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Ministry of Irrigation, Water Development and Flood Control

BANGLADESH FLOOD ACTION PLAN

FAP 12
FCD/I AGRICULTURAL STUDY

FINAL REPORT

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Appendices E - J

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

The full series comprises the following reports:

FAP 12

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

Project Impact Evaluation studies of:

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

Rapid Rural Appraisal Studies of:

Protappur Irrigation Project
Nagor River Project
Sonamukhi Bonmander Beel Drainage Project
Improvement of Sakunia Beel
Silimpur-Karatia Bridge cum Regulators
Khatakhali Khal
Halir Haor
Kahua Muhuri Embankment
Konapara Embankment [1]
Polder 17/2
BRE Kamarjani Reach [1]
BRE Kazipur Reach [1]

Draft Final Report (4 Volumes)
Final Report (4 Volumes)

FAP 13

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

[1] Revised versions of these reports were issued in December 1991.

APPENDIX E

PLANNING, DESIGN AND IMPLEMENTATION

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APPENDIX E

PLANNING, DESIGN AND IMPLEMENTATION

E1 PROJECT PLANNING

E1.1 Overall Aims

In general the FCD/I projects were planned with the following primary objectives:

i. self sufficiency in food;

ii. expansion of productive employment;

iii. acceleration of economic growth; and

iv. promotion of self reliance.

These aims were to be achieved through:

i. construction of flood protection embankments;

ii. excavation of drainage canals and construction of water control structures;

iii. provision of Irrigation facilities; and

iv. by enhancement of agricultural extension services.

Most of the FCD/I projects studied under FAP 12/13 were planned in the 1960s and 1970s. While assessing the planning, design and implementation standards of the projects, one should take into consideration the data and modelling limitations at that time. During the 1960s available hydrological data covered only a few years and there was little scope for regional hydrological studies.

The radical change in agriculture which occurred during the 1980s with the growth in groundwater irrigation could not have been predicted when the original project plans were made. However, many of the projects evaluated were either planned or re-appraised and completed in the 1980s and at that time planners should have taken into account improved hydrological data and variation from the previously anticipated agricultural trends.

Despite these adverse factors some of the projects studied appeared quite successful in fulfilling their primary objectives (Halir Haor, Kolabashukhali, Zilkar Haor, among others). Some projects might in isolation have been successful but failed to take account of other FCD/I projects and regional hydrological changes (Nagor River Project, Chalan Beel D).

The project planning was generally carried out by consultants or BWDB. However, while planning these projects very little or no collaboration with other relevant departments such as Roads and Highways, Livestock, Fisheries, Inland navigation, Forests and Agriculture was made; and as a result most of the FCD/I projects experienced either negative impacts in those fields or a lack of coordination with the programmes of the other departments.

E1.2 Embankments

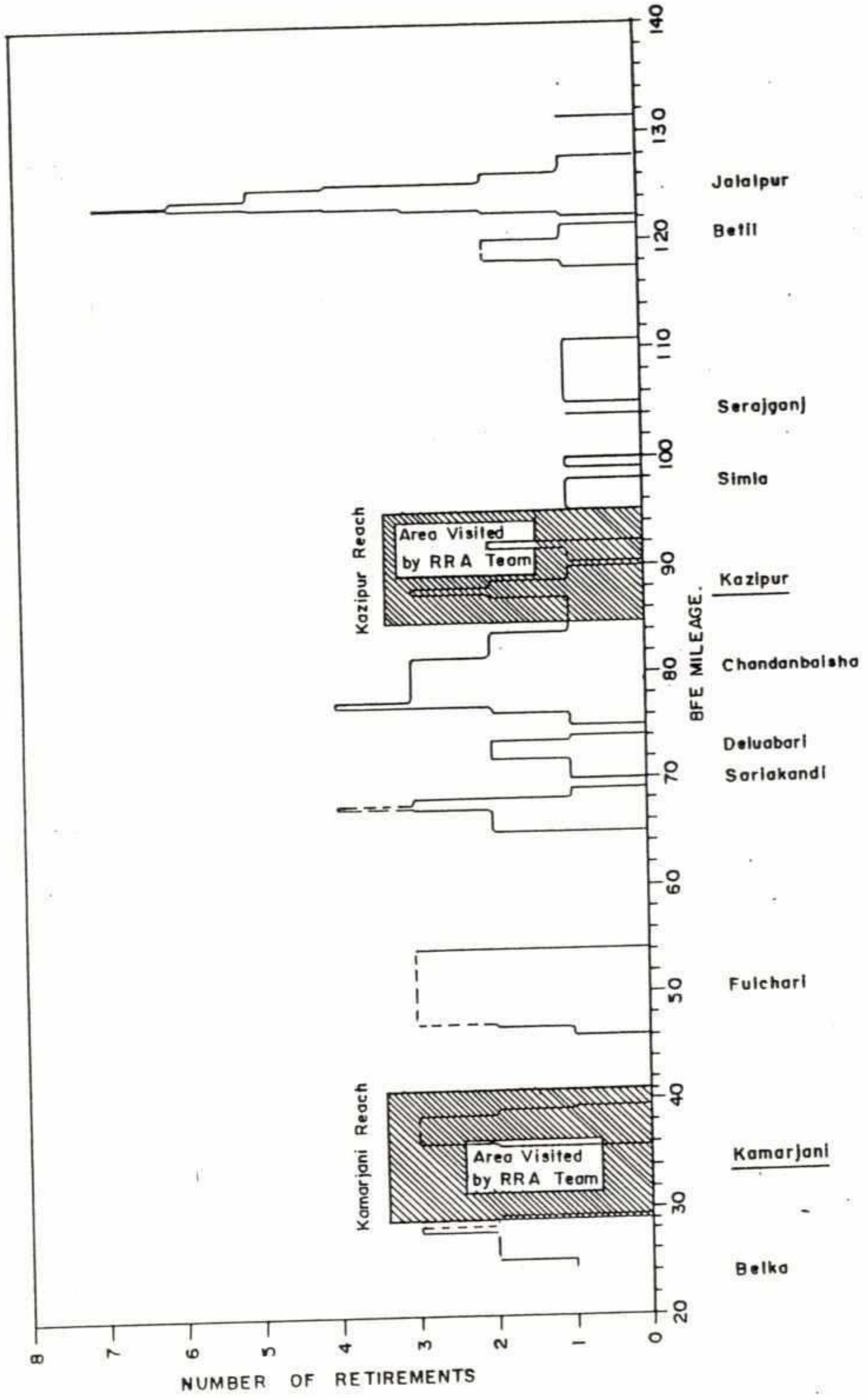
Embankments are a major component of almost all FCD/I projects. They are primarily planned to save the project area from the inflow of flood water from outside and the most common secondary use is as roads. Thousands of kilometres of BWDB project embankments are actually used as an effective road network for rural areas throughout Bangladesh, and hundreds of regulators are being used as culverts and bridges. The utility of these embankments and regulators as a part of a road network would have been further enhanced by co-ordination between BWDB and the Roads and Highways departments. It is commonly seen that a single culvert could connect the polder with the main highway to make a significant contribution to the road network, (Zilkar Haor, Polder 17/2). This co-ordination might have changed some conventional specifications in the design of embankments and regulator slabs but by having either joint responsibility for the road-embankment, or by dividing responsibilities, proper maintenance of the embankment and structures would be assured since either Roads and Highways or BWDB would be required to maintain the infrastructure to a proper standard as part of the contract, and the maintenance burden on BWDB would be reduced. Apart from use as roads, the embankments may be used as flood shelters both for human beings and domestic animals with minor changes in planning. Depending on soil conditions and the nature of the embankment (flood control embankment, canal banks), they could be made useful for social forestry, but thorough research and co-ordination between BWDB and Forestry experts at the planning stage would be necessary.

Set back distance is an important factor for the safety and life span of the embankment, and wrong planning of embankment alignments may cause frequent construction of retired embankments (as at MDIP and on the BRE). Inclusion of thickly populated villages, important historic/archaeological structures, towns, existing roads, problems of land acquisition, and influence of local elite groups have sometimes compelled alterations to the originally planned alignment. In some of the projects the set back distance was found to be almost zero along a major portion of the embankment (Nagor River project, MDIP, Chalan Beel Polder D, BRE, Kurigram). The BRE has faced retirements as many as seven times at some locations (Figure E1), while in MDIP, the construction of a retired embankment was required at least twice even before the completion of the project. Bank protection works are under way in some of the projects to save the embankment (MDIP, BRE, Kurigram, Chalan Beel Polder D). Locations where the embankments pass through the active floodplain are facing acute problems due to wave action and much money is being spent for bank protection works, for example brick mattressing to save the embankment in Chalan Beel Polder D.

E1.3 Structures

The main structures planned in all the FCD/I projects are regulators/sluices, weirs, irrigation inlets, pumping stations, distributors, and checkgates, depending on the nature of the project. Table E2 details the water control structures found in the 17 projects studied. Proper planning of the type and location of structures determines the success of both flood control and irrigation components. Improper location of structures reduces their utility and efficiency, and ultimately they may be abandoned (KBK). The purpose and function of a structure should be accurately planned after a thorough survey of the field conditions to avoid damage and increase in O&M cost. For example, in KBK project, all the single purpose regulators (drainage or flushing) are used both for drainage and flushing and, as a result, all these structures are damaged to different degrees and their structural integrity is threatened.

Figure E1



NUMBER OF RETIREMENTS ALONG BRE

Source : BRTS. First Interim Report (Four Volumes) – FPCO.

The necessity of a structure in a project should be studied minutely. It was noted during field visits that many of the one vent irrigation/flushing regulators of BRE were seldom used and as such these were avoided in the subsequent retired embankment. In Silimpur-Karatia project the regulator fallboards were used in 1991, for the first time, a long period after their construction. Local people there reported that they were not getting any benefit from the regulators, and simple culverts in lieu of costly regulators would have served them well.

E1.4 Hydrology

The planning of the FCD/I projects evaluated under FAP-12 was undertaken without the benefit of detailed hydrological studies, as the available data covered only a few years in most of the cases and there was very little scope for regional hydrological studies - a vital requirement for the future functioning of the projects.

The absence of proper comprehensive hydrological surveys and regional/project level modelling studies has resulted in a series of post-project problems, (See Table E.1) such as:

i. frequent public cuts (both by insiders and outsiders) and breaches (13 out of 17 projects);

ii. back flow in rivers and channels (6 out of 17 projects);

iii. severe erosion (13 out of 17 projects);

iv. increase in drainage problems (9 out of 17 projects); and

v. increased siltation problems (15 out of 17 projects).

Various studies of the Atrai and Nagor River basins predict a rise of about 2-3 m. in river water levels in the region after full confinement of the rivers by embankments. If this happens it will create havoc in all the projects and seriously endanger lives and property in this region. The present frequency of public cuts and breaches of embankment and the damage to crops and property within the projects (Nagor River, Chalan Beel Polder D) due to sudden unexpected inundation is gradually strengthening the view in favour of submersible embankments instead of full flood protection. Some public cuts in Nagor/Chalan Beel projects are either left open for years or restored as dwarf embankments with an elevation just sufficient for the safe harvest of the Boro crops.

E1.5 Drainage

Elimination of drainage problems is one of the primary objectives of FCD/I projects, but it is one which could not be achieved at all in the majority of projects and has only been partially achieved in few projects (Table E.1). MDIP with a pump drainage system has eliminated the drainage problems completely but with the penalty of an O&M cost which is much higher than in other projects.

Lack of regional hydrological data has frequently retarded or seriously jeopardised the function of a drainage structure. This happens when the river water level remains higher than the level inside the project for most of the time and drainage through the regulator is not possible even during peak requirement (Chalan Beel, Zilkar Haor, Kurigram). Fig. E2 illustrates the problem with BWDB data from one of the regulators at Zilkar Haor.

Table E.1 Summary of Key Hydrological Impacts

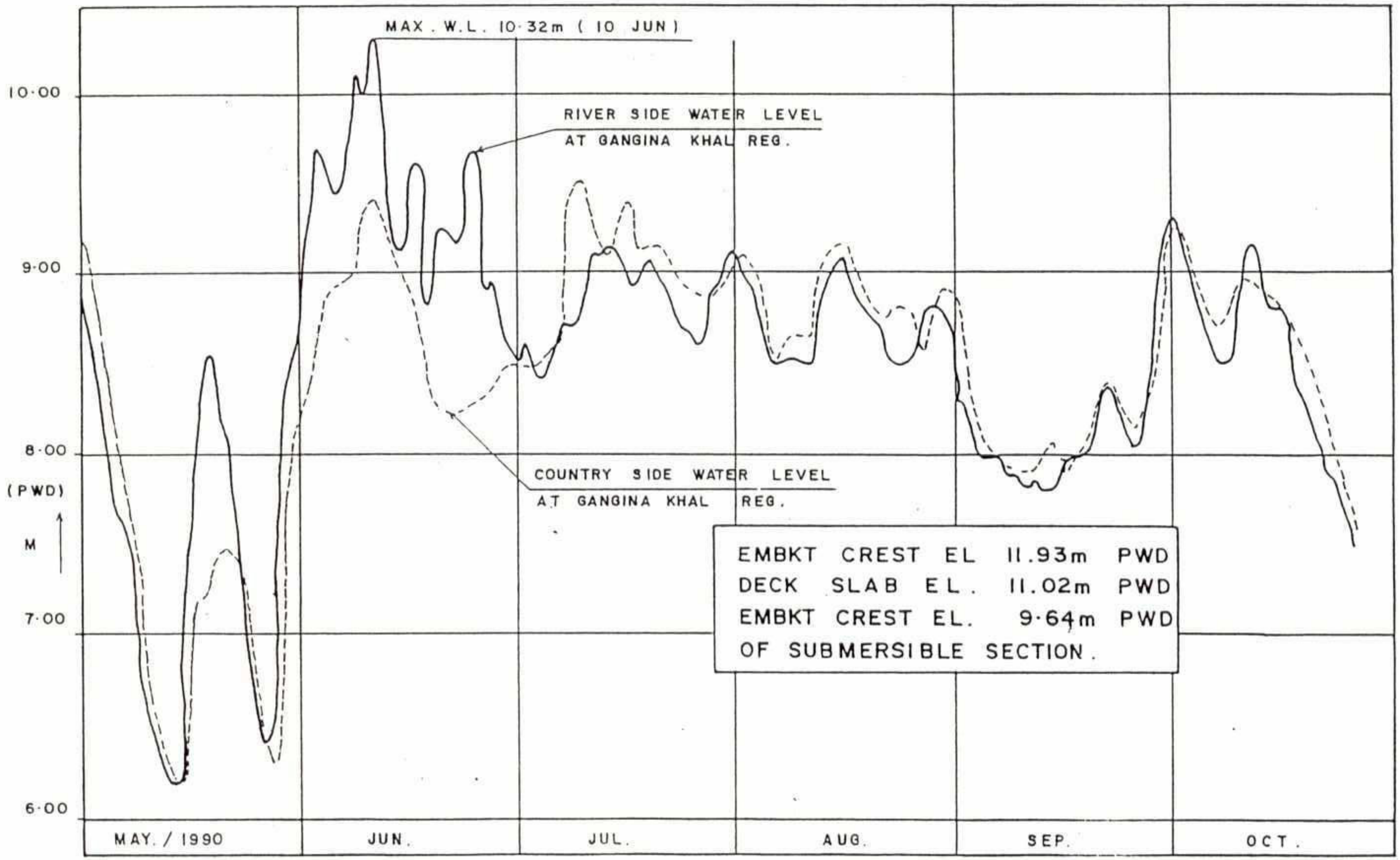
Flood type	Project Name	Post Project Flood Characteristics								Breaches/ Public cuts
		Inside Project				Outside Project				
		Delayed onset of floods	Reduced normal flood depth	Prevented peak floods	Drainage problems	Silta-tion	Back-flow	Bank erosion	Water level	
L	Chalan Beel Polder - D	Yes	Yes	(Partly) Yes	I^{**}	I	No	I	I^{**}	B^{*} P^{***}
M/F	Kurigram South	Yes	Yes	Partly	I^{**}	I	No	I	0	B^{*} P^{**}
M	Meghna Dhonagoda Irrigation Project	Yes	Yes	(Partly) Yes	Ta	0	No	I^{***}	0	B^{***}
H	Zilkar Haor	Yes	Yes/No+	Yes/No+	D^{*}	I	No	0	I^{*}	-
T/L	Kolabashukhali	TIDAL	Yes	Yes	D^{*}	I	TIDAL	I	I^{*}	-
L	Protappur Irrigation Project	Yes	Yes	Yes	Ta	I	No	I	I^{*}	-
L/F	Nagor River Project	Partly	No	No	I^{*}	I	Yes^{***}	I^{***}	I^{**}	P^{***}
L	Sonamukhi-Banmander Beel Drainage Project	No	Yes	Yes	D^{*}	I	Yes^{**}	0	I^{**}	-
L	Impv. Sakunia Beel	Yes	Yes	Yes	D^{*}	0	Yes	I	I^{*}	B^{**}
L	Silimpur-Karatia Bridge-cum-Regulator	No	No	No	I^{*}	I	No	I	I^{**}	B^{*}
L	Katakhali Khal	No	Yes^{**}	No	I	I	No	I	I^{*}	P^{**} B^{**}
H	Halir Haor	Yes	No	No	D^{*}	I	Yes	0	I^{*}	P^{*} B^{*}
F	Kahua-Muhuri Embankment	Yes	Yes	No	I^{*}	I	Yes	I^{***}	I^{*}	B^{***} P^{***}
F	Konapara Embankment	Yes	Yes^{**}	No	I^{*}	I	Yes	I	I^{**}	B^{*} P^{**}
T	Polder 17/2	TIDAL	Yes	Yes	I^{*}	I	TIDAL	0	I^{*}	P^{**}
M	BRE - Kamarjani	Yes	Yes	Yes	I^{***}	I	No	I^{***}	0	P^{***} B^{**}
M	BRE - Kazipur	Yes	Yes	Partly	0	I	No	I^{***}	0	B^{***}

Notes:
Flood Type: M = Monsoon flood; L = local flooding and internal drainage; F = flash floods; H = haor areas; T = tidal flooding; Ta = Target achieved.
Yes = Intended target achieved; No = No impact apparent; I = Increase/Rise; D = Decrease/Fall; * = Moderate; ** = Medium;
*** = Severe; B = Breach; P = Public cut; + yes in full flood protection part, no in submersible embankment part

Source: RRA Overview Reports

2)

FIGURE E2 WATER LEVEL RECORD (ZILKARHAOR – 1990)



Complete or partial closure of an existing channel or river passing through the project area, without a hydrological model study may cause adverse hydrological impacts both inside and outside the project (Kompo River in Chalan Beel Polder D, Ratnai river in Kurigram south).

For example, in Chalan Beel Polder D the Kompo river connecting the Sib River (off-take) to the Fakirni River (out fall) was closed at its off-take and outfall by the polder without providing regulators with the required capacity, and as a result in each year the Sib river water level (outside the project) now rises higher than in the pre-project conditions and submerges the houses and crops on the right bank river side areas. Hence, the affected outsiders cut the embankment near Tangrapara. On the other hand, the accumulation of rain water inside the project cannot be drained out properly to the Fakirni River, and this problem of waterlogging is further aggravated by the public cuts at Tangrapara, causing damage to the standing crops. As a result the insiders cut the embankment near Birkaya in each year to get rid of the drainage congestion.

Public cuts in Chalan Beel Polder D and Nagor Valley projects create direct negative impacts on Chalan Beel Polder C and Nagor River projects respectively, resulting also in public cuts in the latter projects.

The drainage congestion at Sonamukhi-Banmander Beel drainage project could not be overcome as the huge inflow of flood water from Indian territory into the project area was apparently overlooked during planning and implementation stages. Clearly for border projects, the effects of engineering activities on the other side of the border, particularly in connection with flood control, irrigation and river training works, should be studied thoroughly to avoid investments which may be rendered ineffective by the other country's actions, and so that compromise between the projects of the two countries can be negotiated.

The FCD/I projects have in general reduced the magnitude of peak floods (Table E.1) inside the project area, but failed to solve drainage congestion problems. The concept of compartmentalization may reduce the drainage congestion problem. Another major factor behind drainage congestion is that the importance of an efficient drainage network is overlooked. Normally the drainage regulators are planned to be constructed on the prominent drainage channels but the scattered depressions (beels) in the project area are not connected with a planned network, which causes drainage congestion in different low pockets.

The evidence concerning hydrology and drainage in project planning is clear. FCD/I project planning in isolation runs a great risk of damaging the aims of other projects and adversely affecting many other people. It is easy to adopt a piecemeal approach - 'improving' affected projects to try to preserve their intended benefits following the impacts of other projects. However, such a process of escalation is not only inefficient and wasteful, but ultimately likely to result in catastrophe. Planning needs to consider much larger areas affected by a water management proposal.

E1.6 Agriculture

The rapid changes in cropping and land use patterns which have occurred throughout Bangladesh were not (though perhaps they could have been) predicted in the original planning of the FCD/I projects studied by FAP 12. The key radical changes in agriculture started during the 1980s with the development of ground water irrigation. All the FCD/I projects, in general, have considered only surface water irrigation and the drainage requirements for the then prevailing crops, but ignored the possibility of irrigation by ground water with STW/DTW. As a result, the original scope of work for FCD/I projects has often failed to cope with the present irrigation and drainage requirements for the changing cropping and land use patterns. In some projects the existing surface irrigation system has become obsolete (Protappur Project). The changes in cropping pattern have brought changes in drainage requirements too, which are closely connected with the sowing/planting seasons. The changes in the frequency and magnitude of drainage requirements for present cropping patterns have made the existing drainage capacity of structures inadequate.

Regular co-ordination with the Agriculture Department could have addressed this set of problems to a great extent, either through revised operational methods or through modifications to the projects, as experienced in some of the projects. However, many of the projects evaluated were either planned or re-appraised and completed in 1980s, when the planners could reasonably have been expected to take into account the changes in prevailing agricultural trends.

E1.7 Boat transportation

Boat transport is the most common, easiest and cheapest means of communication and transportation in most of Bangladesh, including almost all areas where FCD projects have been built. Within the poldered areas during the monsoon and even during the harvesting seasons the farmers face great problems for the transportation and marketing of their products. In all the FCD/I projects this cheap mode of bulk transport is now almost extinguished, due to closure of natural channels by the embankments, except in the projects which are facing regular public cuts in the embankments. Provision of simple navigation locks to connect the project area to outside markets in large polders is essential. The MDIP feasibility studies recommended such provision but this was dropped in the detailed design, most probably due to financial problems. The introduction of shallow tubewell engines for powering country boats has made boat transportation more convenient and time saving and makes it more important to take proper account of water transport in project planning. Construction of good roads above flood level in the marshy areas is very expensive and maintenance of such roads is a regular problem, whereas boat transport costs practically nothing to the government. Good drainage channels can be used as navigation routes. In the planning of future projects and rehabilitation programmes of completed projects, the importance of boat transport should be given due consideration.

E1.8 Fisheries

Most of the FCD/I projects have created moderate to severe negative impacts on fisheries and the fishing community inside and outside the project area. Firstly, the full flood protection embankment and the gated structures of the polders have completely eliminated the free migration of mature fish from the beels to rivers and movement of the fish spawn/fry/fingerlings from the rivers to the beels. Secondly, efforts to complete the reclamation of the lower beel areas for agriculture have severely reduced the perennial water bodies within the project areas, and thus practically extinguished all kinds of fish in the beels during the dry season. As a result, the potential for future generations of fish from the project area is ended. As a result, to overcome this problem and for survival, the genuine fishermen's community often creates problems in many projects by modifying sluice operation or even by cutting the embankment during the monsoon to allow fish spawn/fry to enter into the beels.

