Government of the People's Republic of Bangladesh

Flood Plan Coordination Organisation,
Ministry of Irrigation, Water Development and Flood Control

BANGLADESH FLOOD ACTION PLAN

FAP 12
FCD/I AGRICULTURAL STUDY

RAPID RURAL APPRAISAL OF PROTAPPUR IRRIGATION PROJECT

September 1991

Hunting Technical Services Limited

in association with

Bangladesh Institute of Development Studies
Flood Hazard Research Centre
Hunting-Fishtech
Intoconsult International Limited

under assignment to
UNITED KINGDOM
OVERSEAS DEVELOPMENT ADMINISTRATION

Sanyu Consultants Inc.

under assignment to
JAPAN INTERNATIONAL COOPERATION AGENCY

The present report is one of a series being produced by Flood Action Plan components 12, the FCD/I Agricultural Study and 13, the Operation and Maintenance Study.

The full series is expected to comprise the following reports:

FAP 12

Inception Report (joint with FAP 13)
Methodology Report (2 Volumes)
Rapid Rural Appraisals Overview (2 Volumes)

Project Impact Evaluation studies of:

* Chalan Beel Polder D
* Kurigram South
* Meghna Dhonagoda Irrigation Project
* Zilkar Haor
* Kolabashukhali Project

Rapid Rural Appraisal Studies of:

Protappur Irrigation Project
* Nagor River Project
* Sonamukhi Bonmander Beel Drainage Project
Improvement of Sakunia Beel
* Silimpur-Karatia Bridge cum Regulators
* Khatakhali Khal
Halir Haor
* Kahua Muhuri Embankment
* Konapara Embankment
* Polder 17/2
* BRE Kamarjani Reach
* BRE Kazipur Reach

* Draft Final Report (2 Volumes)
* Final Report (2 Volumes)

FAP 13

Methodology Report
Appraisal of Operation and Maintenance in FCD/I Projects (2 volumes)
Draft Final Report (2 Volumes)
* Final Report

Note: * Report not yet available

Project Summary Sheet

Project Name	: Protappur Irrigation Project
Project Type	: Flood Control, Drainage & Monsoon Inundation Irrigation
Location	
FAP Region	: North-West
District	: Bogra
Area (ha.)	: 5,200 ha.(gross) 4,000 ha.(cultivable)
Funding Agency	: Government of Bangladesh
Implementing Agency	: BWDB
Construction started	: FY 1974/5
Scheduled Completion	: FY 1977/78
Actual Completion	: FY 1977/78
Original Cost Estimate	: Tk. 0.670 million
Final Cost Estimate	: Tk. 4.340 million
Major Flood Damage:	:
Repair/rehabiltation in	: 1990 to present

Major works still required for completion/rehabilitation:

Resectioning 2 km. of embankment.
Repair of 7 regulators and 1 culvert-cum-regulator.
Reexcavation of approx. 12 km. of main drainage channels.
Rehabilitation of Khalashi sheds.

RRA OF PROTAPPUR IRRIGATION PROJECT
SUMMARY OF FINDINGS

General Features of the Project

Protappur Irrigation Project is a small (4,000 ha. net area) FCDI (combined flood control, drainage and irrigation) project located near Bogra in the Barind Tract of north-west Bangladesh, a relatively elevated and free-draining area. The main water management problems of the area pre-Project were flash floods in the early monsoon from the Nagor River which forms one side of the Project area, and moisture deficit for the maturing Aman paddy crop in the post-monsoon period due to rapid drainage of monsoon rainfall.

The Project was implemented in the mid-1970s in response to demands from the local community, articulated through the Pally Mangal Samity, or village cooperative society. The Project works consisted of a flood control embankment to give protection from the flash floods, a series of regulators on the internal drainage channels intended to retain water at the end of the monsoon, and deepening of the channels themselves so as to more efficiently evacuate excess water during the monsoon. The regulators were intended to be a more durable replacement for an existing system of earth cross-dams erected annually by communal effort. This, together with the communal initiative for implementing the Project, means that the Project was more firmly rooted in the locally perceived needs of the community and farming system than is the case in many FCD/I projects.

The Project was completed in 1977/78 and is reported to have operated well for a few years, despite the existence of a number of planning, design and construction defects. Probably the most important of these relate to the regulator gates, which were ill-fitting and, at least initially, not provided with effective seals. However, little or no maintenance was undertaken, and by the time of the FAP 12/13 RRA fieldwork in 1991 most of the regulators were damaged to some extent and the internal channels were silted up; only the embankment was still functioning well. In addition, the BWDB khalashis appointed to operate the regulators had either absconded or been withdrawn, and de facto operation of the system was in the hands of locally influential individuals or small groups - a situation less likely in the pre-Project period when water management involved joint action by scores or hundreds of beneficiaries.

Overall Findings on Project Performance

The original concept of the Project appears to have been sound, in relation to the water management systems generally in use in Bangladesh at the time it was built. The Project was expected to facilitate replacement of Local Transplanted Aman by HYV Aman and thereby to increase paddy production. This objective has been fulfilled to a greater extent than than originally anticipated, output having increased by 58 per cent compared to 40 per cent envisaged during planning. A provisional recalculation of economic benefits indicates an EIRR of 54.3 per cent, NPV of Tk. 86.7 million (in 1991 Taka) and BCR of 9.5 (both the latter at a discount rate of 12 per cent); planning estimates were of an EIRR of 28.4 per cent and BCR of 3.04.

The Project appears to have been largely free of the disbenefits often associated with FCD/I projects. In particular, there has been little or no adverse impact on capture fisheries, though this is largely due to the small development of such fisheries in this area or relatively high land. Linkages with culture fisheries have been positive, with reinvestment of profits from

HYV paddy in pond construction. Intensification of the cropping system has put livestock feed sources under additional pressure, at the same time that draught power requirements have increased, and a switch to power tillers has started. Employment and wage rates in agriculture and agro-industries have increased, including additional employment opportunities for women. Women of low-income groups have also benefited directly from employment for maintenance work on the embankment; this benefit would have been larger had the Project works been better maintained. Calorie nutrition has improved with increased foodgrain output. Environmental impact has been slight, since the area was already intensively cultivated pre-Project, but the effects of high use of fertiliser and chemicals need to be monitored.

Although the Project has been highly successful in increasing output, it is very doubtful that it should be replicated in its existing form. This is because the tubewell irrigation revolution, which was only starting in Bangladesh when the Project was built, has made available an alternative approach to supplementary post-monsoon irrigation. Use of tubewells for this purpose would probably be more cost-effective than single-use structures such as the regulators, since tubewells are already very widely used in the area for dry-season irrigation. A tubewell system would also probably be more flexible than regulators, due to the smaller area commanded per unit, and would offer less scope for monopolisation of operation by a cabal of the local elite. However, notwithstanding the obsolescence of the Project concept, the Project provides a clear indication of the value of project interventions firmly based on local demand and existing local practice.

Engineering, Operation and Maintenance

The regulators, especially those in the low lying areas, have been successful in preventing over-drainage of those areas, but their effectiveness has been reduced by inadequate maintenance. The size of channels is not well adjusted to the flows of water they must carry or retain for irrigation purposes, and uncontrolled operation of regulators has been adversely affecting both irrigation and drainage since a few years after completion of the Project. Retention of monsoon water and prevention of over drainage are likely to have contributed significantly to groundwater recharge.

The embankment has improved communication on the south-western side of the Project area and most of the regulators have contributed to improvement of internal road communication.

Institutions

The Project was initiated on public demand, articulated through the agricultural cooperative societies, but the mismanagement and disrepair of the regulators have caused public apathy towards the Project. There was public involvement in the operation of several of the regulators in the early years of the Project, but later influential people assumed control of the regulators to their own advantage. There are signs of social conflict due to this conversion of public into private property by a few wealthy persons.

Many of the regulators have become non-functional due to enforced or voluntary absenteeism by the khalashis (operators) who have not been effectively supervised and supported by BWDB.

There is no effective liaison between BWDB and the Upazila Parishad for operation of the Project.

Agriculture

The verifiable agricultural impact of the Project is confined to the monsoon season and is overshadowed by the growth of dry season cropping with tubewell irrigation. This raises important issues of agricultural development strategy. However, it is possible that the Project has made some contribution to dry season development by improving groundwater recharge.

Crop security has improved due to the embankment, which is successful in preventing flash floods from the Nagar River, but there is still a problem of rainwater congestion which causes crop damage in the lowest areas, due to defects in the design, maintenance and operation of the regulators.

Retention of water by the regulators has assisted the move from local T.Aman to HYV T.Aman, with consequent increase in yield.

The tubewell system provides a possible alternative source of supplementary irrigation in the monsoon season which is more flexible, more responsive, and is paid for by the beneficiaries. However, the implications for groundwater depletion of substituting tubewell water for retained water require investigation.

Livestock

The livestock population appears to have increased since the construction of the Project, probably in part due to increased availability of paddy straw. However, the food value of the extra straw is partly offset by the lower palatability of HYV straw.

Fisheries

The Project has helped to create the economic climate for fishery development, by increasing disposable income both for fishery investment and fish consumption, though on timing grounds, it is unlikely that the recent growth of pond fish culture in the Project area is directly related to Project impact. Fish ponds remain at risk from overtopping by rainwater floods in the lower areas of the Project.

Environment

The Project effect in increasing the area of HYVs may be leading to fertiliser and pesticide residues in surface water, especially in the lower part of the Project, which may have an adverse effect on fisheries and may lead to pesticides entering the human food chain. Project impact on groundwater recharge may have prevented falls in groundwater level detrimental to shallow drinking water tubewells. This is a benefit in itself and is also likely to have reduced incidence of diarrhoeal diseases.

Women

The Project has increased wage employment for women as agricultural workers, in paddy processing and in embankment maintenance. Despite the extra female employment, the differential between female and male wages has not narrowed. Better communications facilitated by Project structures have increased female access to education, family planning and other facilities.

Nutrition

There is no food grain scarcity, and the position of the Project area as a net surplus region for foodgrains has been strengthened by the Project. The beneficial linkage between Project agricultural impact and fishery investment may in time reverse the present declining trend in per capita protein consumption.

Economics

The Project has surpassed its economic objectives and would be assessed as viable even if only a small fraction of estimated agricultural benefits were attributable to it.

The Project has raised farm incomes by assisting the move from local T.Aman to HYV T.Aman, but the effect could probably have been achieved without the Project by use of tubewells for supplementary monsoon season irrigation. There has been a small increase in real wages for farm labour, due partly to the Project's effect on introduction of HYV Aman.

The Project has generated an increase in employment for crop production, paddy processing, transportation, input supply and manufacture/repair of farm equipment.

CONTENTS

TABLES

FIGURES

ANNEXES

ABBREVIATIONS AND GLOSSARY

ADB	Asian Development Bank
Aman	Main monsoon season paddy crop
Aus	Late dry season/early monsoon paddy crop
BADC	Bangladesh Agricultural Development Corporation
Boro	Winter (dry) season paddy crop
BRAC	Bangladesh Rural Advancement Committee
BRDB	Bangladesh Rural Development Board
BRE	Brahmaputra Right Embankment
bund	Earthen embankment
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere
CE	Chief Engineer
CEP	Coastal Embankment Project
CFE	Cash Foreign Exchange Budget
CIDA	Canadian International Development Agency
CIP	Chandpur Irrigation Project
crore	Ten million (10,000,000)
CTA	Chief Technical Adviser
DAE	Department of Agricultural Extension
DB	Development Budget
DDP	Delta Development Project
DOF	Department of Fisheries
DTW	Deep tube-well (with positive-displacement pump)
EC	European Economic Community
EIP	Early Implementation Project(s)
EPWAPDA	East Pakistan Water & Power Development Authority (see WAPDA)
ERD	External Resources Division
ESCAP	Economic and Social Commission for Asia and the Pacific
FAO	Food and Agriculture Organisation
FAP	Bangladesh Flood Action Plan
FCD	Flood Control and Drainage
FCDI	Flood Control Drainage and Irrigation
FCD/I	FCD (see above) with or without Irrigation
FFW	Food For Work
FHRC	The Flood Hazard Research Centre, Middlesex Polytechnic
FPCO	Flood Plan Coordination Organisation
FY	Financial Year
gher	Bunded area of saline water for shrimp cultivation
ghog	Animal burrow in embankment
GK	Ganges-Kobadak Irrigation Project
GOB	Government of Bangladesh
GON	Government of the Netherlands
gram	Locally recognised smallest settlement unit; 1 or more per mouza (q.v)
HTS	Hunting Technical Services Limited

HYV	High yielding variety
IBRD	International Bank for Reconstruction and Development (World Bank)
IDA	International Development Agency (World Bank)
IDP	Infrastructure Development Programme (LGEB)
IETC	Irrigation Extension Training Centre (BWDB)
ILO	Intermediary Level Organisation (of SRP Water Managment System)
IOM	Improved Operation and Maintenance
IRWP	Intensive Rural Works Programme
ISP	Institutional Suport Programme (LGEB)
JICA	Japan International Cooperation Agency
KBK	Kolabashukhali Project
KIP	Karnaphuli Irrigation Project
khal	Natural channel/minor river/tidal creek
khalashi	'Cleaner' (actually guard) of regulator/sluice
kutcha	Locally made, not manufactured; earthen (of roads, structures)
lakh	Hundred thousand (100,000)
LCS	Landless Contracting Society
LGEB	Local Government Engineering Bureau
LLP	Low Lift Pump (suction type for irrigation from open water bodies)
LPC	Local Project Commitee
LRP	Land Reclamation Project
maund (md.)	37.3 kg.
MDIP	Meghna-Dhonagoda Irrigation Project
MEU	Mechanical Engineering Unit (BWDB)
MIP	Muhuri Irrigation Project
MIWDFC	Ministry of Irrigation, Water Development and Flood Control
MOF	Ministry of Finance
MOI	Ministry of Irrigation (see MIWDFC)
mouza (mauza)	Revenue village (may comprise several physical settlements)
mt.	metric tonne (1,000 kg., 2,204 lb.)
MPO	Master Plan Organisation
NGO	Non-governmental Organisation
O&M	Operation & Maintenance
O&MCC	Operation & Maintenance Cost Cell (CIDA/BWDB)
ODA	United Kingdom Overseas Development Administration
OFD	On Farm Development
Parishad	Elected council (e.g. of Upazila or Union)
PC	Planning Commission
PEP	Production Employment Programme (of BRDB, q.v.)
PMU	Project Management Unit (BWDB)
PP	Project Proforma
PWD	Public Works Datum
RESP	Rural Employment Sector Programme
RHD	Roads and Highways Department
RMP	Rural Maintenance Programme (CARE)
RRA	Rapid Rural Appraisal

SDE	Sub-Divisional Engineer (BWDB)
SE	Superintending Engineer (BWDB)
seer	Unit of weight, approx. 2 lb. or 0.91 kg.
SO	Section Officer (BWDB)
SRP	System Rehabilitation Project
SSDFCP	Small Scale Drainage and Flood Control Project
SSSFCDIP	Second Small Scale Flood Control Drainage and Irrigation Project
STW	Shallow tube-well (with suction pump)
ToR	Terms of Reference
TWUA	Tertiary Water Users Association
UDEP	Upazila Drainage and Embankment Plan
Union	Administrative level below Upazila (q.v.), typically 10 per Upazila
UNO	Upazila Nirbahi Officer (principal staff officer of Upazila Parishad)
Upazila	Administrative unit above Union & below Zila (460 Upazilas in Bangladesh)
USAID	US Agency for International Development
WAPDA	Water & Power Development Authority (precursor of BWDB)
WFP	World Food Programme
XEN	Executive Engineer (BWDB)

1. INTRODUCTION

1.1 THE FAP 12 STUDY

The FAP 12 Study is one of the 26 numbered component studies of the Bangladesh National Flood Action Plan, and is jointly supported by the United Kingdom Overseas Development Administration (ODA) and the Japan International Cooperation Agency (JICA). It is being carried out by a group of international and Bangladeshi consulting organisations led by Hunting Technical Services Limited of the United Kingdom and comprising Sanyu Consultants Inc. of Japan, the Bangladesh Institute of Development Studies (BIDS), the Flood Hazard Research Centre of Middlesex Polytechnic, UK, Hunting Fishtech of UK, and Technoconsult International Limited of Bangladesh.

The objective of FAP 12 is to conduct post-evaluations of a total of 17 projects representative, in type and location, of the FCDI projects so far executed in Bangladesh (see Figure 1.1). The results of these evaluations will be passed to other FAP components for guidance in developing strategies for improved flood control and management for the future.

Of the 17 projects for study, 5 will be assessed mainly by Project Impact Evaluation (PIE) methods, using a formal questionnaire approach and probability sampling. The remainder will be assessed by Rapid Rural Appraisal (RRA) techniques, and RRA is also being used for preliminary reconnaissance of the 5 PIE projects. The present report describes the findings of the RRA of Protappur Irrigation Project in Bogra District.

1.2 RAPID RURAL APPRAISAL

RRA is a technique of project assessment intended to produce results more quickly than formal interview surveys, while avoiding biases in the data collected. RRA consists of selective direct observation and interviews of informed respondents from representative areas of the project by a small team of well-qualified and experienced specialists who can reach informed judgements quickly in the field. Maximum use is made of documentary sources to minimise the amount of data which have to be collected by interview and to obtain guidance on the location and content of interviews.

In well-conducted RRAs great care is taken to avoid both locational biases (for example, observing/interviewing only in easily accessible areas) and socio-economic biases (for example, omitting coverage of women, landless people, and other groups which it is difficult to identify, locate or obtain access to).

By its nature RRA is better at obtaining qualitative data than quantitative data, though it is generally possible to obtain fairly good quantified data on key agricultural parameters for the selected locations. What RRA cannot do (in contrast to PIE methods using probability sampling) is provide statistical validation of how far observations can be generalised over the project area, or of differences between areas and time-periods. Its findings must therefore always be interpreted as informed judgements, not as precise statements with known margins of error.

1.3 PROJECT DESCRIPTION

The Protappur Irrigation Project is a combined flood control, drainage and irrigation (FCDI) project covering a gross area of 9,200 ha. in Kahalu Upazila, some 16 km. west of Bogra in Bogra District (see Figure 1.1). The construction of the project commenced in Financial Year 1974-75 and was completed in Financial Year 1977-78, at a cost of Tk. 4.34 million (current Taka at time of construction).

The Project area is part of the Barind tract of north-west Bangladesh, a zone of relatively high ground (14.6 m. to 17.4 m. PWD datum in the Project area) with well defined slopes which cause rainwater to drain fairly quickly to the rivers. The climate is relatively dry, with an average of just over 1500 mm. of rain per year, but there is abundant easily accessible fresh groundwater.

The Project is bounded on the west by the Nagor River, on the south by the Bogra-Santahar railway line, and on the north by a road-cum-flood embankment paralleling the upper course of the Nagor River (see Figure 1.2). The eastern boundary is indefinite, the boundary shown on Figure 1.2 being the limit of the area estimated as benefited at the time of construction.

The main problems the Project was intended to correct were:

- flash floods resulting from heavy rainfall in the upper catchment of the Nagor River; and
- water shortages for the Aman crop, especially at the end of the monsoon in September-October, which were caused by the combination of dry spells and rapid run-off.

Prior to the Project, there was no protection against flash floods, but local farmers had attempted to improve the security of the late monsoon crop water supply by building earth cross-dams in the drainage channels. The dams are stated by Project documents to have been prone to failure, but the concept of water retention was clearly already established in the area, and indeed the construction of the Project is stated to have been due to pressure by local cooperative groups.

Under the Project, a flood protection embankment some 10 km. long was constructed along the east bank of the Nagor River from opposite Dubchanchia southwards as far as the railway line, and then parallel to the railway along the south side of the Project area as far as Panchpir station. Within the Project area, a series of regulators with movable gates was constructed on the drainage channels to retain water in place of the previous cross dams, and regulators were also constructed at the outfalls of the channels into the Nagor River (Figure 1.2). The channels themselves were deepened with the intention of discharging excess water more efficiently.

