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 HALIR HAOR PROJECT




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Hunting Technical Services Limited

in association with:
Bangladesh Institute of Development Studies
Flood Hazard Research Centre
Hunting Fish-Tech
Technoconsult International Limited

under assignment to
UNITED KINGDOM OVERSEAS DEVELOPMENT ADMINISTRATION

Sanyu Consultants Inc.

under assignment to
JAPAN INTERNATIONAL CO-OPERATION AGENCY

## Project Summary Sheet

**Project Name** : Halir Haor Project

**Project Type** : Submersible Embankment (FCD)

**Location**

**FAP Region** : North-East
**District** : Sunamganj



**Area (ha.)** : 8,000-8,700 ha.(gross)

**Funding Agency** : IDA (World Bank: SSDFCP) and WFP FFW

**Implementing Agency** : BWDB

**Construction started** : embankment 1976/77-1983

**Scheduled Completion** : structures: 1983

**Actual Completion** : structures: 1987

**Original Cost Estimate** : Tk 8.5 million (1983 prices)

**Final Cost Estimate** : not known



**Major Flood Damage:** : 1990 (overtopped almost a month before target date)

**Repair/rehabiltation in** : annual because overtopped each year

**Key points**

Partially effective in protecting Boro harvest (intended impact), however embankment not maintained to design crest level - requires resectioning. Regulators added to improve drainage (achieved) and reduce maintenance costs (limited impact as cannot be opened to equalise water levels between harvest and overtopping because of fallboards and low embankment crest). Even so expected Boro harvest about one third higher with project than without project, and high economic rate of return. Limited adverse fisheries and environmental impacts, although suggestions to add more sluices (because regular cuts still needed to drain out water) would possibly cause loss of winter beel areas (a serious environmental loss). Minimal gain to poor households: somewhat more work but also increased population and adverse effects of crop failures (due to early floods and weather - storms, drought, and post-harvest loss). Previously free access to monsoon season fishing now limited (external control of Jalmahal), out-migration to find work increased, and severe food shortages in pre-harvest period. Project does not help in coping with high floods.

## CONTENTS

## ABBREVIATIONS AND GLOSSARY

| | |
|---|---|
| **BBS** | Bangladesh Bureau of Statistics |
| **benthic** | bottom of a water body (ecology) |
| **BWDB** | Bangladesh Water Development Board |
| **dheki** | traditional foot operated paddy husker |
| **euhalophytic** | of fresh water (plant) |
| **FAP** | Flood Action Plan |
| **FFW** | Food For Work |
| **FPCO** | Flood Plan Coordination Organisation |
| **Haor** | a large water body in a natural depression |
| **HYV** | High yielding variety |
| **IDA** | International Development Agency (World Bank) |
| **IUCN** | International Union for the Conservation of Nature and Natural Resources |
| **Jalmahal** | Fisheries owned by the government, but for which fishing rights are leased out. |
| **khalashi** | guard/operator |
| **LV** | Local variety |
| **machan** | platform of bamboo or wood |
| **maund** | 37.23 kg |
| **mohajan** | moneylender |
| **MPO** | Master Plan Organisation (National Water Plan) |
| **O&M** | Operation and Maintenance |
| **PWD** | Public Works Datum (for water levels) |
| **RRA** | Rapid Rural Appraisal |
| **SDE** | Sub-Divisional Engineer (of BWDB) |
| **SSDFCP** | Small Scale Drainage and Flood Control Project |
| **UAO** | Upazila Agricultural Officer |
| **UNO** | Upazila Nirbanhi Officer (senior Upazila administrative officer) |
| **WFP** | World Food Programme |
| **XEN** | Executive Engineer (of BWDB) |

## SUMMARY


### Project description
A submersible embankment project in Sunamganj District. Taken over from local bodies by BWDB sometime between 1976/77 and 1983/84, embankment length 53 km. Two regulators built 1984-87 under SSDFCP (IDA credit 955-BD) to improve drainage and reduce recurrent maintenance of annual cuts. Aim of project: to safeguard the Boro harvest by preventing floods before 15 May of more than 20' PWD. Benefited area: about 8,000-8,700 ha in total.

### Engineering assessment
The structures appear to have been well constructed, but fallboards are inappropriate because they cannot be removed to equalise the water level before the embankment is overtopped. Regular cuts are needed to drain out water after the monsoon. The embankment is maintained regularly and the cuts closed, but the crest level is less than the design standard due to insufficient FFW allocations.

### Institutional assessment
A formal arrangement for project management is lacking, and the regulators are under the control of influential local persons. There is a lack of liaison between BWDB and the local administration. Local resources are not provided for embankment maintenance, except that one person cuts and closes the embankment of his own initiative each year.

### Agriculture
There is one crop per year, mostly local Boro. Following the project the cultivated area has increased by 6% of the total area, and now 5% of the area is under HYV Boro. Before the project Boro yields were on average considerably lower than possible because of frequent early flood losses. The project does not protect Boro completely, for example in 1990 early flooding led to a total loss, but on average yields are estimated to be about 19% higher with the project than pre-project, because of somewhat better flood protection. Overall these changes result in about one third more paddy being produced on average, but output still fluctuates.

### Livestock
The cattle population has declined because of losses during high flood years, reduced areas of grazing, and continued crop failures resulting in sale of cattle, while draft power requirements have increased slightly.

### Fish
Fish catches are apparently unchanged, but there has possibly been a change in catch composition with delayed onset of flooding affecting fish migration. There is no benefit to pond cultivation.

### Environment
The rivers outside the project are silting up with an unknown effect on flooding and the environment in the long term in the haor. The area of beels in winter is reduced resulting in lower numbers of wintering wildfowl. The area of wet grassland is also reduced, affecting grazing and grass supplies. There is a shortage of trees, but the embankment could be planted with flood tolerant *Barringtonia* trees.

### Nutrition
Food intake is no better and there are severe food shortages for many households just before the (Boro) harvest. Foodgrain production is higher but so is the population, while access to the fishery is now restricted.

**Women**
Women have not been adversely affected compared with men. There is some increase in paddy processing, and some women find work on repairing the embankment, but women have not yet started to work harvesting paddy.

**Socio-economic**
The project benefits and management have not been targeted to help the poor. Many men migrate out of the area for work for seven months, while much harvesting is done by in-migrants. Availability of fish to casual and small scale fishermen has declined as the main Jalmahal is now controlled by outside interests. Likewise much of the agricultural gain goes to a few large landowners.

**Floods**
Early floods damaging Boro are only one important aspect of life in haor areas. In parallel, assistance for the post-harvest period and in coping with high floods is needed. For example, earlier maturing Boro paddy varieties, improved/safe drying and storage technologies, cattle shelters and safe places for people in high floods would be valuable.

**Economic re-assessment**
Limited data on project costs was available, but valuing the agricultural gains using MPO and FPCO data, and assuming that there were no other major economic impacts, results in an estimate of the economic rate of return for the whole project of about 65%. The incremental return on investing in the two regulators may well have been even higher. However, there would probably also be similar returns to improving embankment maintenance to achieve the intended performance.

## SOME KEY LESSONS

1 A formal institutional framework for liaison between BWDB, District, Upazila and Union administrations, and representatives of project inhabitants (including farmers, fishermen, and landless) is needed. There should be a project committee to co-ordinate maintenance and ensure that local contributions are made and used fairly. While regulator committees could improve on the operation of the structures.

2 Annual maintenance is critical in a submersible embankment, and part should be funded from local resources - a levy in cash or kind on beneficiaries according to the extent that they benefit; however resistance to this may be strong given that it would be on top of land revenue which is not charged according to the productivity of land.

3 Submersible embankments by definition do not protect people from floods. While the people of the haor are adjusted to living with annual floods, living conditions for half of the year are very poor. Applied research and small scale investments are needed to improve peoples' ability to cope with their environment: for example earlier maturing paddy, improvements in paddy drying and processing methods to help safeguard the harvest, providing safe places in village mounds during extreme floods, safeguarding livestock and fodder during the monsoon, and extension of the homestead areas to provide a minimum living area during the monsoon.

4 Complete drying out of smaller beels with low-lift pumps for fishing may adversely affect fish stocks - further research is needed and a ban might need to be imposed. Existing perennial water bodies and wetlands should be protected and not drained or encroached further to preserve the ecological balance of the haor (in particular its fishery).

# 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 Halir Haor Project.

## 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 are 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. Further background to RRA will be found in the FAP 12 Methodology Report.

## 1.3 GENERAL LOCATION

Halir Haor is located in Jamalganj Upazila (apart from a very small part in Tahirpur Upazila) in Sunamganj District (greater Sylhet district) and is bounded by the Surma river to the south-east and the Boala river to the north-west and south-west (Figure 1.2). The project area takes its name from the main haor in its area but includes a number of smaller beels.

The project was selected for post-evaluation, using rapid rural appraisal methods, at random as a representative submersible embankment project completed after 1975 from the main haor basin in north-east Bangladesh.

The region comprises a series of haors - depressions which flood deeply (often to depths of 4m or more) for at least half of the year, and separated from one another by rivers and the slightly higher land of natural levees along the river banks. Under these conditions only one crop is possible in the winter period when flood water recedes - this is usually Boro paddy. The main limiting factor on its cultivation is the short period of flood free conditions and in particular the risk of early flooding just before harvest which can destroy the crop. Water depths are too deep for too long, and rise too quickly, for a monsoon crop to be possible. In addition the haors and the perennial beels within them are important fisheries. Transportation for most of the year is by boat. Homesteads are located on village mounds which are above all but extreme flood levels. As a result people and livestock are crowded into very small areas for half of the year.

Most of the haors in the region have been protected from early flooding by submersible embankments - designed to keep early floods out of the haor until the Boro crop has been harvested. After this the concept is that flood water should be allowed into the area in a controlled way so that water levels are more or less equalised before the main flood peak which submerges the embankments occurs, in order to minimise damage to the embankment during overtopping.

## 1.4 HALIR HAOR

A locally constructed submersible or dwarf embankment had been constructed for some time around at least part of Halir Haor, perhaps dating back to the early Pakistan period. However, 18 out of 29 miles (29 out of 46 km) of embankment were reported by IDA to have been built under a WFP Food-For-Work (FFW) programme in 1976-77; unfortunately the engineers responsible for the project were unable to confirm this construction date and only have records of FFW maintenance carried out from 1984. Moreover the official length of embankment according to the responsible BWDB sub-division is 53 km. What is clear is that as part of IDA credit no 955-BD (Small Scale Drainage and Flood Control Project - SSDFCP) Halir Haor was taken up as a sub-project and two regulators were built between 1984 and 1987 and have been operational from 1988. Hence the appropriate comparison for evaluation of the project is between 1988-1991 (with project conditions) compared with pre-1977 conditions (before project) with some allowance for without project trends which might have occurred in any case.

The area of the project is not clear from the documents available: the sub-project report prepared for Halir Haor under SSDFCP gives a gross area of 20,000 acres (about 8000 ha) which may refer to the total project area, and a net area of 16,000 acres (6475 ha) which may refer to the area to benefit from the two regulators (not equal to the whole project area) or to the cultivated area. However, the most recent FFW scheme submission for Halir Haor (1990) gives a net area of 8677 ha and a gross area of 7335 ha - which is clearly inconsistent. Few official records are available, and recall by local people of information for the early-mid 1980's is difficult. In any case the project can be regarded as not being complete during that period.

No statement of ultimate objectives of the project is available. However, according to the sub-project summary prepared by the consultants to IDA credit 955-BD the sub-project aimed at irrigation, drainage and flood control although the only reference to problems in the area is to delays in transplanting Boro due to drainage congestion, and early flooding causing

damage to crops at the maturing stage. Hence it may be deduced that the aims were to raise agricultural production by ensuring the harvest of Boro crops and did not include any general increase in cropping intensity, switch in crop types, or wider flood protection. Moreover there seems to be no provision in the plans or in practice in the project for delivery of irrigation water to potential users, so there was not an effective irrigation objective.

## 1.5 RELEVANT AIMS AND CRITERIA OF SSDFCP

Since the structures built for Halir Haor were part of the Small Scale Drainage and Flood Control Project, it is appropriate to review the criteria for sub-project selection and aims of this Project which should apply to Halir Haor. This was one of the first projects aimed at financing water control structures to complement and improve on embankments being built under the WFP FFW programme. The original plan was to fund structures in about 100 sub-projects (World Bank, 1979). However, it was possible to expand this considerably, due to lower construction costs and devaluation of the Taka, to 204 sub-projects (World Bank, 1990). The following were criteria for sub-project selection (World Bank, 1979):

a) constructed under FFW and designed by BWDB;

b) subject to an up-to-date technical, economic, and financial appraisal to include evaluation of soils and hydrology;

c) at least 1000 acres and/or 500 farming families benefited, at least 70% of which with holdings of 3 acres or less;

d) to cost not more than US$150 per acre to complete in direct costs (at 1979 prices);

e) to yield an economic rate of return not less than 25% on project financed investments (excluding sunk costs);

f) to be completed by December 31, 1984;

g) to be operated and maintained under arrangements satisfactory to IDA;

h) to have no serious adverse environmental impact (paying particular attention to the potential effects of the project on fish production); and

i) to be consistent with the programme for improving BWDB's water sector planning organisation and procedures.

Particular points noted were that there should not be any adverse public health impacts, but that soil fertility could be expected to decline with flood protection - the loss being assumed to be outweighed by the benefit from protecting non-agricultural activities and assets from flooding. Disturbance to "fish culture" by bunds and embankments was to be specifically investigated and guarded against (World Bank, 1979).

Operation and maintenance (O&M) was specifically discussed for SSDFCP and the problems of funding routine maintenance in Bangladesh and other countries noted. It was proposed (World Bank, 1979) that since O&M of earthworks is mostly labour intensive it could be achieved by "local councils" on a voluntary basis or under FFW, but maintenance of structures was to be funded by BWDB - the latter at a cost of US$0.86 per acre at 1979 prices (World Bank, 1979). Consistent with this plan BWDB was to give priority in its choice of sub-projects to locations where the local councils indicated an interest in assuming

responsibility (including funding) for O&M (as agreed under the then Thana Irrigation Programme). If this was not possible BWDB was to ensure satisfactory O&M from its own sources.

The Project Completion Report (World Bank, 1990) notes in general that the project overran but was more successful than anticipated in the sense that more sub-projects were funded and almost three times the expected area was benefited. However, it implicitly noted that project sustainability was low since O&M has not received the resources it needed. It is noted that some of these issues are addressed in the Systems Rehabilitation Project, but that transfer of control to beneficiaries is proposed for irrigation and not for flood control and drainage projects.

A major problem both for this evaluation and in attempting a reliable evaluation of the SSDFCP is that only six sub-projects were studied at appraisal and the same ones evaluated after completion. These include Sanir Haor which is adjacent to Halir Haor and provides some useful comparative information. However, the possibility that more attention was paid to the focus sub-projects cannot be ruled out (observation by the RRA team and the opinion of the responsible SDE indicated that the embankment of Sanir Haor had been constructed and/or maintained to a higher standard than that protecting Halir Haor). No actual cost data for construction of structures at Halir Haor are available.

