementation of the 23 sub-projects designed is recommended.

Financial analysis, which pertains to the farmers' private financial circumstances and addresses all costs incurred by them in achieving farm production, was conducted for seven sub-projects.

Table S-5 summarizes annual financial returns per acre for each sub-project. It shows the disposable income obtained by farmers at irrigated and non-irrigated farms for the present and future situations, with and without sub-project development. Because not all sub-projects provide irrigation water and because those that do may not provide water for all farms in the area, increments in disposable income were computed to represent three situations:

Situation 1 shows the increment in disposable income for areas that now irrigate and will be irrigating in the future.

Situation 2 shows the increment in disposable income for areas that do not now irrigate but will irrigate under sub-project development.

Situation 3 shows the increment in disposable income for areas that do not now irrigate and will not irrigate under sub-project development.

Disposable income at all sub-projects for the three different situations will significantly increase. Situation 2 shows the greatest increments, and it is this situation that must be closely analyzed for the determination of irrigation water charges. The minimum increment in disposable income in this situation is equal to Tk 3,304 per acre per year for Sub-project No. 1, which provides more than enough income to cover O & M costs. For a one-acre farm in this sub-project area, water charges sufficient to cover all costs of irrigating boro, t. aman, and t. aus are Tk 520.

The Consultant recommends that charges should be in accordance with water use: i.e., benefited farms should pay the charges; therefore, different rates should be charged for different crops irrigated. Because it would be cumbersome to charge different rates for each crop at each sub-project area, the Consultant recommends that charges be set for each irrigated crop on a district basis. For example, rates of Tk 400/acre and Tk 450/acre of irrigated boro rice could be charged in the districts of Chittagong and Dacca, respectively. These rates should be revised annually and adjusted to reflect changes in prices and in the financial situation of farmers.

The Government of Bangladesh has not established a formal policy for repayment of irrigation capital costs. Apparently, construction costs are not expected to be repaid, but attempts are made to assess charges for annual operation and maintenance expenses.

Landholders benefit somewhat from increased agricultural production immediately following the installation of irrigation facilities and the construction of hydraulic structures, but significant increases in crop yields come only after a reliable supply of new inputs is available to the farmers -- at the times they need them. At present, the uncertain availability of inputs is considered to be a major constraint to increased agricultural production. The GOB is now attempting to improve the supply of all inputs; when this has been achieved, the disposable income of farmers should again be reviewed to determine their ability to repay capital costs.

Development of sub-projects would provide enough increased disposable income to enable farmers to repay 100 percent of the capital costs by converting from dry-farming to irrigation. Because landholders are the primary beneficiaries, they should repay capital costs at some future time when their disposable income permits.

Development of selected sub-projects will significantly affect the economic well-being of people in the area. Several strata of the population will be benefited, but to different degrees. Owners of relatively large farms will receive the most benefits.

Landless laborers will indirectly benefit from sub-project development. They will have more opportunities to work thoroughout the year in the cultivation of the fields and in marketing related activities, and they will provide labor for the construction of facilities and for the operation and maintenance of structures.

Rural women will also indirectly benefit from the increase in agricultural production. Bangladeshi women are active in the processing of rice and jute, the main crops of the country. Because production of these crops will increase substantially in the sub-project areas, rural women will have more work opportunities.

It is important to remember that sub-projects designed for development were selected according to criteria that guarantee the selection of sub-projects located in the poorest areas of the country and sub-projects having a high percentage of small farms (less than 1 acre) and landless people. Therefore, although within each sub-project more benefits would accrue to the relatively large farms and although the overall income distribution would remain essentially the same, development of sub-projects will reduce the degree of absolute poverty within these areas.

Socio-Economic Impact (Chapter VI)

The likely socio-economic impacts associated with the development of irrigation works in a typical sub-project area were assessed.

Short-term and long-term impacts were identified, and differential impacts were discussed with reference to specific sub-groups within the larger recipient population (i.e. poorest farmers, landless laborers, and women).