No limitations have been placed at the project planning stage on the complete reclamation of the lowest beel beds (Khas land) for agriculture. Creation of wetland conservation areas/perennial ponds in the lowest parts of the beels to provide a year round habitat for non-migratory fish species should be considered by the planners.

Proper planning with modifications in conventional structures and canal networks, in collaboration with the Fisheries Department, could save the fish population and the fishermen in new projects. The problems of public cuts of the embankments and social conflict between fishermen and farmers would thus be reduced, with a subsequent reduction in O&M costs. More detailed proposals for such structures, and for appropriate modifications to operating procedures, are given in the Final Report of FAP 13, the FCD/I O&M Study, which was conducted jointly with FAP 12.

Borrow-pits for embankments should be planned prior to execution for use as fish ponds, drains or irrigation canals (on the country side of embankments only). If the borrowpits are productive and useful to the local people, then the problem of land acquisition will be easily solved. In the coastal region the riverside borrowpits (within the set back distance) could be used as shrimp ponds (Polder 17/2).

The key point is that project planning has up to the present been single purpose, aimed solely at water management measures thought beneficial for agriculture, perhaps with mitigatory means to avert some (but never all) adverse impacts. Planning would be more complex but would offer greater benefits and minimise conflicts if it became multipurpose, aimed at developing the floodplain economy as a whole.

Even the technical aspects of the single purpose planning undertaken have often been handicapped. This is well illustrated by the problem of shrimp farming (Polder 17/2). The massive expansion in shrimp farming could not be predicted in the late 1960s, but subsequently project management and design were not modified, to accommodate it even though it should have been clear that a compromise would be needed once the economic opportunities changed so radically in Polder land use. This is most obvious in Polder 17/2 which remained incomplete during the expansion in shrimp cultivation. No reassessment of the original planning and design, or of water management needs, was undertaken before construction resumed and the polder was closed.

E1.9 Co-ordination with Upazilas and NGOs

Close co-ordination of FCD/I projects at the planning stages with Upazila and NGO activities and vice versa can save projects from unwanted adversities. During the FAP 12 studies it was noticed that many earth roads and dwarf embankments were constructed under Upazila/NGO programmes within the project areas without providing required drainage facilities, and these have contributed towards unwanted drainage congestion and damage to crops. Well coordinated planning from either side could have easily avoided these unintended hazards. It was not possible in the FAP 12 surveys to quantify the contribution of Upazila and BWDB infrastructure to drainage; this would only be possible in the detailed redesign of a project.

E1.10 Public Participation

Generally there was no discussion with the intended beneficiaries at the planning stage and hence local needs and knowledge were not taken into account. Public participation is a vital factor for the success of the projects. The objective should be to make the project locally acceptable, to identify local conflicts of various interests, to create a sense of ownership by the people, and to encourage spontaneous involvement of the people in all project activities. The planners should take advantage of local knowledge (for example drainage routes, past flood experience, change in river courses etc.).

A process of public consultation at the planning stage should be adopted. The consultants/BWDB should highlight the objectives, benefits and project activities in public meetings within the impacted areas. Presentations of the project benefits/disbenefits should also be made in liaison meetings with local administration and elected/public representatives at least in each Upazila. In a few cases in which there was consultation with beneficiaries at the planning stage, and local knowledge and needs were taken into account, the projects are generally found to be better conceived, and their implementation and subsequent O&M were facilitated (e.g. Zilkar Haor, Protappur, Kolabashukhali).

E2 PROJECT DESIGN

The design of FCD/I project components was generally found to be sound, given the purposes that the planners had identified for those components. However, some of the embankments and structures faced foundation problems due to lack of subsoil data, drainage problems due to inadequate hydrological data and mistakes in field survey, and there was a general lack of local information regarding drainage patterns, past flood experience, changes in river courses, siltation and scouring.

E2.1 Soils

Where the designers had insufficient sub-soil data, the chances of inappropriate designs of embankment and structural foundation were high, and as a result some of the projects are facing problems with defective structures and embankments. For example, the foundation of Uddamdi pump house at Meghna Dhonagoda Irrigation Project (MDIP) settled and cracked, and was repaired after exerting much effort and additional expenditure. The construction of Bhumbag regulator in Kolabashukhali (KBK) project, has been halted for a long time due to its foundation failure. The pile length had been increased, but the piles have still failed and the engineers have blamed insufficient sub-soil data. Two other regulator boxes of KBK (Harikhali and Madhupur regulators) settled by about 6-8 inches and the regulators had to be kept out of operation for several years, causing great damage to the crops.

Since BWDB structures are designed to more or less the same design criteria, the only differences among the structures depend on the field conditions. Thus the failure of a few structures established the fact that they were not over designed.

In MDIP, the permeability in the sub-soil layer under the embankment led to development of severe piping action at several locations after the construction of the project and it was considered to be mainly responsible for the failure of the embankment in 1987 and 1988 in the Durgapur area. Proper investigation of the sub-soil layers prior to design of the project and careful adoption of the results in the design works could have saved the projects from the problems mentioned above.

E2.2 Structures and Canals

Almost all the FCD/I projects studied are experiencing moderate to severe drainage problems (Table E.1)and shortcomings. The designs of structures and canal networks have been major contributors to these problems.

Faulty assessment of the regulator ventages with reference to the volume of water to be discharged, taking into consideration the available drainage period, has caused drainage congestion in most of the projects. The drainage is normally controlled by the fluctuations in river side water level and the regulator capacity of the project. Inadequate drainage capacity of regulators due to insufficient ventages is a common complaint in all the projects. The present trend in the changes in land use and cropping patterns should be taken into consideration in the design criteria of all drainage structures.

The inadequate drainage capacities of some existing regulators are causing backflow, water logging and siltation inside the project area (for example, the 6 vent regulator on the Betna River and the 3 vent regulator on the Daudkhali Khal in Sonamukhi-Banmander project are causing backflow for a long distance up-stream). The problems of frequent public cuts of embankments (9 out of 17 projects, Table E.1) are the result either of the non-existence of drainage sluices or of the inadequate drainage capacity of the sluices provided. These design inadequacies are often so serious in their subsequent impact that they compromise the scheme's viability.

The projects also suffer from public cuts due to incomplete drainage networks, which are the result of poor planning and design. When isolated drainage basins are omitted from the drainage network and a regulator is also not provided, but the normal drainage is obstructed by the embankment, a public cut is the obvious local solution (Halir Haor, Kurigram, Katakhali Khal)

Linking of drainage structures with an efficiently designed drainage network is an important factor for the success of the FCD/I projects. Some of the structures are not connected with designed drainage channels and have subsequently been abandoned (Lohargati Khal regulator, KBK).

Some regulators/sluices designed for a single purpose (drainage or flushing) are actually being used both for drainage and flushing, in line with the actual requirements of the project. Since the floor and apron design of regulators with a single function differ from those of a dual function (both drainage and flushing) regulator, they have experienced rapid damages and in some cases (KBK) the very existence of these regulators is endangered. The designer should have visited the site and discussed with the local people to determine the actual functions of the structures for a realistic design.

In Protappur Irrigation Project most of the regulators could have been replaced by simple masonry weirs and this would have reduced the cost of the project as well as the subsequent operational hazards. Moreover, the leakage through the gates has reduced the efficiency of water retention, the main purpose of the project.

E2.3 Regulator Gates

Regulator gates are leaking practically everywhere to some extent. This factor in the coastal zone has allowed unwanted intrusion of saline water which damages the crops. In other cases the purpose of water retention in the canals/beels for surface irrigation is jeopardised.

In these cases defects in the rubber seals or absence of the seals, improper size of gates, and defects in the gate hoisting system are the main reasons for the leakage. Improved design of gate seals to stop leakage and minimise maintenance needs should be a priority target for BWDB.

The wooden fall boards commonly used in small regulators are an O&M menace to any FCD/I project. On technical grounds their use should be avoided, except for temporary closures during the maintenance of regulators. In submersible embankment projects the fall boards are very difficult to operate, especially under high head differences and they are frequently stolen, misplaced, damaged or washed away.

In some drainage-cum-flushing regulators two flap gates are used instead of a single vertical lift gate causing more operational hazards. Vertical lift gates are a more efficient solution for water control, even if more expensive.

E2.4 Embankments

Embankments are generally found to be well designed, though MDIP is an exception to the general findings. The original proposal for the MDIP embankment was altered (original crest width of 21' was reduced to 14') at the time of detailed design and the revised embankment section failed at several places due to insufficient earth section and piping below the embankment.

Designers should give due importance, to proper quality control of embankment compaction both when embankments are originally constructed and when they are reconstructed as retired embankments.

E2.5 Fisheries

Modifications in the planning and design of structures are essential in the light of the prevailing trend for fisheries development. Modifications in regulator design and operation could allow migration of mature fish to and from beels as well as the entrance of fish spawn/fry into the beels, but experiments will be needed to test the viability of such changes.

E2.6 Navigation locks

The provision of navigation locks in large FCD/I projects should not be avoided. At present, planning and design failures leading to drainage congestion sometimes have a beneficial side effect, when public cuts provide navigation access to the project interior. When the problem of public cuts is solved, the problem of inland boat transport will be even more acute.

E3 PROJECT IMPLEMENTATION

Almost all the engineering components of the FCD/I projects studied under FAP 12 were visited on site, and are listed in Table E2.

Table E2 Existing Project Components

Project name	Embankment (km.)	Regulator/ Sluice	Gate type	Canal/channel/ drainage/irrigation (km.)	Pumping station	Irrigation inlet	Irrigation outlet	BWDB Road/ bridge
Chalan Beel Polder D	132.28	17	VL	123.6+10.7	-	77	-	-
Kurigram South	103.00	11+4 = 15	11-VL+3-FB+1-FG	-	-	-	-	-
Meghna Dhonagoda	60.00	69	VL	218(IRR.)+125.5(DR.)	2+2	-	387	72
Zilkar Haor	24.71	3+6+5 = 14	3-VL+5-FB+1-FG	3.5	-	25	-	-
Kolabashukhali	85.50	6-DR+9-FS+1-DR-cum-FS	5-VL+10-FG+1-VL&FG	8.85	-	-	-	7
Protappur Irrigation Project	10.00	10	VL	12.5+8.1+2.28	-	-	-	-
Nagor River Project	27.00	6	FB	14	-	14	-	-
Sonamukhi-Banmander Beel	2.00	5	-	50	-	-	-	6+4
Improvement of Sakunia Beel	14.60	2	VL	16	-	-	-	-
Silimpur-Karatia	-	4	FB	-	-	-	-	-
Katakhali Khal Project	14.16	7	VL+FB	14	-	-	-	-
Halir Haor	53.00	2	-	-	-	-	-	-
Kahua-Muhuri	36.00	1	4-FG+1-(FG+VL)	-	-	15	-	-
Konapara Embankment Project	21.56	-	VL	-	-	5	21	-
Polder 17/2	10.50	5	-	-	-	-	-	-
BRE - Kamarjani Reach	19.50	6		-	-	-	-	-
BRE - Kazipur Reach	16.00	?		-	-	-	-	-

Note: PS - Pipe Sluice; DR - Drainage Regulator; FS - Flushing Sluice; FB - Fall Board; VL - Vertical Lift Gate; FG - Flap Gate

Table E3 Project Implementation

Name of the Irrigation Project	Construction started	Scheduled completion	Actual Completion
Chalan beel polder D	1981/82	?	1988-89
Kurigram South	1971	?	1983/84*
Meghna Dhonagada	1978	1983	1987
Zilkar Haor	1983/84	1986/87	1986/87
Kolabashukhali	1975	1983	1983
Protappur Irrigation Project	1974/75	1977/78	1977/78
Nagor River Project	1983/84	1985/86	1986
Sonamukhi-Banmander Beel	1970	?	1978
Improvement of Sakunia Beel	1981/82	1983/84	1984/85
Silimpur-Karatia	1982	1983	1983/84
Katakhali Khal Project	1980/81	1981	1982/83
Halir Haor	1976/77	1983	1987
Kahua-Muhuri	?	?	1980/81 to 1985/86
Konapara Embankment	1980/81	?	1983/84
Polder 17/2	1969/70	1970/71	1983/84
Bhahmaputra (Kamrjani reach)	1963 original 1974 rehab.	?	1970 original 1985 rehab.
Bhahmaputra (Kazipur reach)	1963 original 1974 rehab.	?	1970 original 1985 rehab.

Note: *Completion of original FCD components, the project has yet to be declared complete as the intended irrigation components have never been built and would now be difficult to justify.

E3.1 Implementation Period

BWDB is the implementing agent of all the FCD/I projects studied under FAP 12. Many of these projects took longer to implement than the scheduled period of completion and some were left incomplete for a long period (Table E3). Sometimes the construction of small components such as the construction of one or two regulators or closures was left uncompleted for a long period and the project was deprived of most of its benefits even after more than 80 per cent of the project cost had been disbursed (Polder 17/2).

E3.2 Reasons for Delay

Delay in implementation happened due to various reasons such as problems in land acquisition, poor subsoil data, inefficient contractors, and deficit of funds, but in most of the cases these reasons ultimately reflected poor original planning or design. For example, the initial attempt at the Gangrail closure in Polder 17/2, at the time of independence, failed. Two later attempts in 1975 and 1977 also failed due to technical reasons and inefficient contractors. Finally the closure was completed under EIP scheme in 1982-83, almost a decade after the scheduled completion.

In Kurigram South a small reach of the embankment could not be completed due to land acquisition problems.

The Benda Khal in KBK project could not be closed with a pucca regulator due to a land acquisition problem. The present practice is that each year the local population close the khal just before the onset of monsoon flood and cut the closure during the dry season to take in irrigation water. The beneficiaries now understand the utility of a regulator and are requesting BWDB for one.

Delay or lingering construction periods invariably increased the total project cost and led to postponement of benefits, both consequences having seriously adverse effects on the economic viability of the projects affected. MDIP, where the project was completed 4 years late (on an original 5-year schedule) and 25 per cent over cost, is a particularly serious example.

E3.3 Quality Control

a) Embankments and Canals

In general, the quality of the original embankments constructed by BWDB was found to be sound except on a few reaches, where 'ghogs' (animal burrows) and piping through the embankments appear due to improper compaction. The original BRE, which was machine compacted and perfectly graded, is an exception. However those parts of the embankments originally constructed or rehabilitated under FFW programmes generally had inferior quality control which resulted in a lack of proper compaction (BRE retired embankment, parts of new projects). The FFW programmes are facing institutional complexities among the BWDB, Upazila, Union Parishad and NGO staff in the field of project supervision. Quality control in earthworks is also a cause for concern among contractor implemented works.

Similarly the excavation or re-excavation of canals under FFW programmes faces problems. Different reaches of the canals are allotted to different groups without proper co-ordination and as a result the canal sections and slopes vary between reaches, and sometimes there are discontinued reaches due to shortage of wheat.

E3.4 Non-Implementation of Designed Parameters

Failure to implement the planned/designed parameters during construction may reduce the expected benefit or even result in failure to achieve the project objectives. In Halir Haor the embankment crest was constructed 1.5 ft. lower than the designed crest level for about 14 km., resulting in more frequent damage to the Boro crops.

The drains in almost all the projects studied were either not excavated or were only partially excavated during the implementation period, though they were included both in planning and design. Non-existence of well planned drainage networks in the FCD/I projects is one of the major constraints on the drainage of scattered low pockets/depressions in the project areas. Such projects are invariably experiencing frequent public cuts as a local solution to the drainage problem. Regulators which were not linked to the beels by the planned channels (either for flushing or drainage) are eventually abandoned (Lohargati regulator, KBK).

E3.5 Structures

The most common structure in FCD/I projects is the regulator/sluice. The construction of regulators was generally up to the acceptable standard at the time of project completion but due to lack of O&M many of them are in a deplorable condition. The loose aprons (loose talus) were found to be the weakest part of the regulators and were damaged and displaced in all the regulators. The water stoppers at the construction joints between the regulator box and the wing walls were mostly found not to have been well placed at the time of construction, and as a result became damaged within a short period. The settling of two regulators in KBK project (Harikhali and Madhupur regulators) appeared to be due to design deficiency but the water stoppers at the construction joints between the wing walls and regulator box have been destroyed and the huge volume of leaking water has found its path behind the abutments of the regulators. This leaking water will soon wash away the embankment behind the abutment leaving the structure isolated. The water tightness of the regulator gates was not achieved even during implementation and as a result all the gates of the water control structures are leaking to different degrees. Existing conditions of the water control structures and the canals of the PIE projects are shown in Tables E4 to E7.

Some link roads were constructed by BWDB within the FCD/I projects. Such a road between Ghazirhat and Terokhada (KBK) is left incomplete as the construction of two culverts on this road is still kept pending.

The brick mattressing works for protection against washing/scouring of embankments due to wave action failed at 9 places within one year in Chalan Beel Polder D. This happened due to defective toe works for the brick mattress. In general protection works constructed during the operating phase of the projects are a large drain on scarce resources and on the evidence of the projects studied their success is uncertain. There is a danger of wasting money on ineffective protection of structures whose contribution to benefits may even be dubious.

Table E4 Summary of Condition of Main Drainage/Flushing Structures in Chalan Beel Polder 'D'

Type and Location of Structure	Present condition of structures									Present Condition of Drainage Channel	
	Regulator/Sluice							Gate		Need reexcavation (km.)	
	No. of Ventage	Type of Gate	Wing wall C/S	Wing wall R/S	Box	Apron C/S	Apron R/S	Gate	Rubber Seal/ Groove	C/S	R/S
Kashimala Drainage Regulator	2	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Dangapara Drainage Regulator	3	V.L.	G	G	G	F	L.A. to be constructed	G, one gear box missing	R.S to be provided	G	F
Ratandanga Drainage Regulator	1	V.L.	G	G	G	F	F	G	R.S to be provided	G	F
Singa Drainage Regulator	4	V.L.	G	G	G	F	F	G	R.S to be provided	F	G
Saldha Drainage Regulator	1	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Beel Pabni Drainage Regulator	5	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Kalamara Drainage Regulator	1	V.L.	G	G	G	F	G	G	R.S to be provided	F	F
Goalmanda Drainage Regulator	2	V.L.	G	G	G	F	F	G, 1 gate need repair	R.S to be provided	F	F
Purbadaulatpur Drainage Regulator (Brick Masonry)	8	V.L.	G	G	G	G	F	G	R.S to be provided	G	G
Joker khal Drainage Regulator	1	V.L.	G	G	G	G	F	G	R.S to be provided	G	F
Birkaya Drainage Regulator (Brick Masonry)	6	V.L.	G	G	G	G	G	G	R.S to be provided	P	F
Gopalpur Drainage Regulator	1	V.L.	G	G	G	G	F	P, penium is missing	R.S to be provided	F	P
Bagmara Flushing cum Drainage Regulator (Brick Masonry)	3	V.L.	G	G	G	G	G	G	R.S to be provided	F	F
Monglardara Drainage cum Flushing Regulator	2	V.L.	G	G	G	G	G	G	R.S to be provided	F	F
Dhopaghat Drainage cum Flushing Regulator	1	V.L.	G	G	G	F	F	G	R.S to be provided	F	G
Gobindapur Drainage Regulator	5	V.L.	G	G	G	G	G	G	R.S to be provided	F	G
Chandpur Drainage Regulator	2	V.L.	G	G	G	G	F	G	R.S to be provided	F	F

Note: C/S - Country Side; R/S - River Side; V.L. - Vertical Lift; F.B. - Fall Board; F.G. - Flap Gate; G - Good; F - Fair; P - Poor; N/A - Not Available

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E3.6 Record Keeping

Record keeping of the projects was found to be very poor at all levels and the most important construction documents, such as the As-Built Drawings, were not available at all in any BWDB field offices. The Project Completion Report (PCR) was available for most projects, but even this was lacking in some cases. Any future O&M works on rehabilitation of the foundation of structures will be very difficult in the absence of As-Built Drawings.

Table E5 Summary of condition of main drainage structures in Kurigram South Unit.

Type and Location of Structure	Present condition of structure									Present Condition of Drainage Channel	
	Regulator/Sluice							Gate		Need reexcavation (km)	
	No. of Ventage	Gate	Wing wall C/S	Wing wall R/S	Box	Apron C/S	Apron R/S	Gate	Rubber Seal/ Groove	C/S	R/S
Gharial danga Regulator	2	V.L.	G	G	G	F	F	G	R.S to be provided	F	F
Kishorepur Regulator	12	V.L.	G	G	G	F	F	G	R.S to be provided	F	P
Harichari Regulator	12	V.L.	G	G	G	G	G	G	Nil		
Chasler Beel Pipe Sluice [a]	1	F.B.	P	P	F	P	P	-	-	-	-
Chilmari Regulator	10	V.L.	G	G	F*	G	G	G	-	G	G
Raniganj Pipe Sluice[a]	1	F.B.	P	P	F	P	P	-	-		
Raniganj Regulator[b]	2	V.L.	G	G	G	G	G	1 G, Other not installed	Nil	-	-
Bamni Regulator(additional) [b]	3	V.L.	G	G	G	G	G	V.L. not yet installed, Closed by F.B.	N/A	-	-
Bamni Regulator (main)	12	V.L.	G	G	G	G	G	G, 1 not operating	Nil	G	G
Dalan Pipe Sluice[a]	1	F.B.	P	P	F	P	P	damaged	-		
Malbhanga Regulator	16	V.L.	G	G	G	G	G	13 G, 3 not operating	Nil	G	G
Palashbari Regulator	2	V.L.	G	G	G	G	G	G	Provided		
Çhar Modajalfara Pipe Sluice[a]	1	F.G.	G	G	G	G	G	G	Provided	-	Needed
Siramali Regulator[b]	3	V.L.	Not yet completed								
Ratnai Regulator	8	V.L.	Collapsed due to public cut - now a breach on both sides								

* Minor Crack in Vertical Wall
[a] not listed in project infrastructure
[b] built in 1991, remaining sluices date from 1970s.

Note: C/S - Country Side; R/S - River Side; V.L. - Vertical Lift; F.B. - Fall Board; F.G. - Flap Gate; G - Good; F - Fair; P - Poor; N/A - Not Available

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Table E6 Summary of Condition of Main Existing Features of Zilkar Haor Project

	Present condition of structures									Present condition of Embankment		Present condition of Drainage channels
	Regulator/Sluice							Gate				
	No. of Vents	Type of Gate	Wing Wall C/S	Wing Wall R/S	Box	Apron C/S	Apron R/S	Gate	Rubber Seal/Grove	Full Flood Protection	Submersible	
Dhum Khal Regulator	2	FB							N/A	Total length 15.80 km. Top width 12 ft. for 12.3 km. and 8 ft. for 3.5 km. Side slope = 1:3 50% of length needs repair	Total length 8.91 km. Top width = 8 ft. Side slope = 1:3 50% of length needs repair	Main drainage channel = 1.5 km. Minor drainage channel = 2 km. The drainage channels need re-excavation
Ganginar Khal Regulator	3	VL	G	G	G	G	G	G	?			
*Sanduk Khal Regulator	2	FB	G	G	G	G	G	G	F			
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A			
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A			
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A			
*Box culvert at Jangail	1	FB	G	G	G	G	G	?	N/A			
**Bridge at Chandpur	open											
**Bridge at Chandpur	open											
***Bridge at Latargaon	1	VL	G	G	G	G	G	G	?			
***Bridge at Latargaon	1	VL	G	G	G	G	G	G	?			

* RHD, Box Culvert on Sylhet- Sunamganj road functioning as water control structure for this project.
** RHD, Bridge on Sylhet- Sunamganj road without any water control provision possibly due to little or no impact on the project.
*** RHD, Bridge on Sylhet- Sunamganj road modified to water control structure by constructing one vent regulator box through the bridge opening and filling the gap by earth.