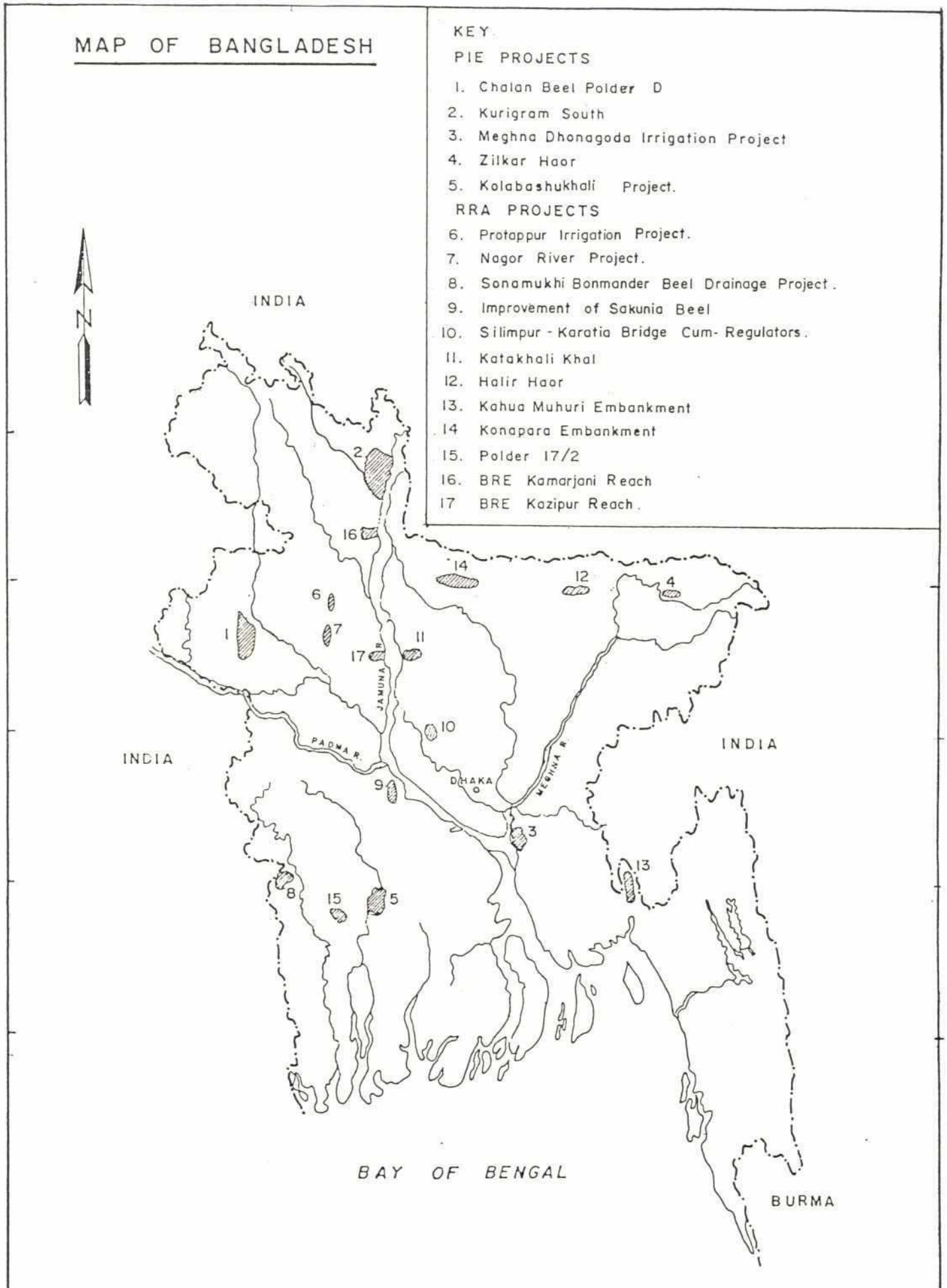
## 1.6 RRA ORGANISATION

The RRA team comprised specialists in: engineering, agriculture and livestock, environment, economics, and institutions. Fieldwork took place between 10-16 May inclusive and was based in the Upazila town of Jamalganj. Access to the project area was by engine boat. We are very grateful to the BWDB Sunamganj Division for arranging hire of the boat, and to the Upazila Chairman and UNO of Jamalganj for arranging accommodation and generously providing assistance and information. Information obtained during the fieldwork is based on discussions with the relevant BWDB staff, officers of Jamalganj Upazila, and with the inhabitants of some 13-14 mouzas (revenue villages) within the project area.

## 1.7 REPORTING

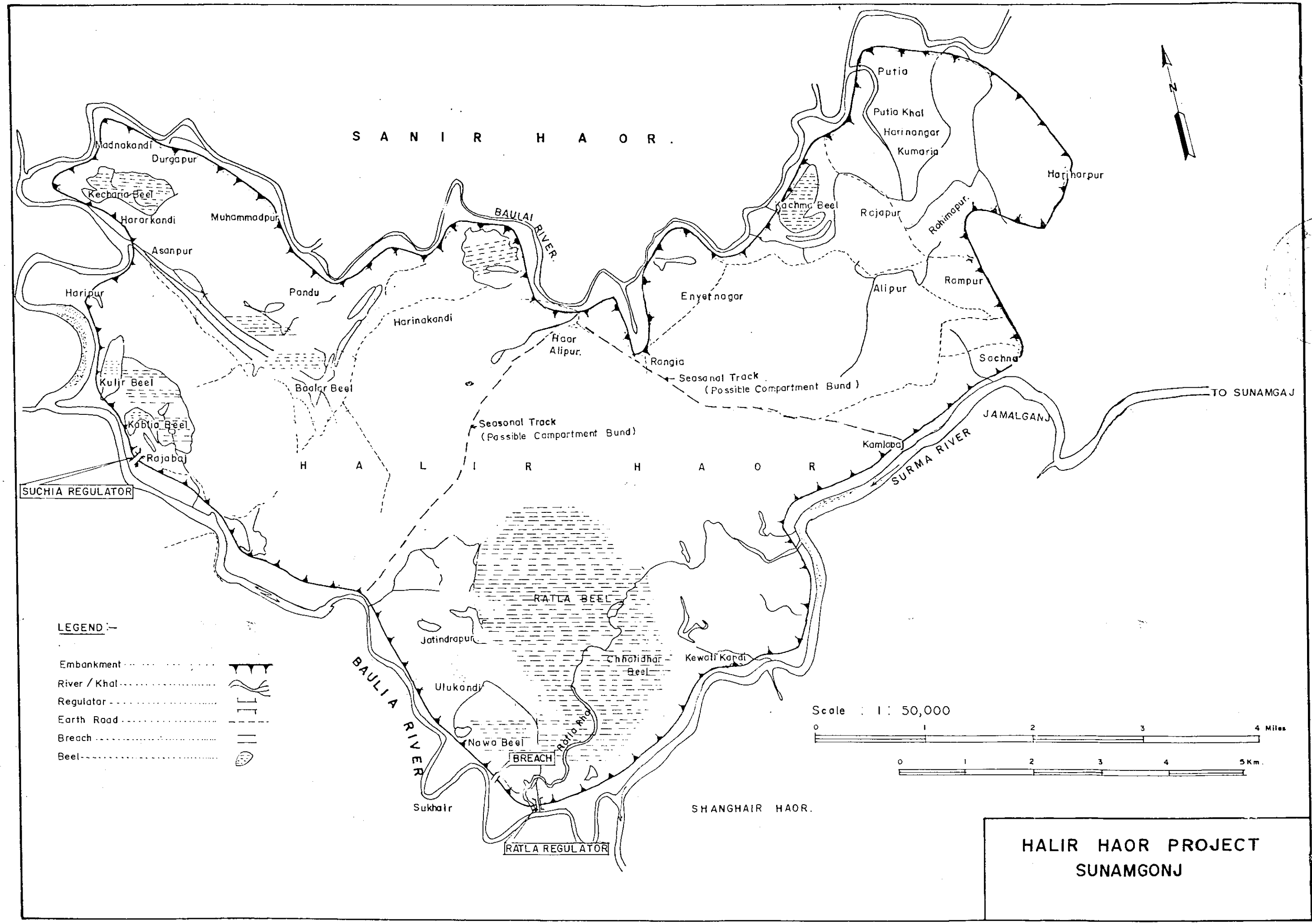
This report falls into three parts: Sections 2 and 3 assess the design of the project in achieving its immediate objectives and the operation and maintenance of the project. Problems in engineering or in institutional aspects of the project implementation and management may explain problems in achieving its ultimate aims. Sections 4-9 cover different subject areas or sectors on which the project could have had planned or unplanned impacts. Sections 10-12 summarise these impacts into three broad headings, respectively: social and environmental assessments of impacts which cannot be evaluated in economic terms, and economic evaluation of the project.

Figure 1.1 Locations of FCD/I projects evaluated by FAP 12




Source Consultants

Figure 1.2 Halir Haor Project showing locations visited and key features



# 2 ENGINEERING DESIGN, IMPLEMENTATION AND PERFORMANCE

## 2.1. PRE-PROJECT SITUATION

The entire area of Halir Haor project is low, except the high homestead areas, and goes under 5' (1.5m) to 20' (6m) depth of water every year from April/May to November/December, due to early flash floods and subsequent monsoon floods from the surrounding rivers. The only crop grown in this area is (mainly local) Boro, and all of the agricultural land, with the possible exception of small areas of higher land along the river banks (mostly outside the project) can be categorised as F4 land according to the MPO criteria (MPO, 1987).

The farmers faced two-fold problems for their crops:

i) Transplanting was delayed due to drainage congestion in the area during the post-monsoon period; and

ii) The crops were partially or fully damaged during the maturing stages due to early flash floods inundating the area.

The then Circle Officer Development, in collaboration with the local people, constructed a dwarf embankment along the river banks surrounding the project area during the 1960's:

a) to protect the area from early flash floods in April/May; and

b) to ensure a safe harvest of their only crop of Boro paddy.

To overcome the drainage congestion problems the people used to:

i) cut the existing embankment in each year at some particular khal closures during the post-monsoon period to release the water; and

ii) close those khals before the next early floods.

But this arrangement did not give satisfactory results to the farmers as:

i) the rate of overtopping of the dwarf embankment was very frequent; and

ii) the closing of the cut portions every year before early floods could not be achieved properly, causing partial or full damage to the crops of the area.

## 2.2 PROJECT OBJECTIVES

The primary objectives of the combined FFW project with IDA funded structures were control of early floods upto R.L. 20' PWD, and controlled drainage of the area, aiming at safe harvest of the only crop - Boro paddy.

## 2.3. ASSESSMENT OF PROJECT FEATURES

### 2.3.1 Project infrastructure

The Halir Haor Project was declared complete in 1986-87. The engineering features of the project (see Figure 1.2) are as follows:

i) Length of submersible embankment = 53 km.

a) Embankment crest elevation + 20' (6.1m) PWD

b) Embankment crest width 8' (2.4m)

c) Closure crest width 14' (4.3m)

d) Side slopes + 1:2 (embankment) both sides
1:3 (closure) both sides

(ii) Flushing cum drainage regulator = 2 nos.

a) Regulator at Ratla khal = 5 vents

b) Regulator at Suchia khal = 3 vents

### 2.3.2 Structures

The structures appear to have been constructed to a satisfactory standard and have not yet silted up. However, there seems to be some variance from the sub-project summary prepared prior to implementation of the structures. The latter refers to the approval of an unspecified number of pipe sluices, yet none have been constructed. Additionally both structures are marked as 5'x18', yet as noted above, the regulators inspected are of different dimensions and capacities. Unfortunately no detailed design drawings or as built drawings could be obtained for the structures in order to verify the construction or understand the reasons for any change in design.

So far there has been no maintenance work on the structures themselves since completion in 1987. However, both use wooden fallboards to close the vents. This has two implications for O&M:

i) the boards are vulnerable to warping, rotting, and damage during operation, some have to be replaced every year, and the SDE reported that in 1990/91 winter 25 out of 75 boards had been replaced - a significant maintenance cost; and

ii) the fallboards are difficult to operate. During the fieldwork the boards in the Ratla Khal regulator were leaking profusely since there was still at least a 40cm head difference flowing into the project. It was reported by local people that "Boail" fish could pass through the gaps.

More importantly the operating objectives of the project cannot be effectively achieved with this design: one of the general concepts behind operation of structures in submersible

embankment projects is that after the Boro crop has been safely harvested water should be let into the project in a controlled way before the embankment is overtopped to equalise the inside and outside water levels and thus reduce damage to the embankment during overtopping. This is not possible with wooden fallboards since it is impossible to remove by hand more than a few boards with a large head difference at the regulator.

It is understood from Sunamganj BWDB Division that this design is no longer used in new projects, but the adjacent submersible embankment projects built at about the same time are reported to use vertical lift gates which are clearly better suited to this type of operation. It should be possible to fit these to the regulators of Halir Haor, although the design and current condition of the inside aprons and spillways could not be assessed as they were underwater. The cost implications in terms of direct investment cost relative to reduced maintenance costs (of boards and embankment) and increased potential efficiency in operation have not been assessed.

While the operating efficiency and annual maintenance costs of the project might be improved, it is just as likely that the current controlling interests of the local elite over the regulators would be strengthened without an improvement in institutional arrangements at the same time (see Section 3).

### 2.3.3 Embankment

The design crest of the embankment was fixed at El.+20' PWD to protect the project area from early flash floods up to 15th May, the target date for the completion of Boro harvest. The actual crest level was found to be inadequate as the embankment was submerged on 17th April, 1990 about 1 month before the target date and almost 100% of the standing crops were damaged. The existing embankment crest is not constructed or maintained to the design elevation of + 20' PWD at several reaches totalling a length of about 14km. These reaches are about 2 - 2.5 ft. (0.6 - 0.76 m) below the design crest level (as mentioned by BWDB SDE responsible for this project) due to inadequate funds (availability of wheat). Observations by the RRA team confirmed that those sections of Halir Haor embankment still visible in mid-May had a lower crest elevation (by about 30cm) than embankments on adjacent haor projects.

The existing embankment was submerged almost everywhere except for a few short reaches during the RRA visit, but it was known from the SDE (BWDB) that the major length will need to be repaired after the flood. The actual annual maintenance work will depend on availability of funds under FFW programme. He also mentioned that if the whole embankment was once repaired to the design section and crest level in one season he expected the maintenance cost in the subsequent years would be reduced to a great extent. At present limited resources mean that only the worst portions of embankment are repaired each year, this invariably involves repairing the public cuts to close off the khals. Table 2.1 shows the quantity of maintenance work under FFW requested and achieved/provided for each year on record with the SDE. It is not clear whether the project had actually been adopted by BWDB before these records.

### 2.3.4 Interior of the project

The 53 km embankment has closed all the drainage khals of the area except the Ratla khal and Suchia khal where drainage-cum-flushing regulators were later constructed. But several beels and low pockets of different sizes within the project area which were being

drained out through the khals are now facing acute drainage congestion during the post-monsoon period. Non-existence of an internal drainage network system to connect these low pockets to the Ratla/Suchia drainage khals is causing the drainage congestion. Environmentally this may be a blessing in disguise (Section 11). If drainage improvements are considered these should not aim to maximise drainage of the entire area, given the fisheries and environmental factors discussed in Sections 6 and 11. However, if areas are not to have more efficient drainage there is likely to be continued pressure or conflict from landowners there who see their neighbours benefiting more from the project.

The existing low level village roads (one between Haor Alipur and Naya Kari (near Ulukandi) and the other between village Rongia and Kamlabaj) are providing dry season communication for harvesting as well as helping in soil moisture retention for the higher region of the project area. But it is not sure that they will be above early flood levels. There appears to be widespread support for raising these roads and higher land areas slightly to provide compartments within the project area (see Sections 2.4.3 and 2.5).

A few Low-Lift Pumps (LLPs) of both 1 cusec and 2 cusec capacity are owned by rich farmers, and used to irrigate their Boro crops (very small area) from the adjacent river or the perennial Beels. The poor farmers have no LLP at all (LLP were found in village Asanpur with the present U.P. Chairman, and with an ex-Member in village Mahmudpur). The use of LLPs appears to have developed since the project but reflects private investments. They are not part of the project infrastructure.

## 2.4 OVERALL ENGINEERING/TECHNICAL ASSESSMENT OF PROJECT

### 2.4.1 Positive impacts

1. The project has partly fulfilled its primary objective, since it protects the area from early floods of elevations up to 20' (6.1m) PWD, but this level may be exceeded before the target date of 15 May, by which date the harvest should be completed.

2. The project has provided a controlled drainage system for part of its area. This also makes possible the retention of water to improve soil moisture content and to facilitate surface water irrigation in the dry season.

### 2.4.2 Negative impacts/aspects

1. Some reaches of embankment have a crest level up to two feet lower than the design standard, because of inadequate maintenance due to limited resources.

2. The actual embankment crest level appears now to be inadequate to achieve protection of crops up to the target date of 15 May (for example breaches and overtopping on 18 April in 1990, and overtopped by 1st week of May in 1991).

3. The quality of embankment maintenance is poor under Food-For-Work (FFW) programme due to lack of compaction and lack of quality control.

4. There is practically no internal drainage network to connect the low pockets to the existing regulators, which causes drainage congestion in the project area.

5. The project did not connect some low areas to the drainage channels and regulators.

In order to drain these areas public cuts are made every year in several places. Hence drainage is uncontrolled and earthwork closures are needed every year for the channels. Obtaining sufficient and suitable earth from the same locations is becoming increasingly difficult, and so the quality of closure work falls.

6. The regulator fallboards leak profusely and, due to the high head of water, cannot be removed to permit controlled flooding after harvest.

### 2.4.3 Recommendations

1. The whole length of the embankment should be raised (where necessary) to the design crest level in the next dry season pending recommendation 2.

2. A re-evaluation should be made of the appropriate design standard in terms of flood frequency and its associated crest level for different protection levels and the appropriate target date, and of the agronomic justification for this target date.

3. Compartmentalisation of the haor with similar internal submersible embankments based on existing dry season village roads would provide an additional safeguard if embankments breach, would be of help in retaining soil moisture, and could improve communications at harvest time. Locations suggested by BWDB and by local people are: Haor Alipur to Noyakaki/Ulukandi, and Rangia village to Lombabaj/Kamlabaj.

4. Replacement of the wooden fallboards used in the regulators with vertical lift gates appears to be technically justified, as in similar projects constructed later.

5. If complaints of inadequate and uncontrolled drainage are substantiated, appraisal of investments in new drainage facilities is needed. Potential locations may be at: Netuar Khal, Mohamadpura Khal, and Putia river; although there may be other appropriate locations.

6. A study should be conducted to assess the costs and benefits of additional regulators and pipe sluices and of the proposed internal drainage network. The adequacy of the existing regulators to drain the entire project area within the target date should also be assessed.

7. There is further scope for supplementary irrigation to improve Boro yields. This would be by low-lift pumps and require pipe inlets through the embankment, it should not be through draining the beels (see Section 11). These might be constructed by private individuals or irrigator groups.