By the mid-1980s many of the structures were in disrepair due to poor planning and design, improper operation and lack of maintenance. A Feasibility Study for the rehabilitation of the Project under the System Rehabilitation Project was undertaken by Engineering and Planning Consultants Limited (EPCL) in association with Harza Engineering International and Sir M. MacDonald and Partners in 1988, and their report (EPCL(1988)) was extensively consulted during the present study. Work on the rehabilitation commenced in

Bangladesh Financial Year 1990-91 but when visited for the present study the Project was essentially still in its pre-rehabilitation condition.

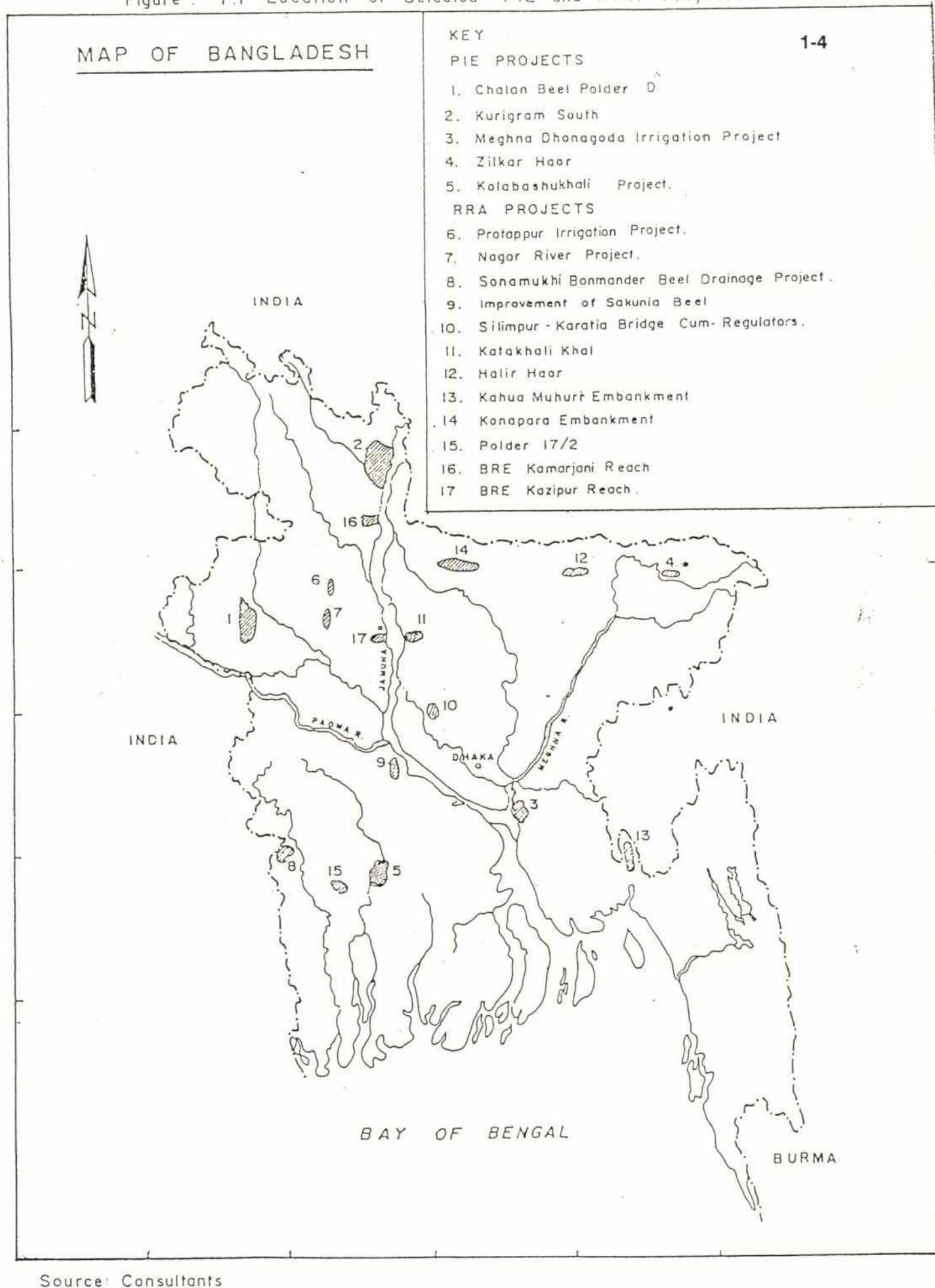
1.4 THE RAPID RURAL APPRAISAL

Protappur Project was selected for study after a process of choice in which FPCO, the Panel of Experts and the North-West Regional Study (FAP 2) were consulted. It was chosen as a representative of a class of integrated flood control, irrigation and drainage projects which could yield lessons for similar developments elsewhere under the Flood Action Plan.

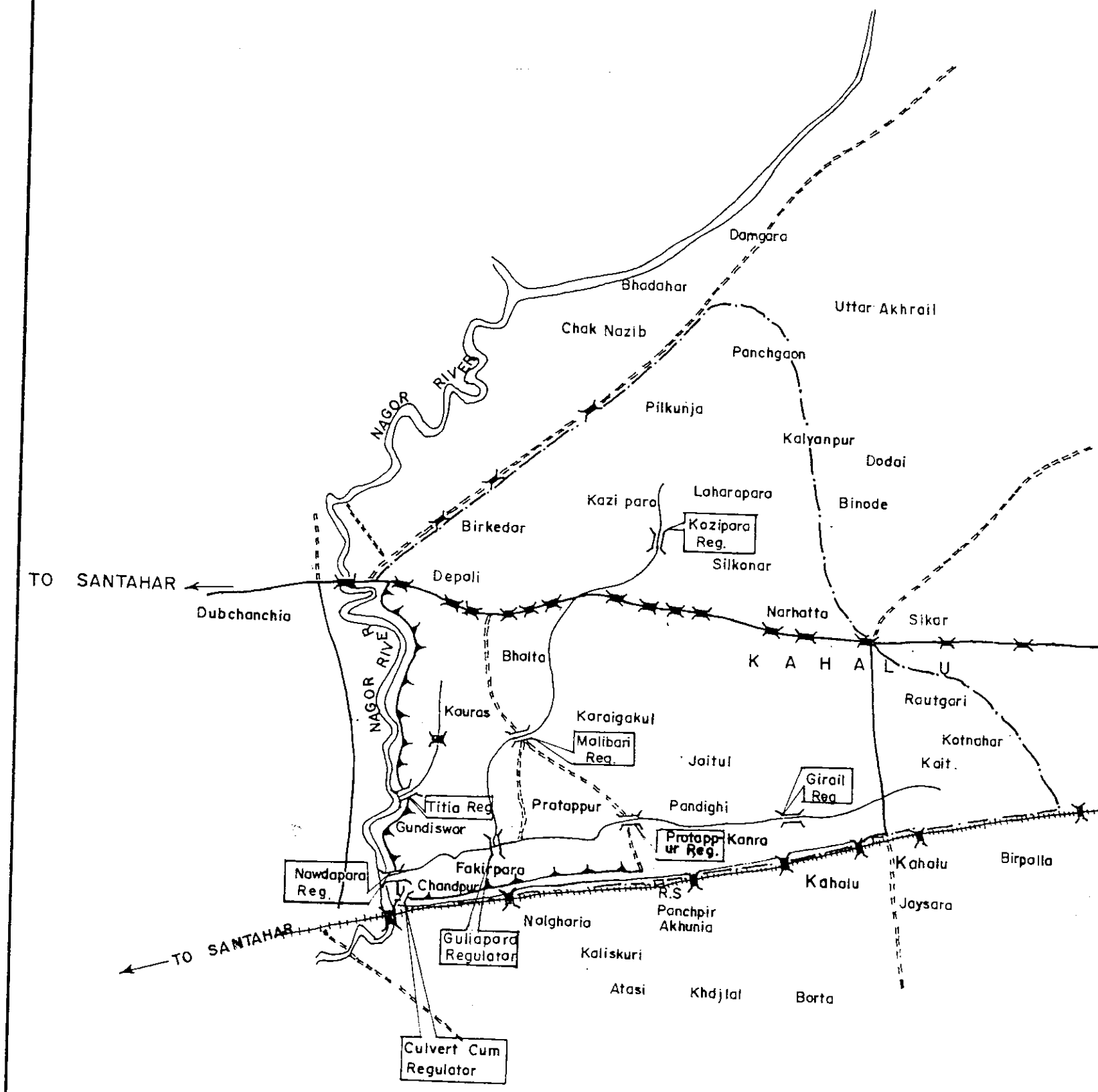
The Rapid Rural Appraisal, comprising preparation, fieldwork and reporting phases, was conducted between 19 June and 7 July 1991, a total of one week being spent in the project area. The RRA team consisted of two agricultural economists (one of whom was Team Leader), a female researcher specialising in women's issues and nutrition, a rural institutions specialist and a civil engineer. A fisheries specialist and an environmentalist spent part of the fieldwork week with the team. Agriculture, livestock and nutrition issues were covered by team members in addition to their own specialisations.

During the RRA the team interviewed numerous officials and private individuals in Bogra, the Upazila township of Kahalu and the Project area. They received cooperation and a cordial welcome from all concerned, but their especial thanks are due to the Superintending Engineer, BWDB Bogra and the Upazila Nirbahi Officer, Kahalu, and the officials working under their respective leadership. The warmest thanks are also due to the Director and staff of the Rural Development Academy, Bogra, for their hospitality to the team.

Figure : 1.1 Location of Selected PIE and RRA Projects



Source: Consultants



LEGEND:-

- Remaining Project Boundory...
- Embankment ...
- River / Khal ...
- Pucca Road ...
- Railway ...
- Bridge / Culvert ...
- Regulator ...
- Earth Road ...

Scale : 1 : 50,000

0 1 2 3 4 Miles

0 1 2 3 4 5 Km

PROTAPPUR IRRIGATION PROJECT, BOGRA.

2. ENGINEERING DESIGN, IMPLEMENTATION AND PERFORMANCE

2.1 PRE-PROJECT SITUATION

The Protappur Irrigation Project is situated in an area of almost flat land having a gradual down slope from the north-eastern side towards the south-western side. The highest elevation is 17.4 m. (57 ft.) PWD in the north-east, near Panchgaon, and the lowest is 14.6 m. (48 ft.) PWD in the south-west near the railway bridge across the Nagor River.

In the pre-Project period there existed three main natural drainage channels. One channel, known as the 'Kahalu Khari', is about 12.5 km. (7.8 miles) long from Kait to Nawdapara via Protappur. A second is about 8.1 km. (5.07 miles) long from Kazipara to Guliapara, where it joins the Kahalu Khari. The third is about 2.28 km. (1.43 miles) long from Kauras to Titia (see Figure 1.2). All of these channels slope towards the south-west corner of the Project area where they finally meet the Nagor River.

During the pre-monsoon period most areas of the Project were flooded by flash floods from the Nagor River. The highest level of this flooding was 16.7 m. (54.77 feet) PWD which caused overflow of water along the left bank of the Nagor River into the south-western part of the Project. The channels mentioned above distributed the flash flood water into most of the medium to low lying areas of the Project. On the other hand the same channels were carrying monsoon water from the high and medium high lands and flooded the low lying areas. Under both circumstances the field crops were adversely affected.

During the late monsoon period the water level in the Nagor River was low which together with the slope of the Project area towards the River caused rapid drainage of monsoon water from the Project area. Consequently there was scarcity of water for irrigation during the postmonsoon period. The local people used to provide temporary dams across the channels to retain water for irrigation. Wells were the only alternative source of irrigation at that time.

2.2 PROJECT OBJECTIVES

The Project Proforma (BWDB 1976) specifies the physical works to be undertaken (7 regulators, 2 pipe sluices and the embankment-cum-road) but is vague regarding the specific benefits expected to flow from these works. The expected impact of the Project is stated to be

"... to check ingress of flood water and to check over drainage of the area through the khals."

BWDB (1976), p.3

No firm details are given of the area to be benefited, though the PP mentions 'public demand' for protection of a gross area of 20.2 square miles (51.7 sq.km.); this is consistent with the assumption in the PP economic justification of a cultivated area of 10,300 acres (41.2 sq.km.). No details are given of the frequency or magnitude of either flood damage or post monsoon drought.

2.3 OVERVIEW OF THE PROJECT

Construction of the Protappur Irrigation Project started in 1974 and was completed in 1978. The infrastructure constructed during this period was as follows:

a) Flood Embankment	- 10 km
b) Regulator	- 7 nos.
c) Culvert-cum-regulator	- 1 no.
d) Khalashi shed	- 5 nos.

2.3.1 Flood Embankment

The flood embankment was constructed along the left bank of the Nagor River in order to prevent submergence of the low lying areas of the Project by premonsoon flash floods. This flood embankment was extended, nearly parallel to the Bogra-Santahar railway line, up to Protappur to prevent flash flood water intrusion inside the Project area from the channel, created by the railway borrow pits, which extends along the south side of the Project boundary.

The flood embankment was constructed with a crest width of 10 feet, side slope of 1:2 on both sides and variable bottom width in conformity with the variable design crest level. It has been functioning well in preventing inundation of the low lying areas of the Project since its completion. The crest width of the embankment has been reduced in many places due to soil erosion on one or both sides and the crest levels have been reduced in many places due to the same reason. In some places embankment sections have been badly damaged, and some of these may fail in the near future.

2.3.2 Regulators

As indicated earlier seven regulators and one culvert-cum-regulator were constructed to prevent overdrainage and to retain monsoon water for irrigation in the postmonsoon period. The regulators were located at reasonably good sites across the drainage channels from both technical and functional points of view. These regulators functioned well for a few years after their construction, so long as the khalashis operated them.

With the exception of the culvert-cum-regulator at the extreme south-western corner of the Project, the basic structural components of the regulators are in good condition, except for the whole gate system including the seat beams, plastering on the brick masonry works and brick pitching works on the upstream and downstream sides of each regulator.

a) Regulator R-1

This regulator is located across the main outfall channel of the Kahalu Khari at Nawdapara and opens into the Nagor River. This outfall regulator has 4 vents each 5 feet by 5 feet in size. A total of eight vertical lift gates, 4 on the river side and 4 on the country side, were provided in this regulator. Some of the screws connecting the gates with the vertical lift rods have been damaged, and the operating wheels are not functioning well. There remain big gaps between the gate ends and the grooves provided at both ends of the vents. After completion of the Project the Mechanical Equipment Unit of the BWDB has provided rubber seals on the country side gates.

b) Regulator R-2

This regulator is located at Guliapara and a little downstream from the meeting point of the channel from Kazipara to the Kahalu Khari. It has 3 vents each 5 feet by 5 feet in size. It was constructed just south of the original channel, which was closed by the north side approach to the regulator. The seat beam which had been provided for supporting the gates collapsed in 1990; hence, all three gates were closed and it created water congestion in the adjacent area. In order to ameliorate this situation the local people have removed the north side approach to the regulator to make the original channel active.

c) Regulator R-3

This regulator is located across the Kahalu Khari at Protappur. It has 2 vents each 5 feet by 5 feet in size. The screws connecting the gates with the vertical lift rods have been severely damaged. The seat beam that has been supporting the gate system has been displaced from its normal position, and this has been creating some problems for gate operation. The gate ends were not well adjusted with the grooves at both ends of the vents. Since completion of the Project, the MEU of the BWDB has provided rubber seals to the gates.

d) Regulators R-4 and R-6

Regulators R-4 and R-6 are located at Girail and Kazipara respectively. Both regulators have single vents 5 feet by 5 feet in size. In both the regulators the screws connecting the gates with the vertical lift rods are in bad condition. Rubber seals were not provided at either regulator. In regulator R-6 the joint between the seat beam and brick masonry has cracked. The road on both sides of this regulator is of low height which causes overtopping of water when the gate is closed.

e) Regulator R-5

This regulator is located at Malibari. It has two vents each 5 feet by 5 feet in size. One gate of this regulator remains permanently closed as the operating gear was stolen by the local people. The other gate is functional, but one of the two screws connecting the gate with the vertical lift rod was damaged and the other one is in bad condition. The gate ends were not well adjusted with the grooves at both ends of the vents. The local people have closed this gate and sealed its ends with clayey soil to provide water to the nearby agricultural lands.

f) Regulator R-7

This regulator is located at Titia. It has 1 vent of size 5 feet by 5 feet. It is an outfall regulator constructed on the embankment and across the channel from Kauras to Titia. The joint between the seat beam and brick masonry has cracked. The gate ends were not well adjusted with the end grooves on the both sides of the vent. Hence, continuous water leakage is a chronic problem of this regulator.

2.3.3 Culvert-cum-regulator

This structure is located at the south-west corner of the Project area and on the embankment. It has 1 vent of size 3 feet by 3.5 feet and has only fall board provision for closing the opening. The apron, curtain wall and wing walls of this structure on the outlet side

have been very severely damaged due to scouring caused by the high velocity of water through the culvert. The local people have closed the inlet opening by a small ring bund (earth dam) to retain water for irrigation.

2.3.4 Khalashi Sheds

Five khalashi sheds were constructed at regulator sites R-1, R-3, R-4, R-5 and R-7 for operation of all the seven regulators by five khalashis. Only the khalashi shed at R-1 regulator site is habitable, but no khalashi is residing there. The other four khalashi sheds have been damaged in various ways: walls and floors have cracked, and the doors and windows were either damaged or stolen by the local people. As a result the khalashis do not reside in the sheds.

2.4 ACHIEVEMENTS OF THE PROJECT

2.4.1 Positive Aspects

The flood embankment along the left bank of the Nagor River and along the railway borrow pit on the south side of the Project area has eliminated submergence of the arable lands caused by premonsoon flash flooding from the Nagor River. It has also assisted in retaining monsoon water surface runoff for irrigation in the postmonsoon period.

The regulators, especially those constructed in the low lying areas, have been successful in preventing overdrainage of monsoon water. These regulators also functioned well in retaining monsoon water for irrigation so long as the khalashis operated the gates and the gate system were in satisfactory condition.

Prevention of overdrainage and retention of monsoon water for postmonsoon irrigation may have contributed to ground water recharge of the Project area. This may have facilitated tube well irrigation, and may have reduced adverse effects on the hand tube wells which are used to provide drinking water.

The flood embankment has improved road transportation facilities on the south-western side of the Project area and most of the regulators have contributed substantially to maintaining continuity of some internal roads.

2.4.2 Negative Aspects

The flood embankment has been seriously damaged after serving its intended purposes for more than 12 years. Some embankment sections have been badly damaged and the local people have constructed houses and shops on one or both sides of the embankment. In particular, a pucca mosque is being built covering at least half of the crest width of the embankment at a location between regulators R-1 and R-7 (between Nawdapara and Titia).

Although the objective of the regulators was to prevent overdrainage and to retain monsoon water for irrigation, the regulator gates were not made water tight during implementation of the Project which resulted in water leakage around the gates. This water leakage problem became more critical when the khalashis left the regulator sites and the local people operated the gates incorrectly. A few years after construction of the regulators the Mechanical Equipment Unit of the BWDB provided rubber seals to some regulators, but those

were not effective because there existed big gaps between the gate ends and the vent grooves, and also there were steel plates placed on the rubber seals which provided steel to steel rather than rubber to steel sliding contact surfaces.

After the regulator khalashis had left the regulator sites, the regulators were under uncontrolled operation. This, together with partially or totally damaged brick pitching, has affected the proper functioning of the regulators, with subsequent adverse effects on both irrigation and drainage. In particular, the culvert-cum regulator at the south-west corner appears to have been used to pass far greater flows than it was designed for, with consequent very severe damage by scouring.

The size of the channels was not well adjusted to the actual quantity of water they are required to carry or retain for irrigation purposes. The inadequate discharge/storage capacity of the channels, which has been further reduced by siltation, has seriously affected the objective of retaining water for postmonsoon irrigation. This problem is more critical near the upstream sides of the regulators where water levels become very high and damage the crops on nearby lands.