The Consultant also prepared a socio-economic profile of a typical sub-project, including descriptions of the area, its demographic features, its social organization, and local economy.

The impact assessment indicates that sub-project development will cause very few changes in the area. Because sub-project development will increase demand for unskilled labor, there is a low likelihood that patron relations will weaken. Non-agricultural employment and the poor's need for this source of cash and subsistence is not expected to be directly affected by the development plans.

Because the socio-economic assessment shows the plan to be socially and economically sound, the Consultant recommends that the plan be implemented. However, to ensure the development's maximum benefits, certain negative effects should be mitigated. Moreover, to maintain derived benefits at a high level, planning efforts must include more than simply increasing the productive inputs to the land. The Consultant provides recommendations intended to guide the mitigation process and to direct the more extensive socio-economic planning effort.

I. Environmental Examination (Chapter VII)

An initial environmental examination was prepared according to USAID guidelines. Its purpose was to identify and assess any forseeable environmental impacts and to recommend any further evaluation that may be required. The report also provides an environmental data base, selection criteria, and a format to be used for future evaluation of irrigation schemes.

Due to time limitations, only eight sub-projects were evaluated. Sub-projects selected were those exhibiting multiple impacts as a result of construction and operational activities. Specifically, schemes having potential impacts upon fisheries, water quality, water use, land use, and public health were favored in the selection pro-

cess. After environmental evaluation of selected sub-projects, areas adversely affected by the proposed actions were identified.

The potential for significant adverse impacts on inland fisheries does exist with the operation of water control structures on some of the sub-projects. Due to lack of data concerning the impact of flood control and irrigation sub-projects on fisheries and the scarcity of knowledge concerning the fisheries and water quality in the sub-project areas, the Consultant recommends that an environmental assessment be prepared for one representative sub-project and that this sub-project be monitored during the construction and operational phases. Field information gathered in this manner will serve as a data base enabling engineers and planners to evaluate and incorporate mitigative measures, if required, during early sub-project planning.

J. Implementation Plan (Chapter VIII)

No government agency in Bangladesh is presently staffed with sufficiently experienced manpower or satisfactory equipment to execute the implementation of the 23 recommended sub-projects. The Consultant recommends that the 23 proposed sub-projects be implemented through RWP of MRD, assisted by an expatriate consulting company to ensure the competence of final design, construction supervision, and essential training programs. Field construction should be performed by local contractors.

The original concept of the project was to develop up to 30 sub-projects during the first year and an approximately equal number during the second and third years; however, local contractors' responses to a questionnaire clearly indicated that the proposed construction was beyond their capabilities. Therefore, the magnitude of construction was decreased to a level within their capabilities. The Consultant recommends that the 23 sub-projects be developed over a three-year period. Table S-6 shows the proposed schedule for sub-project development.

The implementation of the sub-projects recommended by the Consultant, the development of an organization that can undertake future selection, designs, and construction, and the development of the agricultural production of these projects constitute an immense undertaking for any selected agency. Therefore, a completely independent and self-functioning group, completely responsible for and devoted to the success of these sub-projects, must be recognized. This group must be composed of people who, collectively, have a considerably developed background in administration, design, construction, irrigation, and agriculture.

1. The Administration Group should shall consist of two well educated and highly motivated engineers, each with a broad background in administration and organization of new sub-projects and, preferably, with a good knowledge of irrigation and agriculture. Their most important function will be to establish good relations with the farmers and to be able to select qualified people for other groups. These people do not necessarily have to come from the agency involved but should be selected solely on their qualifications for their prospective positions.

2. The Selection & Design Group should begin with six design engineers selected by the administration. Their duty will be to select new sub-projects and implement their construction designs.

3. The Construction Group will also begin with six construction engineers selected by the administration for their capability for the supervision and inspection of the work of the contractors involved in the construction of the projects.

4. The Extension Service will consist of six agricultural extension service people who will take over the projects upon the construction's completion and who will be responsible for the agricultural implementation of the program. They must have a good background in irrigation and agriculture and be capable of

helping the farmers get started and fully utilize all the aspects of their new project.