8. There is a general belief that the reason for higher early floods than before is rising river beds in the area, if this is substantiated by proper investigations, a comprehensive study of the entire haor system of greater Sylhet district should be conducted to assess trends in siltation and provide a long term plan for the submersible embankment projects. Unfortunately baseline data from which to make such an assessment is likely to be incomplete.

## 2.5 LESSONS

1. Regular embankment maintenance is particularly important for submersible embankments, otherwise they may well be overtopped before their target date. Without adequate maintenance it is difficult to assess whether crop losses are due to changing flood conditions or a reducing effective embankment standard.

2. Submersible embankment projects with structures should have gates designed for operation with sizeable head differences, and for operation in both directions.

3. The concept of compartments within projects appears to have obvious merits:

   a) in localising losses when embankments fail or are overtopped, or are badly maintained; and

   b) the compartment inhabitants are more likely to see the benefits of their contributing to their compartment's maintenance, although some coordination would be needed between compartment committees since there would still be a strong interdependence between their activities.

   It is therefore recommended that this concept be tested. Since this would involve new works rather than regular maintenance the opportunity to link these with local planning of the works and a local commitment to their management would be available. Although some land would be taken, at least in the circumstances of Halir Haor this could be a valuable public resource for the local people (access, more safe higher land at harvest, and more trees).

**Table 2.1 Food For Work maintenance (requested and actual) for Halir Haor project, Sunamganj District**

| Financial year | Programmed work | | | Actual work | | | Percentage of plan achieved | |
|---|---|---|---|---|---|---|---|---|
| | Embankment (km) | Wheat (mt) | Earth ($m^3$) | Embankment (km) | Wheat (mt) | Earth ($m^3$) | length | wheat |
| 1984-85 | 19.2 | 256.30 | - | 11.2 | 203.80 | - | 58% | 80% |
| 1985-86 | - | 195.798 | - | - | 187.254 | - | - | 96% |
| 1986-87 | 7.55 | 174.235 | - | 6.97 | 170.174 | - | 92% | 98% |
| 1987-88 | 8.29 | 295.402 | 120048.2 | 6.6 | 235.881 | 96034.6 | 80% | 80% |
| 1988-89 | 5.32 | 203.418 | 73961.0 | 5.32 | 203.418 | 78014.0 | 100% | 100% |
| 1989-90 | 12.48 | 280.273 | 106012.0 | 12.48 | 222.601 | 84708.69 | 100% | 79% |
| 1990-91 | 7.29 | 217.552 | 82493.0 | 6.27 | 137.954 | - | 85% | 63% |
| Mean | 10.02 | 231.6 | | 8.14 | 194.4 | | 81% | 84% |

Note: means for volumes of earth not calculated as number of years with available data is small

Source: BWDB Sunamganj O&M Division

# 3 INSTITUTIONAL APPRAISAL

## 3.1 PRE-PROJECT SITUATION

In the pre-project situation a number of institutions such as traditional co-operatives and BRDB co-operatives were reportedly functioning and operating in and around the project area. However the pre-project period is too distant to assess the effectiveness of rural institutions at that time.

## 3.2 PROJECT OBJECTIVES

The primary objective of the project is to protect the area from early floods (April/May) of elevation up to 20 feet PWD. The ultimate goal is to protect the Boro crop from flooding during its maturing and harvesting stage. However, for the SSDFC project there was an objective that O&M should be organised (and funded) on a voluntary basis by "local councils" and if this was not possible then under FFW or directly from BWDB (see Section 1.5).

## 3.3 INSTITUTIONAL ARRANGEMENT FOR THE PROJECT

There was no special O&M Manual prepared for the SSDFC project, nor has any manual for operation and maintenance been prepared by the O&M division for this project. An important prerequisite for effective operation and maintenance is thus absent. The formal institutional structure is limited to the usual BWDB O&M Divisional structure.

The actual informal "institutional" arrangements and issues in public participation in O&M are:

1. Three regular sites of "public cuts" were reported by BWDB and by local informants, although cuts are also made at other sites. These cuts are "planned" to the extent that the BWDB division agrees that they are needed for post-monsoon drainage and would like to build regulators there. However, in only one of these locations does a local person request permission each year to make the cut - he also arranges for the cut to be filled in each year before the risk of early floods (it is not clear whether this is at his expense or at the cost of local farmers). Cuts are not made to let in water after harvest to safeguard the embankment during overtopping. By this time the embankment is already close to overtopping or breaching.

2. The embankment overtops each year with a head difference causing erosion of its country side. Local involvement at this time is limited to some people patrolling the embankment in the pre-harvest period. They may take action, or request the Upazila to help, if there is a risk of overtopping/failure before harvest. Hence the responsibility for maintenance at the critical time falls on the beneficiaries, otherwise they lose their entire crops. There is no assistance from BWDB or the local administration in forming local responses and organisations for flood-fighting and emergency repairs.

3. Maintenance of earthworks, both the embankment and the closures, is carried out under FFW programme through BWDB. BWDB contracts local UP members to enrol labourers for the earthwork, with supervision by BWDB Work Assistants and Section Officers.

4. Only a casual assignment of operating responsibilities seems to have been made for the regulators: this is the responsibility respectively of the Upazila and Union Parishad chairmen of the project area. This means that there is no direct representation of local

interests in the management of the regulators. BWDB has little influence over operation of the structures. It has provided neither gauge marks nor instructions on recommended water levels or actions at different times of the year.

## 3.4 OTHER RURAL INSTITUTIONS

### 3.4.1 Background

Information obtained from the RRA field visit indicates that besides traditional cooperatives a number of other institutions, such as the Grameen Bank, and an NGO - Institute for Development Education and Action (IDEA), have been functioning since the project was built. Most of the data obtained refers to Jamalganj Upazila as a whole. Virtually all (over 95%) of Halir Haor project falls within Jamalganj Upazila, and the project covers some 36% of the area and population of Jamalganj Upazila (the remainder of which is virtually all haor areas). There did not appear to be any difference in the development of rural institutions between Halir Haor and the rest of the Upazila, which is not surprising as there are other submersible embankment projects covering a large part of the Upazila.

### 3.4.2 Traditional Co-operatives

The activities of the traditional co-operatives obtained from official sources are furnished in Table 3.1.

**Table 3.1 Traditional Co-operatives in Jamalganj Upazila**

| Type of Societies | No.of Societies | Enrolment/ Membership | Share Tk | Savings Tk | Loans Tk | Recovery Tk | Outstanding Tk |
|---|---|---|---|---|---|---|---|
| Union Multipurpose | 2 | 155 | 9850 | 2335 | 197400 | 140000 | 57400 |
| Fisherman co-op Society | 8 | 376 | 8930 | 6333 | | | |
| KSS | 38 | 1035 | 71090 | 35934 | 792500 | 405443 | 387057 |
| Total | 48 | 1566 | 89870 | 44602 | 989900 | 545443 | 444457 |

Source: Jamalganj cooperatives officer

Most of the traditional co-operatives are not operating properly and facing difficulties in improving the poor condition of the activities of the societies. Only a few are in good condition.

### 3.4.3 BRDB co-operatives

BRDB co-operatives were also observed to function in the project area. The current (1991) position is presented in Table 3.2.

Some of the BRDB co-operatives were found to function properly, while some of the societies were reported to function well below their expectation.

The chief function of the farmers co-operative societies is to promote agricultural output and marketing of agricultural products. This happens when farmers have surplus of the produce after consumption. As reported, few farmers have an investible surplus while most

of the farmers in the project area were found to be at subsistence levels. Hence such co-operatives benefit relatively richer farmers.

Other types of BRDB sponsored cooperatives such as small trading, cattle raising, poultry and duck raising, and handcrafts were reported to be quite active.

**Table 3.2 BRDB Co-operatives in Jamalganj Upazila**

| Type of co-operative | No.of Societies | Enrolment/ Membership | Shares Tk | Savings Tk |
|---|---|---|---|---|
| KSS | 33 | 645 | 144700 | 160253 |
| BSS | 15 | 238 | 13230 | 31242 |
| MSS | 12 | 193 | 6700 | 13129 |

Source: BRDB, Jamalgonj.

Notes : KSS = Krishi Samabay Samity; BSS = Bittaheen Samabay Samity;
MSS = Mahila Samabay Samity.

### 3.4.4 Other Institutions

The Grameen Bank located in Jamalgonj Upazila has been extending its services by providing credit to disadvantaged groups. This institution was reported to be helping women in income generating activities: small scale trading, poultry raising, cattle rearing, small cottage industries, and handicrafts. In the project area 69 groups comprising 345 members appeared to function under the purview of Grameen Bank. Grameen Bank disbursed a total amount of Tk 985,650 to its members as of April 1991, for income generating activities. The recovery of the loan amounted to Tk 4,93,950, outstanding amount being Taka 4,11,700.

In addition IDEA has been organizing labourers (both male and female) to achieve greater unity and consciousness, to save and invest in various income generating activities, to enrol in primary education, and to improve health and sanitation.

### 3.4.5 Institutional base

There is, therefore, some development of more effective institutions to support development activities for disadvantaged groups in the project area, although their growth has not been due to the project but part of general programmes for the area. However, this means that there is some basis from which improved management and maintenance of the project organised through local people could be developed. However, this will not be stimulated either by BWDB, the local administration, or by the NGOs alone.

## 3.5 ASSESSMENT OF INSTITUTIONAL ACHIEVEMENTS OF PROJECT

### 3.5.1 Positive Aspects

1. Local people, at least in some areas, have proved capable of developing their own arrangements for cutting and repairing the embankment.

This has not been as a direct result of any initiative by BWDB. In fact there is circumstantial evidence that, by BWDB taking over the submersible embankment, previous local initiatives to maintain the embankments have declined with increased dependence on FFW.

### 3.5.2 Negative Aspects

1. Effective consultation between BWDB, the Upazila administration, and the local people concerning operation and maintenance of the project is virtually nonexistent.

2. As in other FCD projects in Bangladesh, beneficiaries have no direct responsibility (in cash or labour) for project maintenance which is dependent on outside resources under FFW programmes.

3. People are not compensated for earth taken from their land for embankment maintenance under FFW programmes.

4. There is no public participation in operation of the project. Project committees for operation have not been formed and the two regulators are each operated by a single member of the local elite (respectively Chairman of the Union Parishad and ex-Chairman of the Upazila).

5. The regulators are sometimes operated to catch fish for the benefit of the operators and not the farmers, creating a social conflict between the poorer farmers on the one hand and local leaders and fishermen on the other hand.

## 3.6 RECOMMENDATIONS AND LESSONS

### 3.6.1 Recommendation directly related to project

1. There should be a formal institutional framework for liaison between BWDB; District, Upazila and Union administrations, and representatives of project inhabitants (including farmers, fishermen, and landless).

2. There should be a project committee to co-ordinate maintenance and ensure that local contributions are made and used fairly.

3. There should be regulator committees for operation of the regulators including representatives of all the area served, of the different interest groups there, and of BWDB.

4. FFW means that the project is continually dependent on external resources. Attempts at local resource mobilisation through taxation would most likely meet resistance since land taxes at present are not related to the value or productivity of land. The local people believe their land taxes are too high compared with more productive areas. It would also be difficult to gain acceptance of voluntary labour inputs given the availability of FFW. However, a matching commitment from local landowners above some minimum holding (say 1 ha) might provide the extra labour needed to achieve the design embankment, and could be promoted as securing the still uncertain harvest. Because of the public good nature of the embankment some regulation to enforce such contributions, once agreed by the local community, would be needed, this might take the form of the project management committee being able to raise taxes, and the normal FFW being withdrawn if local contributions are not made.

### 3.6.2 Other recommendations

1. The current leasing system for the Halir Haor Jalmahal favours richer and more powerful interests at the expense of poor fishermen (See Section 6). Splitting the leasing between fishing villagers or groups, payment in instalments, and a quota on the number of active fishing units could all help in more fairly distributing access to the resource and in controlling exploitation of the fish stock.

2. Khas land (which is used for cultivation) should be leased out to bona fide landless groups.

3. Basing land revenue assessment on the average value of land (and its productivity) and not on a flat rate should be considered. Farmers in Halir Haor reported that they paid the same rate despite only having one uncertain crop as did farmers growing 2-3 crops a year.

### 3.6.3 Lessons for future projects

1. While the SSDFC project hoped to encourage sustainable O&M of sub-projects, the lack of institutional support and funding for institution building mean that the lack of effective local participation in and resourcing of O&M is no surprise.

2. BWDB, local administration, and beneficiaries could cooperate in having an emergency plan to cope with early floods and risks to the embankment. For example, designated work teams could be available for emergency works under appropriate technical supervision if the local patrols find problems before the harvest is completed.

# 4 AGRICULTURAL IMPACT

## 4.1 LAND AND FLOOD TYPE

The project is a Haor area. It is bounded by the rivers Surma and Boulai. The vast majority of the area is low and goes under 15 or more feet (4.6m) of water every year in the monsoon season from April-May to October-November (Table 4.1), corresponding to F4 land in the MPO categorisation (MPO, 1987). The submersible embankment project has not changed land or flood types as it merely protects against early flooding.

The depth of flood water varies during the monsoon: during June-July near Enathnagar it is +10 ft (3m), while at Satidhara (beel) water level goes up to 21 ft (6.4m) during that period. The water levels are less during the months of March-April and October-November (3-4 ft, 0.9-1.2m), and reach a maximum in June-July. About 6% of the total project area remained under water for the whole year acting as an important source of fish supply.

Only about 0.27% of the area remains above flood level. This mainly consists of homesteads, markets and schools which are all on man-made mounds (Table 4.2). The rim of the haor area is slightly raised (3-5 ft, 0.9-1.5m) above the inside, comprising natural river bank levees. Agricultural land is divided into innumerable small plots, heterogenous in shape and size. Approximately 86% of the total area was under cultivation (Table 4.2) before the project.

There are two major and five minor khals (Table 4.3) which served as the drainage system for the project area. The principal khal, Ratla, normally flows from the north to the south and the Suchia khal flows from north-east to the south-west. These serve as drainage systems for the Satidhara and Suchia beel areas respectively during the post-monsoon period.

## 4.2 PRE-PROJECT CONDITIONS

### 4.2.1 Crops, cropped area and cropping pattern

The project area is mainly low-lying and experienced flooding every year and occasional drought. Particularly because of the risk of pre-harvest flooding, the returns to cultivation were very uncertain.

Local Boro paddy was the only important crop and reportedly occupied about 99% of the net area under cultivation in a selection of villages surveyed (Table 4.4). Substantial areas of fallow land (wetlands) existed, resulting in a cultivated area of 86% of total land area (Table 4.2). The Local Boro seedlings are transplanted in December-January and harvested in late April. For the remaining seven months the land remained fallow due to flood water.

Diversification of crops was negligible due to flood hazards and the cropping pattern followed by the cultivators was dependent on flood and drainage conditions. However, farmers grew chilli, sweet potato, brinjal and countrybean in a very limited area (2% of cultivated area, Table 4.5), mainly near and around the homesteads and near the river banks, where the land elevation is somewhat higher.

The areas in Table 4.5 are based on the UAO's information and while covering the majority of the project area there are some minor differences where block boundaries do not coincide with the project. However, the areas are sufficiently consistent with the recorded area of the project for this to be ignored in an approximate evaluation such as this.

### 4.2.2 Inputs used

Since the project area is a haor area and local Boro paddy was the only main crop grown there, the farmers did not apply any fertilizer and agro-chemicals (Table 4.5). However, some farmers applied cowdung (reportedly at the rate of about 50 mds/acre) in growing chilli, brinjal and country beans.

### 4.2.3 Crop management

Since Local Boro was the only main crop grown in the project area, farmers normally practised a low-labour input management system. Land preparation, raising and transplantation of seedlings, crop establishment and harvesting were the major activities followed. Harvesting is the most critical operation and always involved a large migrant labour input working for a share of the harvest (one seventh part).

### 4.2.4 Yield

The yields of Boro as well as of other crops were low, mainly due to non-use of high yielding varieties, limited use of fertilizers, following of low input crop management practices and natural calamities like drought and flood. It was a common occurrence that nearly ripe and sometimes fully ripe paddy went under water and could not be harvested. The yield of the main crop L. Boro was estimated by the UAO to have been about 21 md/acre (1.9 tn/ha) (Table 4.5). However, this is a **potential yield** rather than an actual average yield in pre-project conditions. Based on discussions with farmers in five villages within the project area yields which took into account the potential yield and the frequency of partial and total loss remembered by the farmers are given in Table 4.4. A weighted mean (by the mouza area represented by each location) of these average or "expected value" yields in pre-project conditions is **1.1 tn/ha for L Boro or 58% of the potential flood free yield**.

The per acre yields of other crops such as winter chilli, groundnut, millet, brinjal, sweet potato and countrybean were also estimated to have been low mainly because of use of traditional varieties and low input use. Farmers, facing early flood risk, were hesitant to invest the required capital for higher yielding varieties, fertilizers and plant protection measures necessary for increasing yields.

## 4.3 OBJECTIVES OF THE PROJECT

None of the documents available gave estimates of with project cropping patterns or anticipated yields. However the aims of the embankment and regulators were to protect the Boro harvest. Implicit in the type of project implemented is the expectation that there would not be any major switch in crop types or pattern. Hence yields ought to rise to their potential by excluding the risk of pre-harvest flooding.