There has been no maintenance of the Project since its completion. This resulted in deterioration of the earthwork of the embankment, siltation of the channels and malfunction or inoperability of the regulators within a few years after completion.

2.5 CONCLUSIONS

The design and implementation of the Protappur Irrigation Project was in general adequate to secure its intended objectives of protection against flash floods and retention of water in the post monsoon period. At the time the Project was conceived, alternative irrigation techniques such as tubewells were not widespread in Bangladesh and the approach to post monsoon water supply using regulators was in those circumstances a realistic one. It also closely followed the concept of the pre-existing temporary works constructed by the local community and was thus in line with local needs and practices.

There were however some significant shortcomings in detailed implementation, especially the failure to provide watertight seals for the regulators at the time of construction, the inadequate anchoring of the regulator seat beams and the inadequate capacity of the culvert-cum-regulator. The adverse effects of these shortcomings have been exacerbated by the almost total absence of maintenance work on the embankment, regulators, khalashi sheds and drainage channels. The crest width, crest height and side slopes of the embankment have been eroded in many places. The local people have made houses, a mosque and shops on the sides of the embankment, which may affect its stability and durability.

The regulators functioned well for about 3-4 years but thereafter have been malfunctioning due to lack of proper maintenance and operation. No rubber seals were provided during implementation to make the gates watertight. Although rubber seals were subsequently provided to some regulators, these were not effective. The grooves provided to guide the gate movement were not well adjusted to the size of the gate, and this has caused continuous water leakage around the gate.

The gate system supporting beams (seat beams) were simply cast on the brick masonry work without any effective anchorage to the bulk masonry works. As a result, these

beams have become displaced. For example, in regulator R-3 this beam has been significantly displaced and in regulator R-2 the beam has collapsed.

The brick pitching on the upstream and downstream sides of the regulators was damaged within a few years of Project completion and was not maintained or repaired until 1990-91. The brick pitching carried out in 1990-91 on some regulators through the System Rehabilitation Project seems to be unstable because the bricks are not mortared into place, and some bricks have already been displaced.

The culvert-cum-regulator constructed at the south-west corner of the embankment seems to be inadequate in capacity because the outlet side structural components of the culvert have been severely damaged and the structure can no longer alleviate drainage conditions in that part of the Project area.

All the khalashi sheds except one at regulator R-1 have been damaged, partly due to poor construction and/or lack of maintenance, and partly by the local people. Some members of the local elite indirectly forced the khalashis to leave the regulator sites and asserted their own control over the regulators.

The drainage channels were not well adjusted in capacity to carry or to retain monsoon water and the problem has been further aggravated by siltation of the channel beds. If the regulators are closed the nearby areas are flooded due to the inadequate capacity of the channels. For example, if the gates of regulator R-1 are closed a large area of agricultural land along with the nearby villages is flooded.

Although some portions of the Kahalu Khari have been re-excavated under the SRP, the programme seems to be inadequate in relation to the need. In general the work undertaken amounts to little more than maintenance of the channel side slopes, without resectioning the channel to restore its capacity.

After implementation of the Project many deep and shallow tubewells were installed for irrigation purposes. This was possible due to improved availability of tubewells at the National level, rather than to any direct impact of the Project. However, the Project may have given some indirect support to these alternative irrigation facilities through ground water recharge.

In summary, the Protappur Irrigation Project could fully realize its desired objectives if all infrastructures were maintained properly, and if the regulator gates could be made watertight and could be operated systematically.

2.6 RECOMMENDATIONS FOR FUTURE FCD/I PROJECTS

a) whenever regulators are intended to retain water for irrigation purposes the gates should be as watertight as possible;

b) the required irrigation or drainage channel capacity should be determined accurately and channels should be constructed to, and maintained at, the designed capacity;

c) where applicable, the possibility for use of fixed weirs or spillways for water regulation should be explored as an alternative to regulators with movable gates, since fixed structures are cheaper, more durable and less susceptible to incorrect operation;

d) development and implementation of the Operation and Maintenance system should be a prerequisite for all FCD/I projects.

3. INSTITUTIONAL ASPECTS

3.1 PRE-PROJECT INSTITUTIONS FUNCTIONING IN THE AREA

According to the Project Proforma (PP) (BWDB 1976), the Protappur Irrigation Project had its origin in a request by the Secretary of the Pally Mangal Samity to the Executive Engineer, WAPDA, Rajshahi Division. The Pally Mangal Samities (Village Welfare Societies) were the fore-runners of the present day cooperative societies. The Pally Mangal Samities depended on voluntary labour and musti vikha (rice savings from cooking pot) as their capital for undertaking social welfare activities in the rural areas. Before the Project was constructed, the village people used to build cross dams in different parts of the natural drainage channels for storing water to overcome the moisture loss due to over drainage in the post monsoon period in the area, and it is quite possible that the Pally Mangal Samity was already involved in coordinating this work.

Having had the experience of water management, and because of limitation of resources, the Samity submitted a petition to the then Water and Power Development Authority (WAPDA) to undertake such a project in the area. After receiving the request from the Pally Mangal Samity, WAPDA made a departmental feasibility study and found the request reasonable. Accordingly, a scheme was prepared and processed through various stages of WAPDA and finally the scheme was approved after the birth of Bangladesh in 1971. Actual work on the scheme started in 1974 and was completed in 1978.

3.2 POST-PROJECT INSTITUTIONS

3.2.1 Institutions for Project Operation

The project has a 10 km. long embankment on the north bank of the Nagor River and seven sluice gates at different locations on the three main channels draining the Project area.

For operation and maintenance of the sluice gates khalashis (caretaker cum operators) were stationed at the sluices by BWDB, with khalashi sheds (in fact, quite well-built small pucca houses) for their accommodation. There were also other supervisory bodies. At some sluices there were local committees organized by the supervising Sub-Divisional Engineer to oversee the work of the khalashi. It is reported by the local people at Bamuza village near Regulator No.3 that the committee consisted of eleven members, with one Chairman and one Secretary, who supervised the work of the khalashi while the regulator was functioning well. However, after three to four years the regulator developed defects and the committee became inactive. In the meantime the Secretary died and the committee was never revived.

At Regulator No.4 the khalashi was absent for a long time and the doors and windows of the khalashi shed were missing from the structure. The operating handle of the sluice gate was reported to be in the possession of a local notable. This person, when interviewed by the RRA team, said he was only acting as the custodian of the handle as there was no khalashi to operate the sluice gate, and that he would welcome any initiative to form a local committee when the sluice gate is properly repaired under the System Rehabilitation Project (SRP) and put into operation again. However, the ordinary farmers in the area expressed their disapproval of the way he got hold of the handle of the sluice gate and thus deprived them of any say in its operation.

3.2.2 BRDB Cooperatives

In the late 1970s the Upazila came into the fold of the BRDB programme which organized a number of Krishi Samabay Samity (KSS), Bittahin Samabay Samity (BSS) and Mahila Bittahin Samabay Samity (MBSS). It is reported that all these cooperatives are functioning well in terms of credit provision, irrigation, small savings and various types of income generating activities such as paddy husking, livestock raising, backyard poultry raising, kitchen gardening, petty trading and weaving.

3.2.3 NGO Activities

In addition to BRDB cooperatives there are a few NGOs such as BRAC and the Islamic Foundation operating in the project area in the fields of education, family planning and primary health care of children and other family members.

3.2.4 Project Relationship with the Upazila Parishad

The project has been under the System Rehabilitation Programme since FY 1990-91, under a programme which includes repair of 2 km. of embankment, provision of new seals for the regulators, and reexcavation of 12 km. of canals. The Upazila Parishad was invited for consultation by BWDB to establish priorities for the work and in a few cases the Water Board complied with the request of the Upazila Parishad for reexcavation of certain section of the canal. This has helped to build up mutual good will between the Upazila Parishad and the Water Board.

3.3 CONCLUSIONS

a) the project was the fulfilment of a public demand and there was involvement of the local people in the operation of some of the sluice gates/regulators while the regulators were in good condition;

b) because of the chronic absence of the khalashis some influential people have gained control over the project property and are using the regulators to their advantage. This may cause damage to the crops of other people;

c) due to the presence of many cooperatives and NGO activities, the project area is substantially benefited, in addition to the benefits derived from flood prevention;

d) there are signs of mutual good will between the Water Board and the Upazila Parishad;

e) because of misuse and mismanagement of regulators by the influential people there are signs of social conflict causing non-operation of those regulators.

3.4 RECOMMENDATIONS

a) once the whole project goes through the process of System Rehabilitation the regulators and the embankment should be placed under the local Union Parishads for

operation and maintenance. The UPs should be authorised to mobilize local resources through taxation if necessary;

b) the relationship between the Water Board and the Upazila Parishad should be further strengthened through frequent mutual consultation;

c) the embankment might be put under the Rural Maintenance Programme to be looked after by local women's groups organized by CARE;

d) there should be a coordination committee consisting of representatives from the Water Board, BRDB, LGEB and NGOs under the Chairmanship of the Upazila Parishad to coordinate the activities of such projects as Protappur Irrigation Scheme.

4. AGRICULTURAL IMPACT

4.1 AGRICULTURAL ENVIRONMENT

4.1.1 Topography

The Project area is part of the Barind Tract of relatively high land in north-western Bangladesh, and varies in elevation from approximately 17.4 m. (57 feet PWD) in the north-eastern corner near Pilkunja village to approximately 14.6 m. (48 feet PWD) in the south-western corner where the railway crosses the Nagor River (see Figure 1.2). Internal drainage is by a network of natural khals falling into the Nagor River. Slopes are in general even, but the fall of approximately 0.25m/km (1.33 ft/mile) means that in the absence of artificial barriers rainfall run off is comparatively rapid.

4.1.2 Soils

The soils of the area are of the Amnura-Lanta and Lanta-Gulta associations. The topsoils are silt loams to clay loams (Amnura-Lanta) and silt loams to silty clay loams (Lanta-Gulta). All the soils are highly suitable for paddy cultivation, and for non-paddy crops including potato, wheat, sugarcane, jute and chilies.

4.1.3 Climate

Mean rainfall is 1560 mm (61.4 in), with a standard deviation of 537 mm. (based on 15 years data from Dubchanchia, adjacent to the western side of the Project). Over 90 percent of the rainfall occurs between May and September, but year to year variation is relatively high especially at the end of the monsoon, and in about 20 percent of years there is under 100 mm. of rain in September, creating moisture shortage for maturing paddy crops.

4.1.4 Hydrology and Land Type

Pre-Project, the area was subject to flooding from the Nagor River up to the 16.7 m. (54.77 ft. PWD) contour (BWDB 1976), implying a maximum flood depth of about 2.1 m. (6.9 ft.) in the lowest areas. The 10-year return flood is 15.9 m. (52.2 ft.) (EPCL 1988), equivalent to a flood depth of 1.3 m. (4.3 ft.) in the lowest areas.

Floods were caused by heavy rainfall in the upper catchment of the Nagor River and were generally not of very long duration (7-10 days, according to local information). They were most hazardous for agriculture in June and July, when the maturing Aus and the newly transplanted Aman paddy crops were liable to be submerged.

More important in terms of lost output, however, were drought spells in September and October, when lack of rainfall combined with rapid run-off to create moisture deficits for the maturing Aman. To retain water farmers were accustomed to build earthen cross-dams in the natural drainage channels, but these frequently failed with resulting crop damage.

The division of the Project area by land type was as follows:

Table 4.1: Area by Pre-Project Land Type

High land (unflooded and < 0.3 m.)	2240 ha.
Medium High land (flooded 0.3 - 0.9 m.)	1440 ha.
Medium Low land (flooded 0.9 - 1.8 m.)	320 ha.
Total cultivable area	4000 ha.

Source: EPCL 1988

4.2 PRE-PROJECT AGRICULTURE

4.2.1 Cropping Sequences

The PP does not give cropping pattern by land type for the pre-Project period, but the RRA obtained these data from group interviews with farmers at a site in each of the land types represented in the Project area. These data are shown in Table 4.2. It should be noted that the local land type represents the farmers' own classifications and reflects local features of micro-relief and drainage congestion. Although there is danger of recall problems with data on a situation some 15 years ago, the patterns given by the farmers correspond closely to the overall cropping pattern given by the PP, and the RRA team feel considerable confidence in them.

The main crop grown was local transplanted Aman, with a little broadcast Aman in the lowest areas. The T.Aman was preceded by a broadcast Aus crop on about half the area. Rabi crops were of little significance except locally in the lowest areas where residual moisture was available.

4.2.2 Crop Yields

Table 4.3 shows farmers' statements of crop yields for the pre-Project period. These yields are consistent between the RRA sites but are considerably higher than the estimates used in the PP. It is possible that farmers' recollection is influenced by subsequent yield improvements, but equally there is no evidence that the PP yields are based on actual observation from the Project area.

4.2.3 Input Use

Use of fertilizers and pesticides was limited in the pre-Project period, though some urea was used on the local T.Aman crop, which is consistent with the relatively high yields stated by farmers. Seed rates, labour use and draught power use are generally stated to be the same as for the post-Project period, though as for yields memory bias is possible. Details of input use are given in the crop budgets shown in Annex 1.

Table 4.2: Pre-Project Cropping Pattern at RRA Sites

Site and Elevation	Project land type	Local land type	% of area	Crops Grown by Season		
				Rabi	Kharif-I	Kharif-II
Loharpara min. 54 ft/16.5 m.	High	High (not flooded)	4	Fallow	Aman seedbed 50% Local T.Aus 50%	Local T.Aman
		Medium (<0.25 m.)	96	Fallow	B.Aus 50% Fallow 50%	Local T.Aman
Bholta min. 51 ft/15.5 m.	Medium-High	High (<0.60 m.)	25	Fallow	Aman seedbed	Local T.Aman
		Medium (<1.2 m.)	75	Fallow	B.Aus 75% Fallow 25%	Local T.Aman
Fakirpara min. 49 ft/14.9 m.	Medium-Low	High (not flooded)	12.5	Potato Chili S.potato	Aman seedbed	Fallow
		Medium (<1.2 m.)	87.5	Fallow	B.Aus 19% B.Aman 13% Fallow 68%	Local T.Aman 87% B.Aman 13%

Source: Consultants estimates

Table 4.3: Pre-Project Crop Yields (kg. paddy/ha.)

Crop	RRA	PP
B.Aman	1588-1906	1,106
B.Aus	1588-1906	1,013
Local T.Aman	2224-2859	1,290

Source: RRA from consultants estimates; PP from BWDB 1976.

4.3 SOURCES OF RRA DATA

The main documentary sources consulted have been the Project Proforma for the original Protappur Project (BWDB 1976), and the EPCL/Harza/MMP Feasibility Report for rehabilitation of the Project (EPCL 1988). No Feasibility Report or Completion Report for the original Project could be provided by BWDB either in Dhaka or in Bogra.

During the RRA, interviews were conducted with the Superintending Engineer, BWDB Bogra, and with the UNO, Upazila Agricultural Officer and Upazila Livestock Officer of Kahalu Upazila. As noted above, group interviews of farmers from sites in each land type were conducted during the RRA, and direct observations were made during traverses (some by vehicle, but mainly on foot) through the Project area.

4.4 PROJECT OBJECTIVES

The agricultural objectives of the Protappur Project were:

a) to provide a more secure system for retaining run-off in order to secure the Aman crop against drought spells, especially in September-October. It was anticipated that this would encourage higher input use and adoption of improved varieties;

b) to prevent damage to the maturing Aus crops and to the newly transplanted Aman crop by flash floods from the Nagor River.

These measures were expected to generate incremental crop production amounting to 2,255 mt. of paddy (BWDB(1976)), of which 783 mt. was expected to be from HYV Aman, 985 mt. from increased output of Local T. Aman, and the remainder (about 485 mt., setting aside a negligible amount of B. Aman) from B. Aus. There was also expected to be an incremental 168 mt. of potato, though the linkage with the Project interventions is not clear. The expected breakdown of paddy benefits clearly reflects the situation in Bangladesh before the tubewell revolution in dry-season cropping, which has led to the virtual elimination of B. Aus in the Project area to make room in the cropping calendar for HYV Boro. It is also noteworthy that although a major switch to HYV Aman was expected (none being grown pre-Project) a larger proportion of benefits was expected to accrue from improved conditions for the existing Local T. Aman.

The PP states that no alternative to the Project existed for achieving there objectives, and so far as flood prevention is concerned this is probably true. In the case of water security

for the Aman crop, subsequent developments in the area clearly demonstrate that an alternative existed in the form of tubewell irrigation. Tubewells were not widespread in Bangladesh in the early to mid 1970s, and the Project concept was in any case based firmly on traditional practice. However, with hindsight it should have been apparent that there was scope for application of tubewell technology for supplementary monsoon season irrigation, and the ignoring of scope for a combined approach to monsoon and rabi season agricultural development is the main shortcoming of the Project concept.

4.5 POST-PROJECT AGRICULTURAL CONDITIONS

4.5.1 Post-Project Cropping Patterns

Table 4.4 shows the present cropping patterns, as estimated by the RRA, for the same sites as Table 4.2. Comparing the two situations, these salient features emerge:

- the replacement of local T.Aman by HYV T.Aman (completely in the higher areas, partially at lower elevations);
- the very large growth of the area under HYV Boro and other dry-season crops;
- the elimination of the B.Aus crop, for which there is now insufficient time between the Boro harvest and Aman transplanting.

The remaining HYV Aus area is a specialised crop grown for seed, which can compete economically for space in the cropping calender. The non-paddy rabi crops are likewise those with a high enough gross margin (particularly potato) to compete with HYV Boro. Overall the RRA data agree with the cropping pattern data in the Rehabilitation Feasibility Report (EPCL 1988) though there has apparently been continued movement from local T.Aman to HYV T.Aman since 1988, and HYV Boro and non-paddy rabi crops have also increased at the expense of fallow.

4.5.2 Crop Yields and Input Use

Table 4.5 shows the yields reported by farmers for the main crops grown post-Project. The yields estimated by EPCL in 1988 are shown for comparison.

Input use has predictably increased with the introduction of HYVs, but has also increased for local varieties. Details of input use are shown in the crop budgets in Annex 1. A feature of present cropping systems in the Protappur area is very low labour inputs (compared for example with MPO (1988)), which may reflect the high wage rates (Tk. 35-40/day, including food) which have resulted from the increased HYV area. There has also been a trend in recent years towards replacement of draught animals by power tillers for land preparation; the Kahalu Upazila Agriculture Officer estimates that about 20 per cent of the Aman area is now mechanically cultivated.

Table 4.4: Post-Project Cropping Pattern at RRA Sites

Site and Elevation	Project land type	Local land type	% of area	Crops Grown by Season		
				Rabi	Kharif-I	Kharif-II
Loharpara min. 54 ft/16.5 m.	High	High (not flooded)	4	Fallow	HYV T.Aus 50% Fallow 50%	HYV T.Aman
		Medium (<0.25 m.)	96	HYV Boro 87.5% Potato, etc.12.5%	Fallow	HYV T.Aman
Bholta min. 51 ft/15.5 m.	Medium-High	High (<0.60 m.)	25	HYV Boro 75% Aus seedbed 5% Potato etc.20%	HYV T.Aus 12% Jute etc. 3% Fallow 85%	HYV T.Aman 50% Local T.Aman 35% Fallow 15%
		Medium (<1.2 m.)	75	HYV Boro 70% Potato 15% Wheat etc. 15%	Aman seedbed 5% Fallow 95%	HYV T.Aman 50% Local T.Aman 50%
Fakirpara min. 49 ft/14.9 m.	Medium-Low	High (not flooded)	12.5	Potato Chili Sweet potato	Aman seedbed	Fallow
		Medium (<1.2 m.)	87.5	HYV Boro	Fallow	HYV T.Aman 50% Loc. T.Aman 50%

Source: Consultants estimates

Table 4.5: Post-Project Crop Yields (kg./ha.)