Each group must have the necessary support personnel. The Administration Group must have office personnel, and the Selection & Design Group must have drafting personnel. The Construction Group must have the necessary help for transportation, as must the Extension Service people.

Each group will form a core that can be used for future expansion, depending on the development of the program. Each member of the groups should eventually be capable of developing a new member of the group in his category.

The consultant should be the developer and the teacher of the members of each group and should unite them into a functioning unit by developing a hands-on training program for all the members of the groups. Such a hands-on program with the maximum involvement of all the members is important to provide maximum motivation.

TABLE S-1

RECOMMENDED CRITERIA FOR RANKING OF SUB-PROJECTS

Criteria	Scale Points
1. Socio-economic Criteria:	
1.1 Probability of Proposed System Providing Substantial Benefits to Poorer Landowners, Tenants, and Landless Laborers;	22
1.2 Existence of or Statement of Intent to Create a Local Institution Capable of Effective Operation, Maintenance and Repair of Proposed Structures; and	12
1.3 Easily Solved Land-Acquisition Difficulties	12
2. Agricultural Criteria:	
2.1 Potential for Increased Agricultural Production; and	14
2.2 Availability of Agricultural Inputs	12
3. Technical Criteria:	
3.1 Likelihood of Effective Operation of System; and	12
3.2 Construction of Sub-Project	16
Maximum Rating	100

TABLE S-2

LIST OF SUB-PROJECTS SELECTED FOR DESIGN AND DEVELOPMENT BY MRD AND USAID

Sub-Project Number	District	Thana	Sub-Project Name
1	Chittagong	Patia	Re-excavation of Khan Mohana Khal
2	Chittagong	Hathazari	Nabajugh Tebhage Khamer DTW Pucca Drain
3	Chittagong	Satkania	Re-excavation of Faranga Sublong Khal
4	Chittagong	Hathazari	Pucca Sluice Gate on Bepula Chara
5	Dacca	Saturia	Pucca Drain for Kawanara Irrigation Project
6	Dacca	Savar	Rajghat DTW Pucca Drain
7	Dacca	Sreepur	Embankment of Saldah River
8	Dacca	Shivalaya	Aricha-Ichhamati Irrigation Project. Parts I, II, III, and IV.
9	Dacca	Palash	High Irrigation Pucca Drain
10	Khulna	Kalaroa	Construction of Sluice Gate over Sharaskati Khal
11	Khulna	Sadar	Extension of Kismat Pucca Drain to Railway Line
12	Khulna	Mollahat	Re-excavation of Chowdhury's Canal from Basuri to Nalua River

(continued)

TABLE S-2

(continued)

Sub-Project Number	District	Thana	Sub-Project Name
13	Khulna	Bagerhat	Reconstruction of Fatepur-Baitpur Embankment, Excavation of Khal and Construction of Two Sluice Gates
14	Khulna	Fakirhat	Sluice Gate at Parshikhali Khal
15	Khulna	Sarankhola	Re-excavation of Nalburia Dhanasagar Khal
16	Rajshahi	Atrai	Re-excavation of Canal from Beel Katchua to Beel Pankha under Hatkalupara U.P.
17	Rajshahi	Bagatipara	Low-Lift Pump Pucca Drain at Salinafar
18	Rajshahi	Nawabganj	Pucca Canal and Spans/Acqueduct in Milky Bidirpur
19	Rajshahi	Gomostapur	Sluice Gate at Pabdamari Dama
20	Rajshahi	Gurudaspur	Nawapara Multipurpose Society DTW Pucca Drain
21	Rangpur	Jaldhaka	Mouza Gobral DTW Pucca Drain
22	Rangpur	Kotwali	Uttam Deep Tube-Well Pucca Drain
23	Rangpur	Ulipur	Hatia Deep Tube-Well Pucca Drain
24	Rangpur	Gaibanda	Sluice Gate at Malibari U.P.
25	Rangpur	Badarganj	Patilvasar Nala Sluice Gate
26	Rangpur	Nageswari	Sluice Gate on Berubari Embankment at Nabulardara
27	Tangail	Basail	Construction of Dubail-Basail DTW Drain