## 4.4 SOURCES OF DATA

During the RRA agricultural information was collected from:

- interview of officials including BWDB Engineers and the Upazila Agricultural Officer (Jamalganj) to know their assessment of the preceding condition as well as the impact of the project and the conditions within and around the project area;

- interviews with farmers in different villages of the project area including Alipur, Jotindrapur, Harinakandi, Putia, Insanpur, Asanpur, Suchiakhal, Mahmudpur,

Gopalpur, Einatnagar, Beheli Alipur, Rajabaj, Lambag, Kamalabaj and Sachna. Farmers were interviewed in groups and also individually. Cross-checking was done to have more reliable information;

- interviews with traders of several bazaars including Beheli and Sachna to note their opinions in respect of pre-and post-project conditions;
- direct observations of such agriculture as was visible; and
- official publications including BWDB reports and the Bangladesh Statistical Year Book.

## 4.5 THE VALUE AND FEASIBILITY OF THE PROJECT OBJECTIVES

Given that the project is a haor area and the loss of potential harvests from early flooding noted in Section 4.2.4, the aim of protecting the Boro crop up to harvest time appears to have been an appropriate and readily attainable objective. By comparison full flood protection could be expected to result in major changes in cropping pattern, but would have been much more expensive, would have vastly changed the environmental conditions of the area, and would have required major extension efforts to assist farmers in adjusting.

As an alternative to the structural response (submersible embankment) to flooding adopted in Halir Haor, it would have been difficult to find an alternative agricultural development strategy which was better adjusted than L Boro to these particular flood circumstances - shorter duration rabi crops would have been less productive. Nevertheless efforts to find and promote HYV Boro varieties which could be harvested within the available time would also have been, and would still be, worthwhile in improving the livelihoods of the people of Halir Haor.

Irrigation does not appear to have figured in project planning, although as will be seen from cropping changes in Section 4.6, there may be some further scope for investment in this (see Section 2.4.3). So far the limited development of irrigation has been through private development of small scale LLP irrigation and interventions may only be needed if the distribution of this resource is unequal.

The agricultural objectives of the project were only attainable in the long term with continued repair of the submersible embankment, and Sections 2 and 3 showed that this was a problem. Despite this the project is still achieving some benefits.

## 4.6 POST-PROJECT AGRICULTURAL CONDITIONS

### 4.6.1 Crops, cropped area and cropping pattern

The field visits revealed some modest but important changes in the cropping pattern. The cropping intensity is still one crop per year, but the cultivated area and the proportion under different crops have changed. According to the UAO the cultivated area has increased by about 6% (see Table 4.5) because some 50% of land which was previously fallow in the winter has been brought under cultivation. This trend was confirmed during group discussions (although the actual area of additional cultivation could not be reliably estimated). Areas which were not free of water for long enough previously are now cultivated because of improved post-monsoon drainage and perhaps because of a more secure harvest period.

Additionally HYV Boro has started to be grown in the project area as a direct result of the project. Table 4.4 shows that in three of the villages visited small to moderate areas are

now under HYV Boro. This is invariably on higher land since this is free of water for slightly longer and local people reported that the varieties of HYV Boro they are using require a 10-14 day longer period in the fields. The HYV Boro appears to have replaced local varieties. Based on observations over a larger part of the project area it was estimated that 5% of the cultivated area of the project is now under HYV Boro. However, this figure is lower than that originally reported by the UAO and the actual area of HYV Boro may be different from the estimate used here, depending on how representative the areas visited were. This growth in HYV Boro has taken place despite an apparently negligible effort at distribution of improved seed to the area - according to BBS (1985) in 1979-83 much more wheat seed than Boro seed was distributed in Jamalganj Upazila.

Farmers of the periphery of the project, especially of Lambabag and Kamlabaj, are now showing some increased interest in cultivating a slightly larger area of rabi crops on their higher land, and a minor area of wheat has been added, because the land is free of water for a longer period.

### 4.6.2 Inputs used

Use of chemical fertiliser has now started, particularly with the introduction of HYV Boro. However application rates are as yet low (Table 4.5) so there should be minimal environmental implications. Chemical fertilisers are also being used on the small areas of rabi crops on higher land, presumably reflecting increased security. Cultivation of L Boro is unchanged. In addition a few LLPs are now used in the area to help irrigate HYV Boro, but not yet on a large scale.

### 4.6.3 Crop management

Labour inputs for a given crop are unchanged from pre-project levels, although HYV Boro requires slightly more labour for harvesting. Additionally the labour system, with harvesting on a share basis by teams of migrant labourers, is virtually unchanged. Draught power is, however, in shorter relative supply as a reflection of cattle sales in response to continued crop failures. Currently only 5% people have their own plough to plough their lands, the rest manage by hiring. Some large landowners have now started to use power tillers, which they also lease out to smaller farmers, increasing the level of purchased inputs. The hire cost in 1990-91 was Tk 70 per 28 decimals, the same as for a plough team if hired for cash.

However, cash inputs such as this require credit - a typical arrangement with local mohajans (moneylenders) is to take Tk 100 as a loan on repayment of 1 maund of paddy at harvest (Tk 180 in 1991) implying over 6 months an effective annual interest rate of 160%. An alternative arrangement is to hire a plough team from neighbouring areas on a crop share basis - 10 maunds of paddy for ploughing four acres. Agricultural wage rates were about Tk 30 plus one meal per day in 1991. However harvesting is traditionally done by migrant labourers for a one seventh share of the paddy.

### 4.6.4 Yield

Since the project has only been fully operational since the completion of the regulators, and because of problems of recall over a longer period, field estimates of Boro yields were based on the last four harvests (1988-1991 inclusive) as reported by farmers. Table 4.4 shows the mean yields reported during this period for Boro. It will be seen that in general L Boro yields in the last four years have been higher than in pre-project conditions but have not averaged the potential yield.

Not all of this difference reflects flooding and problems with the project. In 1988 and 1989 the yield of Boro was affected by drought and hailstorms. There was some difference of opinion on which year experienced which hazard but it seems most likely that the hail-storm occurred in 1989 and affected the crops around villages Sukair, Ulukandi, Jatindrapur, Kalipur, Lambabag and Kamlabaj. Losses varied from close to 100% to 15%. In 1990, however, the embankment was overtopped by early flooding on 18 April and about 90% of the Boro crop was lost.

Although the farmers had just had a bumper harvest in 1991 prior to the survey, due to bad weather (continuous rain) they could not thresh, clean, and dry the paddy; as a result, much paddy had sprouted in temporary stacks and thus post-harvest loss may go up to 30%. This post-harvest loss has not been incorporated in the expected yields, but highlights the fact that early floods are only part of the environmental hazard facing farmers here. Normal post-harvest loss may be in the range 5-10% (based on interviews).

Based on these four years, the weighted mean yields, assuming that the project is unsuccessful in preventing early flooding in 1 in 4 years and that the incidence of other climatic events was typical, were **1.31 tn/ha for L Boro and 2.65 tn/ha for HYV Boro**. This suggests a 19% increase in L Boro yields as a direct result of the project in its current state of maintenance. If the project were effective at preventing early floods up to its target date (omitting 1990 from the calculations and basing the weighted average yield on three years data) then the yields might be 1.76 tn/ha for L Boro and 3.61 tn/ha for HYV Boro (35% higher than the average including 1990 and close to the potential yields noted in Table 4.5).

## 4.7 POSITIVE IMPACTS

It was not possible to clearly separate in the group discussions the impacts of the embankment from those of the regulators. However, the introduction of HYV Boro is relatively recent and it seems plausible that by speeding drainage, along with delays in the onset of flooding, the area of HYV Boro has increased as has the total cultivated area. The embankment alone probably only raised the expected Boro yield without affecting cultivated areas much. **All the following estimates are approximate** and depend on the reliability of information from discussions with farmers and Upazila statistics.

1. The cultivated area has increased by 6%.

2. HYV Boro is now grown on 5% of cultivated land. It is limited by the short growing season and by available surface water.

3. L Boro yields have averaged 19% higher in recent years than they were before the embankment was taken up by BWDB.

4. As a direct result of the project paddy production now averages 9074 tonnes per year, compared with a mid-1970's estimate of 6815 tonnes per year, a 33% increase. 19% of this is due to the protection of existing L Boro areas, with the remaining 14% due to increased cultivated area and conversion of some slightly higher land to HYV Boro.

5 Approximately 42,750 additional person days of agricultural labour have been created as a result of points 1 and 2, although much of this work goes to people from outside the area.

## 4.8 NEGATIVE ASPECTS

Although there do not appear to have been any directly negative impacts on agriculture, there are some limitations on the achievement of potential benefits from the project.

1. The project has had negligible impact on non-paddy crops.

2. The project has not eliminated the risk of early pre-harvest flooding, either because the design embankment crest elevation cannot be maintained or because the effective design standard has fallen with a trend to higher earlier floods.

3. If the project had eliminated flood losses to Boro, yields might be about 35% higher than over the last four years, and in the case of L Boro 60% higher than mid-1970's yields.

4. Total Boro output might average 12,200 tonnes a year with flood protection up to the target date.

5. Even with improved early flood protection, the concentrated harvest period and rising flood waters make large post-harvest losses likely, as in 1991.

6. There appears to have been minimal effort in agricultural extension since the project. For example, there may be other HYV Boro varieties which would mature more quickly. These, or harvesting earlier than the traditional crop stage followed by farmers, might make a larger area of HYV Boro possible or raise the final paddy yield.

## 4.9 RECOMMENDATIONS

1. There is scope for more supplementary irrigation during the dry period to improve Boro yields. This would be by low-lift pumps and require pipe inlets through the embankment. These might be constructed by private individuals or irrigator groups.

2. Compartmentalization of the haor with similar internal submersible embankments based on existing dry season village roads would provide an additional safeguard if embankments breach, and would be of help in retaining soil moisture at the early stage of crop growth, as well as helping to ensure a safe harvest of crop. Locations suggested by local people and BWDB are: Haor Alipur to Noyakandi/Ulukandi; and Rangia village to Lambabag/Kamlabaj.

3. Applied agronomic research and field trials in the project area are needed to assess the suitability of alternative crops such as sweet potato, groundnuts and millet, and of other varieties of Boro paddy, which might be more profitable than crops and varieties currently grown or would be more secure, given the existing risks of early flood and other environmental hazards.

4. Applied research and small scale investments are also needed to improve people's ability to cope with their environment: for example appropriate improvements in paddy drying and processing methods to help safeguard the harvest in the monsoon.

## 4.10 LESSONS

1. While submersible embankments can increase harvested yields substantially, this depends on their continued ability to achieve their targets. Benefits are very sensitive to actual maintenance levels and any changes in hydrological-hydraulic conditions which alter the effective design standard. Continued monitoring is needed to maintain the intended benefits.

2 The limiting factor of very deep flooding for half of the year will continue in the haor areas.

3 Submersible embankments, and associated water control structures, are only one part of a strategy to living with floods in haor areas. Investments in post-harvest technology and in improved and enlarged safe places during the monsoon would also improve living standards.

**Table 4.1 Annual maximum water level in some areas of Halir Haor in monsoon season**

| Place | Water level (ft) |
|---|---|
| Einathnagar | +10 |
| Haripur | 7 |
| Harinakandi | 8 |
| Satidhara (Beel) | 21 |
| Khuria Haor | 20 |

Source: group discussions, Halir Haor, 1991.

**Table 4.2 Land use pattern of the Halir Haor area**

| Land type | mid-1970's (pre-project) | | With project | |
|---|---|---|---|---|
| | Area (acre) | % | Area (acre) | % |
| Net cultivated area | 15578 | 86.0 | 16520 | 91.3 |
| Homestead | 20 | 0.1 | 24 | 0.1 |
| Road, markets, school etc. | 20 | 0.1 | 24 | 0.1 |
| Fallow lands | 1500 | 8.3 | 750 | 4.1 |
| Other use (Tree, bush etc.) | 1000 | 5.5 | 800 | 4.4 |
| Total | 18118 | 100 | 18118 | 100 |

Source: Upazila Agricultural Officer, Jamalganj

**Table 4.3 Major and minor khals of Halir Haor project area**

| Name of the Khals | Grade |
|---|---|
| Ratla khal | Major |
| Suchia khal | Major |
| Netuar khal | Minor |
| Hirakandi khal | Minor |
| Mohammadpur khal | Minor |
| Upaddulla khal | Minor |
| Putia river (dead) | Minor |

Source: Local farmers through interview, 1991

**Table 4.4 Cropping patterns and expected yields in five villages of Halir Haor**

| Land and crop details | Alipur | Jotindrapur | Harinakandi | Einatnagar | Putia |
|---|---|---|---|---|---|
| Total area of mouza (acres) | 547 | 2622 | 814 | 1418 | 322 |
| **"LOWER" LAND** | | | | | |
| **% of cultivated area** | 0 | 87 | 75 | 100 | 100 |
| Present % | | | | | |
| L Boro | - | 100 | 100 | 100 | 94 |
| HYV Boro | - | 0 | 0 | 0 | 0* |
| Previous % | | | | | |
| L Boro | - | 100 | 100 | 100 | 94 |
| HYV Boro | - | 0 | 0 | 0 | 0* |
| **Average yield tn/ha** with (1988-1991) | | | | | |
| L Boro | - | 0.82 | 1.60 | 1.59 | 2.08 |
| HYV Boro | - | - | - | - | - |
| before project | | | | | |
| L Boro | - | 0.94 | 1.49 | 1.23 | 1.37 |
| HYV Boro | - | - | - | - | - |
| **"HIGHER" LAND** | | | | | |
| **% of cultivated area** | 100 | 13 | 25 | 0 | 0 |
| Present % | | | | | |
| L Boro | 67 | 38 | 75 | - | - |
| HYV Boro | 33 | 62 | 25 | - | - |
| Previous % | | | | | |
| L Boro | 100 | 100 | 100 | - | - |
| HYV Boro | 0 | 0 | 0 | - | - |
| **Average yield tn/ha** with (1988-1991) | | | | | |
| L Boro | 2.14 | 1.21 | 1.49 | - | - |
| HYV Boro | 3.00 | 2.26 | 3.04 | - | - |
| before project | | | | | |
| L Boro | 0.79 | 0.94 | 1.49 | - | - |
| HYV Boro | - | - | - | - | - |

Note: * remaining 6% is under miscellaneous rabi crops

Sources: mouza areas from BBS (1986a) Small Area Atlas,
remaining data from group discussions with farmers in each village.

**Table 4.5 Estimated area, yields and production (plus some inputs) of different crops with (1988-91) and before (mid-1970's) Halir Haor project**

| Crops | Total area (acre) | Total area (ha) | Potential Yield md/ac | Potential Yield tn/ha[1] | Mean Yield tn/ha[2] | Total Production (tn) | Inputs used (kg/acre) | | | Labour used Man-day/acre |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Urea | TSP | MP | |
| A. Before Project | | | | | | | | | | |
| T.L Boro | 15308 | 6195 | 21 | 1.9 | 1.1 | 6814 | -- | -- | -- | 40 |
| Millet | 50 | 20 | 12 | 1.1 | | 15 | -- | -- | -- | 30 |
| G. nut | 80 | 32 | 12 | 1.1 | | 24 | -- | -- | -- | 75 |
| W. Chilli | 26.5 | 11 | 9 | 0.8 | | 6 | CD | -- | -- | 20 |
| Brinjal | 5.7 | 23 | 150 | 13.6 | | 21 | CD | -- | -- | 20 |
| S. Potato | 105 | 42 | 120 | 10.9 | | 315 | -- | -- | -- | 30 |
| Countrybean | 2.8 | 1 | 12 | 1.1 | | 0.8 | CD | -- | -- | 10 |
| Total | 15578 | 6324 | | | | 6814* | | | | |
| B. With Project | | | | | | | | | | |
| T. Boro L | 15451 | 6253 | 21 | 1.9 | 1.31 | 8191 | -- | -- | -- | 40 |
| HYV Boro | 823 | 333 | 40 | 3.6 | 2.63 | 876 | 30[a] | 0 | 0 | 45 |
| Wheat | 29 | 18 | 35 | 3.2 | | 25 | 10 | 10 | 5 | 30 |
| Millet | 11 | 4 | 15 | 1.4 | | 4 | 10 | 20 | 5 | 30 |
| G. nut | 51 | 21 | 12 | 1.1 | | 15 | CD | -- | -- | 75 |
| W. Chilli | 45 | 18 | 10 | 0.9 | | 11 | 10+CD | 10 | 5 | 20 |
| Brinjal | 1 | 0.4 | 175 | 15.8 | | 4 | 15+CD | 20 | 10 | 20 |
| S. Potato | 108 | 44 | 150 | 13.6 | | 405 | CD | -- | -- | 30 |
| Country bean | 1 | 0.4 | 12 | 1.1 | | 0.3 | CD | -- | -- | 10 |
| Total | 16520 | 6692 | | | | 9067* | | | | |

1 reported by UAO to be yield in a "good year" * paddy output CD cow dung
2 mean yield including flood and other damage reported by farmers
a actual input use, remainder of fertiliser details are based on UAO's recommendations
Source: Upazila Agricultural Officer, Jamalganj and group interviews

**Table 4.6 Reported yields of highland cash crops and their prices, Halir Haor 1991.**

| Crop type | Yield (maunds per acre) | Market Value (in Tk) | |
|---|---|---|---|
| | | Minimum | Maximum |
| Groundnut | 6-7 | 450 | 550 |
| Millet | 5-7 | 150 | 170 |
| Dry Chilli | 9-12 | 1400 | 1600 |
| Green Chilli | 12-15 | 650 | 900 |

Source: Data from discussions with farmers during the field visit.