Gate type: FB = Fallboard VL = Vertical Lift
Condition: G = Good F = Faulty

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Table E7 Summary of condition of water control structures in Kolabashukhali Project.

Type and Location of Structure	Present condition of structure									Present Condition of Drainage Channel	
	Regulator/Sluice							Gate		Need reexcavation (km)	
	No. of Vents	Gate Type	Wing wall C/S	Wing wall R/S	Box	Apron C/S	Apron R/S	Gate	Rubber Seal/ Groove	C/S	R/S
Madhabpasa F.S. (Used for Flush & Drg.), (M:2-3)	1	F.G.	G	G	G	P	L.T. to be provided	G	P	G	P
Kalia Khal F.S. (Used for Flush & Drg.), (M:6-7)	1	F.G.	G	G	G	P	L.T. to be provided	-	P	G	F
Lohargati Khal F.S.(Abandoned), (M:17-18)	1	F.G.	G	G	Filled up with soil	Buried in Soil		Not visible (Buried)	Buried	1.0 km	0.5 km
Mathabhanga Regulator, Flushing cum Drg. (M:18-19), Incomplete (New)	2	V.L.	G	G	G	G	G	G	G	2.0 km	0.5 km
Terokhada F.S. (M:21-22)	1	F.G.	G	G	G	G	G	P(C/S)	P	1.0 km	0.15 km
Harikhali Reg., (M:28-29), The Reg. operation was stopped for about 3 years	2	V.L. (C/S) F.G. (R/S)	P	P	Settled 20 cm P	P(L.T.)	P(L.T.)	1 Gate damaged	P	4.5 km	0.5 km
Bhujniar Khal F.S. (used for Flush & Drg., (M:2930)	1	F.G.	G	G	P	P(L.T.)	P(L.T.)	G	P	1.6 km	0.5 km
Putimari Khal Reg., (M:32-33)	3	F.G.	P	P	G	P(L.T.)	P(L.T.)	G	P	2.0 km	0.5 km
Jhurjhuria Khal F.S. (Used for both Flush & Drg.), (M:37-38)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	G	P	3.0 km	0.5 km
Bashukhali Khal Reg., (M:42-43)	6	V.L.	G	G	G	P(L.T.)	P(L.T.)	Lifting parts missing	P	3.0 km	0.5 km
Kaibarta Sisa Khal F.S., (M:45-46)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	G	-	-	-
Madhupur Khal Reg., (Box silted and out of operation, M:46-67) Regulator	2	V.L.	P	P	6" Settled & out of operation	G	G	Not working	G	4.0 km	0.6 km
Hatiar Khal Reg., (M:48-49)	8	V.L.	G	G	G	G	G	1 is out of operation	G	1.5 km	0.5 km
Hizaltala Khal F.S., (M:50-51)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	G	P	G	G
Gazirhat (Gangusia Khal) F.S., (M:52-53)	1	F.G.	G	G	G	P(L.T.)	P(L.T.)	P leaking under sized	G	1.5 km	0.4 km
Bhumbhug Khal Reg., (M:0-1)	Under construction (Construction stopped due to foundation failure)										

Note: C/S - Country Side; R/S - River Side; V.L. - Vertical Lift; F.G. - Flap Gate; G - Good; P - Poor; L.T. - Loose Tellus; M - Embankment mileage

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APPENDIX F

OPERATION AND MAINTENANCE

APPENDIX F

OPERATION AND MAINTENANCE

The operation and maintenance of the FCD/I projects studied by FAP 12 is described in the relevant PIE and RRA reports on the individual projects. The O&M studies were conducted jointly with FAP 13, and the detailed implications of the findings on O&M, and recommendations for future modification of O&M procedures, are discussed at length in the FAP 13 Final Report. They are therefore not made the subject of a substantive Appendix in this report.

APPENDIX G

FLOODING, DRAINAGE AND IRRIGATION

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APPENDIX G

FLOODING, DRAINAGE AND IRRIGATION

G1 ASSESSMENT OF PROJECT IMPACTS

G1.1 Introduction

Appendix G deals with an assessment of the project impacts on flooding, drainage and irrigation. The project impacts were assessed on the basis of the types of hydrological changes induced by projects studied, combinig the results obtained by the RRA and PIE surveys. The main information items relevant to the impact assessment are summarised in Table G.1 and Table G.2.

The assessment is presented under the headings of hydrological impacts, agricultural impacts (limited to crop cultivation) and the findings of the PIE household survey. Subjects specific to each project are discussed in the individual project reports. The household survey data on the impact of projects on flooding, drainage and irrigation are presented in the form of tables and figures in the last part of this Appendix.

G1.2 Background to FCDI Projects

Distribution of water does not always meet human requirements in terms of timing, location, quantity and quality. The FCDI projects have been extensively implemented during the past several decades in Bangladesh to modify seasonal deviations of water availability from water requirements. However, there have been few in depth evaluations of project performance to date.

Within the framework of the Agricultural Study for the post-evaluation of the FCDI projects, hydrological impacts of the projects were assessed in relation to the original project objectives.

G2 HYDROLOGICAL IMPACTS

G2.1 Flood Characteristics

There are four hydraulic components which dominate flood characteristics; these are represented in the flow system illustrated in Figure G1. Each component corresponds with the boundary conditions defined as follows:

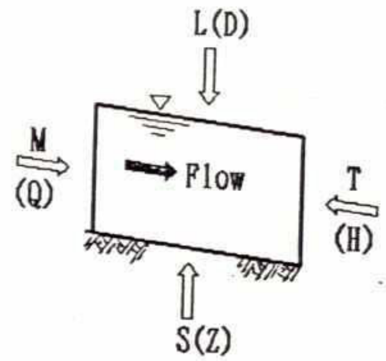

Figure G1 Flow System

M: Monsoon flood given by discharge (Q)
Inflow to the system from upstream side.

T: Tidal flood given by water level (H)
Backflow to the system from downstream side.

L: Local rainfall given by water depth (D)
Locally generated inflow to the system from top side.

S: Topographical conditions given by elevation (Z) The system itself (locational coordinates, elevation, slope and system size).

The flood characteristics at a given site are the combined results of the above four components. Flood type can be classified by the dominant component as described in the next section.

G2.2 Hydrological Impacts by Flood Type

The 17 projects evaluated were specifically selected to represent the range of flood types and regional variations found in FCDI projects in Bangladesh. The project impacts are analysed here by flood types as follows. (See Table G.1).

a) Monsoon floods (Flood Type M)

Monsoon floods refer to flood peaks along the three main rivers which can bring rapid increases in water levels, and longer overbank spills during the peak flow period (July-September). In all the projects assessed which were subject to this type of flood (BRE, MDIP, Kurigram) normal water levels were reduced, but in Kurigram the impact was less as this area is also at risk from flash floods and is relatively high, while MDIP has been highly successful in reducing normal water levels through pumped drainage. However, these projects have had much less success in keeping out peak floods, mainly because of breaches, erosion and flows from upstream areas, but not because of overtopping.

b) Local flooding and congestion of internal drainage basins (Flood Type L)

The majority of projects studied (8 out of 17 projects) experience this type of flooding (Table G.1). River levels back up in the monsoon in the lesser rivers, and the beels and floodplains are flooded by rainwater. The projects protecting against this flood type were all intended to provide full flood protection, with the exception of Sonamukhi-Banmander which is essentially a drainage improvement project.

These projects have successfully reduced normal monsoon water levels, although this is not always by a large amount (note the small changes in proportion of area under different flood depth categories for Chalan Beel D, where drainage congestion has increased, Table G.A-1). Exceptions are Nagor River which has a regular cut/breach which results in the lower part of the project being at least as deeply flooded as in pre-Project conditions each year, and Silimpur-Karatia where flood protection has never been provided along one of the adjacent rivers. These same two projects are the main exceptions where peak floods also have not been excluded, although other projects also flooded from outside in 1988 (Katakhali Khal and Chalan Beel D), and in others local drainage congestion was worse.

Table G1 Summary of Key Hydrological Impacts

Flood type	Project Name	Post Project Flood Characteristics								Breaches/ Public cuts
		Inside Project				Outside Project				
		Delayed onset of floods	Reduced normal flood depth	Prevented peak floods	Drainage problems	Silta-tion	Back-flow	Bank erosion	Water level	
L	Chalan Beel Polder - D	Yes	Yes	(Partly) Yes	I^{**}	I	No	I	I^{**}	B^{*} P^{***}
M/F	Kurigram South	Yes	Yes	Partly	I^{**}	I	No	I	0	B^{*} P^{**}
M	Meghna Dhonagoda Irrigation Project	Yes	Yes	(Partly) Yes	Ta	0	No	I^{***}	0	B^{***}
H	Zilkar Haor	Yes	Yes/No+	Yes/No+	D^{*}	I	No	0	I^{*}	-
T/L	Kolabashukhali	TIDAL	Yes	Yes	D^{*}	I	TIDAL	I	I^{*}	-
L	Protappur Irrigation Project	Yes	Yes	Yes	Ta	I	No	I	I^{*}	-
L/F	Nagor River Project	No	No	No	I^{*}	I	Yes^{***}	I^{***}	I^{**}	P^{***}
L	Sonamukhi-Banmander Beel Drainage Project	No	Yes	Yes	D^{*}	I	Yes^{**}	0	I^{**}	-
L	Impv. Sakunia Beel	Yes	Yes	Yes	D^{*}	0	Yes	I	I^{*}	B^{**}
L	Silimpur-Karatia Bridge-cum-Regulator	No	No	No	I^{*}	I	No	I	I^{**}	B^{*}
L	Katakhali Khal	No	Yes^{**}	No	I	I	No	I	I^{*}	P^{**} B^{**}
H	Halir Haor	Yes	No	No	D^{*}	I	Yes	0	I^{*}	P^{*} B^{*}
F	Kahua-Muhuri Embankment	Yes	Yes	No	I^{*}	I	Yes	I^{***}	I^{*}	B^{***} P^{***}
F	Konapara Embankment	Yes	Yes^{**}	No	I^{*}	I	Yes	I	I^{**}	B^{*} P^{**}
T	Polder 17/2	TIDAL	Yes	Yes	I^{*}	I	TIDAL	0	I^{*}	P^{**}
M	BRE - Kamarjani	Yes	Yes	Yes	I^{***}	I	No	I^{***}	0	P^{***} B^{**}
M	BRE - Kazipur	Yes	Yes	Partly	0	I	No	I^{***}	0	B^{***}

Source: FAP 12 RRA Overview Report

Notes:

Flood Type:
- M = Monsoon flood along main river
- L = local flooding and internal drainage congestion
- F = flash floods
- H = haor areas
- T = tidal flooding

Impacts:
- Yes = Intended target achieved
- I = Increase/Rise;
- * = Moderate; ** = Medium; *** = Severe
- \+ yes in full flood protection part, no in submersible embankment part
- No = No impact apparent
- D = Decrease/Fall

c) Flash floods (Flood Type F)

The topographic component is dominant in flash floods. In areas adjacent to the hilly regions bordering Bangladesh small rivers are subject to rapid flash floods of relatively short duration. Typically flash floods of moderate magnitude occur each year, sometimes more than once in a year, and naturally these are extreme in some years. In both projects which protect only from this type of flooding the embankments were successful in preventing flash floods of normal elevation, and hence protecting crops, but were not able to exclude peak floods (such as in 1988). A similar pattern was found in Kurigram (where the Teesta is 'flashy') and Nagor River; in these two cases morphological changes - erosion and bed raising - have limited the hydrological benefits.

d) Haor areas (Flood Type H)

Haor areas in the North-East region are lowlying basins which experience an early inflow of flood water, which could be termed flashy since the timing of early floods is uncertain, followed by a prolonged period of very deep flooding. In these circumstances submersible embankments are used (Zilkar Haor, Halir Haor) to exclude floods until the Boro paddy is harvested and then to permit normal and extreme flooding. Hence there is no intention of preventing peak or even normal flood levels (although in Zilkar Haor part of the area has been given full flood protection). However, these projects have been successful in delaying the onset of floods in most years.

e) Tidal flooding (Flood Type T)

In coastal and near coastal areas polders protect against saline water intrusion, tidal flooding, and to some extent against cyclonic flooding and tidal surges. The two projects of this type evaluated (Kolabashukhali and Polder 17/2) were successful in excluding saline water and normal flooding to the extent that interests inside the projects would allow. Kolabashukhali has reduced normal water levels considerably enabling expanded cultivation. In Polder 17/2, long delays in completing the project resulted in it being made partially redundant by the growth of shrimp farming and the management of saline water inside the project. Both projects have so far been successful against peak floods, but are not in a critical cyclone prone area.

G2.3 Hydrological Impacts by Type

Nine types of hydrological impact influencing the flow conditions were selected to identify the hydrological change by project (see Table G.1).

The project objectives were achieved as originally intended in most of the projects (13 out of 17 projects), but 4 projects (Nagor River, Sonamukhi-Banmander Beel, Silimpur-Karatia and Katakhali Khal) were not successful in inducing the intended hydrological changes. Common features found in these 4 projects are flood type L, open ended embankments without any interceptor canal along the upstream side of the project boundary, location in local river confluences or other relatively low areas where drainage water accumulates, and frequent public cuts/breaches associated with increased siltation, severe bank erosion and rising regional water levels.

a) Delayed Onset of Floods

The intended target in delayed onset of floods was achieved in 12 out of 15 projects (see Table G.1). Kolabashukhali and Polder 17/2 (flood type T) are excluded, since they are polder projects under tidal influence.

No apparent impact was observed in 3 projects (Nagor River, Sonamukhi-Banmander and Silimpur-Karatia), either due to breaches and cuts, or because the embankments are of the open ended type which cannot completely prevent the flood inflow.

Inundation duration shows a similar pattern to the delayed onset of floods. The PIE household survey showed that inundation duration in Chalan Beel was reduced perceptibly, in Kurigram and Zilkar Haor moderately, and in MDIP and KBK drastically (see Tables G.A-2; Figures G.A-2)

b) Reduced Normal Flood Depth

The project aim in reduced flood depth was achieved in 13 out of 17 projects (see Table G.1). Frequent public cuts in Nagor River and breaches in Silimpur-Karatia result in failure to achieve reduction in normal flood depths. It is not expected that any impact on flood depth would be achieved in Zilkar Haor and Halir Haor, since these are submersible embankments aimed only at delaying inundation.

The changes in distribution of cultivable land by flood depth in the PIE projects is presented in Table G.A-1 and Figure G.A-1.

Chalan Beel D project typifies the impact of projects which are successful in reducing normal flood depth. (see Table G.A-1(1); Figure G.A-1(1)), while MDIP shows a drastic case due to combined effect of poldering and pumped drainage. (See Table G.A-1(3); Figure G.A-1(3).

c) Prevention of Peak Floods

The target in prevention of peak floods was achieved in 11 out of 17 projects (see Table G.1). No apparent impacts can be observed in Zilkar Haor, Halir Haor (flood type H) due to the submersible embankments, or in Nagor River, Silimpur-Karatia and Katakhali Khal (flood type L) due to recurrent public cuts and breaches.

d) Drainage Problems

Drainage congestion increased in 9 projects, decreased in 5 projects, was eliminated fully in 2 projects and was unchanged in 1 out of the 17 projects. Drainage problems thus persist in 14 out of 17 projects, and have actually been made worse in a majority of projects. The large variation in achieving the project objectives on the drainage aspects indicates the existence of certain contradictions inherent in FCDI projects.

Most notably, the primary objective of embankments in FCDI projects is to protect the project area from the intrusion of external water during the flood season. However, the enclosure of the project area with an embankment inevitably hinders drainage of internal (rain) water, which in many parts of Bangladesh is itself sufficient to cause an inundation of several metres. This can be overcome to a certain extent by provision of infrastructure such as regulators and drainage channels, provided they are properly operated.

The capacity and operation of the drainage system are important factors determining the effectiveness of drainage. In most of the full flood control projects studied, regulators can be opened for drainage when internal water levels exceed the external level. However, monsoon water levels often limit this period in Bangladesh to the post-monsoon period.

Public cuts by insiders are relatively common and imply that drainage capacity is insufficient for the aims of the farmers even when river levels permit discharge through the regulators. Local people frequently request additional regulators to alleviate the drainage congestion. Innovative alternatives for drainage operation comprising some additional regulators together with authorised public cuts should be envisaged, since BWDB cannot respond to requests of the local people due to funding constraints.

The projects with reduced drainage problems reflect either favourable local conditions or advanced project design. Out of the drainage projects the two most effective were Kolabashukhali, where drainage is possible even during the monsoon due to the 2.5 metre tidal range, and MDIP where pumped drainage was provided (though at a very high cost).

e) Siltation

Siltation increased in almost all projects (15 out of 17 projects) except MDIP and Sakunia Beel in which the siltation was unchanged.

In most of the FCDI projects, embankments were constructed along both sides of small rivers carrying high sediment loads, which are deposited on the river bed when water levels fall. Siltation is serious for FCDI projects, since it may cause subsequent negative hydrological impacts such as backflow, rising water levels, bank erosion and breaches/public cuts.

f) Back-flow

Back-flow increased in 7 projects and was unchanged in 10 projects, including 2 tidal projects.

Back-flow generally occurs at a confluence of relatively small rivers and propagates upstream, reducing the internal drainage capacity along the rivers. Thus, there is no back-flow in tidal projects (flood type T), the major rivers (flood type M) and the one side embankment projects.

g) Bank Erosion

Bank erosion occurs in 13 out of 17 projects. The 4 projects free from erosion are Zilkar Haor, Halir Haor (flood type H), Sonamukhi-Banmander and Polder 17/2. Bank erosion is severe in MDIP, BRE-Kamarjani, BRE-Kazipur (flood type M), Nagor River and Kahua-Muhuri Embankment. It should be noted that bank erosion and rising water levels are the direct causes of breaches.

h) External Water Level

External water level increased in 13 out of 17 projects and was unchanged in the remaining 4 projects (all of which are flood type M, located along the major rivers). The water level increases when the cross sectional area of flow is reduced by embankment construction. Rise in water level is interrelated with siltation, back-flow and bank erosion, finally resulting in drainage congestion, breaches and public cuts.

i) Breaches and Public Cuts

Breaches happened in 11 out of 17 projects. All projects which experienced breaches correspond to the bank erosion projects except Halir Haor project. It should be noted that the primary cause of the breaches is bank erosion, not overtopping.

Public cuts occurred in 9 out of 17 projects. All the projects which experienced public cuts are identical to the drainage congestion projects, except Halir Haor.

G3 AGRICULTURAL IMPACTS

G3.1 Introduction

There are two aspects to flood control in the FCDI projects. Firstly they are designed to modify "normal" monsoon water levels and timings on cultivable land by excluding external water and improving internal drainage conditions, thus increasing agricultural production. Secondly, they are intended to keep out peak floods up to some specified design standard, and thereby protect crops, property and infrastructure from damage.

The first aspect is related to an improvement in land productivity (or productive system efficiency) and is presented in the following sections. The second aspect refers to a reduction of flood damage (or increased system reliability) and is described in Appendix M.7.

The hydrological changes such as reduced flood depth, reduced drainage congestion and increased irrigation availability, facilitate the introduction of more productive cropping patterns. Dominant changes in the cropping pattern are from B. Aman to T. Aman (and in some cases from Local T Aman to HYV T Aman) during the monsoon season, and from Local Boro to HYV Boro during the winter season. Irrigation availability is a prerequisite for HYV Boro cultivation.

The impacts on crop cultivation due to hydrological changes were assessed for six selected types of impact, as summarised in Table G.2. Impacts are compared with the project targets where possible, though in a number of cases the lack of project documentation, or the vagueness of the objectives set out in the available documentation, means that objectives have to be inferred from the type of works undertaken or from likely linkages with explicit objectives.

G3.2 Agricultural Impacts by Type

a) Protection of Boro Crops

Although Boro paddy makes most of its growth during the dry season, it is at risk from early flash floods at harvest time; this is particularly the case for HYVs. By giving protection at this period, FCD projects may contribute to the viability of Boro cultivation even if they do not have an irrigation component. Out of 10 projects in which this was an explicit or implicit aim, the intended target was broadly achieved in 6, and achieved to a limited extent in 4. In case of tidal projects (flood type T), the target was broadly achieved in Polder 17/2; it is not applicable at Kolabashukhali, where there is little Boro due to limited irrigation potential. The outstanding success in Boro protection is Zilkar Haor, where the submersible embankment has made the crop far more widespread than in the control area, but HYV Boro in the Haparu Haor portion is still liable to be damaged by rainwater congestion inside the embankment, as occurred in May 1991.

b) Protection of Early Aus/Aman Crops

Early flash floods may also damage young Aus and Aman crops at the start of the monsoon. Aus in general is giving way in cropping sequences to HYV Boro, whose harvest overlaps the Aus planting period, but protection of Aus may still be a worthwhile project objective where lack of irrigation limits Boro. Of 11 projects with this explicit or implied objective, 5 broadly achieved their target, and the remainder achieved it to a limited extent.

c) Protection of Aman Crop from Main Monsoon Floods

The crop most at risk from exceptional monsoon flooding is Aman, and most projects which aimed at providing protection in the Aman season had the objective of providing reduced and more stable flood depths in which the shorter-stemmed HYVs could be grown. A major limitation on project effectiveness in achieving this objective is that, although embankments may keep out river flooding, insufficient drainage capacity may still result in rainwater congestion which makes HYV Aman cultivation precarious. Every project studied by FAP 12, with the exception of Halir Haor, had an objective of protecting Aman (though only in the full protection Haparu Haor section at Zilkar Haor). In the two tidal projects, Kolabashukhali and Polder 17/2, protection was provided not only against seasonal fluctuation of water levels, but also against daily tidal inundation.

Five of the projects broadly achieved the targeted degree of protection, though in some cases this was partly offset by drainage problems, as at Kolabashukhali (where a targeted move to T Aman largely failed to materialise, though yields within the existing cropping pattern were improved). Nine of the remaining 11 projects achieved their targets to a more limited extent, the main limiting factor being the prevalence of breaches and public cuts (as at Chalan Beel D, where the project is routinely subject to cuts because it was planned in isolation from regional trends in water levels). Two projects - Nagor River and Silimpur-Karatia - failed to provide any protection, due to planning and design failures.