Crop	RRA	EPCL
HYV Boro	3812-5083	3700
HYV T.Aman	3812-5083	2700 [1/]
LIV T.Aman	2542-3177	2000 [1/]
Local T.Aman	2224-2542	1900 [1/]
HYV T.Aus	3177	2300
Potato	15885	7800

[1/] Estimated yields in absence of drainage and water supply problems

4.6 AGRICULTURAL IMPACT

4.6.1 Impact of Improved Water Supply

Although the cropping systems and output level of the Project area have been revolutionised over the period since Project completion, the part which the Project has played in this process is relatively modest. By definition, the Project's interventions in monsoon season water control, whether for flood protection or water supply, can directly benefit only the kharif season crops. Since there was already an established kharif cropping system pre-Project which used all the available land, little or no increase in cropping intensity has resulted from the Project.

The maximum direct benefit which can be claimed for the Project is the net increase resulting from the switch from Local T.Aman to HYV T.Aman, on the possibly generous assumption that the whole of the switch is due to Project interventions. Even so, the move to HYV T.Aman is by no means complete. Taking the areas by land type given in Table 4.1, and combining them with the area and yield data of Tables 4.2-4.5, the possible extent of agricultural output benefits is a kharif season production increase of about 57 per cent, or 5,400 mt. of paddy (see Table 4.6). This is actually a greater percentage increase than the 40.2% estimated in the PP, where, as noted above, it was expected that Local T. Aman would continue to be much more important than has actually been the case.

In terms of lessons for development strategy, it is instructive to compare the impact of the Project with the impact of the tubewell-based development of rabi cropping which has taken place on the same land over the same period. This has resulted in the cropping of some 3,100 ha. of land with HYV Boro, with a net output (after deducting displaced B.Aus production) of about 10,800 mt.. The tubewell development has thus generated almost double the most optimistic estimate of the foodgrain output benefit of the Project and has also made possible the production of about 540 ha. of non-paddy crops.

Table 4.6: Incremental Crop Output Attributable to Protappur Project

Land Type	Area ha.	Crop	PRE-PROJECT				POST-PROJECT			
			% of area	Area ha.	Yield mt/ha	Output mt.	% of area	Area ha.	Yield mt/ha	Output mt.
High	2240	Local T.Aman	91	2038	2.54	5177	-	-	-	-
		HYV T.Aman	-	-	-	-	91	2038	4.45	9069
Med.-High	1440	Local T.Aman	100	1440	2.54	3658	46	662	2.54	1682
		HYV T.Aman	-	-	-	-	50	720	4.45	3204
Med.-Low	320	B.Aman	11	35	1.75	62	-	-	-	-
		Local T.Aman	77	246	2.54	626	44	141	2.54	358
		HYV T.Aman	-	-	-	-	44	141	4.45	627
Total	4000					9523				14940

Source: Consultants estimates

It is noted in Chapter 2 that it may be supposed, on a priori grounds, that the water-retention component of the Project has had a beneficial effect on ground water levels. If this is true (and it must be borne in mind that the Project works are only a more durable replacement for pre-existing water retention systems), some of the benefits to dry season tubewell irrigation may be attributable to the Project. In the absence of recharge data, or of formal comparisons with non-Project areas in the North-West, the size of the benefit cannot be estimated. However, given the well known large increase in tubewell irrigation throughout the adjacent areas, it is unlikely that the Project has had more than a marginal impact.

4.6.2 Impact of Flood Protection

The flood protection embankment along the Nagor River and along the southern side of the Project area is stated by local residents to have successfully prevented flash floods from the river, but in the view of many people in the Project area this has not materially reduced the frequency or duration of floods. This is because, due to faults in the design, maintenance and operation of the drainage regulators, river flooding has been replaced by rain water congestion in much of the Project area. In the view of the RRA team, it is not possible to claim significant agricultural benefits for the flood protection component.

4.7 CONCLUSIONS AND LESSONS

4.7.1 Lessons for Agricultural Development Strategy

While the Protappur Project has probably had a significant beneficial agricultural impact, and has thereby served its intended purpose, the relatively modest scale of its achievement, when contrasted with the much larger benefits from tubewell based rabi season development, highlights a key issue for agricultural development in Bangladesh. Because dry season agriculture has been until recently less developed than monsoon cultivation, the fastest gains in output are to be made by breaking the dry season moisture constraint, rather than by modifying the existing monsoon cropping pattern.

Although Protappur appears to have avoided the worst of the side effects (especially adverse impacts on fisheries) associated with monsoon season development in other projects studied by FAP 12, it has severe institutional and operational problems (see Chapters 2 and 3) of the type normally associated with government-run FCD/I schemes. Dry season development based on tubewells, while by no means free from such problems (especially in the government-run DTW sector) is inherently more open to private participation and may thus hope in time to minimise them.

4.7.2 Recommendations for Protappur Project

The Protappur Project is currently undergoing a rehabilitation programme aimed at making good defects of design, construction and maintenance. Many of these problems however are likely to recur, given the built-in institutional problems of government schemes. It would have been more appropriate to examine other approaches to maintaining the agricultural benefits achieved by the Project, in particular the scope for using tubewells to provide supplementary monsoon season irrigation instead of the clumsy and ill-managed regulator system. Such an approach, if it permitted the dismantling of the regulators, might also free the Project from the continuing problem of rain water congestion, and should be considered as a matter of priority before major expenditure is incurred on the existing system.

5. IMPACT ON LIVESTOCK

5.1 PRE-PROJECT SITUATION

The Project area, comprising about one-third of Kahalu Upazila, had been in the past under one, or at most two crops; the cropping intensity was 166 per cent in the pre-Project period. Consequently, a significant proportion of the area was available, at least seasonally, for use as grazing areas for cattle and buffaloes.

According to the 1983-84 Agricultural Census (see Table 5.1), about 59 per cent of the total households in Kahalu Upazila (which includes the Project area) possessed bovine animals in that year; among the farm and non-farm households, about 71 per cent and 16 per cent respectively reported possession of bovine animals. This is in agreement with reports received during the RRA that most cultivating households have their own draught animals. The figures for the country, as a whole, were 66 per cent and 14 per cent respectively in 1983-84.

Table 5.1: Project Area Livestock Holdings by Union, 1983-84

Union	Number of		
	Bovines	Sheep & Goats	Poultry
Birkadar	4,399	3,240	25,537
Narhata	4,734	3,956	24,814
Kahalu	6,618	5,469	33,088
Durgapur	6,173	4,581	23,656
All HH (Project area)	21,924	17,246	107,095
Total Upazila (1983-84)	48,295	37,466	229,291
Total Upazila (1990) [1]	53,942 32,104[2]	23,146	277,964 297,624[3]

Source: The Bangladesh Census of Agriculture and Livestock (1983-84), Zila Series - Bogra, 1987.

1 Consultant's estimate based on a sample survey conducted by Upazila Livestock Office in 1990.

2 Represents number of draught animals.

3 Includes pigeons.

Ownership of large livestock is directly proportional to farm size, 97 per cent of large farms owning bovines, while only 60 per cent of small farms had bovine animals. About 40

per cent of all households in the Upazila had goats and sheep in 1983-84. The percentage of farm households possessing goats or sheep ranged from 42 to 50 per cent depending on the area and size of holding. 27 per cent of non-farm households had these animals in 1983-84.

The numbers of bovines, sheep/goats and poultry per household in the Upazila were reported to be 1.7, 1.3 and 8.2 respectively in 1983-84. This compared favourably with the relevant National averages of 1.5, 1.0 and 5.1 in the same year. In the Project area, which comprises 4 out of 9 Unions of Kahalu Upazila, there were about 22 thousand bovines, 17 thousand goats/sheep and 107 thousand poultry in 1983-84. Per household holdings were 1.8, 1.4 and 8.6 respectively, which again compares favourably with both Upazila and National figures.

Table 5.2 : Project Area Livestock Holdings Per Household by Union, 1983-84

Union	Number of HH	Per Household Number of		
		Bovines	Sheep and Goats	Poultry
Birkadar	2,959	1.5	1.1	8.6
Narhata	2,635	1.8	1.5	9.4
Kahalu	3,692	1.8	1.5	9.0
Durgapur	3,199	1.9	1.4	7.4
All HH (Project area)	12,485	1.8	1.4	8.6
Total Upazila	27,918	1.7	1.3	8.2
Average UZ in Bangladesh	-	1.5	1.0	5.1

Source: The Bangladesh Census of Agriculture and Livestock (1983-84), Zila Series - Bogra, 1987.

As elsewhere in the country, poultry were common in the Project area; in particular, ducks were most dominant in the Project area, presumably because of the presence of a large number of small water bodies and ponds and the consequent availability of snails for feed.

The availability of bovine animals per acre of cultivated land in the Project area was 1.1, compared with 1.1 for Bogra District and 1.0 for the country as a whole. In fact, the Project area was relatively well supplied with draught power, although the 29 per cent of households without bovines must have had to resort to hiring or borrowing draught animals.

5.2 PROJECT OBJECTIVES

The Project is primarily a flood control and irrigation Project aiming at retention of water for irrigation to agriculture. The Project had no planned objectives as to possible impacts on livestock, nor had it any explicit or implicit aim towards development of the sub-sector as a whole. Since the Project was expected to increase cropping intensity and therefore to raise total draught power requirement, this linkage at least should have been given consideration in the Project objectives.

5.3 SOURCES OF DATA

The Project Proforma (BWDB 1976) and a Feasibility Report (EPCL 1988) on the proposed rehabilitation of the Project were available. However, neither document contained any information on livestock.

Consequently, the present RRA is entirely based on data collection from various sources, using the usual range of RRA techniques: key informant and group interview; published and unpublished secondary sources; and observation. In particular, interviews were held with the Upazila Livestock Officials, farmers, traders and other knowledgable persons.

5.4 FINDINGS

Given that there are so many intervention variables influencing various sub-sectors of the economy, there is a problem of segregating impacts due to the Project under study. Hence, we may mention some of the findings or changes that have taken place during the post-Project period, but these changes or impacts are not necessarily ascribed directly or fully to the Project. Below are mentioned some findings, positive and negative.

5.4.1 Positive Findings

a) Bovine Population

The total bovine population has increased by an estimated 10-15 per cent since Project implementation, but the number of bovine animals per household seems to have declined. There may be several reasons for the increase of bovine animals. Although cropping intensity and cultivated land have increased, green grasses are abundant in the agricultural fields during the time between cropping seasons; also with the increase in moisture content in the soil green grasses on the embankments and internal roads are now more abundantly grown than before. The acreage under oilseeds is reported to be on the increase due to extension of irrigation facilities and hence the availability of oilcake, which is an important source of nutrition for cattle, has increased.

Due to adoption of HYV Boro (which is not mainly due to the Project, see Chapter 4) availability of paddy straw has increased, but the Project itself has had a negative effect on straw availability due to replacement of the existing long-strawed Aman varieties with short-strawed HVYs. The acreage of pulses has also increased, with increased output of by-products (including pulse straw and pulse bran) which can be used as livestock feeds. Besides the favourable situation with regard to green and dry feedstuffs, reduction of diseases through introduction of extensive free vaccination programmes has probably helped to raise

the bovine population in the recent past. It must be stressed, however, that the role of the Project in these developments is very limited.

b) Poultry Rearing

The percentage of households rearing chickens and the number of chickens per household seems to have increased in the Project area, as in the Upazila as a whole. The net growth of the number of poultry in the Upazila as a whole is estimated to have been 21 per cent during the time from 1983 to 1990. The most severe diseases such as Ranikhet and Fowl Cholera have been reduced considerably in the recent past, according to the Upazila Livestock Office. The free vaccination programme implemented by the Upazila Livestock Office and various NGOs may be credited with this reduction of diseases. The Project has made little contribution towards this development, but increased availability of food grains (which is at least partly due to the Project) seems to have played a role in the increase in the number of chickens in the Project area. Moreover, the activity of chicken rearing, which does not demand much special attention and care, has given rural women, particulary of low income groups, opportunities for income generating and expenditure saving work.

5.4.2 Negative Findings

As in most other FCD/I Projects, in this Project the increased cropping intensity and change in cropping pattern have had some adverse effects on the livestock population. Some of the negative findings are noted below.

a) Availability of Draught Animals

On average, a farm household in the Upazila at present owns about 1.1 draught animals. The present availability of draught animals per acre of cultivated land in the Upazila is estimated at only 0.7, as against 1.0 for the country as whole. Including the cows as draught animals, availability of draught animals in the Upazila is estimated at 1.1 per acre of cultivated land. In the Project area also, the number of draught animals per household and per acre have both tended to decline and there is a tendency for the farmers to use cows as draught animals instead of bullocks. The incidence of hiring and borrowing draught animals also seems to be increasing in the Project area. (The charge for hiring a pair of animals with a ploughman is Tk.50-70 per day depending on season).

However, it is difficult to attribute this decline in draught animal numbers to the Project effect. A more likely cause is that cultivators are increasingly unable or unwilling to pay the cost of maintaining draught cattle. The daily feed cost of one pair of draught animals at present prices is estimated at Tk.13.50, as follows:

Green grasses/paddy straw,10 kg/20 kg	Assumed free
Rice polish, 3 kg	Tk. 2.00
Concentrate feed, 1.5 kg.	Tk. 7.50
Molasses, 0.5 kg	Tk. 1.00
Oilcake, 0.5 kg	Tk. 2.50
Salt, 0.05 kg	Tk. 0.50

Total:	Tk.13.50

The annual maintenance cost of one pair of draught animals thus amounts to about Tk.5000. In addition, there are costs associated with collecting straw/grass, and the wages of a plough boy. On the other hand, one pair of draught animal can cover only 10 bighas (3.33 acres) of land per season (3 tillages).

The maintenance cost of draught animals is probably a major disincentive to keeping them, especially for farmers whose cultivated area is insufficient to employ a pair full-time. As a result, and also due to declining availability of draught cattle, there is increasing use of tractors and power tillers in the Project area. These are considered to do a better and faster job than draught animals, and are competitive on cost (power tiller charges are reported to be Tk.100 per bigha). It is reported that at present about 20 per cent of Aman cultivation is being done by this method in the area.

b) Goat Raising

The activity of goat raising in the Project area has considerably declined in the post-Project period. This is also true for the Upazila as a whole. According to a survey conducted recently, the goat and sheep population in the Upazila has declined to about 23 thousand in 1990 from 37 thousand in 1983-84. The rate of decrease is estimated at 7 per cent per annum. Non-availability of suitable feed, especially during the monsoon season, is reported to be one of the reasons for this decline. Like homestead chicken rearing, raising goats does not demand much capital or training. For that reason, it has potential for providing income generating and expenditure saving work for rural women. In the face of the decline in the goat/sheep population in the area, the women in low income groups have been particularly adversely affected. However, it would be difficult to attribute this change directly to the Project effect.

5.5 RECOMMENDATIONS

a) since livestock, in general, and bovine animals, in particular, are an integral part of the farming system, in future the aims for and effect of FCD/I Projects on livestock should be carefully designed at the very outset and jointly monitored by all concerned sub-sector agencies throughout implementation;

b) measures related to the development of feed and fodder for livestock should be undertaken. In particular, urea-based straw improvement technology should be disseminated in order to improve utilisation of the large amounts of paddy straw which can result from successful agricultural development.

6. IMPACT ON FISHERIES

6.1 PRE-PROJECT SITUATION

The available planning documents for the original Protappur Project contain no mention of the fishery situation in the Project area, and Kahalu Upazila's fishery data go back only to 1982 when the post of Upazila Fishery Officer was created. Statements of the pre-Project situation are therefore based largely on supposition and inference.

Some evidence is nevertheless available from observations and interviews conducted during the RRA. On the basis of interviews with fishermen, it is known that small communities containing significant numbers of traditional full-time fishermen have existed in the Project area for at least two generations. These communities operate a capture fishery in the water bodies within the Project area, never in the Nagor River. Also indicative is the widespread practice of setting triangular dip nets (kora jal) in internal channels. These channels have been deepened under the Project, which may have improved their fishery potential, but there was probably some fishery of this type, which is highly productive on selected sites, before the Project.

The Project area contains a large number of ponds, many of which were originally created as borrow-pits for house construction, or for domestic purposes, and pre-date the Project. Some of these contained wild stocks of magur, shing and koi which must have originated in the Nagor River. Fish moved into and out of the ponds when they were overtopped by flooding, a frequent event since most of the old ponds do not have elevated banks.

No data are available on pre-Project fish production, but some tentative estimates can be made. The total pond area before recent expansion was about 440 ha, and assuming a production rate of 37 kg/ha. (see MPO Technical Report No.17) the pond catch would have been about 16 mt. Estimates of capture fishery output are likewise very tentative, but from statements of present catch levels during the monsoon (5-10 kg/day for 4 months), and assuming a total of 50 kora jal nets set in the natural khals and roadside borrow pit canals, the total might have been in the region of 42 mt.. Assuming a landed value of Tk. 40/kg. and production costs of Tk.10/kg. (consultants' estimates from FAP 2, the North-West Regional Study), the net value of the combined output from ponds and khals would have been of the order of Tk.1.26 million per year.

6.2 PROJECT FISHERY OBJECTIVES

The Project Proforma (BWDB 1976) contains no mention of the existence of fisheries in the Project area, or of the positive and negative effects the Project might be expected to have on fisheries. While such omission is frequent in FCD/I projects, and even understandable in the case of Protappur in view of the seasonal nature of the main river and khals, it is nevertheless a serious weakness in the appraisal of the Project. Assuming a 1976 net output value of Tk.10/kg., the value of production under the assumptions made at 6.1 above would have been Tk.420,000, or 26 per cent of the estimated value of incremental crop production (Tk.1.627 million, BWDB 1976). The economic outcome of the Project was therefore highly sensitive to any impact on fisheries, an important lesson for appraisal of future FCD/I projects.

6.3 SOURCES OF RRA DATA

As noted above, there are no documentary sources for the pre-Project period, and there are no published data for the post-Project period, though the team was given access to unpublished DoF data. During the RRA, data were obtained from interviews with the Upazila Fishery Officer, Kahalu, and his predecessor in post, with fish fry stockists and traders, with traditional fishermen and part-time farmer/fishermen operating capture fisheries, and with fish pond owners. Direct observations of fish ponds were made at several sites covering all land levels in the Project area.

6.4 PRESENT SITUATION

6.4.1 Culture Fishery

The Kahalu Upazila Fisheries Officer does not keep separate records for the Project area, but the Project shares the general trends affecting the entire Upazila, for which data are available from two surveys in 1987 and 1989.

Table 6.1 : Water Bodies Used for Culture Fishery, Kahalu Upazila

	1987		1989	
	No.	ha.	No.	ha.
Private Ponds	1348	437	1681	592
of which used for culture	506	103	1620	n.a.
Khas (Govt.) ponds	334	155	334	155
of which used for culture	66	45	200	n.a.

Source : UFO, Kahalu.

Pond production estimates by species for 1987 are shown in Table 6.2.

Table 6.2 : Pond Fish Production, Kahalu Upazila, 1987 (mt.)

Koi	50
Magur	50
Rui	100
Mrigal	80
Katla	130
Silver Carp	85
Others	90
	585

Source : Upazila Fisheries Officer, Kahalu.

The implied production rate, in relation to the pond area from Table 6.1, is 3.95 mt/ha., which, while technically feasible, is extremely high in relation to levels attained elsewhere in Bangladesh and to outputs quoted by pond owners in the Project area (see Table 6.3 below). The Bogra District 1988/89 average was 1333 kg./ha. from cultured ponds, and 222 kg./ha. from derelict ponds, while the National averages were 1417 kg./ha. and 586 kg./ha. respectively. The Kahalu data should therefore be treated with caution.