# 5 IMPACT ON LIVESTOCK

## 5.1 PRE-PROJECT SITUATION

Information about livestock are lacking in the documents and reports available on the project. All livestock types were kept in the area, but the main types were cattle and ducks. Cattle were the most important livestock as they were being used for draft power as well as threshing purposes, while the cows were used for milk production. The pre-project crop area was less and grazing lands were comparatively more than at present. As such general cattle health was better and so the productivity and work rate can be presumed to have been better than now. A few goats and sheep were kept.

The main feed stuffs of cattle and buffalo were paddy straw and green grasses. Grasses normally grew in the khas and fallow land (Section 11) and fallow paddy fields where cattle used to graze. The available cattle feed was hardly good enough to meet the annual food requirement of the cattle during pre-project conditions, and green fodder was not available during the monsoon (when virtually all the area was and is under water). Specific fodder crops were not grown, but grasses were harvested from the wetlands, both for protection against wave action and for fodder.

## 5.2 PROJECT OBJECTIVES

In the planned objective of the project, the important aspect of livestock was not taken into consideration. However, the livestock resource is an integral part of the farming system, and plays a key role in crop production practices. As such a supplementary objective should have been taken into consideration for livestock improvement with special reference to forage (green feed) development and storage within the project.

## 5.3 DATA COLLECTION SOURCES

Data collection was made through consulting the Upazila Livestock Officer, groups of farmers and individual farmers, public leaders, progressive personalities; and people at large along the riverside, in the market, in the homestead and in the villages.

## 5.4 PRESENT LIVESTOCK SITUATION

The cattle population has decreased by 50% within the project since the mid-1970s due to flood losses, poverty, lack of cattle feed, lack of space, and sale of animals following successive crop failure. The local Boro crop byproducts are mostly used as fuel in paddy processing. HYV Boro paddy is not palatable or easily digestible for cattle. Moreover safe storage facilities for paddy straw are rarely available, as farmers do not have enough space to preserve straw because of the rising water level and very restricted areas above water level.

The area of grazing fields has been reduced by 40-50%, as more lands have been brought under cultivation due to the construction of the project - particularly better drainage. Although the physical condition of the area appears to be favourable for buffalo keeping these are very rare. This may be due to their high cost, high food requirement and low working opportunity. At the same time, although goats and sheep have very diverse food requirements, they are still not abundant in the area and their change in population is not significant. Only a slight increase (5-10%) in chickens was found, but a promising expansion of duck population (50%) was evident (possibly assisted by Grameen Bank projects).

Comparing 'with project' to pre-project conditions, draft power efficiency reduced in general while the draft power requirement has increased somewhat (both because of an increase in cultivated area and because low land dries out more and requires ploughing). This need is currently being meet through renting of draft power (often on a seasonal basis from non-haor areas in the nearby upazilas), mechanised cultivation, and use of less or minimum ploughing for land preparation. Milk production decreased by 30-40% and there is no specialised dairy farm existing in the project area.

Compared to the pre-project time, no improvement was noted in respect of calving rate, but weak calves and early delivery were reported by the people. At the same time death of foetus and the calf death rate are high due to weak and poor condition of the mother cows.

About 80-90% of dung is used as fuel since there is little scope to get fuel wood from other sources. The major cattle diseases in the area noted are diarrhoea, tarka (Anthrax), badla (Black Quarter) and gobasanta (Cow Pox). Farmers of Jotindrapur reported that diarrhoeal disease is severe in the area (in some years 30% of cattle die due to diarrhoeal disease).

Cattle management practices in the haor area differ from some other regions. About 30-35% cattle are retained and managed by the farmers all the year round, while the rest are sold out after the Boro paddy harvest and with the onset of flood in the area, this pattern is little changed since pre-project times. The main reasons for such sales are:

1. Lack of nutritious cattle feed, especially green feed;

2. Unfavourable post-harvest weather continues;

3. Crop failures continue to lower farmers' economic conditions, indebtedness is still high and results in distress sales; and

4. Farmers are still not accustomed to or able to afford concentrate feed.

The floods of 1987 and 1988 washed away the lives of 30-40% cattle head of the area, this is a major reason for the decline in cattle numbers. Given that the project is a submersible embankment, many of these trends might have occurred anyway. However, the loss of grazing land is a consequence of the project, and had the project succeeded in eliminating early flood losses there would have been less distress sale of cattle.

## 5.5 NEGATIVE IMPACT ON LIVESTOCK

The negative livestock trends in Halir Haor are due to the haor environment which is little changed, and the pressure of population on limited resources. Had the project achieved more of its potential then the overall economy would have gained more and livestock numbers might be higher, but without the project there might have been more distress sales.

1. The cattle population decreased by 50% due to livestock loss during the high floods of 1987 and 1988, crop failure (in 1989 and 1990 for example), and cattle disease.

2. Livestock in general, but cattle in particular, suffer from an acute space and fodder scarcity because the whole area is underwater for half the year, and early flooding during the Boro harvest and post-harvest period hinders processing, drying and safe storing of paddy straw (the only cattle feed in the monsoon). Submersible embankments do nothing to help this problem.

3. Reduction of grazing land area by 40-50% had an adverse effect on cattle health and nourishment, following an increase in the cultivated area due to the project.

4. Lack of good quality drinking water (not due to project).

5. The seasonal reduction of cattle health adversely affects draft power, milking rate, calving rate, and calf delivery time and system, as well as size and health of the new borne calf (a consequence of the haor environment).

## 5.6 POSITIVE CHANGES FOR LIVESTOCK

1. The increase in cultivated area and increased crop production resulted in increased availability of paddy straw and other crop byproducts by 15-20%.

2. Increase of duck population by 40-50% (not due to project).

## 5.6 RECOMMENDATION AND LESSONS

1. Sheds for cattle shelter during the monsoon as well as straw and fodder storage facilities should be developed at appropriate locations in the haor area, as part of a development programme to improve people's ability to cope with the flood season.

2. If the submersible embankment was made more effective in its target of safeguarding Boro harvest and transporting paddy to the village mounds, this would also assure the supply of straw and safeguard grazing for a slightly longer period.

3. There are negligible opportunities for growing forage crops, so extension, marketing and storage technologies for different types of concentrate food should be made available in the area. In particular urea treatment of straw would improve cattle nutrition during the monsoon.

4. Veterinary services, both preventive and corrective, should be strengthened.

# 6 FISHERIES IMPACT

## 6.1 PRE-PROJECT SITUATION

There is a long history of temporary bund construction in this area, carried out by local farmers to provide short-term protection for ripening Boro against early flooding. This practice extends back to pre-independence times and has been reinforced during the 1970's by more substantial embankments built with WFP assistance. Most recently two regulators were constructed during 1983/84 to 1986/87.

All of this work over the years will have had some cumulative effects on fish stocks in the rivers and other water bodies and it is thus difficult to identify a particular time as the basis for pre and post-project comparisons. However, the earliest comparable series of annual fisheries statistics for the general area commenced in 1983/84, when the Fisheries Department introduced a new system for data collection and analysis. Table 6.1 gives a summary of fish production data from this source but based on the boundaries of the old Sylhet District which included the present Sunamganj District, for the period 1983/84 to 1987/88. Outside official statistics it is known from local fishermen that the beels within the project area were an important fishery long before the construction of the regulators, and that the main fishery was leased out at least from Independence.

Sylhet was noted in earlier years as an important surplus producer of fish particularly in sun-dried or smoked processed form. 1982/83 statistics show that 1054 tons of dried fish (equivalent to 4200 tons of fresh fish) and 901 tons of fresh fish were transported from Sylhet to other parts of the country, notably Dhaka market.

## 6.2 PROJECT OBJECTIVES

The limited documentation on Halir Haor sub-project includes no reference to either explicit or implicit objectives for fisheries in the project or adjacent areas. The overall IDA project did make explicit mention of fisheries as noted in Section 1.5 (there should be no adverse environmental impact particularly on fish production). There appears to have been no documented assessment of whether there would or would not be any such affect for Halir Haor, which suggests that the criteria given in the project staff appraisal (World Bank, 1979) may not have been given much attention during sub-project selection, planning and design. Hence there is no baseline or target with which to assess the project, other than that it should not have adversely affected fish catches.

## 6.3 RRA DATA SOURCES

Interviews and discussions were held with BWDB officials, with Jamalganj Upazila Fisheries Office staff, and with fishermen and market traders. A summary of current (1990) data on fisheries in the project area, as obtained for the Upazila Fisheries Office, is shown in Table 6.2, and fish prices noted are detailed in Table 6.3.

## 6.4 POSITIVE EFFECTS ON FISHERIES

Unlike other FCD projects based on high embankments intended to exclude floodwater ingress, the submersible embankment only delays the onset of flooding and the possibility of annual recruitment and migration of fish from the rivers to the haors. It might therefore be expected that the beel and river fisheries in this area will have been less drastically affected than in some other parts of the country.

It was not possible to gather sufficient quantitative data to show whether local consumption or fish exports from the area have changed or to confirm whether the area continues to be an overall surplus producer of fish. However, statements from fish traders that part of the catch is still being dried indicate that, at least seasonally the fishery is producing more than can be absorbed by the local market. Moreover a part of the catch is regularly sent fresh by the largest fishtraders to the Sylhet market. Table 6.1 also suggests that in contrast to other areas, overall fish production from Sylhet has remained fairly stable and possibly has even increased slightly. On the other hand, continued population growth will also have increased local demand.

A positive effect of this kind of FCD development, in contrast to the full polder approach, is that once flooding takes place, and especially between late May to November, the traditional common access right to catch fish for subsistence does still operate. Virtually all households have some means of fishing for home consumption and for sale in modest quantity during the flood season. Once the flood has receded however, and the surviving fish are contained within the recognised beels or other water bodies, they either become private property or are subject to restricted fishing by lease-holders and their agents and employees, and thus cease to be generally available to the public.

However, there have been changes in the access of poorer fishermen (traditional part-time and casual fishermen) during the project period, but these reflect institutional arrangements for the lease of publicly owned fisheries ("jalmahals"). It was reported by fishermen within the project that after Independence the fisheries were leased in parts to fishermen's groups over several years with payment by instalments - which made it possible for groups of poor fishermen to take up a lease. However, by the late 1980's the leasing arrangement was for one lease for a fishery (the largest in Halir Haor is 300 acres and administered by the District) - the lease is annual, renewable with a fixed 10% per annum increase in the fee. Hence there is no institutional support for fishing groups to form and have direct access to the fishery. Although nominally the lease still goes to traditional fishing groups and villages they pass on the right (for a small fee) to richer people able to pay the substantial license fee, invest in nets and fish shelters, and hire in fishermen (and of course able to make a large profit from this).

## 6.5 NEGATIVE EFFECTS ON FISHERIES

Notwithstanding that overall fish production in the general area has remained stable, there have been effects on catch composition. It is clear from Table 6.1 that a progressive decline has occurred year by year in carp catches from rivers from 4250 mt in 1983/84 to less than 400 mt in 1987/88. This decline is a consequence of the cumulative impact of FCD work as a whole and not only of this project. However it appears that even submersible embankments must share part of the blame because, although they impose only a temporary blockage to beel/river migration, this is at a critical stage in the spawning cycle, and by the time that deeper flooding restores the link, it may already be too late for the particular batch of mature carp to reproduce. In addition, and for reasons which are not clear, there has also been a serious decline in catfish, especially the large *Clarias* (Magur).

One of the beneficial effects of FCD polders is the encouragement given to pond owners to culture fish in ponds which were previously vulnerable to overtopping by floods. The submersible bund does not provide this benefit in that it merely defers the onset of flooding. Not surprisingly, therefore, there are very few ponds in the project area, and little or no prospect of developing pond fish culture in future.

It was reported that project sluices were sometimes operated at the behest of influential people who held fishing rights, in a manner to facilitate catching fish, but which was detrimental to crop farmers. This operation is not clearly understood, but if correctly reported it could not take place without the project sluices and is thus a negative effect.

## 6.6 LESSONS

1. The lack of consultation during the planning stage, and lack of coordination of project management, as between BWDB, the Fisheries Department and other interested agencies, exacerbates the problem of unintended adverse consequences and precludes any possibility of action to minimise or mitigate such effects. In theory the criteria for sub-project selection under the IDA credit should have encouraged this consultation, but in practice no specific effort was made either by BWDB or the World Bank to ensure that this happened. Moreover, under the FFW programme embankments had already been built and there is no effective consultation over this - even between BWDB and the Upazila Fisheries Officer.

2. The absence of machinery for multi-sectoral project management also provides opportunities for certain interests to misuse project facilities to the detriment of others.

3. It was noted that the limited organisational and financial resources of fishing groups/cooperatives were preventing them from taking advantage of their rights under the New Fisheries Management Policy, to acquire the fishing leases of khas water bodies. So called "influential" persons are still dominating the industry and controlling the fishing rights leases. It was reported that logistical difficulties, eg. lack of boat transport for use during the flood season, was hindering the development of NGO support for such groups in the Sunamganj area, as is happening in other parts of the country. It is also considered that this is an aspect in which the Fisheries Department should play a more active role.

**Table 6.1 Halir Haor FCD project: fish production trends - Sylhet District (Metric Tons)**

| | 1983/84 | 1984/85 | 1985/86 | 1986/87 | 1987/88 |
|---|---|---|---|---|---|
| i) Riverine Catches | | | | | |
| Major carps | 3010 | 1737 | 210 | 20 | 57 |
| Other carps | 1246 | 770 | 1298 | 307 | 338 |
| Catfish | 2234 | 1367 | 1003 | 179 | 277 |
| Hilsa | 637 | 615 | 1814 | 2358 | 1122 |
| Shrimps | 86 | 594 | 388 | 386 | 335 |
| Misc. Spp. | 6814 | 4361 | 7134 | 7701 | 12064 |
| Totals | 14027 | 9444 | 11847 | 10951 | 14193 |
| ii) Beel Fisheries | | | | | |
| Mixed Spp. | 14715 | 15519 | 16993 | 15999 | 17098 |
| iii) Flood lands | | | | | |
| Mixed Spp. | 16919 | 9837 | 15259 | 15300 | 15596 |
| iv) Ponds | | | | | |
| Mainly carps | 3905 | 2625 | 5561 | 9603 | 8722 |
| Totals | 49623 | 37425 | 49660 | 51853 | 55609 |

Source: Dept. of Fisheries, Annual Fish Catch Statistics Reports.

**Table 6.2 Background information on fisheries in Halir Haor**

| | No | Area |
|---|---|---|
| 1. Fish Ponds | | |
| - Public (Khas) ponds | 1 | 1 acre |
| - Private ponds (total) | 2 | 0.6 acre |
| - Derelict ponds | 2 | " |
| - Cultivated ponds | None | - |
| 2. Larger Water Bodies | | |
| - Public (khas) beels,less than 20 acre | 8 | 22 acres |
| * Public beels, greater than 20 acres | 1 | 300 " |
| 3. Fishing Effort | | |
| Number of fishing villages | 14 | |
| " " " families " " " | 350 | |
| Cooperatives | 6 | |
| Membership of the cooperatives | 500 | |
| 4. Estimated fish catch | | |
| a) from ponds | Nil | |
| b) from Beels | 40 mt/year | |
| c) from rivers | NA | |
| Total | NA | |



Note * This is Satidhara Beel Jalmahal in the southern part of the project area and which provides a living for 124 fishermen organised by lease holders into about 20 groups. Leasing revenue for 1990 was stated to be Tk 2,26,940.

Source: Information provided by Jamalganj Upazila Fisheries Officer.

**Table 6.3 Halir Haor FCD project fish prices:**

**Sachna market fish prices 15, May 1991**

| Species | Size | Price (Tk/kg) |
|---|---|---|
| Rui (*Labeo rohita*) | less than 4kg | 60-70 |
| | more than 4kg | 70-80 |
| Boal (*Wallagu attu*) | less than 4kg | 40-45 |
| | more than 4kg | 40-50 |
| Gajar (*Channa* spp.) | 2-3 kg | 35-45 |
| Shol ( " ) | 2-3 kg | 40-45 |
| Bele (*Glossogobius*) | 6"-8" | 40-50 |
| Foli (*Notopterus*) | | 40-50 |
| Pabda (*Ompok padda*) | 6"-8" | 35-40 |
| Golsha (*Mystus* spp.) | 4"-6" | 35-40 |
| Baem (*Mastacembulus*) | large (1½ - 2ft) | 70-80 |
| Singri (*Heteropheustis*) | 8"-10" | 50-55 |
| Lasso | 5"-7" | 30-35 |
| Hilsa | various, poor quality | 80 |

Source: fish traders, Sachna

**Dhaka market fish prices 21st May 1991**

| | | |
|---|---|---|
| Rui | Large | 120-150 |
| Katla | " | 100-110 |
| Pangas | | 110-120 |
| Hilsa | | 55- 60 |
| Shrimp | Large | 90-110 |
| Singri | | 70- 80 |
| Koi | | 80-110 |

Source: Bangladesh Observer, 22 May 1991.