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Table G.2 Impacts on Crop Cultivation

Project name	Key impacts of Hydrological changes					
	Protection of Boro crops from Pre-monsoon flash flood/tidal submersion	Protection of Early Aus/Aman crops from flash floods/tidal submersion	Protection of Aman from Monsoon floods	Improved drainage	Saline exclusion	Irrigation of Boro crop
Chalan Beel Polder - D	NA	NA	Te (A)	Te (N)	NA	NA
Kurigram South	0	0	Te (A)	Te (N)	NA	NA
Meghna Dhonagoda I.P.	-	-	Te (AA)	Te (AA)	NA	Te (AA)
Zilkar Haor	Te (AA)	Te (AA)	Te (A)	Te (A)	NA	Te (A)
Kolabashukhali	NA	Te (AA)	TIDAL	Te (A)	Te (AA)	NA
Protappur I.P.	Te (AA)	Te (AA)	Te (AA)	0	NA	NA
Nagor River Project	Te (AA)	NA	Te (N)	Te (N)	NA	NA
Sonamukhi-Banmander Beel Dr. Project	NA	NA	Ti (A)	Te (A)	NA	Ti (A)
Impv. Sakunia Beel	Te(A)	Te(A)	Te (A)	Te (A)	NA	NA
Silimpur-Karatia Bridge-cum-Regulator	NA	Te (A)	Te (N)	Te (N)	NA	NA
Katakhali Khal	NA	Te (A)	Te (A)	Te (N)	NA	NA
Halir Haor	Te (AA)	NA	NA	NA	NA	Ti (A)
Kahua-Muhuri Embankment	Ti (A)	Ti (A)	Ti (A)	Te (N)	NA	Te (A)
Konapara Embankment	Ti (AA)	Te (AA)	Te (A)	Te (N)	NA	NA
Polder 17/2	Ti (A)	Ti (A)	TIDAL	Te (A)	Te (A)	Ti (A)
BRE - Kamarjani	Te (AA)	Te (AA)	Te (AA)	Te (N)	NA	Ti (A)
BRE - Kazipur	Te (A)	Te (A)	Te (A)	0	NA	Ti (A)

Source: FAP 12 RRA and PIE reports

Notes:
Te = Target (explicit)
Ti - Target (implied)
NA = Not applicable

AA = Broadly achieved
A = Achieved to a limited extent
N = Not achieved at all

O = No change
? = Not clear

d) Improved Drainage

The limitations drainage imposes on monsoon season cropping and on the effectiveness of flood control measures have been noted above (G2.3(d)). Almost all projects (except Halir Haor) had drainage objectives, and Sonamukhi-Banmander was conceived almost exclusively as a drainage project. The only project to function really effectively in drainage was Meghna-Dhonagoda, where very large and costly pumping systems have been installed to solve the inherent contradiction of high rainfalls occurring at high river stages. All other projects relied on gravity drainage, which is inevitably of limited effectiveness, even when regulators are well-sited, properly maintained and efficiently operated. Five projects achieved limited improvement of drainage, while eight were largely ineffective.

e) Saline Exclusion

Exclusion of saline water is a target only in the saline tidal areas, represented among FAP 12's study projects by Kolabashukhali (KBK) and Polder 17/2 in the South-West region. The intended target was broadly achieved in KBK and achieved to a limited extent in Polder 17/2; in the latter case the original objective was total exclusion, but this was incompatible with the continuation of the well-entrenched shrimp farming industry. Some conflict between shrimp farming and paddy farming interests also occurs at KBK and occasionally saline water is released into the polder, damaging Boro crops.

f) Irrigation of Boro Crops

HYV Boro, which requires irrigation for its successful cultivation, is the highest-yielding grain crop in Bangladesh, and its spread has dramatically affected cropping patterns and farm productivity. In many cases where HYV Boro has spread within FCD projects, a linkage with the project is difficult to establish, and FAP 12 has in general taken a conservative position in attributing Boro benefits to FCD unless there are good grounds, for example from the timing of early floods relative to the Boro harvest, to establish such a linkage. Where the project has explicitly set out to provide irrigation for the Boro crop, the linkage is of course clear, and there are also projects where an intention to encourage Boro irrigation can be inferred, even though the actual irrigation is by minor irrigation systems (DTW, STW, LLP) which are not directly due to project interventions.

Out of three projects with an explicit objective of Boro irrigation, the target was broadly achieved at Meghna-Dhonagoda, and achieved to a limited degree at Zilkar Haor and Kahua-Muhuri; in the two latter projects the irrigation structures, while designed to facilitate Boro cropping, were never intended to be the sole source of irrigation. A further five projects had an implicit objective of encouraging Boro irrigation, and all achieved it to a limited extent.

G4 HOUSEHOLD SURVEY FINDINGS ON HYDROLOGICAL IMPACTS

G4.1 Introduction

The agricultural module of the PIE farm household survey collected data on the pre- and post-project flooding and irrigation status of the land cultivated by sampled households. As such, the survey does not provide information on hydrological changes on land which was uncultivated pre-project (for example, the lowest beels in Kolabashukhali). It is nevertheless an important source of data which permits quantification of hydrological impacts by pre-project land level. The indicators collected were normal flood depth (pre- and post-project), flood duration (pre- and post-project) and extent and type of irrigation (post-project only). As for all household survey data, separate samples were interviewed in the impacted and control areas for each project, so that for flood depth and duration it is possible to compare the with- and without-project trends over time. Overall survey results are compiled in Table G.A-1 to Table G.A-4 and Figure G.A-1 to Figure G.A-3.

The major findings are summarised by Project as follows:

G4.2 Chalan Beel Polder D

The farm household survey for this project covers a sample of 100.5 ha of cultivated land in the impacted/protected area, 13.35 ha in the impacted/unprotected area, and 34.72 ha in the control area. The results of the survey revealed the following project impacts:

- while the cultivated land subject to shallower depths of normal flooding increased by 17 per cent in the protected area, it decreased by 11 per cent in the unprotected area, while no significant change was seen in the control area (Table G.A-1 (CB), Figure G.A-1 (CB)). This is consistent with other evidence for benefits within the project, compared to the without-project trend, combined with adverse external effects (due to other Atrai Basin projects as well as Chalan Beel D) which have led to the persistent problem of public cuts affecting this project;

- similarly, the cultivated land subject to shorter inundation periods increased by 16 per cent in the protected area, while it decreased by 10 per cent in the unprotected area. The control area does not show any change as large as in the impacted areas (Table G.A-2 (CB), Figure G. A-2 (CB));

- irrigation plays a vital role in rabi season cropping in the impacted and control areas; two-thirds of the irrigated area is HYV Boro in the impacted area. In the protected area indigenous methods are predominantly practiced (47 per cent of irrigated area), followed by shallow tube wells (28 per cent). About two-thirds of irrigated area in the unprotected area is covered by the low-lift pumps and shallow tube wells. Shallow tubewells occupy 64 per cent of irrigated area in the control area (Tables G.A-3 (CB) and G.A-4 (CB), Figure G.A-3 (CB)). The data therefore do not indicate a significant project impact on irrigation.

G4.3 Kurigram South

The farm household survey sampled a total of 73.93 ha of cultivated lands in the impacted/protected area, 8.12 ha in the impacted/unprotected area, and 70.50 ha in the control area. The major findings obtained are:

- since the project area includes a relatively high area between the two major rivers of Teesta and Dharla, not much impact can be seen on the distribution of cultivated area either by flood depth or by inundation duration, since a high percentage of cultivated land belongs to the high land category both in the protected area (47 per cent) and in the control area (57 per cent) (Tables G.A-1 (KS) and G.A-2 (KS), Figures G.A-1 (KS) and G.A-2 (KS));

- over 80 per cent of total irrigated area is under rabi season cropping. In both the protected area and the control area irrigation is practiced in every land level during the rabi season. Shallow tube wells play an important role, occupying 69 per cent of irrigated area in the impacted/protected area, 81 per cent in the impacted/unprotected area, and 62 per cent in the control (Table G.A-3 (KS) and G.A-4 (KS), Figure G.A-3 (KS)). Considering all means of irrigation, about 42 per cent of the impacted/protected area is irrigated in rabi, compared with about 31 per cent of the control area. Any project impact on irrigation is therefore modest relative to the underlying without-project trend.

G4.4 Meghna Dhonagoda

Since the project area is provided with dual purpose pumping facilities for drainage and irrigation, the very large impacts shown by the farm household survey are not unexpected. The survey covered 64.46 ha of cultivated land in the protected area and 26.56 ha in the control area (only one sample village was drawn in the impacted/unprotected area, which is insufficient to generalise from). The impacts found are:

- the proportion of cultivated land under shallower flood depths has increased tremendously (by about 80 per cent) in the protected area, with a corresponding decrease in area under the deeper flood depths. On the other hand, no significant change is observed in the control area (Table G.A-1 (MDIP), Figure G.A-1 (MDIP));

- similarly, while the proportion of cultivated land free from inundation increased remarkably from 0 to 65 per cent, the control area shows negligible change in the same indicator (Table G.A-2 (MDIP), Figure G.A-2 (MDIP));

- 59 per cent of cultivated land was irrigated in the rabi season in the impacted/protected area, compared with 24 per cent in the control area. Rabi season irrigation occupies nearly 90 per cent of the year-round irrigated area in both the protected and the control areas. In the protected area during the rabi season 65 per cent of irrigated area is covered by the BWDB canals, followed by low-lift pumps (30 per cent), whereas in the control area LLPs predominate (50 per cent) followed by DTWs (21 per cent) (Tables G.A-3 (MDIP) and G.A-4 (MDIP), Figure G.A-3 (MDIP)). The evidence is therefore that while the project has substantially increased irrigation, a significant area could have been irrigated without the project (and probably on a more sustainable basis, since impacted area farmers do not pay for canal water, while control area farmers get their water from LLPs and DTWs and have to pay its full cost).

G4.5 Zilkar Haor

The total area of cultivated land sampled by the household survey was 98.17 ha in the impacted/protected area, 65.08 ha in the impacted/unprotected area, and 79.92 ha in the control area. The results of the farm household survey are as follows:

- no significant impact is apparent in distribution of cultivated land by either flood depth or inundation duration in the impacted/protected area (Tables G.A-1 (ZH) and G.A-2 (ZH), Figures G.A-1 (ZH) and G.A-2 (ZH)). The lack of impact on flood depth is not unexpected, since Zilkar Haor is partly a submersible embankment project which is not intended to exclude the normal flood. The lack of impact on duration is not expected,

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given the project objective of delaying the rise of water level in order to safeguard the Boro harvest. However, the lack of apparent impact may be due to use in the questionnaire of a monthly time division for specifying time of start and end of flooding. Zilkar Haor was the first PIE survey, and in subsequent PIEs the time division was amended to one week, to provide more precise measurement;

- in the impacted/protected area 46 per cent of cultivated land is irrigated in rabi, compared with 42 per cent in the impacted/unprotected area and 13 per cent in the control. Thus, while the impacted area clearly has a higher incidence of irrigation than the control, this cannot be attributed primarily to the project. In the impacted/protected area, 55 per cent of irrigated land is irrigated by indigenous methods, followed by LLPs (44 per cent). In the impacted/unprotected area 67 per cent of irrigated land is covered by LLPs and the rest by indigenous methods. Most of the control area is irrigated by indigenous methods (86 per cent) (Tables G.A-3 (ZH) and G.A-4 (ZH), Figure G.A-3(ZH)).

G4.6 Kolabashukhali

The farm household survey sampled 122.80 ha of cultivated land in the impacted/protected area and 64.78 ha in the control area; there was no impacted/unprotected area at Kolabashukhali. The results of the survey are summarized as follows:

- the project shows major impacts on the distribution of the cultivated land by flood depth and by inundation duration. Cultivated land under the the three shallowest flood depths increased by 32 per cent in the protected area, while that in the control area also increased slightly by 9 per cent. This may reflect the difficulties in selecting a control area for Kolabashukhali, the only available one being in an adjacent incomplete project (Table G.A-1 (KBK), Figure G.A-1 (KBK));

- the distribution of cultivated land by inundation duration shows similar trends to that by flood depth in both the protected and the control areas (Table G.A-2 (KBK), Figure G.A-2 (KBK));

- in this project, irrigation does not play an important role. Total irrigated area throughout the year is 7.06 ha in the protected area and and 2.57 ha in the control area (Table G.A-3 (KBK), Figure G.A-3 (KBK)). Cultivated land in the low and the very low land levels is mostly unirrigated in the protected area. The reason is that the rivers surrounding the project are saline in the dry season, except at the extreme northern end, while groundwater potential is poor;

- about 90 per cent of year-round irrigated area is under rabi season cropping. In the protected area, 88 per cent of the irrigated area is covered by shallow tube wells, while in the control area 51 per cent is commanded by shallow tube wells followed by indigenous methods (37 per cent) (Table G.A-4 (KBK)).

LIST OF TABLES (PIE HOUSEHOLD SURVEY)

LIST OF FIGURES (PIE HOUSEHOLD SURVEY)

Table G.A-1 Cultivated Land by Flood Depth

(1) Chalan Beel Polder D (CB)

(Unit: ha)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High	12.73	28.16	15.43	6.95	5.45	-1.50	8.13	7.93	-0.20
(%)	(12.7)	(28.0)	(15.3)	(52.1)	(40.8)	(-11.3)	(23.4)	(22.9)	(-0.5)
Medium High	8.65	10.02	1.37	2.27	2.40	0.13	3.37	3.31	-0.06
(%)	(8.6)	(10.0)	(1.4)	(17.0)	(18.0)	(1.0)	(9.7)	(9.5)	(-0.2)
Medium Low	19.59	20.76	1.17	0.63	1.37	0.74	6.09	6.61	0.52
(%)	(19.5)	(20.7)	(1.2)	(4.7)	(10.3)	(5.6)	(17.5)	(19.0)	(1.5)
Low	38.26	23.54	-14.72	1.89	2.52	0.63	10.13	9.54	-0.59
(%)	(38.1)	(23.4)	(-14.7)	(14.2)	(18.9)	(4.7)	(29.2)	(27.5)	(-1.7)
Very Low	21.27	18.02	-3.25	1.61	1.61	-	7.00	7.33	0.33
(%)	(21.1)	(17.9)	(-3.2)	(12.0)	(12.0)	(-)	(20.2)	(21.1)	(0.9)
Total	100.50	100.50	-	13.35	13.35	-	34.72	34.72	-
(%)	(100.0)	(100.0)	(-)	(100.0)	(100.0)	(-)	(100.0)	(100.0)	(-)

(2) Kurigram South (KS)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High	32.51	34.81	2.30	1.00	0.75	-0.25	39.45	39.97	0.52
(%)	(44.0)	(47.1)	(3.1)	(12.3)	(9.2)	(-3.1)	(56.0)	(56.7)	(0.7)
Medium High	5.79	11.89	6.10	0.89	1.20	0.31	11.23	12.36	1.13
(%)	(7.8)	(16.1)	(8.3)	(11.0)	(14.8)	(3.8)	(15.9)	(17.5)	(1.6)
Medium Low	19.86	17.49	-2.37	1.90	1.81	-0.09	7.57	7.26	-0.31
(%)	(26.8)	(23.6)	(-3.2)	(23.4)	(22.3)	(-1.1)	(10.7)	(10.3)	(-0.4)
Low	12.32	8.29	-4.03	3.95	3.98	0.03	8.76	8.38	-0.38
(%)	(16.7)	(11.2)	(-5.5)	(48.6)	(49.0)	(0.4)	(12.4)	(11.9)	(-0.5)
Very Low	3.45	1.45	-2.00	0.38	0.38	-	3.49	2.53	-0.96
(%)	(4.7)	(2.0)	(-2.7)	(4.7)	(4.7)	(-)	(5.0)	(3.6)	(-1.4)
Total	73.93	73.93	-	8.12	8.12	-	70.50	70.50	-
(%)	(100.0)	(100.0)	(-)	(100.0)	(100.0)	(-)	(100.0)	(100.0)	(-)

(3) Meghna Dhonagoda (MDIP)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High	0.09	41.54	41.45	-	-	-	0.04	0.04	-
(%)	(0.1)	(64.4)	(64.3)	(-)	(-)	(-)	(0.2)	(0.2)	(-)
Medium High	-	9.40	9.40	-	-	-	0.32	0.32	-
(%)	(-)	(14.6)	(14.6)	(-)	(-)	(-)	(1.2)	(1.2)	(-)
Medium Low	5.04	6.51	1.47	-	-	-	3.64	3.58	-0.06
(%)	(7.8)	(10.1)	(2.3)	(-)	(-)	(-)	(13.7)	(13.5)	(-0.2)
Low	34.24	5.40	-28.84	-	-	-	15.75	14.61	-1.14
(%)	(53.1)	(8.4)	(-44.7)	(-)	(-)	(-)	(59.3)	(55.0)	(-4.3)
Very Low	25.09	1.63	-23.46	-	-	-	6.81	8.01	1.20
(%)	(39.0)	(2.5)	(-36.5)	(-)	(-)	(-)	(25.6)	(30.1)	(4.5)
Total	64.46	64.48	0.02	-	-	-	26.56	26.56	-
(%)	(100.0)	(100.0)	(-)	(-)	(-)	(-)	(100.0)	(100.0)	(-)

Table G.A-1 Cultivated Land by Flood Depth (Cont'd)

(4) Zilkar Haor (ZH)

(Unit: ha)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High	0.06	3.02	2.96	1.76	1.76	-	-	-	-
(%)	(0.1)	(3.1)	(3.0)	(2.7)	(2.7)	(-)	(-)	(-)	(-)
Medium High	6.75	5.35	-1.40	2.37	1.34	-1.03	1.72	1.32	-0.40
(%)	(6.9)	(5.4)	(-1.5)	(3.6)	(2.1)	(-1.5)	(2.1)	(1.7)	(-0.4)
Medium Low	17.14	25.53	8.39	16.05	14.40	-1.65	20.06	19.10	-0.96
(%)	(17.4)	(26.0)	(8.6)	(24.7)	(22.1)	(-2.6)	(25.1)	(23.9)	(-1.2)
Low	40.22	33.04	-7.18	18.09	21.36	3.27	31.31	29.65	-1.66
(%)	(41.0)	(33.7)	(-7.3)	(27.8)	(32.8)	(5.0)	(39.2)	(37.1)	(-2.1)
Very Low	34.00	31.23	-2.77	26.81	26.22	-0.59	26.83	29.85	3.02
(%)	(34.6)	(31.8)	(-2.8)	(41.2)	(40.3)	(-0.9)	(33.6)	(37.3)	(3.7)
Total	98.17	98.17	-	65.08	65.08	-	79.92	79.92	-
(%)	(100.0)	(100.0)	(-)	(100.0)	(100.0)	(-)	(100.0)	(100.0)	(-)

(5) Kolabashukhali (KBK)

Flood Depth	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
High	4.60	10.04	5.44	-	-	-	4.22	5.08	0.86
(%)	(3.7)	(8.2)	(4.5)	(-)	(-)	(-)	(6.5)	(7.8)	(1.3)
Medium High	6.70	22.40	15.70	-	-	-	5.61	7.57	1.96
(%)	(5.5)	(18.2)	(12.7)	(-)	(-)	(-)	(8.6)	(11.7)	(3.1)
Medium Low	22.92	36.90	13.98	-	-	-	12.03	15.13	3.10
(%)	(18.7)	(30.0)	(11.3)	(-)	(-)	(-)	(18.6)	(23.4)	(4.8)
Low	52.47	47.59	-4.88	-	-	-	26.87	25.34	-1.53
(%)	(42.7)	(38.8)	(-3.9)	(-)	(-)	(-)	(41.5)	(39.1)	(-2.4)
Very Low	36.11	5.87	-30.24	-	-	-	16.05	11.66	-4.39
(%)	(29.4)	(4.8)	(-24.6)	(-)	(-)	(-)	(24.8)	(18.0)	(-6.8)
Total	122.80	122.80	-	-	-	-	64.78	64.78	-
(%)	(100.0)	(100.0)	(-)	(-)	(-)	(-)	(100.0)	(100.0)	(-)

Flood Depth: High = Never flooded, Medium High = 0 - 30cm, Medium Low = 30 - 90cm
Low = 90 - 180cm, Very Low = over 180cm

Source: PIE Farm Household Survey

Table G.A-2 Cultitvated Land by Duration of Inundation

(1) Chalan Beel Polder D

(Unit: ha)

Inundation Duaration (months)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	15.18 (15.1)	30.13 (30.0)	14.95 (14.9)	8.00 (60.0)	7.07 (53.0)	-0.93 (-7.0)	7.93 (22.8)	8.31 (23.9)	0.38 (1.1)
0 - 1 (%)	3.62 (3.6)	4.19 (4.2)	0.57 (0.6)	0.40 (3.0)	- (-)	-0.40 (-3.0)	1.22 (3.5)	1.33 (3.8)	0.11 (0.3)
1 - 2 (%)	8.17 (8.1)	6.04 (6.0)	-2.13 (-2.1)	- (-)	0.27 (2.0)	0.27 (2.0)	3.84 (11.1)	3.87 (11.2)	0.03 (0.1)
2 - 3 (%)	10.11 (10.1)	9.07 (9.0)	-1.04 (-1.1)	0.27 (2.0)	1.34 (10.0)	1.07 (8.0)	3.62 (10.4)	3.54 (10.2)	-0.08 (-0.2)
3 - 4 (%)	20.10 (20.0)	17.46 (17.4)	-2.64 (-2.6)	0.27 (2.0)	0.27 (2.0)	- (-)	3.26 (9.4)	3.61 (10.4)	0.35 (1.0)
4 - 5 (%)	20.33 (20.2)	14.23 (14.1)	-6.10 (-6.1)	1.46 (10.9)	1.46 (10.9)	- (-)	4.97 (14.3)	5.48 (15.8)	0.51 (1.5)
5 - 6 (%)	13.43 (13.4)	10.22 (10.2)	-3.21 (-3.2)	1.88 (14.1)	1.41 (10.6)	-0.47 (-3.5)	5.88 (17.0)	4.44 (12.8)	-1.44 (-4.2)
6 and over (%)	9.56 (9.5)	9.16 (9.1)	-0.40 (-0.4)	1.07 (8.0)	1.53 (11.5)	0.46 (3.5)	4.00 (11.5)	4.14 (11.9)	0.14 (0.4)
Total (%)	100.50 (100.0)	100.50 (100.0)	- (-)	13.35 (100.0)	13.35 (100.0)	- (-)	34.72 (100.0)	34.72 (100.0)	- (-)

(2) Kurigram South (KS)

Inundation Duaration (months)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	35.47 (48.0)	39.26 (53.1)	3.79 (5.1)	0.75 (9.2)	0.75 (9.2)	- (-)	48.00 (68.1)	48.52 (68.8)	0.52 (0.7)
0 - 1 (%)	5.97 (8.1)	8.18 (11.1)	2.21 (3.0)	0.71 (8.8)	0.71 (8.8)	- (-)	2.28 (3.2)	2.62 (3.7)	0.34 (0.5)
1 - 2 (%)	7.94 (10.7)	8.12 (11.0)	0.18 (0.3)	0.75 (9.2)	0.75 (9.2)	- (-)	2.80 (4.0)	1.86 (2.7)	-0.94 (-1.3)
2 - 3 (%)	8.18 (11.1)	6.14 (8.3)	-2.04 (-2.8)	1.01 (12.5)	1.30 (16.0)	0.29 (3.5)	4.90 (7.0)	4.22 (6.0)	-0.68 (-1.0)
3 - 4 (%)	7.60 (10.3)	4.68 (6.3)	-2.92 (-4.0)	2.56 (31.5)	2.27 (28.0)	-0.29 (-3.5)	2.11 (3.0)	2.11 (3.0)	- (-)
4 - 5 (%)	2.07 (2.8)	3.06 (4.1)	0.99 (1.3)	2.07 (25.5)	2.07 (25.5)	- (-)	3.83 (5.4)	4.67 (6.6)	0.84 (1.2)
5 - 6 (%)	2.61 (3.5)	1.37 (1.9)	-1.24 (-1.6)	0.02 (0.2)	0.02 (0.2)	- (-)	0.94 (1.3)	1.07 (1.5)	0.13 (0.2)
6 and over (%)	4.09 (5.5)	3.12 (4.2)	-0.97 (-1.3)	0.25 (3.1)	0.25 (3.1)	- (-)	5.64 (8.0)	5.43 (7.7)	-0.21 (-0.3)
Total (%)	73.93 (100.0)	73.93 (100.0)	- (-)	8.12 (100.0)	8.12 (100.0)	- (-)	70.50 (100.0)	70.50 (100.0)	- (-)

Source: PIE Farm Household Survey

Table G.A-2 Cultitvated Land by Duration of Inundation (Cont'd)

(3) Meghna Dhonagoda (MDIP)

(Unit: ha)