The expansion of pond fishery is attributed by the UFO primarily to increased profitability, and this is confirmed by the data from interviews with two pond owners shown in Table 6.3. Gross margins are Tk.41,258/ha. and Tk.29,796/ha. The higher figure is competitive with the margin from the two crops (boro and aman) of HYV paddy which would be the alternative use of the land, confirming the UFO's statement that some large farmers are now adopting fish ponds as a preferred land use. The owner of one newly constructed pond indicated a cost of Tk.22,000 for 0.2 acres (0.08 ha) water area but this could be substantially reduced by use of a better design, the one used being excessively deep (in common with most in the Project area).

Table 6.3: Specimen Pond Culture Budgets

	Owner 1	Owner 2
Pond area ha.	0.08	0.16
Estimated output kg.	71.5	106.6
Output per hectare kg.	893.0	666.0
Costs : Fingerlings Tk.	300	1200
Feeding 1/ Tk.	240	-
Labour 2/ Tk.	160	320
Total Tk.	700	1520
Cost per hectare Tk.	8750	9500
Value of output per ha 3/ Tk.	50008	37296
Margin per hectare Tk.	41258	27796

Notes: 1/ Oilcake is only purchased feed. Cow dung supplied from owners' cattle.
2/ Consultants' estimates.
3/ At Tk.56/kg.

Source: Interviews, Protappur Project area June 1991.

Supply of fingerlings is from two privately owned hatcheries at Kahalu, through a network of stockists and petty traders. There are 15-20 private nursery ponds in and around Kahalu, and others are being established in villages with good communications, including one at Protappur. Fingerling prices are typically Tk.200/seer, one seer containing approximately 100 fingerlings.

Pond owners consult the UFO for advice on problems, and also the hatchery operators, but transport problems prevent the Upazila DoF staff from getting out to the owners. A possible avenue for extension advice would be through the fry traders, if they could be given a short training course.

There are problems of mortality among fingerlings during distribution, associated especially with the use of aluminium containers; these have a loss rate of 15-20% in hot weather, compared to 1.5% for earthenware, but are preferred by the traders on account of their durability. Pond owners in the lowest part of the Project also expressed fears of pond pollution by fertiliser and pesticide residues carried by run-off from the higher ground, and attributed some recent mortality of pond stock to this cause.

6.4.2 Capture Fishery

A 1987 Upazila fishery survey gives the following data for the traditional capture fishery community:

Table 6.4 : Traditional Fishing Community, Kahalu Upazila 1987

Fishermen's villages	15
Fishing families	139
Total family members	676

Source : UFO, Kahalu.

An interview with a traditional fishermen near Birkedar on the northern side of the Project indicated that, contrary to expectation, catches have not declined in recent years, while prices have risen in real terms. Daily earnings are however only of the same order as those of day labourers (Tk.30-40).

In addition to the traditional year-round capture fishery, which mainly uses cast nets, a considerable number of dip nets (kora jal) are erected seasonally on the drainage khals and the road borrowpit canals, the lower reach of the main drainage khal (the 'Kahalu Khari') near Chandpur being especially favoured. These nets are often owned and operated by farmers from the adjacent areas. An exact estimate of numbers is not possible, but there are probably at least 100 operating at the height of the monsoon. On a favourable site a kora jal will catch 5-10 kg per 24 hours.

6.5 PROJECT IMPACTS

6.5.1 Impact on Culture Fishery

It would be expected that by eliminating flash floods from the Nagor River, the Project would have increased the security of stocked ponds in the lower areas, but in fact pond owners at Fakirpara on the southern edge of the Project reported several floods in the 1980s caused by rain water congestion which resulted in loss of pond stock. The numerous problems of design, maintenance and operation of the regulators (see Chapter 2) may actually have worsened this type of flooding. New purpose built ponds, with substantial embankments, are relatively little affected.

There is a definite linkage between the growth of farm income in the Project area (even though this is only in part due to Project impact, see Chapter 4) and the rise of culture fisheries. One informant specifically stated that he was reinvesting the profits of HYV paddy cultivation in a pond, and others indicated that they could now afford to set land aside for fish culture for home consumption and/or sale. It is also likely that the rise in disposable income has played a part in the increasing fish prices and hence the profitability of pond culture.

The main negative linkage, apart from rain water congestion, is the danger of accumulation of fertiliser and pesticide residues. Almost all cropped land in the Project area now receives fertiliser, and most of it receives pesticides, the Project having contributed to this by improving conditions for HYV cultivation. The whole area drains through the south-western corner, and it is possible that significant amounts of residues accumulate in ponds there. A programme of monitoring pond water for dissolved nutrients and pesticide residues is advisable.

6.5.2 Impact on Capture Fishery

Contrary to the normal pattern of FCD/I projects, the Project has probably had a beneficial, or at least not an adverse, effect on capture fisheries. The objective of the regulators is to maintain higher water levels later in the year than was previously the case, and this should have improved the habitat for fish. The Project also deepened the natural drainage channels, which has probably improved them as refuges for the fish stock during the monsoon period.

6.6 LESSONS FOR FCD/I PROJECT PLANNING

Protappur Irrigation Project demonstrates yet again that, even in an apparently unpromising area for fisheries, the value of existing fishery output may be a large fraction of the expected benefits from agricultural production. Failure to adequately assess the pre-Project fishery situation, and if necessary to take measures to safeguard the fisheries, is liable to nullify the economic benefits of FCD/I projects. Protappur is a rare, and lucky, exception to the adverse effects which follow the normal negligence of Project planning and appraisal in this respect.

Although the Protappur Project has not been the main engine of economic growth in the Project area, the experience of that area shows that successful agricultural development, from whatever source, can be expected both to increase demand for fish, and to increase the mobilisable resources for its production. Long-term planning for FCD/I projects which are expected to raise farm incomes should therefore include appropriate steps to exploit this favourable situation for fishery development by strengthening DoF staffing and resources, in order to provide appropriate advice and support for design and management of ponds, hatcheries and nurseries.

7. IMPACT ON WOMEN

7.1 PRE-PROJECT SITUATION

According to the 1974 population census there were 1150 households in the sample villages with a total population of 5,875 out of which 2907 were males and 2969 females (see Table 7.1). For every 100 males there were 102.9 females. In 1974 average family size was 5.12. The major occupations of the people living within the Project area were farming, weaving and working as wage labourers.

Table 7.1: Household Numbers and Population by selected mouzas[1].

Name	Area (Ac.)	Household			Population	
		1974	1981	1986	1974	1981
Protappur Chandpur Fakirpara Talpara	NA[2]	187	196	239	855	1014
Loharpara	391	148	162	190	796	943
Kazipara	339	208	199	NA	1114	1319
Bholta	353	134	191	172	658	1046
Pilkunja	1062	473	524	607	2452	2855
Total	-	1150	1272	-	5875	7175

* Note: 1. Mouzas where RRA has been conducted
2. Not available

Source: 1. Bangladesh Population Census, 1974
2. Bangladesh Population Census, 1981
3. EPCL 1988.

In the pre-Project period women's role in the agricultural sector was limited and poorly rewarded. Over drainage and submersion by flood water caused damage to crops within the Project area. As such most of the land was under single and double cropping. Land was cropped with local varieties of paddy and yield was low (15-20 md./ac.). As a result women's involvement in agriculture was limited to immediate post-harvest activities (mainly winnowing, parboiling, drying and proper storage of paddy and rice). Among these, husking was done on a very small scale and for household use only.

Post harvest operations were performed by two classes of women: women within the family and female wage labourers. Big farmers usually engaged wage labourers for post-harvest activities, but the number of wage labour women was minimal and they were responsible for processing only a small part of the total crop. Wage labourer women received wages which consisted of 1/2 to 1 seer (0.45 - 0.9 kg.) of paddy and two meals per day. However, this was seasonal and for the remainder of the year there were few opportunities for productive activities.

At this time due to traditional attitudes women did not consider working outside the homestead in the non-traditional field. Apart from tending livestock and the homestead women were engaged in small scale vegetable gardening near the homestead. There was no practice of handicrafts among women, with the exception of some handloom weavers in the Pilkunja area.

Travel within and among the villages was not easy, due to the lack of good roads, paths and bridges. There were few schools within the Project area and strongly traditional attitudes encouraged parents to marry off the girls at an early age (13-15 years). These factors kept the numbers of girls in the schools low, despite the number of females exceeding that of males in the population.

7.2 OBJECTIVES

No explicit objectives concerning women can be drawn from the Project Proforma or from any other sources. This is not surprising since at the time of Project implementation, little attention was given to women's issues in the area of rural development. Although at that time the role of women was best exemplified in the agricultural sector it was not considered as an economic activity and hence received little attention. However, it can be inferred that through increasing crop output the Project would increase opportunities for female employment in general, especially in the areas of agro-based trades and industry.

7.3 POST-PROJECT SITUATION

7.3.1 Agricultural Activities

The change in cropping pattern and yield per acre has increased the off-farm activities (Table 7.2). Increase in the amount of paddy to be threshed, winnowed, parboiled and dried has created a higher workload for housewives and provided better wage earning opportunities for female wage labourers. However, as the number of landless households has increased there are more women workers competing for the few jobs available. Female labourers also process rice in the rice mills on a contract basis, but the wage of female labourers in all occupations is half of that of men. For example a woman gets 10 taka and three meals a day while a man gets 20 taka and three meals a day for working in another person's household as agricultural labour.

There was no report of ever employing women in crop production activities (e.g. in sowing or harvesting)

7.3.2 Embankment Maintenance

One direct impact of the Protappur Project is that there is some employment for women in taking care of the embankment and internal roads. This was only reported in the villages located in the south-west part of the Project. Five women reported working in the embankment and roads in Fakirpara village. They receive Tk.280 as wage for a period of 15 days. Another 7 women from the villages of Kazirpara and Bholta are also involved in canal digging and maintenance of roads. The number of women working on such projects (Rural Maintenance Programme) is small. The earnings from this type of employment are often their only source of income and are therefore critical for their family welfare and existence. In

general this indicates that there is a change in traditional views on working women in the area and women could be targeted for routine maintenance of embankments and village roads.

Table 7.2: Women's Involvement in Different Activities in Pre and Post Project Situation.

Activity	LOW LAND			MID LAND			HIGHLAND		
	Pre	Post	Change	Pre	Post	Change	Pre	Post	Change
Agriculture:									
Paddy Boiling	√	√	↑	√	√	↑	√	√	↑
Drying	√	√	↑	√	√	↑	√	√	↑
Winnowing	√	√	↑	√	√	↑	√	√	↑
Gardening:									
Land preparation	√	√	▲	√	√	↑	√	√	▲
Sowing	√	√	▲	√	√	↑	√	√	▲
Weeding	√	√	▲	√	√	↑	√	√	▲
Watering	√	√	▲	√	√	↑	√	√	▲
Harvest	√	√	↓	√	√	↑	√	√	↓
Livestock Raising:									
Chicken/Duck	√	√	↑	√	√	↑	√	√	↑
Goat	√	√	↑	×	√	↑	×	×	▲
Cow	√	√	▲	√	√	▲	×	√	↑
Cottage Industry:									
Jute Crafts	×	×	▲	×	×	▲	×	√	↑
Weavers	×	×	▲	×	×	▲	√	√	↑
Kantha	√	√	▲	√	√	↑	×	×	▲
Others:									
Small business(shops. jute crafts)	×	×	▲	√	√	▲	×	√	↑
Care of embankment/road	×	√	↑	×	√	↑	×	×	▲
Care & upkeep of household	√	√	▲	√	√	▲	√	√	▲
Preparation of food	√	√	▲	√	√	▲	√	√	↑
Cooperative:									
Savings Grameen Bank	×	√	↑	×	√	↑	×	√	↑
Education:	√	√	↑	√	↑	√	√	√	↑
Primary	×	×	▲	×	↑	×	×	×	
Secondary									
Family Planning Workers	×	√	↑	×	√	↑	×	√	↑

Note: √ = present × = not present.
↑ = increased ↓ = decreased ▲ = no change.

Source : Village women.

7.3.3. Other Positive Findings

There are other signs of change in women's role in the area which are not linked to the Project. Some income generating activities have been created through different projects of BRDB (Bangladesh Rural Development Board) and the Grameen Bank. Loans of Tk. 2000-5000 are given to groups of poor women (target group is those who have less than 50 decimal of land including the homestead and who are dependent on physical labour), who mainly use them to buy poultry, livestock, and sometimes buy paddy to process and sell. The loans are being repaid in instalments and BRDB reported a 96 per cent rate of recovery for women.

Within the Project area it was found that some women do not like to work outside the house. They are more or less engaged in raising livestock and poultry, preparing jute crafts or work as weavers. Their husbands or other male members usually sell these products in the market and part of the money is channelled to them so that they can purchase some items of their choice.

The attendance of girls at primary school is much higher than in the pre-Project period. However, the area lacks a girls' school or college. The number of girls dropping out of school is much higher than that of boys. This is due to the fact that during the harvesting and planting season they are needed at home for work as supportive hands. And also parents do not like to give their girls too much education, because of the belief that it will make arranging marriage difficult for them. Parents tend to arrange marriage for girls at between 14 and 17 years of age, which shows a slight increase in the age of marriage from the pre-Project period.

Family planning activities have increased within the Project area. Local women are engaged as family planning workers. Though this programme is successful to some extent, growing social awareness about family planning is coming into conflict with the teaching of religious leaders of the locality. The present average family size is 5.6 in the selected villages.

Current income from different professions is given in Table 7.3. Despite the increase in female employment, women are still getting less salary than men.

7.3.4 Conclusion

Overall there has been a small positive impact of the Project as it has increased employment opportunities for women as agricultural workers. As a secondary effect of the Project, better communication within the Project area has facilitated increased female access to education, family planning and other facilities (e.g. increased security for marketing of other income generating activities like weaving and jute crafts).

7.4 LESSONS LEARNED

The planning stage of Protappur Irrigation Project scheme failed to consider any objectives regarding impact on women. As such the value of the Project or its success in meeting its objectives cannot be discussed. Since a large majority of the families in the rural Bangladesh are poor (50-65 per cent of the households within the Project area are below poverty level according to a study conducted by BRAC), there is a need for giving more attention to the potential role of women in economic activities and its consequent impact on raising socio-economic status of women.

Table 7.3: Present Income Pattern of Women.

Work	Types of wage		
	Cash (Tk)	Food/Meals	Paddy/Rice
Agricultural Threshing Winnowing or Parboiling Drying	10-20.00 -	3 meals 3 meals	- 1-1½ kg rice
Embankment (For 15 days work)	280.00	-	-
Rice Mill Work (work consist of 36 days/year)	-	-	2-2½ kg/75 kg of paddy processed
Non-Traditional wage labour (salary)	110.00	-	-
Poultry (yearly sales income)	1000-1500.00	-	-
Goat (sale price/goat)	600-1000.00	-	-
Jute crafts (monthly income)	300-400.00	-	-

Source : Village Women

7.5 RECOMMENDATIONS

a) FCD/I projects should consider **at the planning stage** creating more job opportunities (from the execution stage of the project to O & M) for women. Women should be linked with the project in such a way that some benefit of the project can be reaped by the poorer women, especially by widowed or divorced women;

b) as there are more women than men (100 males for 104 females according to 1981 statistics), they should be motivated to participate in on-farm activities. Better agricultural extension facilities can teach women production of fruit crops such as papaya or banana and thereby increase women participation in economic activities;

c) the activities of the different government agencies and NGOs for women need to be coordinated so that they can avoid duplicating projects or being in the same village, as happens in most cases.

7.6 SOURCES OF DATA

The following sources were used for data collection :

- Bangladesh Population Census, 1974 and 1981;
- Feasibility Report on Rehabilitation (EPCL 1988);
- Concerned Upazila Officials;
- Rural men and women;
- BRAC managers;
- Rice mill managers.

During the RRA several villages at specific contour levels were visited and women were interviewed in each of them. Although the villages were selected purposively to represent different land levels, selection of neighbourhoods and houses for interviews was random. The villages visited were Bholta, Kazirpara, Pilkunja, Loharpara, Talpara, Chandpur and Fakirpara.

8. IMPACT ON NUTRITION AND HEALTH

8.1 PRE-PROJECT SITUATION

From informal interviews with village men and women it was gathered that pre-Project there were periodic food grain shortages in the area due to failure of crops in case of flash flood in the low lands and water shortage in the high lands. Food grain shortage could be observed in the low-lying areas over a longer period of time than at present (September-October and March-April).

Availability of other foodstuffs, such as pulses, fish, meat, milk, etc., however, was better in the pre-Project time. As the prices of these products were lower they were within the purchasing power of a larger number of people. Consumption of wheat was not common, especially in the lowlands even during the lean periods in terms of food grain availability. For lowland and medium high land the source of drinking water was wells.

Child health was reported as better in the pre-Project situation. This could be due to higher amount of food availability per capita and access to larger variety of food due to better production and lower prices of those products. Primary health care facilities were not easily accessible to all villagers. Therefore, smaller numbers of children were inoculated and vaccinated through government effort. Diseases such as smallpox, cholera, fever, common cold and diarrhoea were more common in the pre-Project period.

8.2 OBJECTIVES

Explicit objectives in the area of nutritional and health impact were not included in the Project planning. However, as the Project has aimed at ensuring a safe harvest for T.Aman and changing cropping pattern it should have had an objective relating amount of yield to overall nutritional status of the area. As the Project has a positive impact on nutritional and health status through increased food grain availability and increased purchasing power of the rural population of the area concerned, an objective should have been included in the planning stage.

8.3 POST-PROJECT SITUATION

8.3.1 Food consumption

Currently the Upazila generates a yearly foodgrain surplus of 27,000 metric tons. The Project area shows an increase both in number of meals per day and amount of rice consumed. The Project has increased the security of rice production in the area, especially in low-lying areas where most changes in consumption were observed.

Although there is a slight increase in wheat consumption (especially during the months of March and April), most people prefer to consume rice. This is because rice and flour are sold for almost the same price (Tk. 10/kg. for rice and Tk. 9/kg. for flour) but when consumed rice provides better bulk and satisfaction.

As production of pulses is limited to certain areas and the area under pulse cultivation is very low, most people have to buy pulses for consumption. Therefore, a declining trend in pulse consumption was noted within the Project area. A declining trend was also noted in case of other protein sources (i.e. fish, meat, poultry, milk, etc.) due to lower availability and increasing prices of these products.

A increase in the consumption of vegetables, especially the leafy kinds, was noted within the Project area. Currently all villagers surveyed consume vegetables every day of the week. There is a slight decline in fruit consumption. This is mainly due to decrease in yield as the trees have grown old.

8.3.2 Safe Drinking Water

Previously most households used to get their drinking water from wells, but by 1988 the number of HTW's within the Project area had risen to 934. As such most villagers got safe drinking water within their reach. The Project may have prevented a fall in ground water level and thus kept shallow water tubewells running. This is a Project benefit itself and it also likely to have reduced incidence of cholera, dysentery and diarrhoeal disease.

8.3.3 Other findings

Within the Project area family planning and health care facilities have improved. All women interviewed reported regular visits from the family planning worker in the years after Project completion. Health workers also provide inoculations and vaccinations to the village children. A decline in diseases such as smallpox and whooping cough was reported.

Despite the evidence for improved calorie nutrition since Project completion, the appearance of the children of the vulnerable age group (0-15 years) suggests the continued presence of borderline nutritional deficiency. Children observed (especially within the landless group) showed signs of being underweight in relation to their height and age. This suggests periods of insufficient food intake. Although agricultural production has increased, the disadvantaged people of the area still suffer from food shortage during the months of March, April, September and October. As a result the amount of rice consumed decreases and the quality of food declines in such households.

Population increase within the Project area has adversely affected the nutritional status of the area. In 1974 average family size was 5.1 in the selected villages. It was 5.6 in 1981. Such population increase has probably resulted in decline in the ability of the family to procure the amount of food grains and other foodstuffs necessary for healthy living.

Table 8.1 presents the pre- and post-Project situation in terms of nutrition and health impact.