(continued)

TABLE S-2

(continued)

Sub-Project Number	District	Thana	Sub-Project Name
28	Tangail	Tangail	Re-excavation of Godtala Mir Kumilli Khal
29	Tangail	Nagarpur	Construction of Lowhati North DTW Pucca Drain
30	Tangail	Pathrail	Construction of Sluice Gate at Deojan Kahl

TABLE S-3

SUMMARY OF COST ESTIMATES (FAR)

District	Thana	Sub-Project Number	1st Year (Tk)	2nd Year (Tk)	3rd Year (Tk)
Chittagong	Patia	1	731,000		
	Hathazari	2	1,202,000		
Dacca	Palash	9	1,438,000		
Khulna	Kalaroa	10	932,000		
Rajshahi	Bagatipara	17	1,219,000		
	Gurudaspur	20	996,000		
Rangpur	Kutwali	22	1,129,000		
	Badarganj	25	735,000		
		Total	8,382,000		
Dacca	Saturia	5		1,524,000	
Khulna	Bagerhat	13		2,069,000	
	Fakirhat	14		479,000	
Rajshahi	Gomostapur	19		2,479,000	
Rangpur	Jaldhaka	21		934,000	
	Gaibanda	24		520,000	
Tangail	Basail	27		1,117,000	
	Tangail	28		117,000	
		Total		9,239,000	
Dacca	Savar	6			967,000
Khulna	Sadar	11			748,000
	Sarankhola	15			1,633,000
Rangpur	Ulipur	23			1,144,000
	Nageswari	26			1,604,000
Tangail	Nagarpur	29			600,000
	Tangail	30			703,000
		Total			7,399,000

TABLE S-4

SUMMARY OF ECONOMIC EVALUATIONS

Sub-Project Number	B/C Ratios at 12%	B/C Ratios at 16%	B/C Ratios at 20%	Internal Rate of Return (Percents)
1	1.5	1.3	1.1	23.3
5	2.2	1.9	1.6	35.9
6	2.0	1.7	1.5	33.3
13	1.6	1.4	1.2	26.2
19	5.3	4.5	3.8	76.6
23	1.6	1.3	1.2	24.4
27	1.3	1.1	0.9	17.9

TABLE S-5

SUMMARY OF ANNUAL FINANCIAL RETURNS

Situation	Sub-Project Number 1 (tk/ac)	5 (tk/ac)	6 (tk/ac)	13 (tk/ac)	19 (tk/ac)	23 (tk/ac)	27 (tk/ac)
Present Situation							
Irrigated	3,702	2,943	4,500	-	-	2,891	4,184
Non-Irrigated	1,456	1,744	1,420	773	1,006	1,678	1,507
Future Without							
Irrigated	3,924	4,338	4,860	-	-	3,238	4,351
Non-Irrigated	1,543	1,918	1,533	812	1,006	1,890	1,567
Future With							
Irrigated	4,847	6,122	5,933	5,178	-	4,929	4,955
Non-Irrigated	2,206	-	-	1,309	1,460	-	-
Increment in Disposable Income							
Situation 1	923	1,784	1,073	-	-	1,691	604
Situation 2	3,304	4,204	4,400	4,366	-	3,039	3,388
Situation 3	663	-	-	497	454	-	-

TABLE S-6

SCHEDULE OF SUB-PROJECT IMPLEMENTATION

District	First Year Sub-Project Numbers	Second Year Sub-Project Numbers	Third Year Sub-Project Numbers
Chittagong	1		
	2		
Dacca	9	5	6
Khulna	10	13	11
Rajshahi	17	19	
	20		
Rangpur	22	21	23
	25	24	26
Tangail		27	29
		28	30