Inundation Duaration (months)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	- (-)	42.09 (65.3)	42.09 (65.3)	- (-)	- (-)	- (-)	0.04 (0.2)	0.03 (0.1)	-0.01 (-0.1)
0 - 1 (%)	0.80 (1.2)	2.68 (4.2)	1.88 (3.0)	- (-)	- (-)	- (-)	0.11 (0.4)	0.11 (0.4)	- (-)
1 - 2 (%)	1.76 (2.7)	2.48 (3.8)	0.72 (1.1)	- (-)	- (-)	- (-)	0.80 (3.0)	0.80 (3.0)	- (-)
2 - 3 (%)	4.63 (7.2)	4.31 (6.7)	-0.32 (-0.5)	- (-)	- (-)	- (-)	0.56 (2.1)	0.57 (2.2)	0.01 (0.1)
3 - 4 (%)	11.65 (18.1)	4.17 (6.5)	-7.48 (-11.6)	- (-)	- (-)	- (-)	1.91 (7.2)	2.44 (9.2)	0.53 (2.0)
4 - 5 (%)	31.28 (48.5)	4.38 (6.8)	-26.90 (-41.7)	- (-)	- (-)	- (-)	11.84 (44.6)	10.84 (40.8)	-1.00 (-3.8)
5 - 6 (%)	10.86 (16.9)	1.93 (3.0)	-8.93 (-13.9)	- (-)	- (-)	- (-)	10.08 (37.9)	10.57 (39.8)	0.49 (1.9)
6 and over (%)	3.48 (5.4)	2.42 (3.7)	-1.06 (-1.7)	- (-)	- (-)	- (-)	1.22 (4.6)	1.20 (4.5)	-0.02 (-0.1)
Total (%)	64.46 (100.0)	64.46 (100.0)	- (-)	- (-)	- (-)	- (-)	26.56 (100.0)	26.56 (100.0)	- (-)

(4) Zilkar Haor (ZH)

Inundation Duaration (month)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	0.49 (0.5)	3.70 (3.8)	3.21 (3.3)	2.04 (3.1)	1.56 (2.4)	-0.48 (-0.7)	1.01 (1.3)	- (-)	-1.01 (-1.3)
0 - 1 (%)	6.76 (6.9)	9.84 (10.0)	3.08 (3.1)	7.45 (11.4)	7.81 (12.0)	0.36 (0.6)	3.05 (3.8)	3.10 (3.9)	0.05 (0.1)
1 - 2 (%)	5.57 (5.7)	10.63 (10.8)	5.06 (5.1)	4.43 (6.8)	5.99 (9.2)	1.56 (2.4)	4.80 (6.0)	9.82 (12.3)	5.02 (6.3)
2 - 3 (%)	22.85 (23.3)	23.53 (24.0)	0.68 (0.7)	10.47 (16.1)	12.40 (19.1)	1.93 (3.0)	11.76 (14.7)	12.64 (15.8)	0.88 (1.1)
3 - 4 (%)	15.46 (15.7)	10.40 (10.6)	-5.06 (-5.1)	12.74 (19.6)	11.74 (18.0)	-1.00 (-1.6)	20.68 (25.9)	19.13 (23.9)	-1.55 (-2.0)
4 - 5 (%)	20.00 (20.4)	20.62 (21.0)	0.62 (0.6)	14.03 (21.6)	16.27 (25.0)	2.24 (3.4)	19.33 (24.2)	17.18 (21.5)	-2.15 (-2.7)
5 - 6 (%)	17.24 (17.5)	15.06 (15.3)	-2.18 (-2.2)	11.13 (17.1)	7.25 (11.1)	-3.88 (-6.0)	15.90 (19.9)	14.80 (18.5)	-1.10 (-1.4)
6 and over (%)	9.80 (10.0)	4.39 (4.5)	-5.41 (-5.5)	2.79 (4.3)	2.06 (3.2)	-0.73 (-1.1)	3.39 (4.2)	3.25 (4.1)	-0.14 (-0.1)
Total (%)	98.17 (100.0)	98.17 (100.0)	- (-)	65.08 (100.0)	65.08 (100.0)	- (-)	79.92 (100.0)	79.92 (100.0)	- (-)

Source: PIE Farm Household Survey

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Table G.A-2 Cultitvated Land by Duration of Inundation (Cont'd)

(5) Kolabashukhali (KBK)

(Unit: ha)

Inundation Duaration (month)	Impacted Area						Control Area		
	Protected Area			Unprotected Area					
	Before	Present	Increase	Before	Present	Increase	Before	Present	Increase
0 (%)	5.20 (4.2)	29.55 (24.1)	24.35 (19.9)	- (-)	- (-)	- (-)	4.27 (6.6)	5.09 (7.9)	0.82 (1.3)
0 - 1 (%)	2.33 (1.9)	4.29 (3.5)	1.96 (1.6)	- (-)	- (-)	- (-)	1.23 (1.9)	3.07 (4.7)	1.84 (2.8)
1 - 2 (%)	6.62 (5.4)	8.50 (6.9)	1.88 (1.5)	- (-)	- (-)	- (-)	5.45 (8.4)	5.96 (9.2)	0.51 (0.8)
2 - 3 (%)	7.16 (5.8)	11.34 (9.2)	4.18 (3.4)	- (-)	- (-)	- (-)	7.37 (11.4)	7.07 (10.9)	-0.30 (-0.5)
3 - 4 (%)	12.85 (10.5)	12.98 (10.6)	0.13 (0.1)	- (-)	- (-)	- (-)	9.19 (14.2)	7.80 (12.0)	-1.39 (-2.2)
4 - 5 (%)	26.51 (21.6)	8.02 (6.5)	-18.49 (-15.1)	- (-)	- (-)	- (-)	13.51 (20.8)	11.63 (18.0)	-1.88 (-2.8)
5 - 6 (%)	10.81 (8.8)	16.42 (13.4)	5.61 (4.6)	- (-)	- (-)	- (-)	7.83 (12.1)	7.49 (11.6)	-0.34 (-0.5)
6 and over (%)	51.32 (41.8)	31.70 (25.8)	-19.62 (-16.0)	- (-)	- (-)	- (-)	15.93 (24.6)	16.67 (25.7)	0.74 (1.1)
Total (%)	122.80 (100.0)	122.80 (100.0)	- (-)	- (-)	- (-)	- (-)	64.78 (100.0)	64.78 (100.0)	- (-)

Source: PIE Farm Household Survey

Table G.A-3 Irrigated Area by Flood Depth and Crop Season

(1) Chalan Beel Polder D

(Unit: ha)

Crop		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total
Boro, LV	Crp. A.	0.20	-	-	1.81	1.36	3.37	-	-	-	-	0.53	0.53	-	-	-	0.35	0.40	0.75
	Irr. A.	0.02	-	-	1.62	1.32	2.96	-	-	-	-	0.53	0.53	-	-	-	0.35	0.40	0.75
	(%)	(10.0)	-	-	(89.5)	(97.1)	(87.8)	-	-	-	-	(100)	(100)	-	-	-	(100)	(100)	(100)
Boro, HYV	Crp. A.	5.63	1.19	5.63	10.76	14.40	37.61	-	-	0.40	2.52	1.07	3.99	0.46	0.06	1.87	6.37	5.69	14.45
	Irr. A.	5.63	1.19	5.37	10.76	14.16	37.11	-	-	0.40	2.05	1.07	3.52	0.45	0.06	1.86	6.20	5.41	13.98
	(%)	(100)	(100)	(95.4)	(100)	(98.3)	(98.7)	-	-	(100)	(81.3)	(100)	(88.2)	(97.8)	(100)	(99.5)	(97.3)	(95.1)	(96.7)
Wheat	Crp. A.	0.59	0.98	2.14	1.32	0.19	5.22	-	-	-	-	-	-	2.65	0.85	0.77	-	0.48	4.75
	Irr. A.	0.31	0.77	1.41	1.20	0.13	3.82	-	-	-	-	-	-	2.64	0.84	0.49	-	0.48	4.45
	(%)	(52.5)	(78.6)	(65.9)	(90.9)	(68.4)	(73.2)	-	-	-	-	-	-	(99.6)	(98.8)	(63.6)	-	(100)	(93.7)
Rabi, Others	Crp. A.	4.42	1.12	1.36	0.29	0.15	1.74	0.18	-	-	-	-	0.18	2.65	0.24	0.13	-	-	3.02
	Irr. A.	3.27	0.63	0.93	0.15	-	1.12	0.17	-	-	-	-	0.17	2.09	0.24	0.13	-	-	2.46
	(%)	(74.6)	(56.3)	(68.4)	(51.7)	(-)	(64.4)	(94.4)	-	-	-	-	(94.4)	(78.9)	(100)	(100)	-	-	(81.5)
Rabi Sub-total	Crp. A.	10.84	3.29	9.13	14.18	16.10	53.54	0.18	-	0.40	2.52	1.60	4.70	5.76	1.15	2.77	6.72	6.57	22.97
	Irr. A.	9.23	2.59	7.71	13.73	15.61	48.87	0.17	-	0.40	2.05	1.60	4.22	5.18	1.14	2.48	6.55	6.29	21.64
	(%)	(85.1)	(78.7)	(84.4)	(96.8)	(97.0)	(91.3)	(94.4)	-	(100)	(81.3)	(100)	(89.8)	(89.9)	(99.1)	(89.5)	(97.5)	(95.7)	(94.2)
Aman, T, LV	Crp. A.	10.54	5.81	7.98	-	-	24.33	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.67	1.00	0.82	-	-	2.49	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(6.4)	(17.2)	(10.3)	-	-	(10.2)	-	-	-	-	-	-	-	-	-	-	-	-
Aman, T, HYV	Crp. A.	-	0.45	2.41	-	-	2.86	-	-	-	-	-	-	1.04	1.60	1.82	-	-	4.46
	Irr. A.	-	0.45	0.70	-	-	1.15	-	-	-	-	-	-	0.30	1.06	1.77	-	-	2.13
	(%)	-	(100)	(29.0)	-	-	(40.2)	-	-	-	-	-	-	(28.8)	(66.3)	(92.3)	-	-	(47.8)
Aman, Others	Crp. A.	2.09	0.08	-	-	-	2.17	-	-	-	-	-	-	1.43	-	-	3.66	-	5.09
	Irr. A.	1.95	0.08	-	-	-	2.03	-	-	-	-	-	-	1.38	-	-	0.08	-	1.46
	(%)	(93.3)	(100)	-	-	-	(93.5)	-	-	-	-	-	-	(96.5)	-	-	(2.2)	-	(28.7)
Aman Sub-total	Crp. A.	12.63	6.34	10.39	-	-	29.36	-	-	-	-	-	-	2.47	1.60	1.82	3.66	-	9.55
	Irr. A.	2.62	1.53	1.52	-	-	5.67	-	-	-	-	-	-	1.68	1.06	0.77	0.08	-	3.59
	(%)	(20.7)	(24.1)	(14.6)	-	-	(19.3)	-	-	-	-	-	-	(68.0)	(66.3)	(42.3)	(2.2)	-	(37.6)
Aus, T, LV	Crp. A.	-	0.79	0.20	-	-	0.99	-	-	-	-	-	-	0.16	-	-	-	-	0.16
	Irr. A.	-	0.27	0.04	-	-	0.31	-	-	-	-	-	-	0.09	-	-	-	-	0.09
	(%)	-	(34.2)	(20.0)	-	-	(31.3)	-	-	-	-	-	-	(56.3)	-	-	-	-	(56.3)
Aus, T, HYV	Crp. A.	0.32	-	1.24	-	-	1.56	0.40	-	-	-	-	0.40	0.53	0.48	0.53	0.03	-	1.57
	Irr. A.	0.22	-	0.13	-	-	0.35	0.37	-	-	-	-	0.37	0.29	0.28	0.53	0.03	-	1.13
	(%)	(68.8)	-	(10.5)	-	-	(22.4)	(92.5)	-	-	-	-	(92.5)	(54.7)	(58.3)	(100)	(100)	-	(72.0)
Aus, Others	Crp. A.	2.10	1.10	-	-	-	3.20	-	-	-	-	-	-	2.69	-	-	-	-	2.69
	Irr. A.	1.59	0.51	-	-	-	2.10	-	-	-	-	-	-	1.33	-	-	-	-	1.33
	(%)	(75.7)	(46.4)	-	-	-	(65.6)	-	-	-	-	-	-	(49.4)	-	-	-	-	(49.4)
Aus Sub-total	Crp. A.	2.42	1.89	1.44	-	-	5.75	0.40	-	-	-	-	0.40	3.38	0.48	0.53	0.03	-	4.42
	Irr. A.	1.81	0.78	0.17	-	-	2.76	0.37	-	-	-	-	0.37	1.71	0.28	0.53	0.03	-	2.55
	(%)	(74.8)	(41.3)	(11.8)	-	-	(48.0)	(92.5)	-	-	-	-	(92.5)	(50.6)	(58.3)	(100)	(100)	-	(57.7)
Grand Total	Crp. A.	25.89	11.52	20.96	14.18	16.10	88.65	0.58	-	0.40	2.52	1.60	5.10	11.61	3.23	5.12	10.41	6.57	36.94
	Irr. A.	13.66	4.90	9.40	13.73	15.61	57.30	0.54	-	0.40	2.05	1.60	4.59	8.57	2.48	3.78	6.66	6.29	27.78
	(%)	(52.8)	(42.5)	(44.8)	(96.8)	(97.0)	(64.6)	(93.1)	-	(100)	(81.3)	(100)	(90.0)	(73.8)	(76.8)	(73.8)	(64.0)	(95.7)	(75.2)

Flood Depth: H. = High (never flooded), M.H. = Medium High (0 - 30 cm), M.L. = Medium Low (30 - 90 cm), L. = Low (90 - 180 cm), V.L. = Very Low (over 180 cm)

Note: Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Source: PIE Farm Household Survey

Table G.A-3 Irrigated Area by Flood Depth and Crop Season (Cont'd)

(2) Kurigram South (KS)

(Unit: ha)

Crop		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total
Boro, LV	Crp. A.	-	-	0.14	-	-	0.14	-	-	-	-	-	-	-	-	-	0.99	-	0.99
	Irr. A.	-	-	0.14	-	-	0.14	-	-	-	-	-	-	-	-	-	0.79	-	0.79
	(%)	-	-	(100)	-	-	(100)	-	-	-	-	-	-	-	-	-	(79.8)	-	(79.8)
Boro, HYV	Crp. A.	12.48	2.85	7.76	3.74	0.29	27.12	-	-	0.94	0.72	0.38	2.04	9.05	2.57	4.11	3.88	0.81	20.42
	Irr. A.	12.23	2.84	7.75	3.74	0.29	26.85	-	-	0.94	0.72	0.38	2.04	9.05	2.56	4.11	3.62	0.81	20.15
	(%)	(98.0)	(99.6)	(99.9)	(100)	(100)	(99.0)	-	-	(100)	(100)	(100)	(100)	(100)	(99.6)	(100)	(93.3)	(100)	(98.7)
Wheat	Crp. A.	1.94	-	0.30	1.02	-	3.26	-	-	-	0.16	-	0.16	4.14	-	-	-	-	4.14
	Irr. A.	0.98	-	0.20	0.32	-	1.50	-	-	-	0.10	-	0.10	0.53	-	-	-	-	0.53
	(%)	(50.5)	-	(66.7)	(31.4)	-	(46.0)	-	-	-	(62.5)	-	(62.5)	(12.8)	-	-	-	-	(12.8)
Rabi, Others	Crp. A.	5.27	0.46	-	-	-	5.80	-	-	0.16	-	-	0.16	1.25	-	-	-	-	1.25
	Irr. A.	2.48	0.46	-	-	-	2.94	-	-	0.16	-	-	0.16	0.25	-	-	-	-	0.25
	(%)	(47.1)	(100)	-	-	-	(50.7)	-	-	(100)	-	-	(100)	(20.0)	-	-	-	-	(20.0)
Rabi/Boro Sub-total	Crp. A.	19.69	3.31	8.20	4.76	0.29	36.25	-	-	1.10	0.88	0.38	2.36	14.44	2.57	4.11	4.87	0.81	26.80
	Irr. A.	15.69	3.30	8.09	4.06	0.29	31.43	-	-	1.10	0.82	0.38	2.30	9.83	2.56	4.11	4.41	0.81	21.72
	(%)	(79.7)	(99.7)	(98.7)	(85.3)	(100)	(86.7)	-	-	(100)	(93.2)	(100)	(97.5)	(68.1)	(99.6)	(100)	(90.6)	(100)	(81.0)
Aus, B, LV	Crp. A.	7.45	-	-	-	-	7.45	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.42	-	-	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(5.6)	-	-	-	-	(5.6)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, T, HYV	Crp. A.	1.35	1.87	0.60	0.36	-	4.18	-	-	-	0.08	-	0.08	9.64	2.11	-	-	-	11.75
	Irr. A.	1.30	1.01	0.10	0.14	-	2.55	-	-	-	0.08	-	0.08	0.64	0.81	-	-	-	1.45
	(%)	(96.3)	(54.0)	(16.7)	(38.9)	-	(61.0)	-	-	-	(100)	-	(100)	(6.6)	(38.4)	-	-	-	(12.3)
Aus, Others	Crp. A.	0.20	-	-	-	-	0.20	-	-	-	-	-	-	9.64	-	-	-	-	9.64
	Irr. A.	0.20	-	-	-	-	0.20	-	-	-	-	-	-	0.26	-	-	-	-	0.26
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	(2.7)	-	-	-	-	(2.7)
Aus Sub-total	Crp. A.	9.00	1.87	0.60	0.36	-	11.83	-	-	-	0.08	-	0.08	19.28	2.11	-	-	-	21.39
	Irr. A.	1.92	1.01	0.10	0.14	-	3.17	-	-	-	0.08	-	0.08	0.90	0.81	-	-	-	1.71
	(%)	(21.3)	(54.0)	(16.7)	(38.9)	-	(26.8)	-	-	-	(100)	-	(100)	(4.7)	(38.4)	-	-	-	(8.0)
Aman, T, LV	Crp. A.	21.95	8.55	14.45	-	-	44.95	-	-	-	-	-	-	31.75	-	-	-	-	31.75
	Irr. A.	2.04	0.40	0.13	-	-	2.57	-	-	-	-	-	-	0.13	-	-	-	-	0.13
	(%)	(9.3)	(4.7)	(0.9)	-	-	(5.7)	-	-	-	-	-	-	(0.4)	-	-	-	-	(0.4)
Aman, T, HYV	Crp. A.	4.18	-	-	-	-	4.18	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.40	-	-	-	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(9.6)	-	-	-	-	(9.6)	-	-	-	-	-	-	-	-	-	-	-	-
Aman Sub-total	Crp. A.	26.13	8.55	14.45	-	-	49.13	-	-	-	-	-	-	31.75	-	-	-	-	31.75
	Irr. A.	2.44	0.40	0.13	-	-	2.97	-	-	-	-	-	-	0.13	-	-	-	-	0.13
	(%)	(9.3)	(4.7)	(0.9)	-	-	(6.0)	-	-	-	-	-	-	(0.4)	-	-	-	-	(0.4)
Grand Total	Crp. A.	54.82	13.73	23.25	5.12	0.29	97.21	-	-	1.10	0.96	0.38	2.44	65.47	4.68	4.11	4.87	0.81	79.94
	Irr. A.	20.05	4.71	8.32	4.20	0.29	37.57	-	-	1.10	0.90	0.38	2.38	10.86	3.37	4.11	4.41	0.81	23.56
	(%)	(36.6)	(34.3)	(35.8)	(82.0)	(100)	(38.6)	-	-	(100)	(93.8)	(100)	(97.5)	(16.6)	(72.0)	(100)	(90.6)	(100)	(29.5)

Flood Depth: H. = High (never flooded), M.H. = Medium High (0 - 30 cm), M.L. = Medium Low (30 - 90 cm), L. = Low (90 - 180 cm), V.L. = Very Low (over 180 cm)

Note: Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Source: PIE Farm Household Survey

Table G.A-3 Irrigated Area by Flood Depth and Crop Season (Cont'd)

(3) Meghna Dhonagoda (MDIP)

Crop		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total
Boro, HYV	Crp. A.	23.53	7.01	4.25	0.49	1.12	36.40	-	-	-	-	-	-	-	-	0.46	3.49	1.34	5.29
	Irr. A.	23.12	7.01	4.25	0.44	0.69	35.51	-	-	-	-	-	-	-	-	0.40	3.49	1.28	5.17
	(%)	(98.3)	(100)	(100)	(89.8)	(61.6)	(97.6)	-	-	-	-	-	-	-	-	(87.0)	(100)	(95.5)	(97.7)
Wheat	Crp. A.	1.09	-	-	-	-	1.09	-	-	-	-	-	-	-	0.08	-	2.08	1.51	3.67
	Irr. A.	0.50	-	-	-	-	0.50	-	-	-	-	-	-	-	0.08	-	0.08	0.05	0.21
	(%)	(45.9)	-	-	-	-	(45.9)	-	-	-	-	-	-	-	(100)	-	(3.8)	(3.3)	(5.7)
Oilseeds	Crp. A.	3.00	0.46	-	-	-	3.46	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.36	0.06	-	-	-	0.42	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(12.0)	(13.0)	-	-	-	(12.1)	-	-	-	-	-	-	-	-	-	-	-	-
Pepper	Crp. A.	1.27	-	-	-	-	1.27	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	1.21	-	-	-	-	1.21	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(95.3)	-	-	-	-	(95.3)	-	-	-	-	-	-	-	-	-	-	-	-
Winter Vegetables	Crp. A.	0.10	-	-	-	-	0.10	-	-	-	-	-	-	0.04	0.09	0.15	-	-	0.28
	Irr. A.	0.10	-	-	-	-	0.10	-	-	-	-	-	-	0.04	0.09	0.05	-	-	0.18
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	(100)	(100)	(33.3)	-	-	(64.3)
Potato	Crp. A.	-	0.07	-	-	-	0.07	-	-	-	-	-	-	-	-	0.74	1.75	-	2.49
	Irr. A.	-	0.07	-	-	-	0.07	-	-	-	-	-	-	-	-	0.44	0.24	-	0.68
	(%)	-	(100)	-	-	-	(100)	-	-	-	-	-	-	-	-	(59.5)	(13.7)	-	(27.3)
Sweet Potato	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.06	-	-	0.06
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	0.02
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(33.3)	-	-	(33.3)
Rabi/Boro Sub-total	Crp. A.	28.99	7.64	4.25	0.49	1.12	42.49	-	-	-	-	-	-	0.04	0.17	1.41	7.32	2.85	11.79
	Irr. A.	25.29	7.14	4.25	0.44	0.69	37.81	-	-	-	-	-	-	0.04	0.17	0.91	3.81	1.33	6.26
	(%)	(87.2)	(93.5)	(100)	(89.8)	(61.6)	(89.2)	-	-	-	-	-	-	(100)	(100)	(64.5)	(52.0)	(46.7)	(53.1)
Aus, T.HYV	Crp. A.	15.91	4.53	1.33	-	-	21.77	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	1.62	0.13	0.07	-	-	1.82	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(10.2)	(2.9)	(5.3)	-	-	(8.4)	-	-	-	-	-	-	-	-	-	-	-	-
Aus, B	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.78	-	-	-	0.78
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.17	-	-	-	0.17
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	(21.8)	-	-	-	(21.8)
Aus Sub-total	Crp. A.	15.91	4.53	1.33	-	-	21.77	-	-	-	-	-	-	-	0.78	-	-	-	0.78
	Irr. A.	1.62	0.13	0.07	-	-	1.82	-	-	-	-	-	-	-	0.17	-	-	-	0.17
	(%)	(10.2)	(2.9)	(5.3)	-	-	(8.4)	-	-	-	-	-	-	-	(21.8)	-	-	-	(21.8)
Aman, T.HYV	Crp. A.	27.52	7.19	5.47	-	-	40.18	-	-	-	-	-	-	-	0.12	-	-	-	0.12
	Irr. A.	3.01	-	0.23	-	-	3.24	-	-	-	-	-	-	-	0.12	-	-	-	0.12
	(%)	(10.9)	(-)	(4.2)	-	-	(8.1)	-	-	-	-	-	-	-	(100)	-	-	-	(100)
Total	Crp. A.	72.42	19.36	11.05	0.49	1.12	104.34	-	-	-	-	-	-	0.04	1.07	1.41	7.32	2.85	12.69
	Irr. A.	29.92	7.27	4.55	0.44	0.69	42.87	-	-	-	-	-	-	0.04	0.46	0.91	3.81	1.33	6.55
	(%)	(41.3)	(37.6)	(41.2)	(89.8)	(61.6)	(41.1)	-	-	-	-	-	-	(100)	(43.0)	(64.5)	(52.0)	(46.7)	(51.6)