8.4 CONCLUSION

The Project has increased food grain production considerably and the Project area is a net surplus area, though this is more due to the simultaneous upsurge in Boro cultivation, which is not directly related to the Project. As a result, the year-round nutrition of people living within the area, especially those in the lowlands, has improved. Widespread culture fishery

activity was observed within the Project area, and along with the agricultural benefit this may in time reverse the present declining trend in per capita protein consumption.

8.5 LESSONS LEARNED

Since nutritional and health status are closely associated with food production both the quality and quantity of food production needs to be considered at the planning stage of FCD/I projects. Although the Project has had some impact on grain production, it has done little or nothing for other crops such as pulses. There is a need for encouraging farmers in increasing pulse and legume cultivation as alternative sources of protein. Women also need to be encouraged to give more effort to homestead gardening. Fish culture activities need to be encouraged, so that fish becomes more available throughout the year. Women need to be taught in basic health care and proper weaning practice. All these activities need to be planned in a proper manner so that they can have a positive impact on the nutritional status in the long run.

8.6 SOURCES OF DATA

Bangladesh Population Census, 1974 and 1981.
Village men and women.
Village doctor.
Upazila officials.

Table 8.1 Pre and Post Project Nutritional and Health Situation

	Low land			Medium land			High land		
	Pre	post	change	pre	post	change	pre	post	change
No. of meals/day	2	3	↑	3	3	▲	3	3	▲
No. of people/meal	7.3	7	↓	3.5	7	↑	3	5.2	↑
Rice consumption	√	√	↑	√	√	↑	√	√	↑
Wheat ,,	x	x	▲	√	√	↑	√	√	↑
Pulses ,,	√	√	↓	√	√	↓	√	√	↓
Fish ,,	√	√	↓	√	√	↓	√	√	↓
Meat ,,	√	√	↓	√	√	↓	√	√	↓
Milk ,,	√	√	↓	√	√	↓	√	√	↓
Egg ,,	√	√	↓	√	√	▲	√	√	↓
Vegetables ,,	√	√	↑	√	√	↑	√	√	↑
Fruits ,,	√	√	↓	√	√	↓	√	√	↓
Scarcity of food (among poor)	Sept-Oct Mar-April	Mar-April	↓	Sept-Oct.	x	↓	Sept-Oct.	x	↓
Source of drinking water	Well	TW	-	Well	TW	-	TW	TW	-

Notes: ↑ = increased ↓ = decreased ▲ = no change √ = present x = not present.
Source: Village men and women, village doctor.

9. ENVIRONMENTAL IMPACTS

9.1 PRE-PROJECT SITUATION

The Protappur Project Area is entirely within Agro-ecological Subregion 25a, the Highland and Medium Highland Subregion of the Level Barind Tract Agroecological Region (FAO, 1988). The relatively elevated situation of the Barind Tract causes it to be fairly well drained, despite only gentle slopes and the slowly permeable clay subsoil.

There is a consistent slope towards the south-west corner of the Project Area, where flooding occurred if levels in the Nagor River prevented run-off from escaping downstream. The RRA findings suggest that the flooding was primarily due to rainfall run-off from within and beyond the Project Area, rather than to substantial overtopping of its banks by the Nagor River. Flooding does not seem to have been a serious problem, therefore, except occasionally in the south-west corner. The chief disadvantage seems to have been the rapid drying-out of the land after the monsoon, due to efficient run-off and low soil moisture capacities.

As would be expected in Agroecological Subregion 25a, Highland and Medium Highland comprise the two main agroecological divisions, with a small extent of Medium Lowland in the south west. A more detailed environmental evaluation would assess impacts in terms of each of these agroecological units.

The Grey Terrace Soils which dominate the area are ideally suited to paddy cultivation. Consequently Protappur has been intensively cultivated, mainly for rice, and increasingly densely populated for a long period prior to the Project. Thus, at the time of Project implementation in 1976, little of the natural flora and fauna remained, other than the fish communities. Natural vegetation had long been largely replaced by rice fields and their associated weeds, or by the trees and gardens of the villages. Wildlife, such as mammals, reptiles and amphibians, had been decimated by the sheer pressure of population, and even the fish population would have been considerably reduced. Migratory and resident birdlife was probably already in rapid decline for the same reason.

This scenario is impossible to demonstrate with data because none exist, other than verbal information from the older villagers during the RRA. The implication is that the critical environmental issues for projects implemented in recent years and in the future are primarily physical and human issues, except for the key biological issue of the fish fauna.

9.2 PROJECT OBJECTIVES

Neither the Project Proforma (BWDB, 1976) nor the Rehabilitation Feasibility Report (EPCL, 1988) include the environment amongst their concerns. No attempt at pre-Project environmental assessment was proposed in either. Even though the Protappur Project would not have been expected to have major negative environmental consequences, at least the 1988 proposal should have considered a brief, initial assessment, given the increasingly delicate environmental stability of Bangladesh as population grows and development proliferates.

9.3 APPROACH AND SOURCES OF INFORMATION

The approach to the environmental component of rapid rural appraisal (RRA) is based on simple scaling checklists for each of the three main categories of environmental issue: physical, biological, human (Tables 9.1-9.3). This in effect consists of post-evaluation screening and scoping, aimed at:

- identification of Project activities that have caused significant impacts (screening);
- identification of significant environmental issues arising from the project (scoping);
- assessment of the need for more detailed environmental post-evaluation (environmental audit) of this or similar projects.

An attempt is made at scaling the degree of impact as follows:

0 - nil or negligible impact
1 - minor impact
2 - moderate impact
3 - major impact.

Impacts thus scaled may be positive (+) or negative (-).

This simple scaling assessment of impacts is intended to be indicative rather than quantitative, suggesting those environmental issues which should receive more attention in any subsequent more detailed environmental post-evaluation.

Rapid scoping of the full range of potential FCD/I environmental issues allowed the identification of those issues relevant to the Protappur Project. Impacts relating to these are summarised in Tables 9.1-9.3. The main emphasis here in the discussion of environmental impacts concerns those affecting ecological (i.e. physical and biological) issues. The human issues are mostly discussed in more depth in other chapters of this report, although summarised here in Table 9.3.

The PP and Rehabilitation Feasibility Report include some data of relevance to physical and human aspects of the environment but no biological data. Information on agroecological zonation and characteristics are available in the comprehensive FAO (1988) work which covers all of Bangladesh.

All other information and data were acquired by the RRA approach of interviews with villagers and government officials and by direct field observation. Equally important for the environmental evaluation have been the findings of the other disciplines within the RRA team.

9.4 PHYSICAL ENVIRONMENTAL IMPACTS

Physical issues have been subdivided into water-related and land-related; other physical issues such as climate and atmosphere have not been affected by the Project.

9.4.1 Physical Impacts (Water)

(a) River Flow

The volume, duration, timing and velocity of the Nagor River seem not to have been significantly affected by the Protappur Project. Very slight increases in volume and velocity may have resulted from the embankment containing the occasional river floodwater that previously entered the southwest of the area. Timing and especially duration of high river flows are possibly slightly affected by the more efficient ponding of run-off. None of these, however, are likely to be sufficient to cause significant external impacts, either adjacent to the Project Area or downstream. More efficient operation of the regulators on the khals might allow more significant amounts of water into the Nagor but in practice this seems not to happen - see (d).

There are no rivers within the area, the khals being considered with wetland and waterbodies in (g) and (h) below.

(b) River and Pond Water Quality

River and pond water quality could be affected by the quality of the drainage effluent if this has deteriorated and if significant amounts entered the river. As seen in (a), the inefficient operation of drainage during the monsoon and deliberate retention for irrigation afterwards restricts the amount of effluent. Effluent quality has not been measured. It could be affected by increases in agrochemical usage and indiscriminate sewage, but there is only circumstantial evidence for this, as discussed in (e).

Sediment from erosion and salinity are not factors in Protappur. The conclusion, therefore, is that external impacts on river quality are negligible.

(c) River Morphology

River morphology changes result from bank erosion, scour and siltation. It is evident from (a) that the Project will not significantly have affected any of these in the Nagor.

(d) Flooding

The Project was designed to exclude early monsoon river floods and to pass rainstream run-off to the Nagor. In practice, it appears to have achieved only a minor degree of success. Flooding appears to be generally much as before, except that some relief from more severe flooding events is gained. In Chapter 4, no significant effect on agriculture is claimed for the flood protection measures. The minor positive impact is evidenced by some improvement in communications and property security plus very slight positive effects on agriculture and culture fisheries.

Another reason for the disappointing Project impact on flooding is that flooding pre-Project does not seem to have been a problem comparable to that in areas outside the Barind Tract.

(e) Groundwater Level

To the extent that the Project regulators are more efficient than the locally constructed earthwork cross dams which they replaced, there is some evidence to suggest an impact on groundwater levels, due to recharge from the water deliberately retained for irrigation and from that ponded by inefficient operation of the regulators. EPCL (1988) dismissed groundwater potential because of 1984 estimates showing about 17 percent over-extraction in Kahalu Upazila. Subsequent tubewell development suggests this was unduly pessimistic, although it clearly demands that groundwater levels should be monitored. Monitoring should also help to clarify the degree of impact due to the Project.

(f) Groundwater Quality

Again, lack of real data prevents firm impact evaluation. Chapter 4 has revealed the substantial increase in the use of agrochemicals, especially fertilisers and pesticides, and although much of this relates to tubewell development of HYV Boro, a significant part is due to the change to HYV Aman induced by the Project. In addition, the Project has helped to encourage rapid population growth and this is likely to have increased the amount of indiscriminate sewage polluting surface waters. As the Project has precluded the direct flushing of pollution to the Nagor, it is possible that more contaminated water reaches the groundwater than previously.

Monitoring is urgently needed in representative areas such as Protappur to gauge the effects of agrochemicals and inadequate sanitation on water quality in both surface and subsurface waters. A minor negative impact is assumed here, but queried because of the uncertainty (Table 9.1). Use of agrochemicals still falls far short of usage in those areas of higher technology where such problems have been detected. Sewage pollution may be largely filtered out before reaching the groundwater.

(g) Wetlands and Waterbodies Extent/Recharge

There are no true wetlands in the Project area, which is typical of the Barind Tract. However, the three main khals (Section 2.1) are considered here, because they are the areas of temporary concentrations of surface water that do form during the monsoon.

Despite siltation since Project implementation, the khals have benefitted to a minor degree from the initial clearing and excavation, which is now being repeated. This makes them much more effective and useful waterbodies, in terms of physical, biological (fish) and socio-economic considerations.

(h) Wetlands and Waterbodies Quality

The same remarks apply as in (g), except that the drainage system's failure to flush out indiscriminate sewage must cause an increasing concentration in the khals. Again, hard data are required, as throughout most of Bangladesh, to evaluate such trends with any accuracy. Similarly, the levels of nitrate, phosphate, BOD, pesticide residues and other key indicators need to be known. A minor negative impact is assumed, as for (g), but is again

queried. The impact may in fact be negligible or it may be more serious than anticipated here. The question, of course, is much more pressing in areas where wetlands and other internal waterbodies are much more extensive and important in ecological and socio-economic terms.

9.4.2. Physical Impacts (Land)

(a) Soil Fertility

Soil fertility in Protappur has been affected only in the temporary seasonal raising of fertility levels by the increasing application of fertilisers to HYV rice. The extent of flooding has not changed greatly, while run-off retention for irrigation is now more efficient, so that the incidence of blue-green algae, aquatic vegetation and crop residues associated with increasing fertility under wet conditions are probably not significantly different. River silt was never extensively deposited in pre-Project times and in any case does not contribute significantly to current soil fertility.

(b) Soil Physical Characteristics

Similarly, the generally unchanged supply of organic material and limited decrease in river flooding have led to no real changes in soil physical characteristics, such as texture, structure, moisture capacity, infiltration rate, permeability, etc.

(c) Soil Moisture Status

This has been moderately improved by the reasonably effective retention of surface water for irrigation at the end of the monsoon period, thus overcoming the Project Area's main original disadvantage.

(d) Soil Erosion

Soil erosion prior to the Project was negligible but the construction of the embankments and regulator structures has resulted in a minor degree of erosion. This has arisen primarily due to poor construction, exacerbated by poor operation and maintenance. Consequently embankments are scarred by incipient gullying and at least one structure has been completely washed out.

(e) Land Capability

Land capability has benefitted from the improved soil moisture status and expanded irrigation capacity noted in (c). This improved land capability has allowed the switch from Local to HYV T. Aman.

(f) Land Availability

Although land capability has improved, there has been no significant increase in the land available for cultivation. The area was intensively cultivated pre-Project, with no land left idle throughout the year and little land lost to permanent inundation.

9.5 BIOLOGICAL ENVIRONMENTAL IMPACTS

Biological environmental issues affected by the Protappur Project can be subdivided into fauna and flora issues. Most biological issues in Protappur have suffered no significant impacts but they are briefly examined here because of the popular awareness of them as issues.

Since Section 9.4.1 showed that the Project has not significantly affected the Nagor River, there are no biological external impacts in either adjacent or downstream areas.

9.5.1 Biological Impacts (Fauna)

(a) Bird Communities/Habitats

The decline in bird communities and their habitats was more or less complete pre-Project and any further deterioration is a function of population density rather than the Project. The absence of important bird habitats such as wetlands or forests in 1976 means that the Project's slight impact on population growth (Section 9.6.2) is not sufficient to cause a significant indirect impact on birdlife.

(b) Fish Communities and Habitats

The Project has improved fish habitats in two ways, although neither dramatically:

- excavation of the khals increased their suitability and capacity, as habitats for fish;
- the embankments must have increased confidence in fishpond construction/ rehabilitation to help accelerate the considerable growth of culture fisheries in the area, and may also have occasionally provided a degree of actual protection against wash-outs.

As a result, local capture fisheries have not declined as in most FCD/I areas, while culture fisheries have expanded rapidly (although primarily due to non-Project reasons - see Chapter 6).

(c) Other Macro-fauna Communities/Habitats

The same comments apply as for (a) above: already by 1976 the intensive occupation and utilisation of the land had reduced mammals, reptiles, amphibians, etc., almost to the very low populations found today. The continued imperceptible decline during the Project's life has not been significantly accelerated by the Project, in part because it started from too low a base-level.

The lack of historical data for this and most other biological issues in Bangladesh is unfortunate, as it prevents any attempt to plot the decline of the country's wildlife and habitats. This would have enabled the Project's impact on these issues to be shown in a true perspective.

(d) Micro-fauna Communities/Habitats

This issue has already been touched upon in Section 9.4.2 (a), where it was noted that no significant change had occurred with respect to the incidence of blue-green algae, one of the major microbiota elements in Bangladesh. In the total absence of data, it is assumed that other microbiota remain similarly insignificantly affected by the Project.

9.5.2 Biological Impacts (Flora)

(a) Trees

The populations in the area have not been affected by the Project, although the embankments provide an excellent opportunity for afforestation (as seen in other FAP 12 areas such as Chalan Beel D).

(b) Other Terrestrial Vegetation

The same comments apply as to (a) and (c) in Section 9.5.1.

(c) Aquatic Vegetation

The communities and habitats of aquatic vegetation have remained largely unchanged during the Project, as the flooded area seems to be much the same.

9.6 HUMAN ENVIRONMENTAL IMPACTS

Some of the most important environmental impacts of the Protappur Project are those affecting the human environment. However, many of these are covered in other chapters of this report. Here they are presented in Table 9.3 and are briefly summarised below.

Again, as the Project has not significantly affected the Nagor River, there are no external human impacts registered.

Human impacts can be conveniently grouped into five sub-categories: human use, social, economic, institutional, and cultural.

9.6.1 Human Use Impacts

(a) Agriculture

In Chapter 4 a generous estimate of Project impact on agriculture suggests a maximum 58 per cent increase in production in the kharif season, compared to 40.2 per cent forecast in the PP. This was largely due to retention of irrigation water in the post-monsoon period to allow the switch from Local to HYV T. Aman. The increased output must be regarded as at least a moderate positive impact, even though overshadowed by the success of tubewell irrigation.

(b) Livestock - Not significantly affected by the Project (Chapter 5).

(c) Fisheries

A slight positive impact is recognised, because of improvements to the khals that appear to have encouraged capture fishing and due to the confidence and slightly improved protection provided by the embankments (Chapter 6).

(d) Afforestation

No impact, but an opportunity to plant the embankments is being missed, which would enhance tree fauna, provide fuelwood and/or fodder, and provide protection against erosion.

(e) Agro-industrial Activities

Slight positive impact due mainly to the Project's minor part in the increased number of local rice mills.

(f) Road Transport

The Project structures are said to have provided or protected improved footpaths, animal tracks and roads, to a limited extent.

(g) Water Transport

Water transport was insignificant before the Project, and remains so.

(h) Domestic Water Supply

The assumed Project impact on maintaining groundwater levels may have had a minor positive impact (and possibly greater) on domestic water supplies from shallow drinking water tubewells.

(i) Sanitation

The embankments prevent any effective flushing of surface water in which indiscriminate sewage has accumulated, creating at least a minor negative effect.

(j) Recreation - Not affected.

(j) Energy

A slight negative impact results from the increased absorption of energy via the increased number of rice mills and other agro-industrial activities encouraged by the Project.

9.6.2 Social Impacts

(a) Human Carrying Capacity

The increased land capability and consequent crop and fish production have caused a slight rise in human carrying capacity, although population growth has at least matched this.

(b) Demography

The Project itself has probably not significantly influenced demographic structure and trends, except as in (a) above.

(c) Gender

A minor positive impact on the role of women, by creating greater employment opportunities - see Chapter 8.

(d) Age

No real impact, unless the increased agricultural activity takes children out of school too early.

(e) Health and Nutrition

Minor positive impact due to Project-related increases in crop and fisheries production and to the maintenance of a clean drinking water supply from the shallow tubewells - see Chapter 9.

(f) Disruption, Safety and Survival

Only a minor issue on the Barind Tract, though the embankment has made a small contribution to reduced disruption from flash floods in the lower areas.

(g) Land Ownership

Not affected.

(h) Land Acquisition

The Project does not appear to have encountered significant problems of land acquisition, possibly because it was implemented to some extent as a result of local initiatives.

(i) Equity

A slight negative impact because the benefits of the Project have been skewed to some extent in favour of the better-off, larger landowners.

(j) Social Cohesion

Chapter 3 indicates a minor negative impact resulting from majority resentment of actions and attitudes on the part of a few influential people.

(j) Social Attitudes

The current apathy and disinterest in the Project seems to arise from (i) above and to the poor institutional effectiveness of BWDB and the Upazila, causing another minor negative impact.

9.6.3 Economic Impacts

The three main economic impacts on the people are incomes, employment and land values. These have all received at least minor positive impacts, and possibly moderate (Chapter 10). In all three cases, the impacts arise primarily from the increased cultivation and fisheries activities and production.

9.6.4 Institutional Impacts

Institutional activity by both BWDB and Kahalu Upazila seems to have been limited and ineffective (Chapter 3). As a result, the originally substantial public participation in the Project has dwindled into apathy and some resentment of the landowners who have been allowed by this situation to control Project operation. Both issues, therefore, have suffered moderate negative impacts.

9.6.5 Cultural Impacts

It is difficult to see that the Project has significantly influenced cultural heritage and continuity or scenic qualities in the Project Area. There are no particular historical, archaeological or more recent cultural sites.

However, overall the Project can reasonably claim to have improved the quality of life in the Project Area to a limited degree, through the increased affluence, health and general well-being of the people.

9.7 ENVIRONMENTAL SCREENING

The primary Project activities were flood protection, drainage and run-off retention for irrigation. The scoping exercise in Sections 9.4 - 9.6 shows that only the last of these was wholly justified and successfully implemented. Most of the Project's significant environmental impacts relate to this.

9.8 CONCLUSIONS

The Protappur Project has had relatively limited environmental impact because:

- the area was ecologically already much as it is now when the Project started in 1976;
- the socio-economic achievements were at best moderate and have been overshadowed by the large increase in tubewell irrigation;
- only one of the three main Project components seems to have been successfully implemented.