# 7 OTHER IMPACTS ON NON-FARM ECONOMIC ACTIVITY

## 7.1 SOURCES OF DATA

No baseline survey was available, nor was there any information on the non-farm sector in any of the scanty project documents, hence all information is based on discussions during the RRA with residents of the project - cultivators and non-cultivators, and with traders in Sachna Bazaar - the main market in the area and located just within the project area. Representative villages throughout the area were visited, but gaps in the data sources include owners of engine boats, small scale rice millers, and small scale industry in the Upazila town of Jamalganj which is located immediately opposite the project.

## 7.2 PRE-PROJECT CONDITIONS

Agriculture and fishing were the dominant economic activities in the area in the mid-1970's and have been discussed in detail in Sections 4 and 6. At that time there were virtually no additional economic activities within the area - local transport by country boat had some importance but for bulk transport of paddy after harvest larger ships from outside the area came to load up and export grain. At this time there was no locally based paddy or rice trade, and the only trading was small scale petty trading serving local needs. During the lean period, which comprised the entire monsoon period from late May to November, economic activity within the area was very low and a high proportion of males of working age migrated to find work outside the area (particularly from landless households). The remainder (mostly farmers and fishermen), plus women and children remained in the area tending livestock and fishing for subsistence or as a part time occupation.

## 7.3 PROJECT OBJECTIVES

There were no explicit objectives of the project regarding non-farm activities in the area. This presumably reflects the view of the project implementing agency and the donors that the project was simply an agricultural development project limited to improving water management for five months of the year, rather than any integrated rural development programme which might encourage linkages to agro-industries and improved economic conditions in the monsoon period.

The one exception to this is the aim of FFW schemes which are primarily aimed at providing employment for labourers and poor households on earthwork schemes in order to improve their food security during a lean period. To this extent there is an explicit aim of employment generation, but it is not self sustainable being dependent on continued external provision of food aid.

## 7.4 EMPLOYMENT CHANGES

The current overall pattern of employment throughout the project area is relatively simple. For just over five months of the year (late Agrahan to end of Baishak, that is December to mid-May) most males of working age are fully engaged in agriculture, while for the remainder of the year they are either active in fishing or migrate out of the project area to find work.

On closer examination, households and sometimes villages can be characterised as: traditional fishermen still dependent largely on fishing, traditional fishermen who also cultivate, cultivators and landless people who are occasional/part-time fishermen, and pure cultivators and landless labourers.

Effectively all but a few professional fishermen are occupied in agriculture for five months. For labouring households, earthwork on the embankment (FFW) helps to provide employment during March and April during the period when Boro paddy is growing and less agricultural work is available. Some of the fishermen active in clearing the beels (which are much reduced in surface area at this time) are from outside the area and are brought in under contract by the powerful interests which control the Jalmahal (see Section 6).

During the harvest of Boro time is at a premium (before the embankment is overtopped and rain becomes persistent) and the harvest and threshing of paddy throughout the project is highly synchronised. A substantial part of the labour for harvesting (up to 75% in some villages) comes from outside the project area. Thus labour demand at harvest time has increased somewhat (excepting years of crop failure) as a result of the project - due to an expansion of the cultivated area and increased cultivation of HYV Boro with consequent higher yields. This benefits people from outside the project area (in-migration at harvest time has reportedly increased). Labourers in the project area could have obtained as much work without the project, except that failure to harvest was probably slightly more frequent, and so the project only helps local labouring households through FFW maintenance. Because migrant harvesters are paid a share of the crop (generally one seventh) food availability within the project area is not so much increased, nor is there much additional income which might have generated increased business and investment.

For the remaining seven months households remain in the haor and catch fish or send male workers outside the area for work. In some villages all households have migrant workers living away for part of the year, while other villages comprise fishing households or a mixture of migrants and fshermen. Based on discussions in eight villages on average 57% of households are dependent on fishing during the lean period; 36% depend on migrating to other areas - working in other districts as labourers for Aman transplanting, doing earthwork, working for the cement factory near Sunamganj, as rickshaw pullers, or in more distant towns; and 8% either do not need additional income or work for rich households in their village (for example, tending their livestock).

Hence any benefit from the project for employment of local labourers has been small. In pre-project conditions the pattern of employment was largely similar except that before out-migration was generally less, partly because the population pressure was less and the fishery was not regulated so that some villages of non-traditional fishermen could catch fish. However without the project the population would probably have been similar so even less employment per capita might have been available.

## 7.5 OTHER ECONOMIC ACTIVITIES

Virtually no handicrafts or trades are found in the project villages - within households there is net repairing and drying of fish for own consumption, but the lack of raw materials means that there is little scope for other productive activities to grow up since most households have no funds available to buy raw materials when they have time available and there is a lack of nearby markets. There is some trade in bamboos brought from outside the project for house construction and particularly protection of homesteads from wave action and consequent erosion during the monsoon. At Tk 80-90 per large bamboo (1991 prices), and with 20 or more needed to protect some homesteads each year, this is a substantial investment. There is some rearing of poultry but its scale is small and it is not related to the project.

However, an important local market at Sachna Bazaar is located on the edge of the project and serves much of its area. There are about 150 small traders and businesses

operating in the bazaar and this number has probably changed little during the last 10-15 years. Outside of retailing there has, however, according to discussions with the traders operating there, been some growth in economic activity, particularly in paddy and rice trading, in fish trading, and in transport.

Although launch services have served the area and linked it to outside areas for many years, in the last five years there has reportedly been a big growth in the number of engine boats operating from the bazaar - from one to 35 boats. This is probably linked to deregulation of the diesel engine and low-lift pump market, increasing the availability of engines, rather than a growth in imports and exports to and from the project area. The previous boatmen have been able to gain from speedier and more reliable intermediate scale transport and this has been interlinked with an opportunity to squeeze into a gap in transport and markets and take advantage of a wide profit margin.

Ships are able to move along the Surma river next to the project during the monsoon. Previously ships from other areas came to buy paddy directly from large producers. Now fewer large boats are coming and smaller engine boats are used to take grain to the new traders who can offer a slightly higher price and buy smaller quantities over a longer period and are able to move grain out of the area in the same way. There are now about 20 paddy wholesalers/traders in this bazaar where five years previously there were reportedly none. On balance there is probably little change in the quantity of grain entering the market from Halir Haor (the source for about 90% of paddy traded in Sachna Bazar). Although paddy output on average is higher, so is the population and output is still subject to wide fluctuations which mean that market sales fluctuate widely. Thus compared with the 1991 harvest and expectated volume of paddy sales, it was estimated that local marketed paddy supplies had been 80% of this level in 1988, 40% in 1989, and 20% in 1990. This is in broad agreement with the harvests reported by farmers (Section 4.6.4).

Purchase and exporting of paddy generally takes place from Chaitra (forward buying?) to Kartik (April-October), and for the rest of the year the traders buy in rice to sell locally to small shopkeepers/traders - a pattern which may have become more pronounced in recent years, but due to population growth and despite the project. There has not been an associated growth in commercial paddy processing in the area and there are few small engine powered paddy mills. Paddy for home consumption is of course processed at home (see Section 8), but a possible opportunity to process paddy locally to export to other regions as rice, thereby adding value locally and obtaining a supply of byproducts (for livestock feed for example), appears not to have been taken up.

Hence there has been little induced economic growth in the area as a result of the project. What income is generated locally by increased trade controlled by local people has been used to invest in buying land rather than in other productive businesses.

## 7.6 NON-AGRICULTURAL FLOOD LOSSES

Submersible embankments are not designed to protect the project area from extreme floods, since they only delay the onset of flooding. It is important to state that flood losses to property and disruption to lives continue. The villages and inhabitants of Halir Haor are well adjusted to the monsoon, which every year leaves their homestead areas as islands in an inland sea. But in addition to the congested normal living conditions (Section 11.4.1) losses in extreme floods occur, most recently in the 1988 flood. In only one village were houses reportedly not affected by above floor flooding in that year. In the remainder 50-100% of houses were flooded with the inhabitants mostly remaining during the flood peak living on machans within the house or moving into the few houses above flood level in the village. Very

few people moved to relief camps. Livestock are safeguarded by keeping them on piles of water hyacinth and grasses. Additionally the normal erosion of homestead areas by wave action was worse that year, and houses and grain stores were washed away (in one case 25% of the village).

Hence there are clearly losses to property due to unusual floods. While the annual average losses may be low (there have only been two damaging floods of this type in recent memory - in 1988 and in the 1970's), submersible embankment projects are clearly areas where applied research and small scale investments in non-structural measures to help people 'live with floods' and even normal monsoon conditions would be appropriate. For example, these might include safe places (such as schools) in each village which could double as flood shelters and as dry storage places at harvest time.

## 7.7 OVERALL NON-FARM AND NON-FISHERIES IMPACT

Halir Haor project has had a minimal impact on the non-farm economy of the area. Some additional employment for local people is generated by the recurrent need for maintenance of the embankment, and this is carried out under FFW schemes; however any increase in employment in cultivation and harvesting has been absorbed by population growth and by migrant workers because of the short duration of this labour demand peak. Although there has been some growth in trade based in the area this does not appear to be due to the project, which has not induced any development of agro-based industries in the area or provided more stable conditions in which to invest in business.

# 8 NUTRITION AND HEALTH IMPACT

## 8.1 DATA SOURCES

Qualitative information was obtained from the Upazila Health Officer and from villagers within the project concerning food intake over the year and the types of food consumed at present along with an assessment of whether conditions were better or worse in the 'pre-project' period (defined as mid-late 1970's) and any reasons for differences. It was not possible to assess quantitatively the nutritional status of project inhabitants, nor is there any baseline pre-project information with which to compare their present situation. However, it does not appear that nutritional conditions in Halir Haor project differ to any noticeable extent from the rest of Jamalganj Upazila.

## 8.2 PROJECT OBJECTIVES

Although there was a lack of explicit objectives for this project, since it aimed to ensure a safe harvest for the one crop grown in the project area it ought to have indirectly improved the availability of food grains in the area - both in terms of total supply and in terms of purchasing power for labouring households if more work is available. Sections 4 and 7 have shown a limited positive impact in terms of these more immediate objectives through which any project impact on nutrition would work. Since information depended largely on recall the current situation is described and then any differences from pre-project conditions and reasons for them.

## 8.3 PRESENT NUTRITIONAL STATUS

### 8.3.1 Food consumption

There is considerable inequality in the food security of households in the project area: in the villages visited only 4-8% of households were reported to be in surplus or able to eat three meals a day throughout the year. The majority of households are therefore by peoples' own standards in some degree of food stress for at least part of the year.

The peak period when few households face problems over food quantity is on average Baishak to Ashar (early May to July) when between 50-100% of households, depending on the village, reportedly eat three times a day. From Ashar to Kartik (late July to November) is an intermediary period when under 50% of households have enough food, and in most cases two meals a day are eaten. However, from Kartik through to Chaitra (November to April), which is approximately half of the year, all but the few households able to eat well throughout the year reportedly face a shortfall with many households eating only once or sometimes twice a day. The stress is particularly acute just before harvest (Falgon-Chaitra; March-April) when most households eat once a day or may even not eat during the day. At this time wheat from FFW schemes and 'inferior' foods like sweet potatoes are eaten more often. This all assumes a 'normal' harvest, but may be influenced by the recent experience of reduced harvests in 1988-1990.

Compared with the food grain problems, the inhabitants of the project have the advantage that fish are widely available. At least during the monsoon a majority of households either catch fish for sale and own consumption or just casually/secretively for their own consumption. However, because of the control of the main Jalmahal fishery, which is most strictly exercised during the peak fishing period in the dry season, just when most households are engaged in cultivation, fish supplies to the local market are least and purchasing power is lower, adding to nutritional stress at this time.

### 8.3.2 Health and water supplies

Vegetable production in the project area (and Jamalganj Upazila as a whole) is very low: some are grown on or by homestead plots during the dry season, but production of any crops during the monsoon is impossible since all but the homesteads themselves are under water. This was identified as one of the main health problems in the area by the Upazila Heath Officer who reported that in 1988 20-25,000 children in the Upazila suffered night-blindness. Distribution of vitamin A tablets has apparently substantially reduced the incidence to 1-2 cases per 1000.

Drinking water supplies are also a problem. Although there are tubewells in the area these are relatively few - 1-4 per village - and costly since potable water is reported to be at a depth of about 400 feet (125m). Although households try to use tubewells, this involves transporting water by boat or carrying it in the dry season. Hence many households use haor water (up to 50% in some villages). This creates an additional health hazard since sanitation is very poor - with earth cutting expensive and the crowded conditions on village mounds most latrines are over the open water of the haor. Even so the general incidence of diarrhoeal diseases was not reportedly exceptional.

## 8.4 COMPARISON WITH PRE-PROJECT CONDITIONS AND PROJECT IMPACT

Overall the nutrition and health condition of project inhabitants in the mid-1970's was probably little different from at present, and the general pattern of food consumption was the same. However, some villages reported that at that time conditions never got so bad that only one meal a day was eaten, others reported that if there was a good harvest then (compared with now) people ate well for longer, and some reported a higher consumption of fish in the past. Although there has been some sinking of tubewells since the project this might well have happened without the project.

Overall any fall in nutritional and general health status is more likely to be due to population growth than the project. However, the project has not had any notable effect in improving the nutrition and health of people. Whether it would have been even worse without the project is impossible to say.

# 9 IMPACT ON WOMEN

## 9.1 DATA SOURCES

Due to logistical problems this study was handicapped in evaluating any impacts on women because there was no female member of the team. Hence most information came indirectly from discussions with men, although some direct observation of women's work in paddy processing, and discussions with female Grameen Bank group members were possible.

## 9.2 PROJECT OBJECTIVES

There were no explicit objectives concerning or references to women in the project planning, which is not too surprising given the lack of attention given to women in rural development projects in general at the time of project implementation. While it is well known that women play an important part in the overall agricultural production process, little of this contribution is made through the market place and hence it has received little attention. However, the project aimed to increase harvests on average by reducing flood risk, without considering any implications on post-harvest processing.

## 9.3 PRE-PROJECT ACTIVITIES OF WOMEN

As in much of Bangladesh, women in Halir Haor have traditionally not taken paid work outside the homestead area. In pre-project conditions the main activities were paddy processing - which peaks in the immediate post-harvest period - although husking is carried out by mortar and pestle rather than by dheki in the project area. For the remainder of the year there were very few opportunities for productive activities - apart from tending the homestead and livestock, since most of the landscape is under water, travel is not easy, and a high percentage of the male labour force left the area to find work. During the winter some cultivation of vegetables near the homestead was possible, and undertaken by women, but the area was very small since most land was under Boro. There was no tradition of handicrafts among women - capital and raw materials are lacking - with the exception of some net repairing in fishing households.

## 9.4 POST-PROJECT ACTIVITIES OF WOMEN

### 9.4.1 Work on embankment maintenance

The overall pattern of women's activities is virtually unchanged with the project. The one direct impact of the project is that there is some employment for women as labourers for embankment maintenance under the FFW programme. This was not reported in all villages, which could either be because men hid women's involvement in this activity, or because women do not take part in earthwork which is distant from their village. However, in one village close to the embankment 38% of labourers working under FFW programme were reportedly women.

Not only is this a source of income for poor households, but it indicates that there would be no cultural barrier in the area to employment in routine maintenance targeted at women (which is one of the maintenance models being developed in Bangladesh). However, there is little if any routine maintenance (as normally understood) in a submersible embankment project. Instead there is a limited period for repair of damage from the previous monsoon's submersion before the embankment again has to face early floods. Nevertheless the maintenance earthwork could be divided. Work on closures of breaches and public cuts could be done by local contractors, since more intensive and higher standards of work are

required, while raising, sectioning, dressing and turfing of normal lengths of embankment could be done by teams of poor women (as could tree planting, see Section 11). Unfortunately the nature of submersible embankment projects means that they cannot provide employment for more than a few months of the year, but by employing women the work could be spread over four months rather than the current approximately two month period between transplanting and harvesting.

### 9.4.2 Post-harvest activities

The impact on post-harvest work (mostly threshing, drying, and husking paddy) is unclear. With good harvests the quantity of grain to process is greater with the project, but unchanged when crops fail or are affected by the weather. However, this work peak only lasts two months, and there has been no change in the technology used since the project. Perhaps a few more households now have so much grain that they employ poorer women in the village to help process the paddy, but in most cases the work has been absorbed by household members. Moreover the slide into landlessness for many households has resulted in less work for these women at harvest time. There appears to have been no move to employing women in harvesting itself, although this would be one way of keeping more paddy for the household, or purchasing power in the area, rather than paying migrant labour a share of the harvest.