Flood Depth: H. = High (never flooded), M.H. = Medium High (0 - 30 cm), M.L. = Medium Low (30 - 90 cm), L. = Low (90 - 180 cm), V.L. = Very Low (over 180 cm)

Note: Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Source: PIE Farm Household Survey

Table G.A-3 Irrigated Area by Flood Depth and Crop Season (Cont'd)

(4) Zilkar Haor (ZH)

Crop		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total
Boro, L	Crp. A.	-	0.49	0.95	7.44	20.65	29.53	-	-	0.48	4.49	5.65	10.62	-	0.40	0.13	3.63	12.71	16.87
	Irr. A.	-	0.16	0.86	5.76	17.87	24.65	-	-	0.48	4.25	4.79	9.52	-	0.40	-	0.87	7.72	8.99
	(%)	-	(32.7)	(90.5)	(77.4)	(86.5)	(83.5)	-	-	(100)	(94.7)	(84.8)	(89.6)	-	(100)	(-)	(24.0)	(60.7)	(53.3)
Boro, HYV	Crp. A.	1.94	0.55	5.62	6.96	5.87	20.94	1.23	1.09	3.10	7.61	5.99	19.02	-	-	1.01	-	0.28	1.29
	Irr. A.	1.82	0.55	5.62	6.47	5.80	20.26	1.15	1.09	2.97	7.48	5.22	17.91	-	-	1.01	-	0.28	1.29
	(%)	(93.8)	(100)	(100)	(93.0)	(98.8)	(96.8)	(93.5)	(100)	(95.8)	(98.3)	(87.2)	(94.2)	-	-	(100)	-	(100)	(100)
Rabi/Boro Sub-total	Crp. A.	1.94	1.04	6.57	14.40	26.52	50.47	1.23	1.09	3.58	12.10	11.64	29.64	-	0.40	1.14	3.63	12.99	18.16
	Irr. A.	1.82	0.71	6.48	12.23	23.67	44.91	1.15	1.09	3.45	11.73	10.01	27.43	-	0.40	1.01	0.87	8.00	10.28
	(%)	(93.8)	(68.3)	(98.6)	(84.9)	(89.3)	(89.0)	(93.5)	(100)	(96.4)	(96.9)	(86.0)	(92.5)	-	(100)	(88.6)	(24.0)	(61.6)	(56.6)
Aus, T, LV	Crp. A.	-	0.06	0.91	2.35	0.20	3.52	-	-	1.21	2.91	0.85	4.97	-	-	1.25	0.37	-	1.62
	Irr. A.	-	0.06	-	1.25	0.20	1.51	-	-	0.24	-	-	0.24	-	-	-	-	-	-
	(%)	-	(100)	(-)	(53.2)	(100)	(42.9)	-	-	(19.8)	(-)	(-)	(4.8)	-	-	(-)	(-)	-	(-)
Aus, B	Crp. A.	-	-	1.75	0.16	-	1.91	0.08	0.24	0.79	0.12	-	1.23	-	0.59	9.23	4.32	1.55	15.69
	Irr. A.	-	-	-	-	-	-	-	-	0.24	-	-	0.24	-	-	-	0.17	-	0.17
	(%)	-	-	(-)	(-)	-	(-)	(-)	(-)	30.38	(-)	-	19.51	-	(-)	(-)	3.94	(-)	1.08
Aus, T, HYV	Crp. A.	-	0.61	0.30	1.03	0.24	2.18	-	-	0.48	0.20	0.36	1.04	-	0.34	-	-	-	0.34
	Irr. A.	-	-	-	0.73	-	0.73	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	-	(-)	(-)	(70.9)	(-)	(33.5)	-	-	(-)	(-)	(-)	(-)	-	(-)	-	-	-	(-)
Aus Sub-total	Crp. A.	-	0.67	2.96	3.54	0.44	7.61	0.08	0.24	2.48	3.23	1.21	7.24	-	0.93	10.48	4.69	1.55	17.65
	Irr. A.	-	0.06	-	1.98	0.20	2.24	-	-	0.48	-	-	0.48	-	-	-	0.17	-	0.17
	(%)	-	(9.0)	(-)	(55.9)	(45.5)	(29.4)	(-)	(-)	19.35	(-)	(-)	6.63	-	(-)	(-)	3.62	(-)	0.96
Aman, B, LV	Crp. A.	-	2.91	-	1.94	-	4.85	0.24	-	0.73	0.24	1.94	3.15	-	-	3.70	10.70	15.60	30.00
	Irr. A.	-	2.17	-	1.46	-	3.63	-	-	-	-	-	-	-	-	0.24	1.05	0.12	1.41
	(%)	-	(74.6)	-	(75.3)	-	(74.9)	(-)	-	(-)	(-)	(-)	(-)	-	-	(6.5)	(9.8)	(0.8)	(4.7)
Aman, T, LV	Crp. A.	1.98	2.10	21.23	17.93	3.40	46.64	0.87	1.34	9.00	10.59	12.34	34.14	-	0.99	11.14	12.96	2.46	27.55
	Irr. A.	-	-	5.28	0.18	1.15	6.61	-	-	-	0.54	2.67	3.21	-	-	0.53	1.14	0.19	1.86
	(%)	(-)	(-)	(24.9)	(1.0)	(33.8)	(14.2)	(-)	(-)	(-)	(5.1)	(21.6)	(9.4)	-	(-)	(4.8)	(8.8)	(7.7)	(6.8)
Aman, T, HYV	Crp. A.	-	0.21	0.30	0.38	0.58	1.47	-	-	0.05	1.53	0.77	2.35	-	-	-	-	-	-
	Irr. A.	-	-	0.30	-	0.49	0.79	-	-	-	0.79	0.77	1.56	-	-	-	-	-	-
	(%)	-	(-)	(100)	(-)	(84.5)	(53.7)	-	-	(-)	(51.6)	(100)	(66.4)	-	-	-	-	-	-
Aman Sub-total	Crp. A.	1.98	5.22	21.53	20.25	3.98	52.96	1.11	1.34	9.78	12.36	15.05	39.64	-	0.99	14.84	23.66	18.06	57.55
	Irr. A.	-	2.17	5.58	1.64	1.64	11.03	-	-	-	1.33	3.44	4.77	-	-	0.77	2.19	0.31	3.27
	(%)	(-)	(41.6)	(25.9)	(8.1)	(41.2)	(20.8)	(-)	(-)	(-)	(10.8)	(22.9)	(12.0)	-	(-)	(5.2)	(9.3)	(1.7)	(5.7)
Grand Total	Crp. A.	3.92	6.93	31.06	38.19	30.94	111.04	2.42	2.67	15.84	27.69	27.90	76.52	-	2.32	26.46	31.98	32.60	93.36
	Irr. A.	1.82	2.94	12.06	15.85	25.51	58.18	1.15	1.09	3.93	13.06	13.45	32.68	-	0.40	1.78	3.23	8.31	13.72
	(%)	(46.4)	(42.4)	(38.8)	(41.5)	(82.5)	(52.4)	(47.5)	(40.8)	(24.8)	(47.2)	(48.2)	(42.7)	-	(17.2)	(6.7)	(10.1)	(25.5)	(14.7)

Flood Depth: H. = High (never flooded), M.H. = Medium High (0 - 30 cm), M.L. = Medium Low (30 - 90 cm), L. = Low (90 - 180 cm), V.L. = Very Low (over 180 cm)

Note: Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Source: PIE Farm Household Survey

Table G.A-3 Irrigated Area by Flood Depth and Crop Season (Cont'd)

(5) Kolabashukhali (KBK)

Crop		Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total	H.	M.H.	M.L.	L.	V.L.	Total
Boro, LV	Crp. A.	-	-	1.21	3.26	-	4.47	-	-	-	-	-	-	-	-	3.97	3.59	-	7.56
	Irr. A.	-	-	0.06	0.38	-	0.44	-	-	-	-	-	-	-	-	0.40	0.50	-	0.90
	(%)	-	-	(5.0)	(11.7)	-	(9.8)	-	-	-	-	-	-	-	-	(10.1)	(13.9)	-	(11.9)
Boro, HYV	Crp. A.	0.93	1.55	2.14	1.15	-	5.77	-	-	-	-	-	-	-	-	1.46	-	-	1.46
	Irr. A.	0.93	1.55	2.14	0.90	-	5.52	-	-	-	-	-	-	-	-	1.46	-	-	1.46
	(%)	(100)	(100)	(100)	(78.3)	-	(95.7)	-	-	-	-	-	-	-	-	(100)	-	-	(100)
Wheat	Crp. A.	0.28	-	-	-	-	0.28	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	0.28	-	-	-	-	0.28	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	(100)	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Rabi/Boro Sub-total	Crp. A.	1.21	1.55	3.35	4.41	-	10.52	-	-	-	-	-	-	-	-	5.43	3.59	-	9.02
	Irr. A.	1.21	1.55	2.20	1.28	-	6.24	-	-	-	-	-	-	-	-	1.86	0.50	-	2.36
	(%)	(100)	(100)	(65.7)	(29.0)	-	(59.3)	-	-	-	-	-	-	-	-	(34.3)	(13.9)	-	(26.2)
Aus, T, LV	Crp. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	-	(100)	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aus Sub-total	Crp. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	Irr. A.	-	0.82	-	-	-	0.82	-	-	-	-	-	-	-	-	-	-	-	-
	(%)	-	(100)	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Aman, T, LV	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	0.21
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	0.21
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	(100)	-	-	-	(100)
Aman Sub-total	Crp. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	0.21
	Irr. A.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	-	-	-	0.21
	(%)	-	-	-	-	-	-	-	-	-	-	-	-	-	(100)	-	-	-	(100)
Total	Crp. A.	1.21	2.37	3.35	4.41	-	11.34	-	-	-	-	-	-	-	0.21	5.43	3.59	-	9.23
	Irr. A.	1.21	2.37	2.20	1.28	-	7.06	-	-	-	-	-	-	-	0.21	1.86	0.50	-	2.57
	(%)	(100)	(100)	(65.7)	(29.0)	-	(62.3)	-	-	-	-	-	-	-	(100)	(34.3)	(13.9)	-	(27.8)

Flood Depth: H. = High (never flooded), M.H. = Medium High (0 - 30 cm), M.L. = Medium Low (30 - 90 cm), L. = Low (90 - 180 cm), V.L. = Very Low (over 180 cm)

Note: Crp. A. = Cropped Area, Irr. A. = Irrigated Area

Source: PIE Farm Household Survey

Table G.A-4 Irrigated Area by Flood Depth and by Mean

(1) Chalan Beel Polder D (CB)

(Unit: ha)

Season	Flood Depth	Impacted Area										Control Area				
		Protected Area					Unprotected Area									
		DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total
Rabi/Boro	High	0.13	2.62	2.84	3.64	9.23	-	0.10	-	0.07	0.17	0.27	1.87	1.14	1.90	5.18
	M.H.	0.27	0.25	0.96	1.11	2.59	-	-	-	-	-	-	0.76	-	0.38	1.14
	M.L.	1.45	2.66	1.44	2.16	7.71	0.40	-	-	-	0.40	0.26	0.96	0.02	1.24	2.48
	Low	1.57	7.06	0.53	4.57	13.73	-	0.17	1.48	0.40	2.05	0.31	5.37	-	0.87	6.55
	V.L.	1.27	1.28	1.62	11.44	15.61	0.13	1.07	-	0.40	1.60	0.59	4.97	0.36	0.37	6.29
	Total	4.69	13.87	7.39	22.92	48.87	0.53	1.34	1.48	0.87	4.22	1.43	13.93	1.52	4.76	21.64
Aus	High	-	0.22	-	1.59	1.81	-	0.10	-	0.27	0.37	-	0.09	0.52	1.10	1.71
	M.H.	-	0.16	-	0.62	0.78	-	-	-	-	-	-	0.08	-	0.20	0.28
	M.L.	0.04	0.13	-	-	0.17	-	-	-	-	-	-	-	-	0.53	0.53
	Low	-	-	-	-	-	-	-	-	-	-	-	-	0.03	-	0.03
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.04	0.51	-	2.21	2.76	-	0.10	-	0.27	0.37	-	0.17	0.55	1.83	2.55
Aman	High	-	0.27	-	2.35	2.62	-	-	-	-	-	-	0.27	0.44	0.97	1.68
	M.H.	-	-	0.13	1.40	1.53	-	-	-	-	-	-	-	-	1.06	1.06
	M.L.	-	-	-	1.52	1.52	-	-	-	-	-	-	0.13	-	0.64	0.77
	Low	-	-	-	-	-	-	-	-	-	-	-	0.08	-	-	0.08
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	0.27	0.13	5.27	5.67	-	-	-	-	-	-	0.48	0.44	2.67	3.59
Total	High	0.13	3.11	2.84	7.58	13.66	-	0.20	-	0.34	0.54	0.27	2.23	2.10	3.97	8.57
	M.H.	0.27	0.41	1.09	3.13	4.90	-	-	-	-	-	-	0.84	-	1.64	2.48
	M.L.	1.49	2.79	1.44	3.68	9.40	0.40	-	-	-	0.40	0.26	1.09	0.02	2.41	3.78
	Low	1.57	7.06	0.53	4.57	13.73	-	0.17	1.48	0.40	2.05	0.31	5.45	0.03	0.87	6.66
	V.L.	1.27	1.28	1.62	11.44	15.61	0.13	1.07	-	0.40	1.60	0.59	4.97	0.36	0.37	6.29
	Total	4.73	14.65	7.52	30.40	57.30	0.53	1.44	1.48	1.14	4.59	1.43	14.58	2.51	9.26	27.78

Irrigation Mean: DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous Ones
Flood Depth: High = Never flooded, M.H. = 0 - 30 cm, M.L. = 30 - 90 cm, L. = 90 - 180 cm, V.L. = over 180 cm
Source: PIE Farm Household Survey

Table G.A-4 Irrigated Area by Flood Depth and by Mean (Cont'd)

(2) Kurigram South (KS)

(Unit: ha)

Season	Flood Depth	Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		DTW	STW	LLP	Ind.	MOSTI	Total	DTW	STW	LLP	Ind.	MOSTI	Total	DTW	STW	LLP	Ind.	MOSTI	Total
Rabi/Boro	High	1.80	11.55	0.56	1.29	0.49	15.69	-	-	-	-	-	-	2.74	5.26	0.51	1.13	0.19	9.83
	M.H.	0.18	2.66	-	0.06	0.40	3.30	-	-	-	-	-	-	0.80	1.03	0.13	0.60	-	2.56
	M.L.	1.26	4.37	2.04	0.42	-	8.09	-	0.94	-	0.16	-	1.10	0.13	3.41	0.57	-	-	4.11
	Low	-	2.94	0.66	0.46	-	4.06	0.10	0.60	-	0.12	-	0.82	-	4.02	-	0.39	-	4.41
	V.L.	-	0.22	-	0.07	-	0.29	-	0.38	-	-	-	0.38	-	0.81	-	-	-	0.81
	Total	3.24	21.74	3.26	2.30	0.89	31.43	0.10	1.92	-	0.28	-	2.30	3.67	14.53	1.21	2.12	0.19	21.72
Aus	High	0.42	1.18	-	-	0.32	1.92	-	-	-	-	-	-	0.64	0.13	-	0.13	-	0.90
	M.H.	-	1.01	-	-	-	1.01	-	-	-	-	-	-	0.81	-	-	-	-	0.81
	M.L.	-	0.10	-	-	-	0.10	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	0.14	-	-	-	0.14	0.08	-	-	-	-	0.08	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.42	2.43	-	-	0.32	3.17	0.08	-	-	-	-	0.08	1.45	0.13	-	0.13	-	1.71
Aman	High	0.40	1.62	0.42	-	-	2.44	-	-	-	-	-	-	-	-	-	0.13	-	0.13
	M.H.	-	0.40	-	-	-	0.40	-	-	-	-	-	-	-	-	-	-	-	-
	M.L.	-	0.13	-	-	-	0.13	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.40	2.15	0.42	-	-	2.97	-	-	-	-	-	-	-	-	-	0.13	-	0.13
Total	High	2.62	14.35	0.98	1.29	0.81	20.05	-	-	-	-	-	-	3.38	5.39	0.51	1.39	0.19	10.86
	M.H.	0.18	4.07	-	0.06	0.40	4.71	-	-	-	-	-	-	1.61	1.03	0.13	0.60	-	3.37
	M.L.	1.26	4.60	2.04	0.42	-	8.32	-	0.94	-	0.16	-	1.10	0.13	3.41	0.57	-	-	4.11
	Low	-	3.08	0.66	0.46	-	4.20	0.18	0.60	-	0.12	-	0.90	-	4.02	-	0.39	-	4.41
	V.L.	-	0.22	-	0.07	-	0.29	-	0.38	-	-	-	0.38	-	0.81	-	-	-	0.81
	Total	4.06	26.32	3.68	2.30	1.21	37.57	0.18	1.92	-	0.28	-	2.38	5.12	14.66	1.21	2.38	0.19	23.56

(3) Meghna Dhonagoda (MDIP)

Season	Flood Depth	Impacted Area												Control Area					
		Protected Area						Unprotected Area											
		DTW	STW	LLP	Ind.	BWDB	Total	DTW	STW	LLP	Ind.	BWDB	Total	DTW	STW	LLP	Ind.	BWDB	Total
Rabi/Boro	High	-	-	7.74	1.41	16.14	25.29	-	-	-	-	-	-	-	-	-	0.04	-	0.04
	M.H.	-	0.25	2.54	0.07	4.28	7.14	-	-	-	-	-	-	-	-	-	0.17	-	0.17
	M.L.	-	-	1.99	-	2.26	4.25	-	-	-	-	-	-	-	-	0.12	0.79	-	0.91
	Low	-	-	0.37	0.04	0.03	0.44	-	-	-	-	-	-	0.78	0.08	2.28	0.67	-	3.81
	V.L.	0.30	-	0.34	-	0.05	0.69	-	-	-	-	-	-	0.53	-	0.75	0.05	-	1.33
	Total	0.30	0.25	12.98	1.52	22.76	37.81	-	-	-	-	-	-	1.31	0.08	3.15	1.72	-	6.26
Aus	High	-	-	-	-	1.62	1.62	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	-	0.13	0.13	-	-	-	-	-	-	-	-	-	0.17	-	0.17
	M.L.	-	-	-	-	0.07	0.07	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	1.82	1.82	-	-	-	-	-	-	-	-	-	0.17	-	0.17
Aman	High	-	-	-	-	3.01	3.01	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.12	-	0.12
	M.L.	-	-	-	-	0.23	0.23	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	3.24	3.24	-	-	-	-	-	-	-	-	-	0.12	-	0.12
Total	High	-	-	7.74	1.41	20.77	29.92	-	-	-	-	-	-	-	-	-	0.04	-	0.04
	M.H.	-	0.25	2.54	0.07	4.41	7.27	-	-	-	-	-	-	-	-	-	0.46	-	0.46
	M.L.	-	-	1.99	-	2.56	4.55	-	-	-	-	-	-	-	-	0.12	0.79	-	0.91
	Low	-	-	0.37	0.04	0.03	0.44	-	-	-	-	-	-	0.78	0.08	2.28	0.67	-	3.81
	V.L.	0.30	-	0.34	-	0.05	0.69	-	-	-	-	-	-	0.53	-	0.75	0.05	-	1.33
	Total	0.30	0.25	12.98	1.52	27.82	42.87	-	-	-	-	-	-	1.31	0.08	3.15	2.01	-	6.55

Irrigation Mean: DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous, MOSTI=Manually Operated STW, BWDB = BWDB Canal

Flood Depth: High = Never flooded, M.H. = 0 - 30 cm, M.L. = 30 - 90 cm, L. = 90 - 180 cm, V.L. = over 180 cm

Table G.A-4 Irrigated Area by Flood Depth and by Mean (Cont'd)

(4) Zilkar Haor (ZH)

(Unit: ha)

Season	Flood Depth	Impacted Area										Control Area				
		Protected Area					Unprotected Area									
		DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total
Rabi/Boro	High	-	-	1.82	-	1.82	-	-	1.15	-	1.15	-	-	-	-	-
	M.H.	-	-	0.55	0.16	0.71	-	-	1.09	-	1.09	-	-	-	0.40	0.40
	M.L.	-	-	6.06	0.42	6.48	-	-	2.79	0.66	3.45	-	-	1.01	-	1.01
	Low	-	-	7.08	5.15	12.23	-	-	8.64	3.09	11.73	-	0.87	-	-	0.87
	V.L.	0.36	-	4.37	18.94	23.67	-	-	4.79	5.22	10.01	-	-	-	8.00	8.00
	Total	0.36	-	19.88	24.67	44.91	-	-	18.46	8.97	27.43	-	0.87	1.01	8.40	10.28
Aus	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	0.06	0.06	-	-	-	-	-	-	-	-	-	-
	M.L.	-	-	-	-	-	-	0.48	-	-	0.48	-	-	-	-	-
	Low	-	-	-	1.98	1.98	-	-	-	-	-	-	-	-	0.17	0.17
	V.L.	-	-	-	0.20	0.20	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	2.24	2.24	-	0.48	-	-	0.48	-	-	-	0.17	0.17
Aman	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	2.17	2.17	-	-	-	-	-	-	-	-	-	-
	M.L.	-	0.42	5.16	-	5.58	-	-	-	-	-	-	-	-	0.77	0.77
	Low	-	-	-	1.64	1.64	-	-	0.61	0.72	1.33	-	-	-	2.19	2.19
	V.L.	-	-	0.49	1.15	1.64	-	-	0.77	2.67	3.44	-	-	-	0.31	0.31
	Total	-	0.42	5.65	4.96	11.03	-	-	1.38	3.39	4.77	-	-	-	3.27	3.27
Total	High	-	-	1.82	-	1.82	-	-	1.15	-	1.15	-	-	-	-	-
	M.H.	-	-	0.55	2.39	2.94	-	-	1.09	-	1.09	-	-	-	0.40	0.40
	M.L.	-	0.42	11.22	0.42	12.06	-	0.48	2.79	0.66	3.93	-	-	1.01	0.77	1.78
	Low	-	-	7.08	8.77	15.85	-	-	9.25	3.81	13.06	-	0.87	-	2.36	3.23
	V.L.	0.36	-	4.86	20.29	25.51	-	-	5.56	7.89	13.45	-	-	-	8.31	8.31
	Total	0.36	0.42	25.53	31.87	58.18	-	0.48	19.84	12.36	32.68	-	0.87	1.01	11.84	13.72

(5) Kolabashukhali (KBK)