The major positive impacts seem to have been:

- maintenance of groundwater levels;
- improved soil moisture status due to irrigation;
- improved land capability;

- increased crop production.

The only important negative impacts were:

- institutional shortcomings in the operation and maintenance of the Project;
- a failure to sustain an initial high level of public interest and participation.

The clear conclusion to be drawn is that the Protappur Project has had limited environmental repercussions, especially in respect of ecological (physical and biological) issues. The Project has had no significant external environmental impacts, outside the Project Area. In consequence of these two findings, there is no call for any more detailed environmental evaluation of the Project.

Table 9.1 : Physical Environmental Impacts.

Environmental Issues	Degree of Environmental Impact	
	Project Area Impacts	External Impacts
WATER		
a. River Flow	-	0
b. River Quality	-	0
c. River Morphology	-	0
d. Flooding	+1	0
e. Drainage	-1	0
f. Groundwater Levels/Recharge	+2	0
g. Groundwater Quality	-1	0
h. Wetlands and Waterbodies Extent/Recharge	+1	0
i. Wetlands and Waterbodies Quality	-1	0
LAND		
a. Soil Fertility	0	0
b. Soil Physical Characteristics	0	0
c. Soil Moisture Status	+2	0
d. Soil Erosion	-1	0
e. Land Capability	+2	0
f. Land Availability	0	0

Table 9.2 : Biological Environmental Impacts

Environmental Issues	Degree of Environmental Impact	
	Project Area Impacts	External Impacts
FAUNA		
a. Bird Communities/Habitats	0	0
b. Fish Communities/Habitats	+1	0
c. Other Macro-Fauna Communities/Habitats	0	0
d. Micro-Fauna Communities/Habitabs	0	0
FLORA		
a. Trees	0	0
b. Other Terrestrial Vegetation	0	0
c. Aquatic Vegetation	0	0

Table 9.3 : Human Environmental Impacts

Human Issues	Degree of Environmental Impact	
	Project Area Impacts	External Impacts
HUMAN USE		
a. Agriculture	+2	0
b. Livestock	0	0
c. Fisheries	+1	0
d. Afforestation	0	0
e. Agro-industries	+1	0
f. Road transport	+1	0
g. Water transport	0	0
h. Domestic Water Supply	+1	0
i. Sanitation	+1	0
j. Recreation	0	0
k. Energy	-1	0
SOCIAL		
a. Human Carrying Capacity	+1	0
b. Demography	0	0
c. Gender	+1	0
d. Age	0	0
e. Health and Nutrition	+1	0
f. Disruption, Safety and Survival	+1	0
g. Land Ownership	0	0
h. Land Acquisition	0	0
h. Equity	-1	0
i. Social Cohesion	-1	0
j. Social Attitudes	-1	0
ECONOMIC		
a. Incomes	+1	0
b. Employment	+1	0
c. Land Values	+1	0
d. Credit Availability	0	0
INSTITUTIONAL		
a. Institutional Activity/Effectiveness	-2	0
b. Public Participation	-1	0
CULTURAL		
a. Historical/Archaeological Sites	0	0
b. Cultural Continuity	0	0
c. Aesthetics	0	0
d. Lifestyle (quality of life)	+1	0

10. ECONOMIC IMPACT

10.1 PROJECT ECONOMIC OBJECTIVES

The Project Proforma (BWDB 1976) includes an economic justification using shadow prices, which gives an estimated economic B/C ratio for the Project of 3.04, and an EIRR of 28.42 per cent. The PP does not specify any objectives in terms of employment generation, whether on- or off-farm, though these were clearly to be expected under the envisaged intensification of agriculture with the Project.

10.2 PROJECT FINANCIAL IMPACT

As already described in Chapter 4, since the completion of the Project there has been a marked shift in kharif cropping pattern, with farmers moving from Local T. Aman (and to a small extent B. Aman) to HYV T. Aman. The Project was designed to facilitate such a move through improved late-monsoon water supply, and the consequent gain in output value is considered to be a Project benefit. Dry season cropping in the Project area has also been revolutionised during the 1980s by the strong growth in production of irrigated HYV Boro, and to a lesser extent non-paddy rabi crops. While the Project may have played some part in facilitating this change, by improving groundwater recharge, the extent of such benefit is very difficult to quantify. As discussed below, it is not critical to the economic re-evaluation of the Project.

At farm level the move from Local to HYV T. Aman has been highly profitable. Based on crop budgets for representative localities compiled during the RRA (see Annex 2) the financial gross margin for HYV T. Aman is about Tk.21,000/ha., compared with about Tk.12,000/ha. for Local T. Aman and Tk.4,000/ha. for B. Aman. Working capital requirements for seed, fertiliser and chemicals are almost three times higher for HYV T. Aman, but at yields quoted during the RRA the risk of failing to cover the incremental cost in the first season is small, even at informal sector interest rates. The low-risk nature of the innovation goes far to explain its widespread adoption.

Table 10.1: Gross Production and Value of Aman Cultivation

Variety	Gross Production (mt.)		Net Value (million Taka)[1]	
	Without	With	Without	With
Local T. Aman	9484	2040	45.7	9.8
B. Aman	79	-	0.2	-
HYV Aman	-	12900	-	61.1
Total	9563	14940	45.9	70.9
Incremental benefit	-	5377	-	25.0

Notes: [1] Net of production costs, and including value of straw.
Source: Consultant's Estimates.

As shown in Table 10.1 the increase in paddy output can be estimated at just under 5400 mt., with a net financial value of Tk.25 million . These figures are based on farmers' statements of yields, which are probably based on a season without noteworthy problems. It is expected that with the chronic O&M problems of the Project they will have not been achieved been achieved on all land in every year, especially in recent years.

10.3 ECONOMIC RE-EVALUATION

Table 10.2 (including the value of by-products) and a net economic value of about Tk.22 million (Table 10.2)

Table 10.2: Annual Economic Value of Incremental Crop Output
(in 1991 economic prices)

Crop	Area Pre-Project ha.	Area Post-Project ha.	Economic Gross Margin Tk./ha.	Change in Total Gross Margin Tk.
	1/	2/	3/	4/
Local B. Aman	45	0	4742	-213396
Local T. Aman	3734	803	12004	-35183469
HYV T. Aman	0	2899	20056	58141553
Total	3779	3702		22744688

Source: Consultants' estimates

1/ From Table 4.6, plus 20 ha. used for embankment (assumed 50% B. Aman and 50% Local T. Aman)
2/ From Table 4.6
3/ From Annex 3, Tables A3.1-A3.3
4/ Due to rounding Total GM may not be exactly equal to (GM/ha.)x(Area)

An economic re-evaluation of the Project has been undertaken, based on the RRA data on outputs and the information on construction, O&M and rehabilitation costs available from the various Project documents (principally BWDB(1976), BWDB(1990) and EPCL(1988)).

In making the re-evaluation all costs and benefits have been expressed in constant 1991 Taka. The choice of 1991 as base year was dictated by the decision to use RRA agricultural input and output levels and prices, rather than the standard coefficients supplied in MPO(1988) and FPCO(1991), which were found to differ considerably from RRA observations. Conversion factors from financial to economic prices have however been drawn from FPCO(1991). Cost data from the Project documents have been raised to 1991 levels using the relevant price indices from BBS(1981, 1984, 1989). Costs have been disaggregated as far as possible (generally, into unskilled labour, skilled/managerial labour, and materials) in applying cost inflation and economic conversion factors. Details of the derivation of constant 1991 economic costs and benefits are given in Annex 2.

The amount of land acquired for the Project was small (20 ha.) and its cost has been included through deducting this amount from the benefited area; that is, production foregone has been calculated on the gross area, but benefits have been calculated on the area net of the 20 ha. used for the embankment.

In assessing the cost stream of the Project, it has been assumed that the growing delapidation of the Project structures (see Chapter 2) means that the rehabilitation started in FY 1991/92 is essential for maintenance of the benefit stream at its present level. Since the rehabilitation is already under way, its costs, and the subsequent level of O&M expenditure envisaged in BWDB(1990) have been built into the future cost stream. O&M expenditures up to 1991 have been negligible compared to those projected, but the price of this has been the decay of Project structures which has necessitated the rehabilitation programme.

The build-up of agricultural benefits is assumed to have followed a typical 'S'-shaped curve. There is no evidence from the RRA or any other source on the rate at which benefits actually built up, but for computational purposes the pattern shown in Table 10.2 has been assumed:

Table 10.3: Build-up of Project Benefits

Project Year	% of Benefits
5	5
6	15
7	35
8	65
9	85
10	95
11	100

This may be conservative, in view of the evidence on the low risks attached to adoption of HYV Aman (see 10.2 above).

It has also been assumed that defective structures and operating procedures will subsequently have degraded the level of benefits from their peak by making HYV T. Aman production more hazardous due to late season water shortages. The Feasibility Study for the rehabilitation of the Project (EPCL 1988) justifies its proposed programme in terms of facilitating continued movement from Local to HYV T. Aman, but this is based on a pre-rehabilitation cropping pattern which is difficult to reconcile with the high adoption of HYV Aman found by the RRA. The somewhat arbitrary assumption has therefore been made of a decline in benefits of 5 per cent per year from PY 12 (1985/6) to PY 17 (1990/91). Benefits are assumed to be restored to their peak level by PY 20 (1993/4) and to be maintained there for the remainder of a 35-year Project life by a comprehensive maintenace programme funded at the levels proposed in BWDB (1990).

The economic cost and benefit flows of the Project are summarised in Table 10.4. The EIRR is estimated at 54.3 per cent, NPV over a 35-year life at Tk.86715 million, and BCR at 9.5 (both at the assumed cost of capital of 12 per cent). On these criteria the Project is clearly an outstanding economic success, despite its numerous operation and maintenance problems.

Table 10.4
Protappur Irrigation Project: Discounted Economic Cash Flow
(Tk.'000 at constant 1991 economic prices)

Project Year	Financial Year	Construction	Rehabilitation	Operation & Maint.	Total Costs	% of benefits realised	Agricultural Benefits	Net Benefit
1	1974/75	1365.7			1365.7		0.0	-1365.7
2	1975/76	3023.2			3023.2		0.0	-3023.2
3	1976/77	3491.2			3491.2		0.0	-3491.2
4	1977/78	3329.3			3329.3	5	1137.2	-2192.0
5	1978/79			17.8	17.8	15	3411.7	3394.0
6	1979/80			17.8	17.8	35	7960.6	7942.9
7	1980/81			17.8	17.8	65	14784.0	14766.3
8	1981/82			17.8	17.8	85	19333.0	19315.2
9	1982/83			17.8	17.8	95	21607.5	21589.7
10	1983/84			17.8	17.8	100	22744.7	22726.9
11	1984/85			17.8	17.8	95	21607.5	21589.7
12	1985/86			17.8	17.8	90	20470.2	20452.5
13	1986/87			17.8	17.8	85	19333.0	19315.2
14	1987/88			17.8	17.8	80	18195.8	18178.0
15	1988/89			17.8	17.8	75	17058.5	17040.8
16	1989/90			17.8	17.8	70	15921.3	15903.5
17	1990/91			17.8	17.8	65	14784.0	14766.3
18	1991/92		1108.5	17.8	1126.2	70	15921.3	14795.1
19	1992/93		1238.7	17.8	1256.5	85	19333.0	18076.5
20	1993/94		688.7	17.8	706.5	100	22744.7	22038.2
21	1994/95			423.9	423.9	100	22744.7	22320.8
22	1995/96			635.5	635.5	100	22744.7	22109.2
23	1996/97			635.5	635.5	100	22744.7	22109.2
24	1997/98			635.5	635.5	100	22744.7	22109.2
25	1998/99			635.5	635.5	100	22744.7	22109.2
26	1999/2000			635.5	635.5	100	22744.7	22109.2
27	2000/01			635.5	635.5	100	22744.7	22109.2
28	2001/02			635.5	635.5	100	22744.7	22109.2
29	2002/03			635.5	635.5	100	22744.7	22109.2
30	2003/04			635.5	635.5	100	22744.7	22109.2
31	2004/05			635.5	635.5	100	22744.7	22109.2
32	2005/06			635.5	635.5	100	22744.7	22109.2
33	2006/07			635.5	635.5	100	22744.7	22109.2
34	2007/08			635.5	635.5	100	22744.7	22109.2
35	2008/09			635.5	635.5	100	22744.7	22109.2

Economic Performance Measures: EIRR %: 54.3

NPV @ 12%: 86714.6

Source: Consultants' estimates

BCR @ 12%: 9.5

To test the importance of the assumption of effective rehabilitation (which Chapter 2 indicates may be doubtful), the economic performance measures were recalculated for an alternative scenario involving no rehabilitation, continuation of the existing minimal level of O&M, and a continued 5 per cent per year decline in benefits. The Project still appears highly successful in economic terms, EIRR remaining at 54.3 per cent while NPV is reduced to Tk.71221 million and BCR is reduced to 8.6.

The most critical assumption underlying the economic analysis is the proportion of the change from Local to HYV T. Aman attributable to the Project. The sensitivity of the economic indicators to level of agricultural benefit was therefore tested. The switching value (i.e. the level of benefits which reduces EIRR to 12 per cent, NPV to zero and BCR to 1) is about 12 per cent of total benefits regarded as possibly attributable to the Project. In other words, to conclude that the Project has been an economic success it is not necessary to regard more than a fraction - say 25 per cent - of the cropping pattern change as being Project-induced.

10.4 AGRICULTURAL WAGE RATES

The increased cropping intensity (from 166 in the pre-project period to 199 at present) and the introduction of HYV Aman to a large extent has considerably improved the employment opportunities to wage labourers, particularly in the agriculture sector. The wage rate of an agricultural labourer at present amounts to Tk.40 (inclusive of food) as against Tk.16 (again inclusive of food) in 1977-78, just before the project. Converted in terms of rice, the ratio of wages stands at 1:0.8 at post and pre-project periods respectively. This implies that there has been a 25 per cent increase in real wages for farm labourers due, at least partly, to the project's effect on introduction of HYV Aman and increased cropping intensity. It is noteworthy in this connection that the Project area attracts seasonal migrant labourers from other parts of Bangladesh.

10.5 LAND PRICES

Land prices by type of lands according to level are shown in Table 10.4. It appears that the prices have increased by 4-5 times. However, if the increase due to inflation is taken into consideration, the residual increase may reflect, at least partly, the increase due to productivity. It appears that the productivity of land, by and large, has increased which can again be attributed to the adoption of HYVs, and thus in part to the Project. It is interesting to note that the residual price increase of low and medium lands is much higher than that of high lands. This finding is not very surprising, because high lands were the most productive and high-priced before the Project, and therefore stood to gain least. After the project, crop security has increased due to the flood control and drainage measures, and due to the successful retention of water, low and medium lands would have the advantage of more water availability - a condition particularly important for Aman HYV cultivation.

Table 10.5: Price of Land by Type (Tk./ha.)

Type	Price per Hectare (TK)		% of residual increase
	1977-78	1990-91	
High	51,103	204,414	55
Medium	38,328	178,862	121
Low	34,069	161,828	129

Note : Residual increase is defined as that part of the increase which is not due to inflation, considered here as 10% per annum. The residual increase, therefore, may reflect, at least partly the increase in productivity.

Sources : District Statistics, Bogra, BBS, 1983
Upazila Agriculture Office
Consultant's estimates.

10.6 EMPLOYMENT

Kahalu is one of the Upazilas in Bogra district which has maintained a continuous surplus in paddy production for the last one and a half decades. According to a recent estimate, it has a paddy surplus of 27,000 mt. at present (Upazila Food Officer, Kahalu June 1991). The area of the project under study comprises half of the total 9 unions of the Upazila, including the Upazila head quarters.

In recent years, particularly in the last decade, mechanised rice milling has largely increased. Almost all the village centres have some form of mechanised rice milling facilities, either husking or boiler mills. In and around the project embankment and the Upazila headquarters, a number of automatic rice mills can be seen, most of which have recently been established. Growth of rice milling, obviously having great linkage effects on transportation, input supply and engineering workshops, eventually has increased non-farm employment opportunities. All these can be, at least partly, attributed to the introduction of high yielding varieties in the project area.

From data obtained in interviews with rice mill owners and workers, a typical mill processes a batch of 100 maunds (3.73 mt.) in an average of 1.5 days (allowing for drying delays due to wet weather). During the 6-month milling season it will thus process about 450 mt. of paddy, and the incremental 5,400 mt. of paddy attributable to the project would thus have required an additional 12 mills. A 100-md. capacity mill employs about 13 people (manager, technician, assistant and 10 labourers, about 3 of whom would be women). Labourers' earnings are about Tk.50-60 per batch for men, and about half that for women, but at least a third of working days are lost due to weather.

The 6-month paddy milling season is also the peak employment period for transport workers. Freight rickshaw pullers can earn Tk.80 per day at this season, compared with Tk.30-60 per day at other periods. A case was noted of a small farmer who had invested his profits from growing HYV paddy in a freight rickshaw which he operates himself, his farm area being insufficient to employ him fully.

The increased intensity of cultivation has also, predictably, increased demand for manufacture and repair of agricultural implements. A blacksmith at Panch Pir Mazar in the southern part of the Project area stated that the number of smiths in the village had increased to 4, from a single one 10 years ago. The peak period for plough refurbishment is the months of Ashar and Srabhan (mid-June to mid-August) and for other tools is Aghrayan (mid-November to mid-December).

10.7 CONCLUSIONS

The good economic performance of the Protappur Project can be attributed to the following factors:

a) the Project interventions (embankment and regulators) were made in response to a need expressed by local inhabitants and thus with a good chance of breaking a real constraint on farm output. So far as the regulators are concerned, the Project structures replace in more durable form local structures of proven value;

b) the agricultural innovation - replacement of Local by HYV T. Aman - which the Project was intended to facilitate was a straightforward and largely risk-free intensification of the existing farming system, with a high expectation of rapid uptake by farmers;

c) the Project cost is low (Tk.3,675 per hectare benefited at 1991 prices) in relation to the expected benefits (about Tk.6,750 per hectare benefited per year);

d) by luck rather than design, the Project has not created the major disbenefits (particularly in capture fisheries) associated with many other FCD/I projects.

Other RRAs, for example that of the Silimpur-Karatia Bridge-cum-Regulators, show that it is not necessarily true that small projects, even when constructed in response to local demand, are invariably successful. However, from Protappur, and also from a number of other projects, especially submersible embankments, it seems likely that small projects which represent an evolution of local practice and which are modest in their engineering interventions and in cost per hectare stand a better than average chance of meeting or surpassing their economic objectives.

REFERENCES

Documents:

BBS 1983: District Statistics - Bogra, Bangladesh Bureau of Statistics, Dhaka 1983.

BBS 1987a: Small Areas Atlas of Bangladesh: Bogra District, Bangladesh Bureau of Statistics, Dhaka 1987.

BBS 1987b: Bangladesh Census of Agriculture and Livestock (1983-84), Zila Series - Bogra, Bangladesh Bureau of Statistics, Dhaka 1987.

BWDB 1976: Project Evaluation Proforma, Protappur Irrigation Scheme in P.S. Kahaloo, District Bogra, Bangladesh Water Development Board, Dakha, September 1976.

BWDB 1990: Project Proforma, System Rehabilitation Project, Bangladesh Water Development Board, Dakha February 1990.

EPCL 1988: Feasibility Report Rehabilitation Protappur Irrigation Scheme, Engineering & Planning Consultants Ltd. in association with Harza Engineering Company International & Sir M. MacDonald & Partners, Dhaka November 1988.

FAO 1988: Land Resources Appraisal of Bangladesh for Agricultural Development: Report 2 - Agroecological Zones of Bangladesh, FAO, Rome 1988.

FPCO 1991: Bangladesh Action Plan for Flood Control - Guidelines for Project Assessment, Flood Plan Coordination Organisation, Ministry of Irrigation, Water Development and Flood Control, Dhaka July 1991.