### 9.4.3 New initiatives

The only other sign of change in women's economic role in the area is through the activities of the Grameen Bank. However its programme of productive loans to groups of poor women is not linked to the project. The loans (Tk 2000 or 2500) are mainly used to buy livestock, particularly poultry - for example to earn income from sale of eggs, and sometimes to buy grain to process and sell. The programme appears to be successful - loans are being repaid in instalments and the women are obtaining small regular incomes which they reportedly can keep. The programme depends on regular visits by advisors to keep the groups functioning, but does indicate scope for some further production. Duck rearing would appear particularly attractive, both to improve nutrition and to earn income, but is limited to the areas adjacent to homesteads (there is less food and a risk of loss in the open haor), and by the logistics of marketing from scattered villages in the haor.

## 9.5 OVERALL IMPACT ON WOMEN

Overall there appears to have been a small positive impact by providing some employment to poor women outside the homestead, and no negative impacts on women. However, more attention to the potential role of women in economic activities, with group organisation linked to the project, might have resulted in more of the limited benefits of the project being captured by the project inhabitants - and particularly by poorer women since female headed households (widowed or divorced) are often the most vulnerable households.

# 10 SOCIAL IMPACT

## 10.1 PRE-PROJECT SITUATION

Halir Haor comprised an agrarian community with fishery as its second source of livelihood. It is bounded by the Surma and Boala rivers. These rivers greatly influenced the economic activities in the area by causing early flooding and by uneven distribution of water supply for crops. Hence the haor people have developed their social lifestyle around the annual flood cycle. Distribution of land was and is very skewed, and so the portion of landless people is substantial. There are a few big farmers and settlers who bought large areas of land, and a community of migrant landless labourers. The prominence of absentee landlords had resulted in a negligible rate of reinvestment in agriculture.

Much of the current population are reported to have originally been settlers from outside the area, since previously land prices were very low. One interesting social aspect came out in terms of more social integrity among these settlers than the original inhabitants, and so a social distinction is maintained.

## 10.2 SOCIAL OBJECTIVES

The project did not have any explicit social objectives, although the regular FFW maintenance of the project provides some additional employment for the landless.

## 10.3 WITH PROJECT CONDITIONS

The social situation at present appears to be little different from that before the project. Because there have been local embankments for perhaps 30 years it is very hard to distinguish any process of social dynamics due to the project. As far as the social variables like occupational composition, demographic transitions, social interaction in terms of leadership pattern, values, tastes and behaviours are concerned, these have more or less remained the same as they had been in the past. Farmers and fishermen have only changed their traditional occupations to the extent that some fishermen have become cultivators and their access to the haor fishery for the remainder of the year has declined with the growing influence of non-fishermen who can control access to the Jalmahal. A small distinct affluent class owning about 70% of land dominates the social life of the community.

A few differences from previous social conditions can be found:

a) a higher rate of out-migration of agricultural labourers during the slack period;

b) increased seasonal migration of some settlers outside the project area, particularly during the monsoon;

c) increased employment opportunities under the Food-For-Work programme in the project area;

d) recent conflict between the local leaders and the landless over the use of khas land;

e) conflict between the fishermen, local leaders and farmers over the operation of the regulators.

f) The Grameen Bank has helped, in a few villages, to promote income earning activities for poor women, a particularly disadvantaged group given the difficulty of mobility in

the monsoon season and the need for someone to look after the homesteads.

Some of these changes (which are negative with the exception of FFW employment) are related to the project, but social conflicts were probably likely in any case given an increasing population and limited resource base.

## 10.4 LESSONS

1. There has been no attempt to use the project to target possible benefits from its management towards poorer and landless households. In itself the project is not biased in its benefits towards larger landowners, but inevitably the landless receive little benefit except indirectly from higher labour demand at harvest and directly in embankment maintenance work.

2. The current leasing system for the Halir Haor Jalmahal favours richer and more powerful interests at the expense of poor fishermen. Splitting the leasing between fishing villagers or groups, payment in instalments, and a quota on the number of active fishing units could all help in distributing access to the resource more fairly and in controlling exploitation of the fish stock. Since this is a local resource, part of the revenue should be used locally to improve the infrastructure (including embankments).

3 Khas land (which is used for cultivation) should be leased out to bonafide landless groups or be preserved as wetlands. The lack of a management plan meant that often the areas with most changed flood conditions and which could be brought under cultivation were public lands, but there was no plan for their distribution or use.

# 11 ENVIRONMENTAL IMPACT

## 11.1 PRE-PROJECT SITUATION

Halir Haor is bounded by the river Surma in the east, and by the Boulai to the south, west and north. The haor areas have been formed by gradual deposition of sediments. The northern part of Halir Haor is relatively higher than the south and south-western parts. There were and are some permanent beel areas in the Haor. However, the whole Haor area is low lying and is a depressed basin generally inundated by 1.5m (5ft) to 6m (20ft) flood water in the monsoon.

The hydrology of the Haor area is controlled by three rivers (Surma, Boulai and Paiker talla) receiving flood water from the Khasi and Jainta hills.

The Haor area remains under water from May to November-December. Much of the land was and is under cultivation, but agriculture is limited to Boro cultivation which starts from January and continues upto the first week of May. The water level in the river rose rapidly in April or early May overtopping river banks, and causing damage to the crops.

## 11.2 ENVIRONMENTAL OBJECTIVES

Although the SSDFC project stated that sub-projects should have no serious adverse environmental effect, it appears that environmental and ecological impacts were not included in the planning of Halir Haor project. The main objective of this submersible embankment was to prevent early flash flooding upto mid-May, to safeguard the Boro harvest (see Sections 1.4 and 4), and so it might be expected to have smaller environmental impacts than would full flood protection.

## 11.3 SOURCES OF DATA DURING RRA

The data were collected from Upazila Chairman, UNO, and Upazila technical officials, and by interviewing rich and poor farmers, landless people, boatmen, and the Union Chairman. In addition, personal observations on the ecology and environment of the Haor are also presented.

## 11.4 PRESENT ENVIRONMENT

### 11.4.1 Human Environment

The agricultural systems and economy of the area have been discussed elsewhere. Although the man-made highlands for houses are very limited, people appear to be well adjusted to living in these conditions and are living in a cordial atmosphere. However, the houses are highly congested and gaps between the houses are basically missing. The density of the population living in the monsoon on village mounds is exceptionally high (Table 11.1) and the human environment is not hygienic. Open highlands for recreational purposes and also for keeping livestock are lacking.

The crowding of human and livestock populations into very confined areas for over six months in a year, and lack of sanitary facilities pose a health risk, particularly as Haor water is the only readily available supply. The availability of safe drinking water is unsatisfactory and setting up a tubewell is very expensive, because boring to a minimum of 300-350 feet is needed to reach potable ground water.

**Table 11.1 Population density of different villages of Halir Haor**

| Location | Name of the Village | Length ft. | Width ft. | Total area Sq. ft | No. of families | Approx total popn | Sq. ft/ person |
|---|---|---|---|---|---|---|---|
| North West | Harinakandi | 200 | 70 | 14020 | 150 | 780 | 17.9 |
| North West | Rajdarpur | 200 | 50 | 10000 | 30 | 250 | 40.0 |
| North East | Haor Alipur | 150 | 50 | 7500 | 22 | 150 | 50.0 |
| North | Beheli Alipur | 300 | 60 | 18000 | 60 | 400 | 45.0 |
| South West | Insanpur | 125 | 40 | 5000 | 35 | 180 | 27.8 |
| South East | Gopalpur | 400 | 40 | 16000 | 75 | 620 | 25.8 |

Note: The length and width of the village were taken as approximations during the field visit.

Source: Data were collected during discussions with the inhabitants.

### 11.4.2 Natural environment

Fieldwork took place when the Haor was already virtually full of water, hence direct observation was limited and the assessment is partial, particularly as the winter season when water levels are low is the critical period for assessing the importance and status of the haor ecology and environment.

Although the area of permanent water may well have declined there was a lack of evidence for a decline in fish stocks - the project still contains a major fishery, but intensive use of these waters may affect them in the long term. The area of fallow land has declined and with it the area of marsh and grassland, with associated changes in species composition (see Section 11.6). There is now little such habitat during the dry season between the beel areas which are intensively fished and the cultivated areas. The importance of this haor for wildfowl is not known. It is not listed in IUCN (1989), but declines in numbers of wintering ducks were reported by local people. Despite the late date of the survey some 400 Lesser Whistling Duck *Dendrocygna javanica* were observed migrating over the haor, so it may retain some importance.

Of note are the small but important areas of flood tolerant trees which have been planted in the project area, in particular two apparently natural patches close to the Ratla khal regulator. These act as wildlife refuges. Notable incidental observations at this site included a few pairs of Spotbill Duck *Anas poecilorhyncha* in potential breeding habitat (noted as a rare winter visitor in Harvey (1990)), and a party of five Amur Falcons *Falco amurensis* (a scarce migrant) which appeared to have roosted there. Any vegetation above normal monsoon water levels is clearly of importance to wildlife.

## 11.5 POSITIVE IMPACTS ON THE ENVIRONMENT

### 11.5.1 Embankment, Communications and Vegetation

The embankment has provided improved dry season communications for pedestrians. In addition, farmers temporarily (2-4 weeks) use the embankment's top for stacking paddy and straw for final processing in the month of May when flood water inundates all the Haor areas

except embankment and houses. Natural and man made raised areas are vital during this critical period when large volumes of paddy and straw must be moved and dried in a short time before the submergence of the area.

Two natural lines of higher land occur within the Haor, and it has been proposed (Section 2.4) that these be converted into additional submersible embankments to divide the project into three compartments. Since these higher lands remain free of water from October onwards this allows the establishment of woody herbaceous plants such as **Bantosi** and **Boulla**. Their dense growth supplies much of the fuel used in the Haor throughout the monsoon. Expansion of the area of higher (submersible) land for submersible compartments would increase the availability of these useful plants.

### 11.5.2 Afforestation with flood tolerant trees

The submersible embankment has given a potential for afforestation with flood tolerant plants such as Hijal *Barringtonia acutangula* and "Kross". The cultivation of these tree species on the embankment's margin would be highly useful to reduce the present embankment erosion from wave action on the haor side and from high water flow and strong currents on the river side during the monsoon. In addition, increased vegetation cover would maintain ecological harmony, and the branches of these trees would help to solve the scarcity of fuelwood. The coppicing capacity of "Kross" would allow the people to cut this plant at the base for more fuelwood. It might then be possible to use less cowdung as fuel and more manure would go to the cultivated highland as fertilizers and would improve the soil environment.

The basis for highlighting this potential is that a few people have used high land for planting Hijal and Kross plants, particularly because they are used for catching fish. The branches of these trees are cut and put in the haor/jalmahals, fish take shelter in these mahals and this allows the fishermen to catch fish more easily. The leaves of these branches decompose in water and also supply food to the fish during the lean period. The benthic environment of the Jalmohals thus becomes rich in organic matter and keeps the submerged soil environment very fertile.

### 11.5.3 Agro-ecosystem

The project has provided an opportunity to have a slightly changed agro-ecosystem. In the highland, ground nut, millet and chilli are cultivated at present as cash crops. In the pre-project situation, these crops were reportedly cultivated in a limited area of extremely high land. Further details of agricultural changes are given in Section 4.6.

## 11.6 NEGATIVE IMPACTS

### 11.6.1 Wetland, Fallowland and Grass Production

In the pre-project period, there were substantial areas of wetland and fallow wet grassland, supporting the heavy and dense vegetation of two grasses (**Chailla** grass, grows in wetland, usually 4-6' (1.2-1.8m) long, and becomes longer with the increase of flood water; **Dud chailla**, 2-3' (0.6-0.9m) long, grows in moist habitat). These grasses are used as fodder, thatching material, and especially used around the homesteads to protect against erosion from wave action, a very common natural hazard in the haor, during the flood season. As soon as water recedes, the calms (stems) of these grasses are dried and used as a fuel for cooking. Additionally these grasses were an important component of the remnant natural ecosystem.

The project has provided a controlled and improved drainage system, which has allowed an increase in the cultivable area in the lower parts of the Haor. In contrast, the area of fallowland and wetland decreased, hence the area for the growth of grasses and grass production (Chailla grasses) has significantly reduced.

The scarcity of these grasses has resulted in a fodder problem outside the project area, and more importantly inside the project these grasses are in short supply for use around the homesteads to protect against erosion from wave action.

The free floating **Futi** grass *Hygrorrhiza* sp. has more or less disappeared from the project area because of the decrease in wetland, and increased agricultural and fishing activity. In addition to fodder, the dense and profuse growth of green algae on this grass was an important source of fish food.

**Ikor** grass *Sclerostachya fusca*, 4-6'(1.2-1.8m) long, was common in some localised wetlands in the pre-project period. This grass was one of the best thatching materials available. The improved and controlled drainage system has strongly disturbed the growth of this grass, which also dislocated the shelter of wildlife such as migrant wildfowl. At present, this grass is restricted to areas in and around the homestead low-land areas.

### 11.6.2 Soil Environment

The soils of the project area are dark grey in colour, PH 6.0, and piedmont in origin, being derived from sediments from the Jainta and Khasi hills. Considerable peat deposits are found at a depth of 10' (3m) or more, and are collected by the local people to use as fuel. This peat deposition indicates that, possibly, the area was once dominated by bog vegetation.

Flood water enters the area every year, siltation occurs, and the soil environment is fertile. Flood water allows the growth of various euhalophytic plants, and with the recedance of flood water the aquatic plants decompose and add substantial amounts of detritus and organic matter to the soil environment, hence maintaining soil fertility. Present intensive fishing activity does not allow the heavy growth of euhalophytes. Therefore, the addition of organic matter from the decomposition of aquatic plants to the soil environment has decreased and this has already shown a tendency to reduce organic matter in the soils. If the present rate of fishing activity continues it is possible that the soil condition will deteriorate further.

## 11.7 RECOMMENDATIONS

1. **Embankment height**. The way that the submersible embankment of Halir Haor was designed and built seems to have resulted in some adverse environmental effects, but these are not very marked given the existing uses of the area. However, an increase in the embankment crest level of 2-3' (0.6-0.9m), as demanded by some farmers, may bring much greater environmental problems, particularly from conversion of more land to agriculture with resultant losses of flora, fauna and the fishery. Maintenance of the embankment to its intended elevation should be sufficient, and a longer term study of possible changes in bed levels and flood elevation trends in the haor basin would be preferable to piecemeal raising of submersible embankments.

2 **Wetland conservation**. Present controlled and improved drainage is increasing the cultivable area at the expense of wetlands. To maintain the ecological balance, existing water bodies and wetlands should be protected, rather than further drained. This would help to prevent further encroachment of perennial water bodies for

cultivation. Likewise existing small areas of marshland should be preserved to maintain ecological harmony of the natural flora and fauna. Overall conservation areas within the haor would help to increase fish production, and attract numbers of wintering wildfowl.

3. **Embankment, Flood tolerant trees and Timber production**. Most parts of the submersible embankments, and sides of local earth roads within the Haor, could be utilised by planting flood tolerant trees (Hijal and Kross). The cultivation of these trees would not only prevent embankment erosion but also would increase the forest cover in this region. In addition, their branches could be pruned and may be used as fuel and also for fish shelter during the winter season. Those strips of higher land which were found to be densely covered by flood tolerant trees, are important sources of brushwood and form wildlife reserves. Cutting of these trees should be carefully regulated.

# 12 OVERALL ECONOMIC IMPACT

## 12.1 PRE-PROJECT ECONOMIC APPRAISAL

There is no documentary information on the initial BWDB takeover of the Halir Haor embankment. While it is clear that the submersible embankment was improved in the 1970's the costs of this work are unknown, and there is no quantitative estimate of the predicted benefits of the project.

For the IDA funded regulators the summary sheet of Halir Haor simply estimates a construction cost of Tk 85.0 lakh and an economic internal rate of return of 50%. No calculations to support this are given.

## 12.2 PRIMARY ECONOMIC IMPACTS FOUND IN EVALUATION

### 12.2.1 Agricultural impacts for the farmer

The key impacts discussed in Section 4.7 are:

1. Net cropped area increased by 6% as more land was brought under cultivation.

2. HYV Boro was introduced on 5% of the cultivated area, where drainage and water retention were improved.

3. The expected yield of L Boro was increased from 1.1 tonnes to 1.31 tonnes per hectare due to partial protection from pre-harvest flooding.

Compared with pre-mid-1970's flood risks, the financial returns to L Boro cultivation have improved. Table 12.1 gives inputs and outputs and associated values for L and HYV Boro. Because of the very small areas involved and the lack of any major changes in the minor crops grown these have been ignored in the approximate financial and economic analysis.

Table 12.1 shows that the input levels used, particularly in L Boro but also for HYV Boro, at Halir Haor are much less than the MPO figures for the north-east region (MPO, 1987b). This may reflect the remaining risk of early floods causing crop failure. Using current (1991) prices from the field survey and these input and yield figures indicates that the financial cost for a hectare of L Boro is Tk 5025. With pre-project yields the gross income from paddy would have been Tk 4950/ha. The implied loss can be explained in three ways:

1. Straw has not been included, but is an important by-product (estimating a financial value is difficult);

2. The yield figure allows for losses in early floods - this risk meant that financial losses and starvation did occur without the project; and

3. In the case of crop failure the costs of harvesting are clearly not incurred.

However, with the project, and using yields based on how it has performed since completion of the regulators, the gross income from L. Boro averages Tk 5895/ha in 1991 financial prices. There is clearly a financial gain to farmers, as well as increased food production. Moreover it is plausible to assume that this gain was achieved from the date of improvement in the embankment since the khals were closed off with earth at that time.