Season	Flood Depth	Impacted Area										Control Area				
		Protected Area					Unprotected Area									
		DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total	DTW	STW	LLP	Ind.	Total
Rabi/Boro	High	-	1.21	-	-	1.21	-	-	-	-	-	-	-	-	-	-
	M.H.	-	1.55	-	-	1.55	-	-	-	-	-	-	-	-	-	-
	M.L.	-	2.14	-	0.06	2.20	-	-	-	-	-	-	1.14	0.32	0.40	1.86
	Low	0.39	0.51	-	0.38	1.28	-	-	-	-	-	-	0.16	-	0.34	0.50
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.39	5.41	-	0.44	6.24	-	-	-	-	-	-	1.30	0.32	0.74	2.36
Aus	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	0.82	-	-	0.82	-	-	-	-	-	-	-	-	-	-
	M.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	0.82	-	-	0.82	-	-	-	-	-	-	-	-	-	-
Aman	High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	M.H.	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.21
	M.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Low	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-	0.21	0.21
Total	High	-	1.21	-	-	1.21	-	-	-	-	-	-	-	-	-	-
	M.H.	-	2.37	-	-	2.37	-	-	-	-	-	-	-	-	0.21	0.21
	M.L.	-	2.14	-	0.06	2.20	-	-	-	-	-	-	1.14	0.32	0.40	1.86
	Low	0.39	0.51	-	0.38	1.28	-	-	-	-	-	-	0.16	-	0.34	0.50
	V.L.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0.39	6.23	-	0.44	7.06	-	-	-	-	-	-	1.30	0.32	0.95	2.57

Irrigation Mean: DTW = Deep Tube Well, STW = Shallow Tube Well, LLP = Low Lift Pump, Ind. = Indigenous Ones

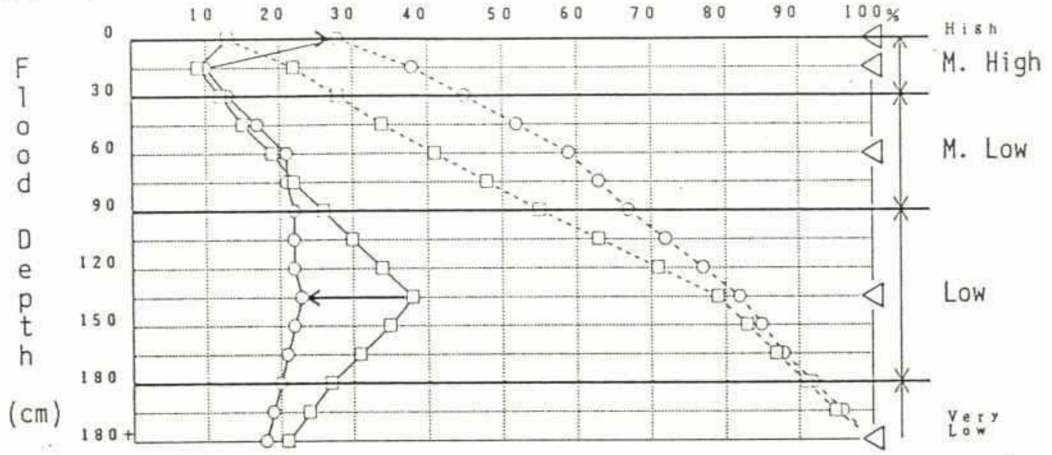
Flood Depth: High = Never flooded, M.H. = 0 - 30 cm, M.L. = 30 - 90 cm, L. = 90 - 180 cm, V.L. = over 180 cm

Source: PIE Farm Household Survey

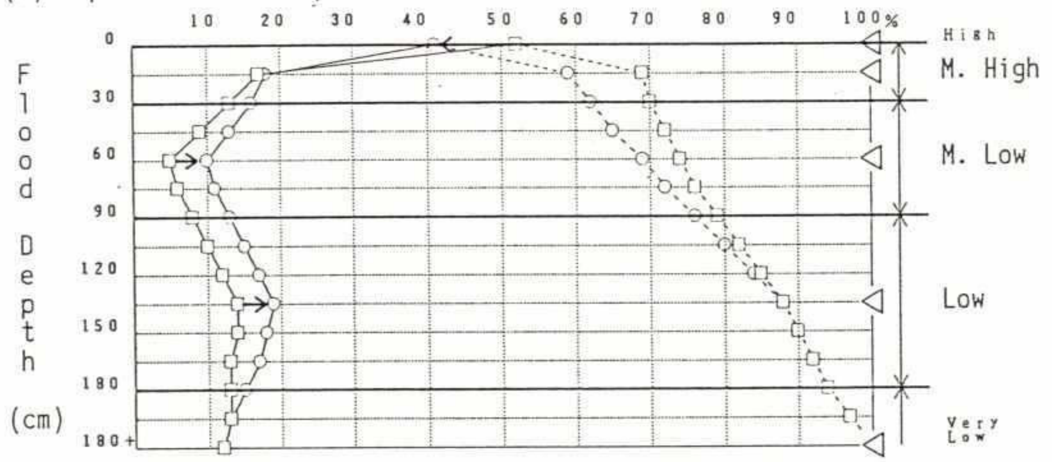
Figure G.A-1 Cultivated Land by Flood Depth

(1) Chalan Beel Polder D (CB)

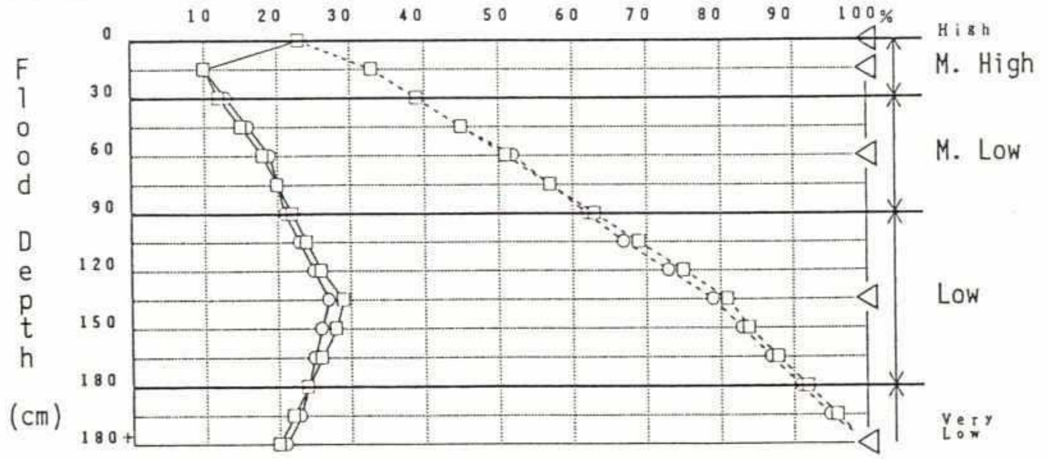
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected



(c) Control Area



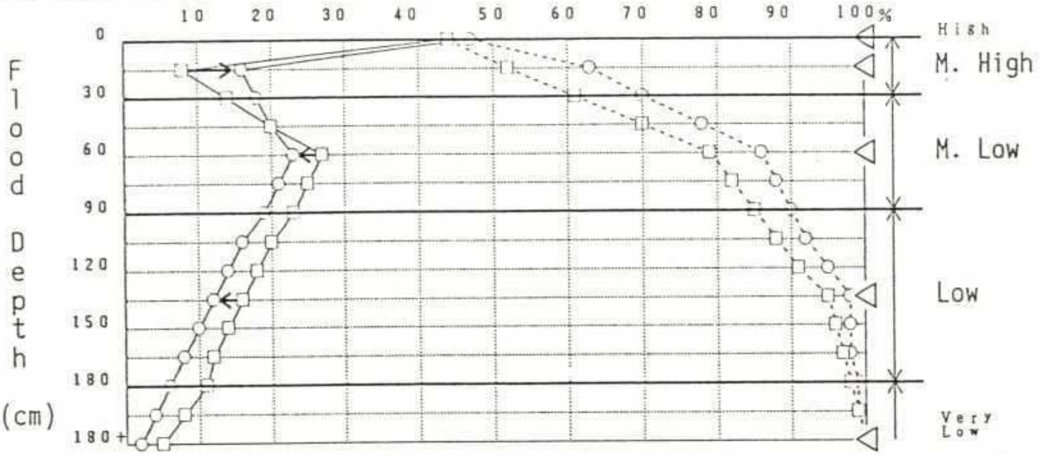
——— Actual Acreage (%) .... Cumulative Acreage (%)

□ Pre-Project, ○ Post-Project, ◁ Median of Range

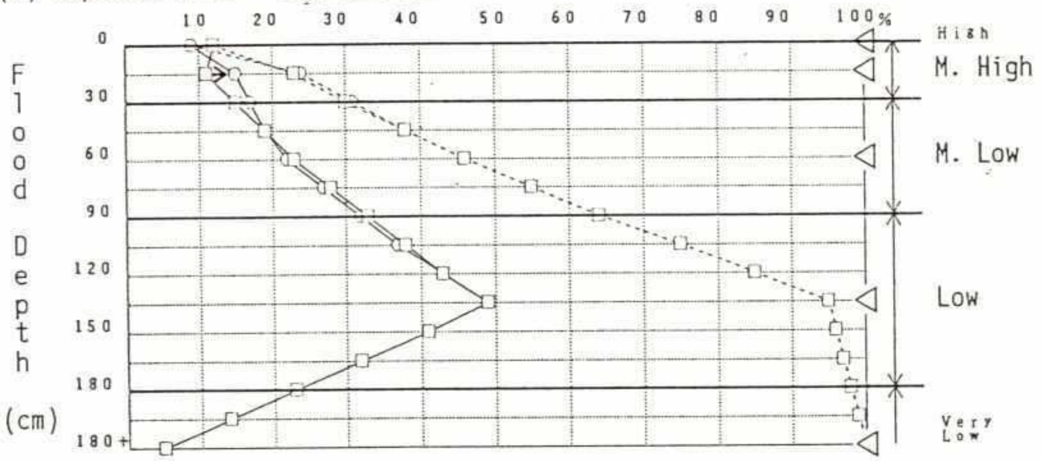
Figure G.A-1 Cultivated Land by Flood Depth (Cont'd)

(2) Kurigram South (KS)

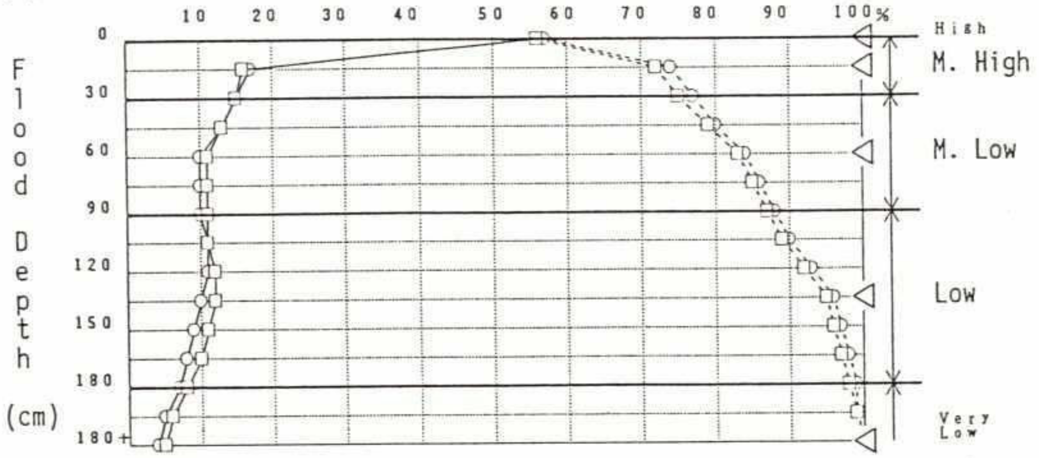
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected



(c) Control Area



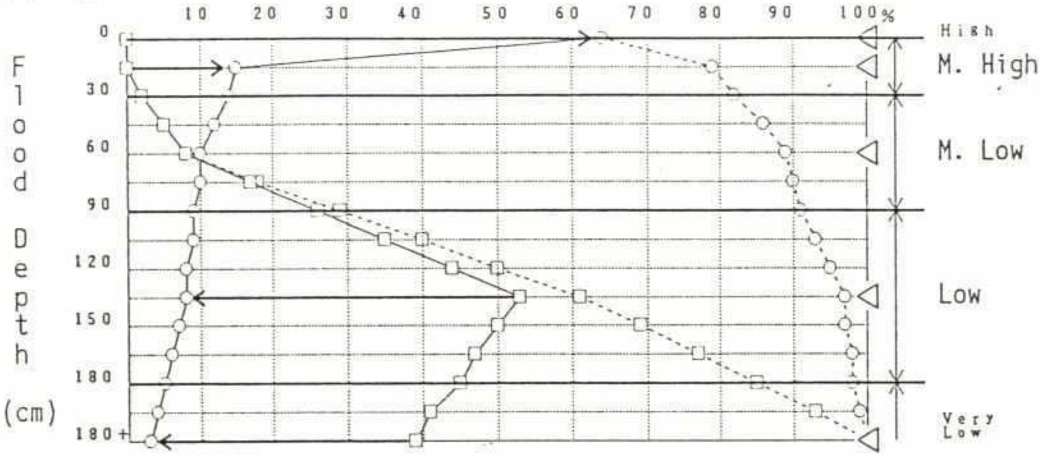
———— Actual Acreage (%) .... Cumulative Acreage (%)

□ Pre-Project, ○ Post-Project, ◁ Median of Range

Figure G.A-1 Cultivated Land by Flood Depth (Cont'd)

(3) Meghna Dhonagoda (MDIP)

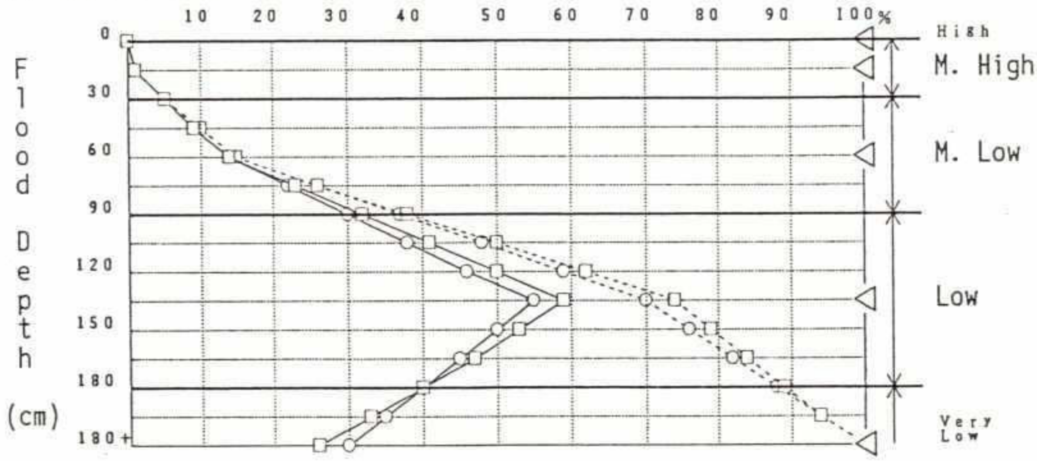
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected

(Not Applicable)

(c) Control Area



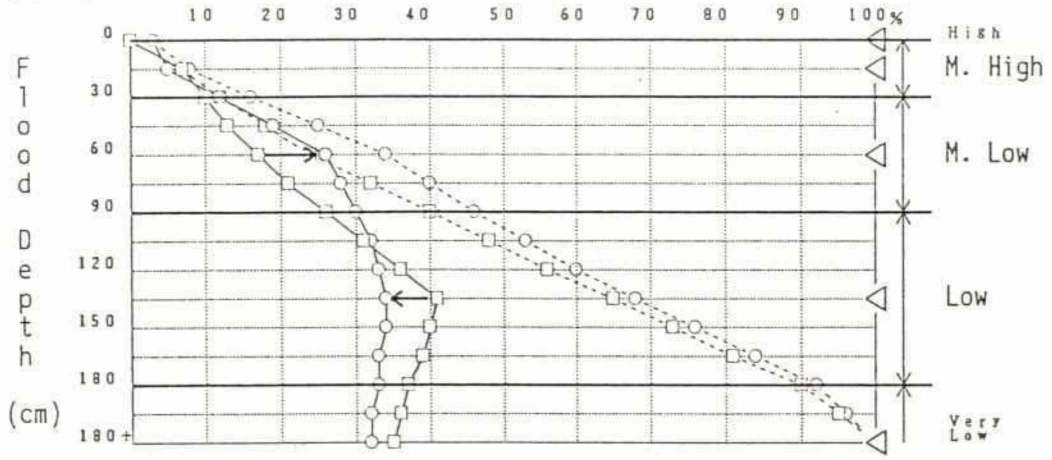
Actual Acreage (%) Cumulative Acreage (%)

□ Pre-Project, ○ Post-Project, ◁ Median of Range

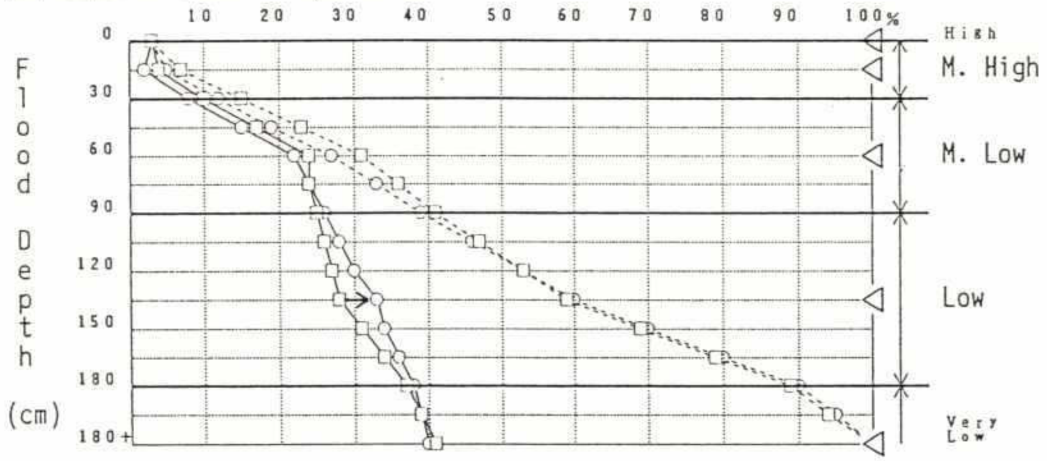
Figure G.A-1 Cultivated Land by Flood Depth (Cont'd)

(4) Zilkar Haor (ZH)

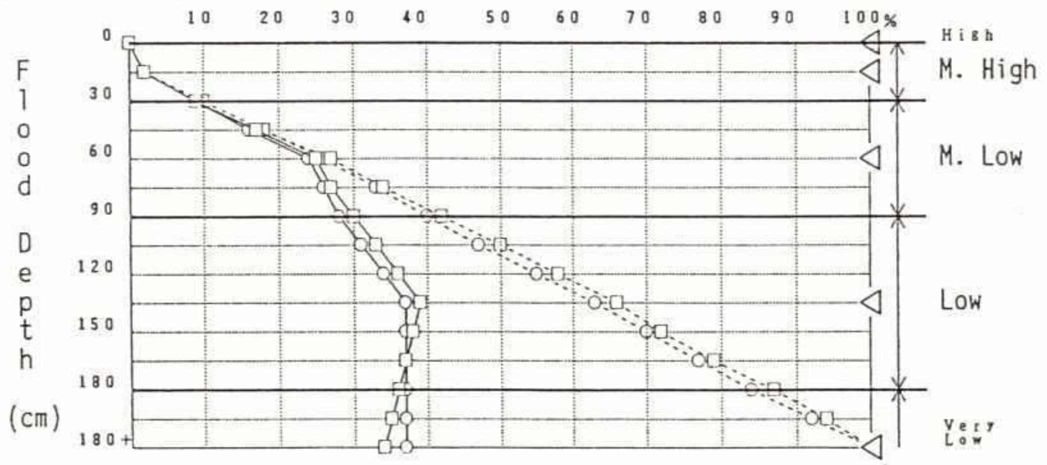
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected



(c) Control Area



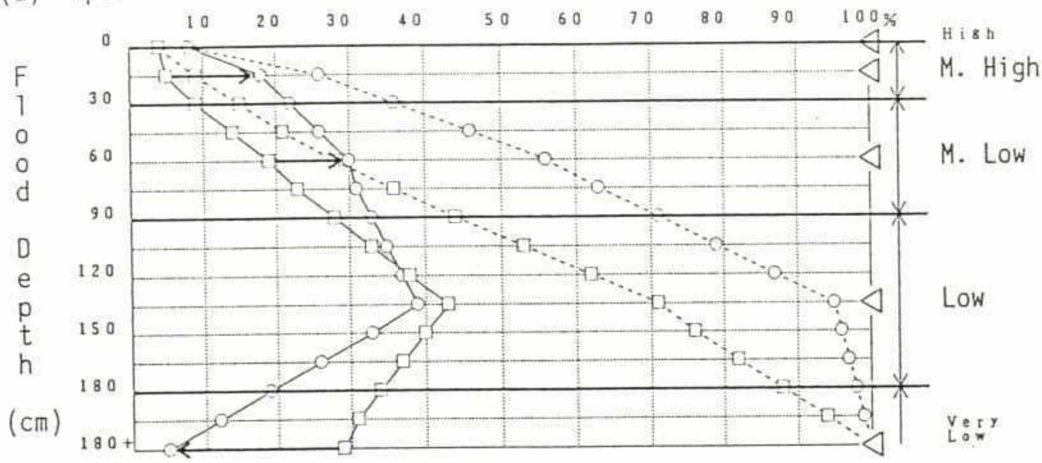
——— Actual Acreage (%) .... Cumulative Acreage (%)

□ Pre-Project, ○ Post-Project, ◁ Median of Range

Figure G.A-1 Cultivated Land by Flood Depth (Cont'd)

(5) Kolabashukhali (KBK)

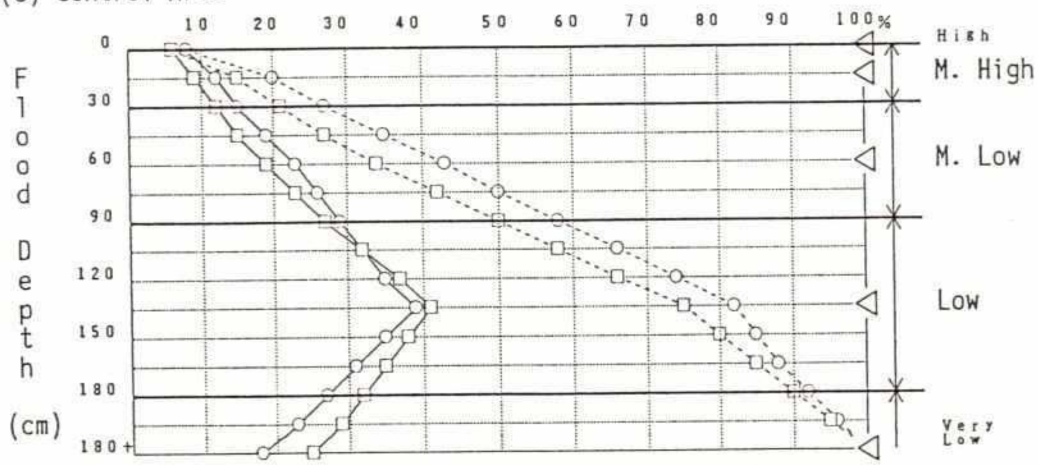
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected

(Not Applicable)