MMI 1990: Draft Review Tender Documents and Engineering Design, Sub-project Protappur Irrigation Scheme, Mott MacDonald International & House of Consultants Limited, Dhaka December 1990.

Maps:

Survey of Bangladesh: 1:50,000 topographical sheets 78H/1 (1983) & 78H/5 (1983)

BWDB: 4 in.:1 mile topograhical sheets

ANNEX 1
PROTAPPUR RRA
SUMMARY OF CROP BUDGETS

A. HYV BORO

i) BHADAHAR VILLAGE

MAIN PRODUCT, PADDY 5400 KG. @TK. 4.6 1/		24840	
BY-PRODUCT, STRAW 5400 KG. @TK. 0.60/KG.		3240	
	TOTAL OUTPUT:	28080	28080
COSTS:			
SEED, 44 KG. @TK. 10.7/KG.		472	
LABOUR, 85 M-D @TK. 40		3400	
CULTIVATION 2/		426	
FERTILIZER, 400 KG. @TK. 6.5/KG.		2600	
CHEMICALS		990	
IRRIGATION (DTW) TK. 4,260/SEASON 3/		4260	
	TOTAL COST:	12148	12148
	GROSS MARGIN:		15932

NOTES: 1/ WEIGHTED AVERAGE OF 80% SOLD POST-HARVEST @TK. 4/KG. AND 20% SOLD LATER AT TK. 6.7/KG.

2/ AT HIRE RATE FOR OXEN OF TK. 50/BIGHA. POWER TILLER WOULD COST TK. 511/HA.

3/ COST PER SEASON TK. 6813 IF STW USED

ii) LOHARPARA VILLAGE

MAIN PRODUCT, PADDY 3812 KG. @TK. 6.6 1/		25039	
BY-PRODUCT, STRAW 3812 KG. @TK. 0.60/KG.		2287	
	TOTAL OUTPUT:	27326	27326
COSTS:			
SEED, 44 KG. @TK. 10.7/KG.		472	
LABOUR, 145 M-D @TK. 40		5792	
CULTIVATION 2/		426	
FERTILIZER, 477 KG. @TK. 6.5/KG.		3066	
CHEMICALS		639	
IRRIGATION 3/		2470	
	TOTAL COST:	12865	12865
	GROSS MARGIN:		14461

HYV BORO (Contd.)

iii) FAKIRPARA VILLAGE

MAIN PRODUCT, PADDY 5083 KG. @TK. 6.1	31006	
BY-PRODUCT, STRAW 5083 KG. @TK. 0.40/KG.	2033	
TOTAL OUTPUT:	33039	33039
COSTS:		
SEED, 68 KG. @TK. 10.7/KG.	729	
LABOUR (CONTRACT)	3151	
CULTIVATION (CONTRACT)	1703	
FERTILIZER, 476 KG. @TK. 6.4/KG.	3066	
CHEMICALS	426	
IRRIGATION (DTW)	4259	
TOTAL COST:	13334	13334
GROSS MARGIN:		19705

B. **HYV AMAN**

i) BHADADHAR VILLAGE

MAIN OUTPUT, PADDY 4606 KG. @TK. 5.04	23215	
BY-PRODUCT, STRAW 4606 KG. @TK. 0.60/KG.	2764	
TOTAL OUTPUT:	25979	25979
COSTS:		
SEED, 44 KG. @TK. 10.7/KG.	472	
LABOUR, 85 M-D @TK. 40	3400	
CULTIVATIONS	426	
FERTILIZER, 238 KG. @TK. 6.5/KG.	1533	
CHEMICALS	958	
TOTAL COST:	6789	6789
GROSS MARGIN:		19190

HYV AMAN (cont'd.)

ii) LOHARPARA VILLAGE

MAIN OUTPUT, PADDY 3495 KG. @TK. 5.3	18522	
BY-PRODUCT, STRAW 3495 KG. @TK. 0.60/KG.	2097	
TOTAL OUTPUT:	20619	20619
COSTS:		
SEED, 55 KG. @TK. 8.1/KG.	447	
LABOUR, 136 M-D @TK. 40	5451	
CULTIVATION	426	
FERTILIZER, 341 KG. @TK. 7.0	2385	
CHEMICALS	596	
TOTAL COST:	9305	9305
GROSS MARGIN:		11314

iii) BHOLTA VILLAGE

MAIN OUTPUT, PADDY 4448 KG. @TK. 6.5	28838	
BY-PRODUCT, STRAW 4448 KG. @TK. 0.40/KG.	1779	
TOTAL OUTPUT:	30637	30637
COSTS:		
SEED, 40 KG. @TK. 10.7/KG.	428	
LABOUR, 77 M-D @TK. 35	2695	
CULTIVATION (POWER TILLER)	1278	
FERTILIZER + FYM	2385	
CHEMICALS	426	
IRRIGATION	-	
TOTAL COST:	7212	7212
GROSS MARGIN:		23425

HYV AMAN (Contd.)

iv) FAKIRPARA VILLAGE

MAIN OUTPUT, PADDY 4130 KG. @TK. 5.95	24573	
BY-PRODUCT, STRAW 4130 KG. @TK. 0.40/KG.	1652	
TOTAL OUTPUT:	26225	26225
COSTS:		
SEED, 68 KG. @TK. 10.7/KG.	728	
LABOUR (CONTRACT)	1576	
CULTIVATION (CONTRACT)	1363	
FERTILIZER,	2513	
CHEMICALS	213	
IRRIGATION (EMERGENCY ONLY)	128	
TOTAL COST:	6521	6521
GROSS MARGIN:		19704

C. **HYV AUS (FOR SEED)**

i) BHADADHAR VILLAGE

MAIN PRODUCT, SEED PADDY 2383 KG. @TK. 10.7	25555	
BY-PRODUCT, STRAW 2383 KG. @TK. 0.60/KG.	1430	
TOTAL OUTPUT:	26985	26985
COSTS:		
SEED, 44 KG. @TK. 10.7/KG.	472	
LABOUR, 85 M-D @TK. 40	3400	
CULTIVATIONS	426	
FERTILIZER, 238 KG. @TK. 6.5/KG.	1533	
CHEMICALS	958	
IRRIGATION	-	
TOTAL COST:	6789	6789
GROSS MARGIN:		20196

HYV AUS (FOR SEED) (Contd.)

ii) LOHARPARA VILLAGE

MAIN PRODUCT, SEED PADDY 3176 KG. @TK. 10.7	33983	
BY-PRODUCT, STRAW 3176 KG. @TK. 0.60	1906	
TOTAL OUTPUT:	35889	35889
COSTS:		
SEED, 42.5 KG. @TK. 10.7/KG.	510	
LABOUR, 128 M-D @TK. 40	5110	
CULTIVATIONS	426	
FERTILIZER, 256 KG. @TK. 6	1533	
CHEMICALS	1192	
IRRIGATION (SUPPLEMENTARY MANUAL)	681	
TOTAL COST:	9452	9452
GROSS MARGIN:		26437

D. **B. AMAN**

FAKIRPARA VILLAGE

MAIN PRODUCT, PADDY 1747 KG. @TK. 5.95	10396	
BY-PRODUCT, STRAW 1747 KG. @TK. 0.60/KG.	1048	
TOTAL OUTPUT:	11444	11444
COSTS:		
SEED, 44 KG. @TK. 10.7/KG.	471	
LABOUR 110 M-D @TK. 40	4400	
CULTIVATIONS, 6 @TK. 50	2555	
FERTILIZER FYM	1019	
CHEMICALS	-	
IRRIGATION	-	
TOTAL COST:	8445	8445
GROSS MARGIN:		2999

E. LOCAL AMAN (T)

i) BHADAHAR VILLAGE

MAIN PRODUCT, PADDY 1859 KG. @TK. 5.04	14411	
BY-PRODUCT, STRAW 3718 KG. @TK. 0.60/KG.	2231	
TOTAL OUTPUT:	16642	16642
COSTS:		
SEED, 44 KG. @TK. 10.7/KG.	472	
LABOUR, 85 M-D @TK. 40	3400	
CULTIVATIONS	1276	
FERTILIZER, 40 KG. @TK. 6.5	260	
CHEMICALS	-	
IRRIGATION	-	
TOTAL COST:	5408	5408
GROSS MARGIN:		11234

ii) BHOLTA VILLAGE

MAIN PRODUCT, PADDY 2383 KG. @TK. 6.5	13488	
BY-PRODUCT, STRAW 4766 KG. @TK. 0.60/KG.	2860	
TOTAL OUTPUT:	18347	18347
COSTS:		
SEED, 40 KG. @TK. 10.7/KG.	428	
LABOUR, 77 M-D @TK. 35	2695	
CULTIVATION (POWER TILLER)	1278	
FERTILIZER + FYM	1133	
CHEMICALS	-	
IRRIGATION	-	
TOTAL COST:	5534	5534
GROSS MARGIN:		12813

LOCAL AMAN (T) (Contd.)

iii) FAKIRPARA VILLAGE

MAIN PRODUCT, PADDY 2542 KG. @TK. 5.95	15122	
BY-PRODUCT, STRAW 5084 KG. @TK. 0.60/KG.	3050	
TOTAL OUTPUT:	18172	18172
COSTS:		
SEED, 5.6 KG. @TK. 8.6/KG.	480	
LABOUR (CONTRACT)	1376	
CULTIVATION (CONTRACT)	1363	
FERTILIZER, 238 KG. @TK. 5.6/KG.	1329	
CHEMICALS	-	
IRRIGATION (EMERGENCY ONLY)	128	
TOTAL COST:	4806	4806
GROSS MARGIN:		13366

F. POTATO

i) BHADAHAR VILLAGE

MAIN PRODUCT, POTATOES 15844 KG. @TK. 2.69	42583	42583
COSTS:		
SEED, 715 KG. @TK. 10.7/KG.	7666	
LABOUR	4252	
CULTIVATIONS	426	
FERTILIZER, 953 KG. @TK. 6.5/KG.	6132	
CHEMICALS	852	
IRRIGATION	2300	
TOTAL COST:	21628	21628
GROSS MARGIN:		20955

G. SUGAR CANE

i) BHADAHAR VILLAGE

MAIN PRODUCT, GUR 9531 KG. @TK. 10.7	102209	
BY-PRODUCT, TOPS (9:1) KG. @TK.	11357	
TOTAL OUTPUT:	113566	113566
COSTS:		
SEED	8517	
LABOUR	34069	
CULTIVATION	1650	
FERTILIZER + MANURE	6473	
CHEMICALS	-	
IRRIGATION	-	
TOTAL COST:	50709	50709
GROSS MARGIN:		62857

ANNEX 2

Table A2.1
Financial and Economic Budgets for: HVY AMAN
(1991 Financial Prices from RRA)

	Qty.	Financial Unit Price Tk.	Financial Value Tk./ha.	SCF 1/ Tk./ha.	Economic Value Tk./ha.
A. Outputs					
Main product (paddy) kg./ha.	4450	6.05	26923	0.97	26115
By-product (straw) kg./ha. 2/	4450	0.60	2670	0.82	2189
Total Output Value Tk./ha.			29593		28304
B. Inputs					
Seed kg./ha.	52	10.7	556	0.97	540
Fertiliser kg./ha.	333	6.5	2165	1.54	3333
Chemicals per ha.			548	0.91	499
Labour m-d/ha.	99	40	3960	0.71	2812
Cultivations no.	3	433	1299	0.82	1065
Irrigation					0
Total Variable Cost Tk./ha.			8528		8248
Gross Margin Tk./ha.			21065		20056

Table A2.2
Financial and Economic Budgets for: LOCAL T.AMAN
(1991 Financial Prices from RRA)

	Qty.	Financial Unit Price Tk.	Financial Value Tk./ha.	SCF 1/	Economic Value Tk./ha.
A. Outputs					
Main product (paddy) kg./ha.	2540	5.77	14656	0.97	14216
By-product (straw) kg./ha. 2/	5080	0.60	3048	0.82	2499
Total Output Value Tk./ha.			17704		16715
B. Inputs					
Seed kg./ha.	42	10.7	449	0.97	436
Fertiliser kg./ha.	107	6.5	696	1.54	1071
Chemicals Tk./ha.			0	0.91	0
Labour m-d/ha.	81	37.5	3038	0.71	2157
Cultivation no.	3	426	1278	0.82	1048
Irrigation			0		0
Total Variable Cost Tk./ha.			5460		4712
Gross Margin Tk./ha.			12243		12004

Notes: 1/ From FAP Guidelines for Project Assessment.
2/ Straw:grain ratios: 1:1 for HYV T.Aman
2:1 for Local T.Aman
1:1 for B.Aman as harvested (long stubble left in deep water)

Annex 2 (cont'd.)

Table A2.3
Financial and Economic Budgets for: LOCAL B.AMAN
(1991 Financial Prices from RRA)

	Qty.	Financial Unit Price	Financial Value Tk./ha.	SCF 1/	Economic Value Tk./ha.
A. Outputs					
Main product (paddy) kg./ha.	1747	5.95	10395	0.97	10083
By-product (straw) kg./ha.2/	1747	0.60	1048	0.82	860
Total Output Value Tk./ha.			11443		10942
B. Inputs					
Seed kg./ha.	44	10.7	471	0.97	457
Fertiliser kg./ha.	157	6.5	1021	1.54	1572
Chemicals Tk./ha.			0	0.91	0
Labour m-d/ha.	110	40	4400	0.71	3124
Cultivation no.	3	426	1278	0.82	1048
Irrigation	—		0		0
Total Variable Cost Tk./ha.			7169		6200
Net Output Value Tk./ha.			4274		4742

Notes: 1/ From FAP Guidelines for Project Assessment.
2/ Straw:grain ratios: 1:1 for HYV T.Aman
2:1 for Local T.Aman
1:1 for B.Aman as harvested (long stubble left in deep water)

Table A2.4: Financial Construction Costs of Protappur Irrigation Project

Project Year	Financial Year	FFW Wheat for Embankment & & Khals		Regulators (labour)		Regulators (materials)		Planning, Design & Management		Total Construction Cost	
		Current 1/	Constant 1991 2/	Current 3/	Constant 1991 4/	Current 3/	Constant 1991 5/	Current 6/	Constant 1991 7/	Current	Constant 1991
1	1974/75	73.2	161.0	102.5	579.0	150.8	442.0	83.3	424.8	409.8	1606.8
2	1975/76	475.8	951.6	64.5	339.2	682.8	1734.3	114.2	525.3	1337.3	3550.4
3	1976/77			397.3	2081.6	570.0	1652.9	169.7	627.9	1136.9	4362.4
4	1977/78			308.5	1502.3	688.6	1976.2	225.1	675.3	1222.2	4153.8
5-35	1978-2009										0.0
Total											4106.2

Table A2.5: Economic Construction Costs of Protappur Irrigation Project
(Tk.'000 at constant 1991 prices)

Project Year	Financial Year	FFW Wheat for Embnkt. & Khals		Regulators (labour)		Regulators (materials)		Planning, Design & Management		Total Constn. Cost
		Financial 1991	Economic 1991 6/	Financial 1991	Economic 1991 6/7/	Financial 1991	Economic 1991 6/	Financial 1991	Economic 1991 6/	Economic 1991
1	1974/75	161.0	157.8	579.0	451.6	442.0	331.5	424.8	424.8	1365.7
2	1975/76	951.6	932.6	339.2	264.5	1734.3	1300.8	525.3	525.3	3023.2
3	1976/77			2081.6	1623.6	1652.9	1239.7	627.9	627.9	3491.2
4	1977/78			1502.3	1171.8	1976.2	1482.1	675.3	675.3	3329.3
5-35	1978-2009									0.0
Total										11209.4

Notes:
1/ From (EPCL 1988), apportioned between years as in (BWDB 1976)
2/ From (BWDB 1976), including contingencies allocated in proportion to original cost estimates).
3/ From (BWDB 1976)
4/ From (BWDB 1990)
5/ Pre-1994/95 from BWDB 1976 (embankment maintenance costs only). From BWDB 1990 for 1994/95 onwards.
6/ All economic costs derived using conversion factors from (FPCO 1991).
7/ Labour for regulators assumed 70% skilled (SCF = 0.82) 30% unskilled (SCF = 0.71)

Annex 2

Table A2.6: Summary of Financial Costs of Protappur Project
(Tk.'000 at constant 1991 prices)

PY	FY	Construction Total 1/	Rehabilitation Costs Labour (Embankt. & Khals) 2/	Regulat-ors 2/	Total Rehab.	O&M Costs 3/	Total Costs
1	1974/75	1606.8					1606.8
2	1975/76	3550.4					3550.4
3	1976/77	4362.4					4362.4
4	1977/78	4153.8					4153.8
5	1978/79					25.0	25.0
6	1979/80					25.0	25.0
7	1980/81					25.0	25.0
8	1981/82					25.0	25.0
9	1982/83					25.0	25.0
10	1983/84					25.0	25.0
11	1984/85					25.0	25.0
12	1985/86					25.0	25.0
13	1986/87					25.0	25.0
14	1987/88					25.0	25.0
15	1988/89					25.0	25.0
16	1989/90					25.0	25.0
17	1990/91					25.0	25.0
18	1991/92		1220.0	323.0	1543.0	25.0	1568.0
19	1992/93		1544.0	190.0	1734.0	25.0	1759.0
20	1993/94		970.0		970.0	25.0	995.0
21	1994/95					597.0	597.0
22	1995/96					895.0	895.0
23	1996/97					895.0	895.0
24	1997/98					895.0	895.0
25	1998/99					895.0	895.0
26	1999/2000					895.0	895.0
27	2000/01					895.0	895.0
28	2001/02					895.0	895.0
29	2002/03					895.0	895.0
30	2003/04					895.0	895.0
31	2004/05					895.0	895.0
32	2005/06					895.0	895.0
33	2006/07					895.0	895.0
34	2007/08					895.0	895.0
35	2008/09					895.0	895.0
Total		13673.5	3734.0	513.0	4247.0	13527.0	31447.5

Notes: 1/ From Table 12.5
2/ From (BWDB 1990)
3/ Pre-1994/5 from (BWDB 1976) (embankment maintenance costs only)
For 1994/5 onwards from (BWDB 1990)

Table A2.7: Summary of Economic Costs for Protappur Irrigation Project
(economic prices in constant 1991 Taka)

PY	FY	Con-struct-ion 1/	Rehabilitation Earthworks (Labour) 2/	Rehabilitation Regulators 3/	O&M 2/	Total
1	1974/75	1365.7				1365.7
2	1975/76	3023.2				3023.2
3	1976/77	3491.2				3491.2
4	1977/78	3329.3				3329.3
5	1978/79				17.8	17.8
6	1979/80				17.8	17.8
7	1980/81				17.8	17.8
8	1981/82				17.8	17.8
9	1982/83				17.8	17.8
10	1983/84				17.8	17.8
11	1984/85				17.8	17.8
12	1985/86				17.8	17.8
13	1986/87				17.8	17.8
14	1987/88				17.8	17.8
15	1988/89				17.8	17.8
16	1989/90				17.8	17.8
17	1990/91				17.8	17.8
18	1991/92		866.2	242.3	17.8	1122.2
19	1992/93		1096.2	142.5	17.8	1256.5
20	1993/94		688.7		17.8	706.5
21	1994/95				423.9	423.9
22	1995/96				635.5	635.5
23	1996/97				635.5	635.5
24	1997/98				635.5	635.5
25	1998/99				635.5	635.5
26	1999/2000				635.5	635.5
27	2000/01				635.5	635.5
28	2001/02				635.5	635.5
29	2002/03				635.5	635.5
30	2003/04				635.5	635.5
31	2004/05				635.5	635.5
32	2005/06				635.5	635.5
33	2006/07				635.5	635.5
34	2007/08				635.5	635.5
35	2008/09				635.5	635.5

Notes: 1/ From Table 2.5
2/ Assumed all unskilled labour, SCF = 0.71
3/ Assumed all materials, SCF = 0.75