The introduction of a limited area of HYV Boro is directly linked to the improved water management offered by the regulators, especially the longer growing season they provide for higher land (but may also depend on the availability of LLPs for irrigation). Ignoring irrigation costs the financial returns to HYV Boro cultivation appear to be a gross income of Tk 11835/ha (from paddy) against costs of Tk 5595/ha (a gross margin of Tk 6240/ha). The input levels (and yield) are much less than noted by MPO (1987b), probably because only limited irrigation is used and there is still a risk of flood loss.

### 12.2.2 Economic gains from agriculture

Two methods of calculating economic gross margins for the two main crops could be used. Either the economic prices given in FPCO (1991) can be used directly (to give 1987/88 economic prices), or the local financial prices reported by farmers can be adjusted to 1991 economic prices using the conversion factors given in FPCO (1991) to estimate 'mixed' prices. In both cases the input and output quantities reported in the field are preferred to secondary source data since it is believed that they are sufficiently reliable and reflect the risks experienced in Halir Haor.

#### a) Economic benefit to agriculture using FPCO prices

Based on the survey quantities and average yields and FPCO (1991) economic prices (Table 12.1), for L Boro the economic gross margin in pre-project conditions is estimated as **Tk 3902/ha in 1987/8 prices**. In **post-project conditions it is Tk 5289/ha**. A sizeable part of the value is due to imputing the MPO/FPCO straw output and value into the calculation. This implies a **net increment in economic gross margins of Tk 1387/ha for L Boro**.

**HYV Boro** was not grown before the project and it is assumed that it would not have been grown without the project (since the flood-free season would have remained too short). The economic return is much higher than for L Boro, particularly because the input levels reported are very much less than for irrigated HYV Boro in MPO (1987b): an **economic gross margin of Tk 11809/ha**.

#### b) Economic benefit to agriculture using 'mixed' prices

The economic (and financial) value of paddy in FPCO (1991) is much higher than that reported by farmers (which was at harvest price - it is known from the study that prices for later sale of grain are higher). Hence 'mixed' prices which are reported financial prices in 1991 adjusted to economic prices by the conversion factors recommended by FPCO (1991) have also been used. For L Boro the economic gross margin in pre-project conditions is estimated as Tk 2466/ha in converted 1991 survey prices. In post-project conditions it is Tk 3658/ha). Again a sizeable part of the value is due to imputing the MPO/FPCO straw output and value into the calculation (these were not obtained in the survey). This implies a **net increment in economic gross margins of Tk 1192/ha for L Boro**.

Even using adjusted survey prices the economic return to HYV Boro is much higher than for L Boro, particularly again because the input levels reported are very much less than for irrigated HYV Boro in MPO (1987b). An **economic gross margin of Tk 8897/ha** of HYV Boro was estimated.

#### c) Net economic gain to agriculture from project

Using the FPCO (1991) values, that is 1987/88 economic prices, the annual benefit from initial improvements in the embankment alone is then based on 6195 ha achieving a 0.21

tn/ha gain in expected yield from L. Boro: the gain in gross margin is Tk 1387/ha giving an **annual benefit of Tk 8.59 million**.

The incremental benefit from the two regulators (assuming continued maintenance of the embankment) derives from a further net increase of 391 ha of cultivated land comprising 333 ha of HYV Boro (switched from L Boro) and 58 ha of L Boro. The economic gross margins on this area total an additional annual benefit of **Tk 4.2 million**.

Combining the two phases of the project the overall gain has been an increase on average of some 2250 tons of paddy production per year. In addition about 42,700 more days of agricultural labour are available.

### 12.2.3 Other economic impacts

The earlier sections showed that there had been no perceptible loss of fish production from the project area, although there may be some loss of value with declines in some more valuable species. The pattern is not clear enough to estimate any loss to fisheries. Also there appear not to have been any very notable linkage effects from the project so far as increased productive economic activity is concerned. Hence no other quantifiable economic impacts are included in the evaluation, although environmental and social impacts or trends have already been noted.

## 12.3 REAPPRAISAL OF THE PROJECT

### 12.3.1 Project costs

The economic costs of the project are unclear. If it is assumed that the regulators were built to the predicted pre-project cost (Tk 8.5 million in 1983 prices), then the relevant domestic inflation factor is 1.398 based on the construction cost index for building materials in BBS (1990), while the most appropriate conversion factor among those given by FPCO (1991), since the costs are not broken down by category, is 0.75 for cement. This implies an economic cost of Tk 8.9 million in 1987/88 prices.

In the period since 1984 annual maintenance costs have run at 194 metric tons of wheat. The opportunity cost of this (the economic value of the non-food aid wheat which would be needed were food-for-work wheat not available) amounts to Tk 1.03 million a year at 1987/88 economic prices.

The unknown factor is the cost of the initial improvements to the embankment. This cost must remain conjecture, but the maintenance work averages 10 km a year, whereas there are 53 km of embankment in the project. If it is assumed that the initial improvement required twice as much earthwork as for maintenance and for the entire embankment then the cost would have been Tk 10.9 million in 1987/88 prices. Additionally annual maintenance costs should have been higher before the regulators (as two major cuts had to be repaired each year). Since three cuts and part of the embankment are repaired at present it may be that earlier maintenance costs were 50% higher than at present, but the average maintenance costs include the years when the regulators were under construction.

### 12.3.2 Benefit-cost re-estimation

The annual net economic benefits and costs of the initial embankment resectioning, the two regulators, and finally the actual joint investment pattern were compared in a discounted cash flow table to estimate the net present value of benefits, benefit-cost ratio, and

economic rate of return. Table 12.2 shows the cash flow for the combined investment in embankment improvement and regulators.

Table 12.3 shows the summary results of all the calculations of the economic performance of the project. These indicate that the economic rate of return on both investments was substantially higher than the test discount rate of 12% recommended by FPCO (1991).

These economic calculations should be regarded as indicative only. They are based on group discussions and data from the Upazila, on which confidence intervals cannot be placed and which may not be representative of the whole project area. The estimates are also sensitive to the prices used. The calculations are in 1987/88 prices based on FPCO (1991) but the input levels and yields are based on survey results. Some major assumptions of unknown certainty have also been necessary over project costs since some of these were not known or are hypothetical. The comparison is also between pre-project and with project conditions, rather than a with-without comparison. There is little reason to believe that average yields would be higher without the project than they were pre-project, or that there would have been much expansion of the cultivated area (although beels tend to dry out rather than expand). However, if the river bed has been raised by siltation, as reported, the incidence of early flood damage to Boro might well have increased without the project. Hence the benefit estimates used are unlikely to overestimate without project agricultural output.

Despite these cautionary notes it is clear that even if the economic gross margins were less and the costs more the project would still show a substantial economic return. Despite the continuing uncertainties for paddy production in the area, if the years 1988-1991 are a representative sample there is a clear gain in "on average" yields, and the later building of the two regulators would appear to have been well justified.

### 12.3.3 Re-appraisal against SSDFCP aims

The Small Scale Drainage and Flood Control Project had nine criteria for sub-project selection (Section 1.5). It is informative to compare the performance of Halir Haor project with these criteria:

a) the project was built/maintained under FFW and designed by BWDB as intended;

b) there is a lack of evidence of a comprehensive appraisal having been carried out for the project;

c) the project benefited over 6000 ha of cultivated land, based on BBS (1989) 3411 households lived in the project area in 1983-84. Out of all the households 67% were cultivating and 35% of all households operated 'small' farms (under 2.5 acres). Hence only 52% of cultivating households had holdings of less than 2.5 acres. It is not possible to say how many have less than 3 acres;

d) the two regulators cost much less than the target cost of not more than US$150 per acre for the SSDFCP. In 1990/91 prices the maximum investment cost acceptable was US$241/acre - updating using the MUV index (World Bank, 1990b), whereas the cost estimated was Tk 16.235 million in 1990/91 prices - based on Bangladesh all products wholesale price index (World Bank, 1991). Using an exchange rate of Tk 36 to US$ 1, for the benefited area of 16520 acres, the investment cost of the regulators was only US$ 27.3/acre in 1990-91 prices.

e) an economic rate of return (excluding sunk costs) of over 200% has been estimated for the structures, assuming they both reduced maintenance costs and led to an increased cultivated area and the introduction of HYV Boro by speeding up drainage and retaining some water for supplementary irrigation;

f) the project was not completed until 1987;

g) operation and maintenance are still problems in this project. Embankment maintenance is entirely by FFW, while there are no effective local committees for regulator operation. There has been minimal liaison by BWDB with the Upazila or Union Parishads, and the latter have not taken or been given any formal responsibility for the project.

h) the project has had some adverse environmental impact but this involves a minimal impact on the important fishery located inside the project (however the potential impact on fish production may well have been ignored in project planning); and

i) BWDB's water sector planning appears to have been unchanged by the sub-project.

## 12.4 THE FUTURE

Table 12.3 also shows what might happen if maintenance were improved so that the embankment was of the intended specification, and that specification was still sufficient to exclude flooding up to the target date. Then simply on the basis of the current cropping pattern and inputs there would be a further large increase in total average production (of 35%) which would also show a high rate of return. The problem is in mobilising the resources to achieve this improvement in maintenance.

This improvement would directly benefit farmers and there are ample numbers of large-medium farmers who could afford to pay a "tithe" (of whatever proportion of the harvest was needed) to cover maintenance costs. If harvests were assured, a percentage of the crop to pay for labourers to maintain the project under the projects own internal FFW scheme might be acceptable, given that draught power owners, pump owners, and harvesters are already paid shares of the harvest. Such a system would also help in redistributing part of the gain in terms of employment for local landless labourers.

It would be worth one year's investment of external funds to put the embankment back in shape on condition that this arrangement was then followed, but its success would depend on the support of the local administration in fairly administering collection of grain, and on BWDB ensuring that the increased level of maintenance was carried out to a sufficient standard.

Such a system might best be achieved by handing the project over to the local community (in this case Upazila or UP), where the risks of misappropriation are perhaps no worse than the current system (FFW in practice works through them in any case). A greater problem would be the availability of continued supplies of earth for the high annual maintenance requirements. Siltation in the adjoining rivers ought to help in this regard, but there would need to be a compromise with an appropriate embankment design and construction procedure to make use of the available material, otherwise the embankment might be weakened compared with its performance targets.

**Table 12.1 Boro inputs, outputs and prices, data from Halir Haor and MPO/FPCO**

| Item | L Boro quantity survey | L Boro quantity MPO[1] | HYV Boro quantity survey | HYV Boro quantity MPO[1] | Prices financial survey (1991 Tk) | Prices economic FPCO[2] (1987/88 Tk) | Prices economic mixed[3] (1991 Tk) |
|---|---|---|---|---|---|---|---|
| **Inputs (all per hectare)** | | | | | | | |
| Labour (person days) | 99 | 156 | 111 | 213 | 35 | 24.8 | 24.8 |
| Ploughing (days) | 18 | 40 | 18 | 52 | 70 | 36.9 | 57.4 |
| Seed (kg) | ? | 30 | ? | 30 | 10 | 8.2 | 9.7 |
| Urea | 0 | 27 | 30 | 132 | 5 | 7.72 | 7.7 |
| TSP | 0 | 7 | 0 | 54 | 5 | 5.52 | 5.45 |
| MP | 0 | 0 | 0 | 7 | 5 | 6.21 | 7.15 |
| **Yield** | | | | | | | |
| paddy (tonnes) without | 1.1 | | | | 4500 | 5294 | 4365 |
| with | 1.31 | 2.1 | 2.63 | 4.04 | 4500 | 5294 (5509*) | 4365 |
| byproduct without | 2.2? | | | | 800? | 656 | 656 |
| with | 2.62? | 4.2 | 2.63? | 4.04 | 800? (600) | 656 (462*) | 656 |

Note:

1 MPO (1987b) Technical Report 14.
2 FPCO (1991) Guidelines on Economic Analysis. Bangladesh Action Plan for Flood Control.
3 1991 financial prices from RRA survey converted to economic prices using FPCO (1991) conversion factors.
* HYV Boro figure where different from L Boro.
? byproduct yields and prices are based on ratios in MPO (1987b) as no data was collected in the RRA.

Sources: see table heading.

Table 12.2 **Discounted cash flow for combined embankment and regulator investment Halir Haor**

HALIR HAOR DCF 1987/8 ECONOMIC VALUES IN TK MILLIONS
COMBINED EMBANKMENT AND REGULATOR CASH FLOWS

| DATE | YEAR | CONSTRUCT COST | MAINT COST | AGRIC BENEFIT | BEN-COST |
|---|---|---|---|---|---|
| 1977 | 1 | 10.9 | 0 | 0 | -10.90 |
| 1978 | 2 | 0 | 1.54 | 8.59 | 7.05 |
| 1979 | 3 | 0 | 1.54 | 8.59 | 7.05 |
| 1980 | 4 | 0 | 1.54 | 8.59 | 7.05 |
| 1981 | 5 | 0 | 1.54 | 8.59 | 7.05 |
| 1982 | 6 | 0 | 1.54 | 8.59 | 7.05 |
| 1983 | 7 | 0 | 1.54 | 8.59 | 7.05 |
| 1984 | 8 | 0 | 1.54 | 8.59 | 7.05 |
| 1985 | 9 | 8.9 | 1.54 | 8.59 | -1.85 |
| 1986 | 10 | 0 | 1.03 | 12.79 | 11.76 |
| 1987 | 11 | 0 | 1.03 | 12.79 | 11.76 |
| 1988 | 12 | 0 | 1.03 | 12.79 | 11.76 |
| 1989 | 13 | 0 | 1.03 | 12.79 | 11.76 |
| 1990 | 14 | 0 | 1.03 | 12.79 | 11.76 |
| 1991 | 15 | 0 | 1.03 | 12.79 | 11.76 |
| 1992 | 16 | 0 | 1.03 | 12.79 | 11.76 |
| 1993 | 17 | 0 | 1.03 | 12.79 | 11.76 |
| 1994 | 18 | 0 | 1.03 | 12.79 | 11.76 |
| 1995 | 19 | 0 | 1.03 | 12.79 | 11.76 |
| 1996 | 20 | 0 | 1.03 | 12.79 | 11.76 |
| 1997 | 21 | 0 | 1.03 | 12.79 | 11.76 |
| 1998 | 22 | 0 | 1.03 | 12.79 | 11.76 |
| 1999 | 23 | 0 | 1.03 | 12.79 | 11.76 |
| 2000 | 24 | 0 | 1.03 | 12.79 | 11.76 |
| 2001 | 25 | 0 | 1.03 | 12.79 | 11.76 |
| 2002 | 26 | 0 | 1.03 | 12.79 | 11.76 |
| 2003 | 27 | 0 | 1.03 | 12.79 | 11.76 |
| 2004 | 28 | 0 | 1.03 | 12.79 | 11.76 |
| 2005 | 29 | 0 | 1.03 | 12.79 | 11.76 |
| 2006 | 30 | 0 | 1.03 | 12.79 | 11.76 |
| 2007 | 31 | 0 | 1.03 | 12.79 | 11.76 |
| 2008 | 32 | 0 | 1.03 | 12.79 | 11.76 |
| 2009 | 33 | 0 | 1.03 | 12.79 | 11.76 |
| 2010 | 34 | 0 | 1.03 | 12.79 | 11.76 |
| 2011 | 35 | 0 | 1.03 | 12.79 | 11.76 |
| | | | | IRR % | 64.50 |
| | | | | BCR @ 12% | 3.28 |
| | | | | NPV Tk mi | 58.03 |

**Table 12.3 Comparison of alternative economic performances from flood protection investments at Halir Haor**

| Project description* | Paddy output (mt pa)[a] | BCR (at 12%) | IRR |
|---|---|---|---|
| Initial embankment improvement (assumed in 1977)[1] | 8115 | 2.99 | 65% |
| Phase 2 only (regulators) | 9064 | 2.31 | 237% |
| Combined investment pattern | 9064 | 3.28 | 65% |
| **Potential gains from improved maintenance[2]** | | | |
| Assuming embankment maintained well from outset, combined investment pattern | 12207 | 5.09 | 205% |
| Incremental benefit from improved maintenance for remainder of project life | 12207 | 4.0 | 65% |

Notes:

**All figures are approximate and indicative only of likely benefits**

* All the above assesments assume that the project life is up to year 2011, this is 35 years from embankment construction (1977) and 25 years from regulator completion (1987) including a year for construction.

a Without project production would be 6814 metric tonnes pa, figures are for maximum production where project is phased.

1 Since current maintenance levels cover only about 20% of the project embankment in any one year, it was assumed that the initial embankment improvements were needed for all the length of embankment and that twice the average maintenance work was required. Even much higher initial costs would still give high economic returns.

2 It has been assumed that three times the existing maintenance pattern would be sufficient to eliminate the risk of early flood losses (currently assessed as 1-in-4 years based on the last four years experience), but even higher maintenance costs would be justified if they had this effect.

Source: consultants estimates

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