(c) Control Area



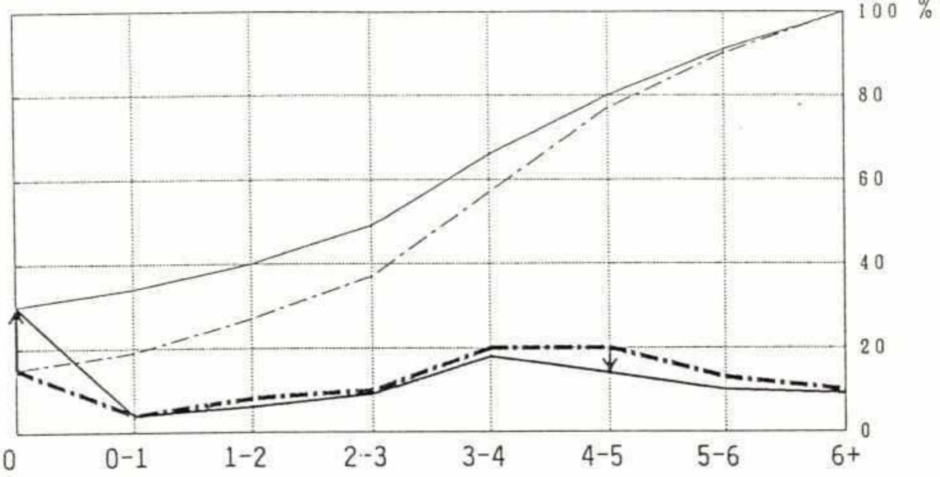
———— Actual Acreage (%) .... Cumulative Acreage (%)

□ Pre-Project, ○ Post-Project, ◁ Median of Range

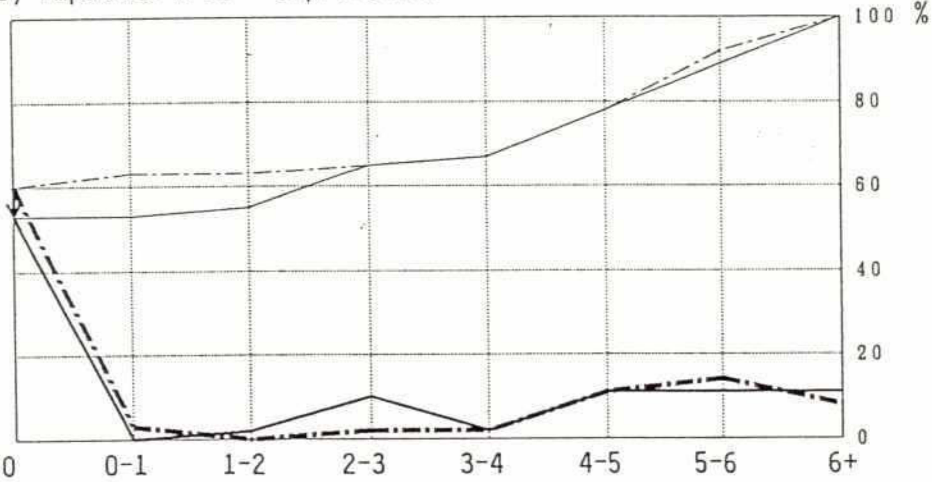
Figure G.A-2 Cultivated Land by Inundation Duration

(1) Chalan Beel Polder D (CB)

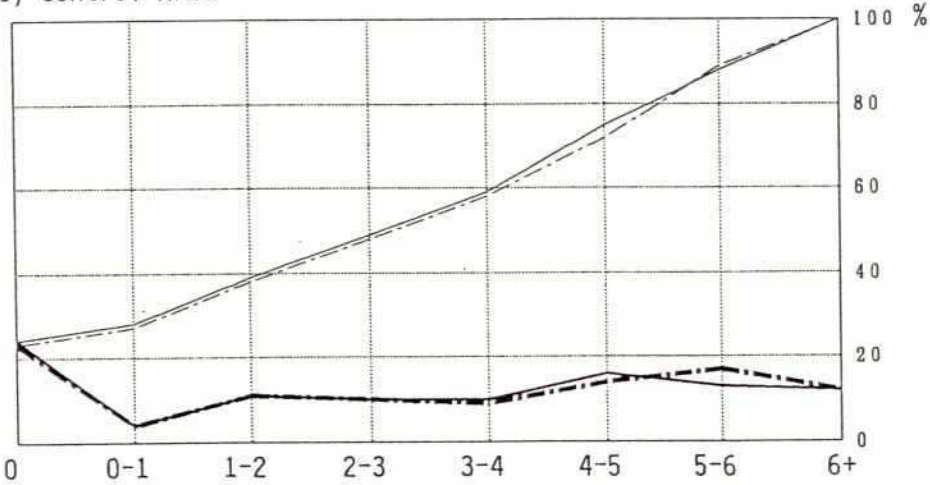
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected



(c) Control Area



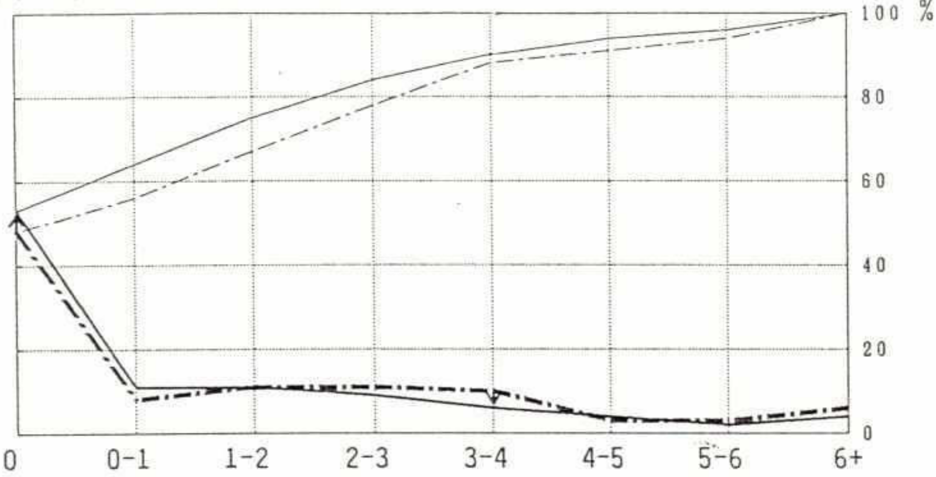
Inundation Duration (Month) →

	Pre-Project (Before)	Post-Project (Present)
Actual Acreage (%)	-·-·-·-	———
Cumulative Acreage (%)	-·-·-·-	———

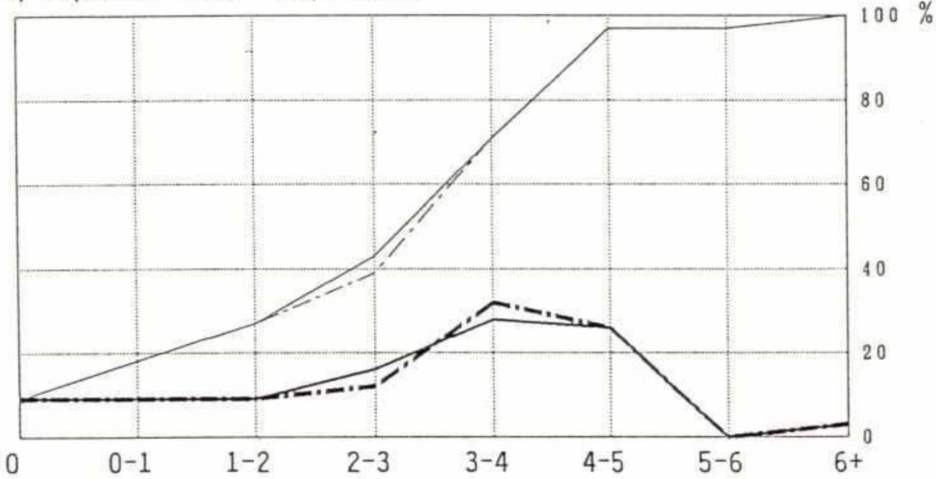
Figure G.A-2 Cultivated Land by Inundation Duration (Cont'd)

(2) Kurigram South (KS)

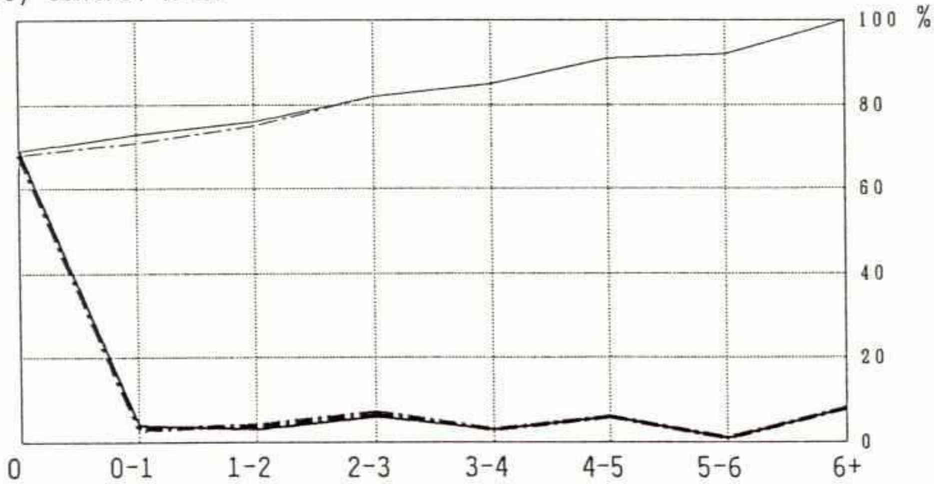
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected



(c) Control Area



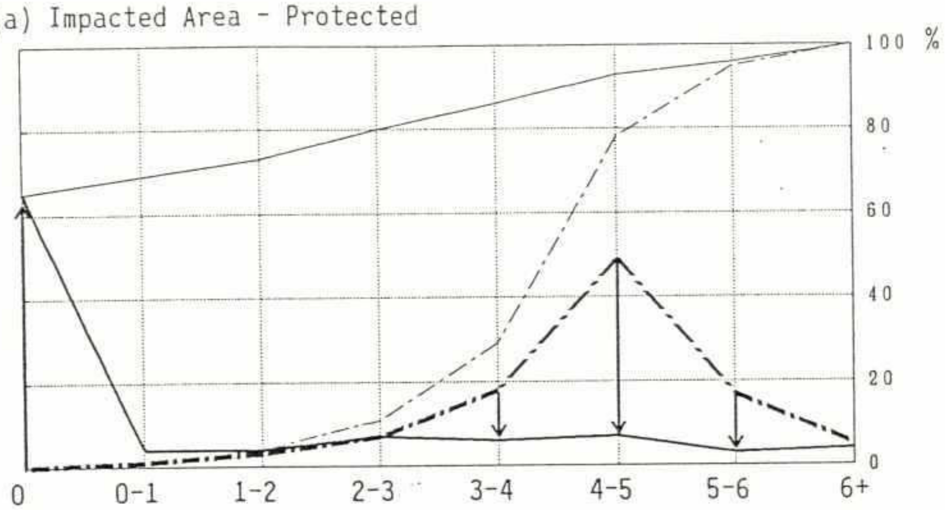
Inundation Duration (Month) →

	Pre-Project (Before)	Post-Project (Present)
Actual Acreage (%)	-·-·-·-·-	———
Cumulative Acreage (%)	-·-·-·-·-	———

Figure G.A-2 Cultivated Land by Inundation Duration (Cont'd)

(3) Meghna Dhonagoda (MDIP)

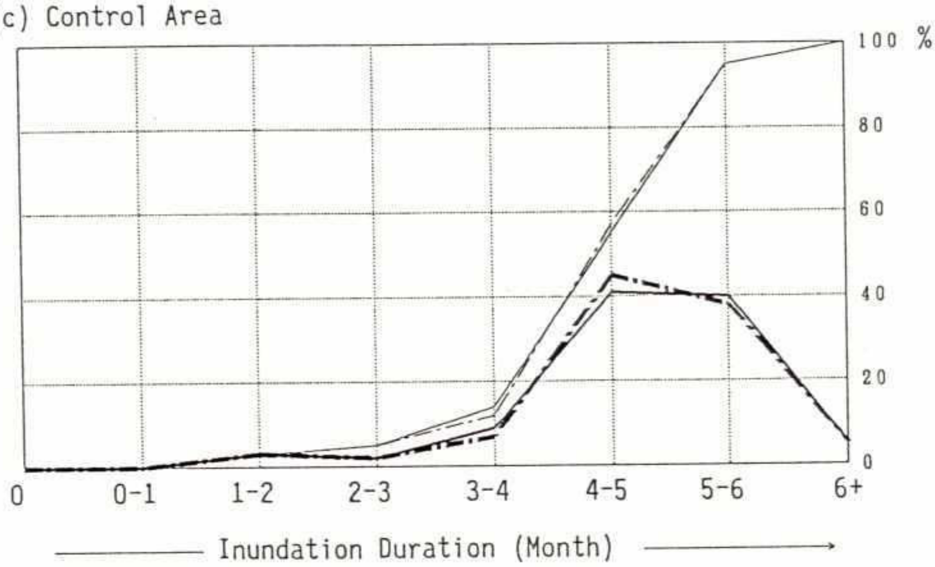
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected

(Not Applicable)

(c) Control Area

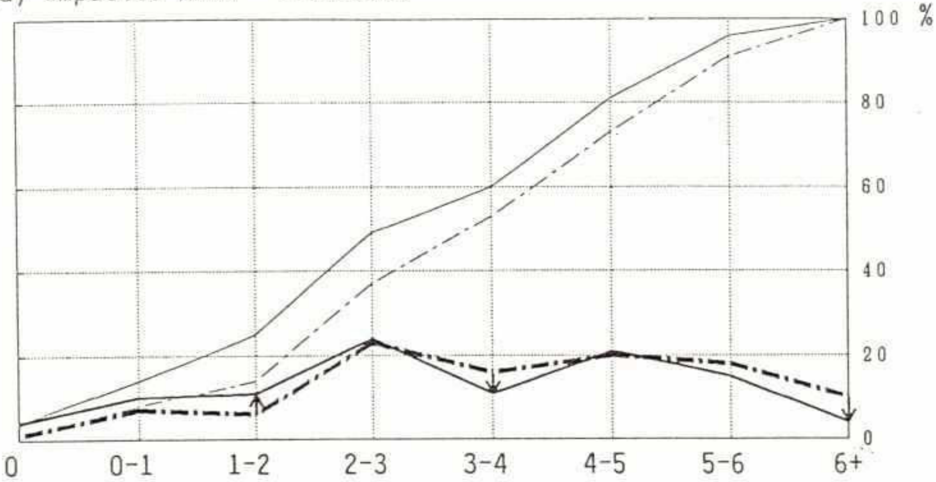


	Pre-Project (Before)	Post-Project (Present)
Actual Acreage (%)	-·-·-·-·-	————
Cumulative Acreage (%)	-·-·-·-·-	————

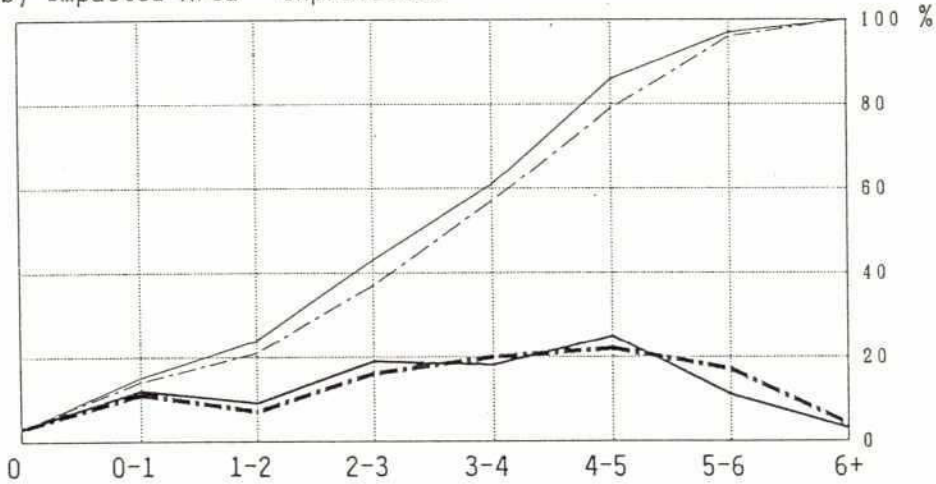
Figure G.A-2 Cultivated Land by Inundation Duration (Cont'd)

(4) Zilkar Haor (ZH)

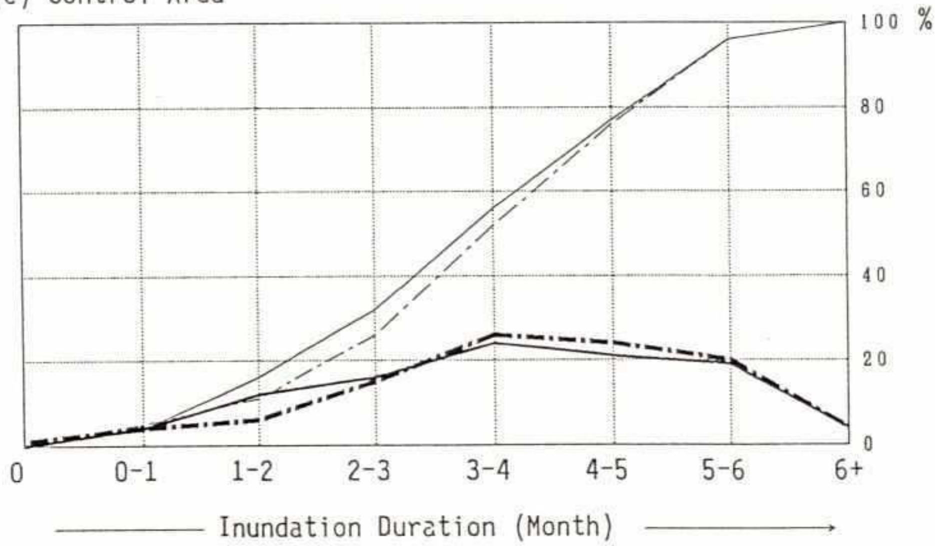
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected



(c) Control Area

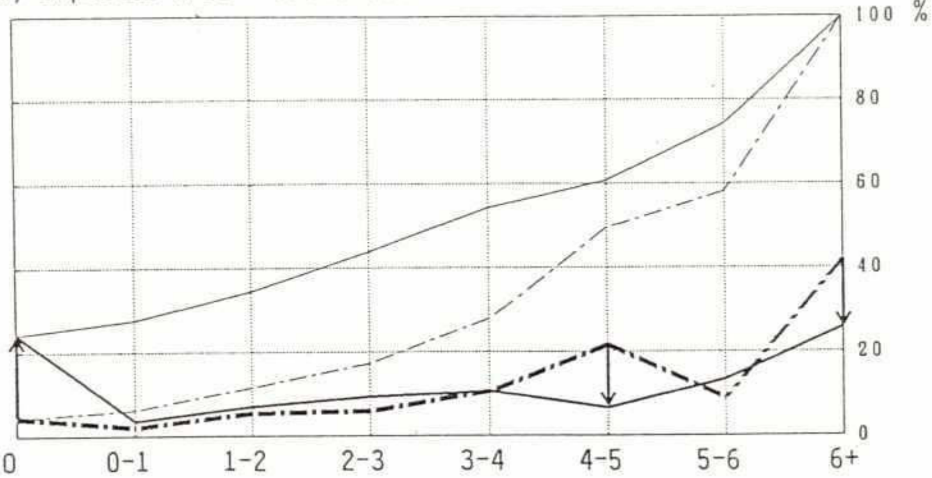


	Pre-Project (Before)	Post-Project (Present)
Actual Acreage (%)	-·-·-·-·-	————
Cumulative Acreage (%)	-·-·-·-·-	————

Figure G.A-2 Cultivated Land by Inundation Duration (Cont'd)

(5) Kolabashukhali (KBK)

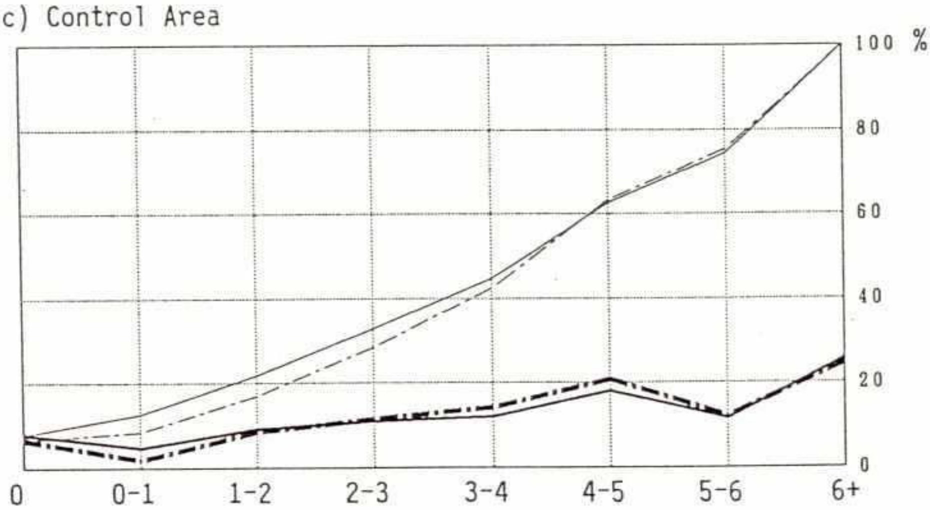
(a) Impacted Area - Protected



(b) Impacted Area - Unprotected

(Not Applicable)

(c) Control Area

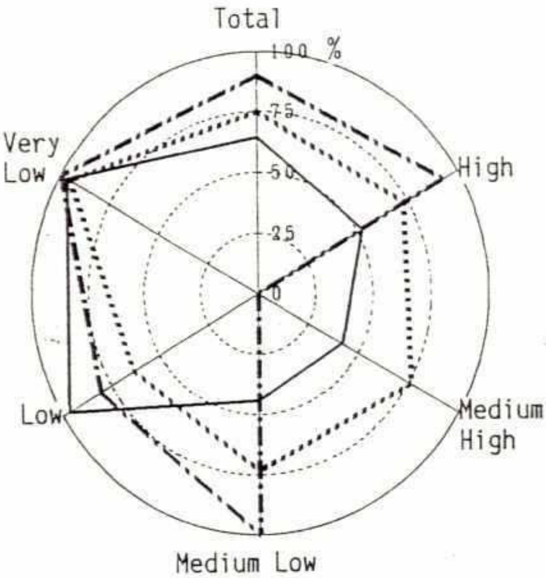


	Pre-Project (Before)	Post-Project (Present)
Actual Acreage (%)	-·-·-·-·-	———
Cumulative Acreage (%)	-·-·-·-·-	———

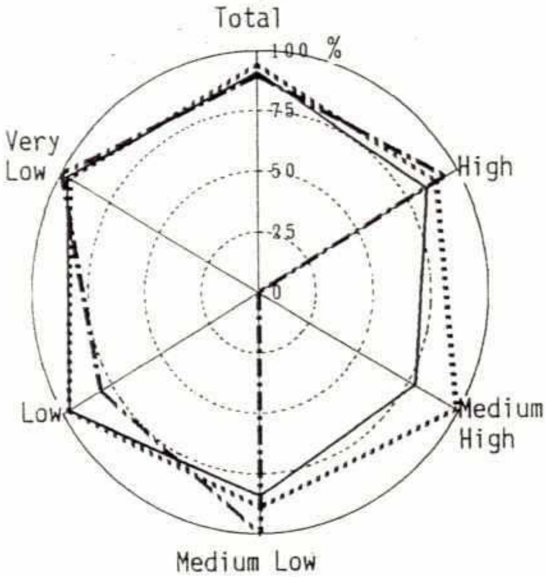
Figure G.A-3 Cropped Area under Irrigation by Flood Depth and Season

(1) Chalan Beel Polder D (CB)

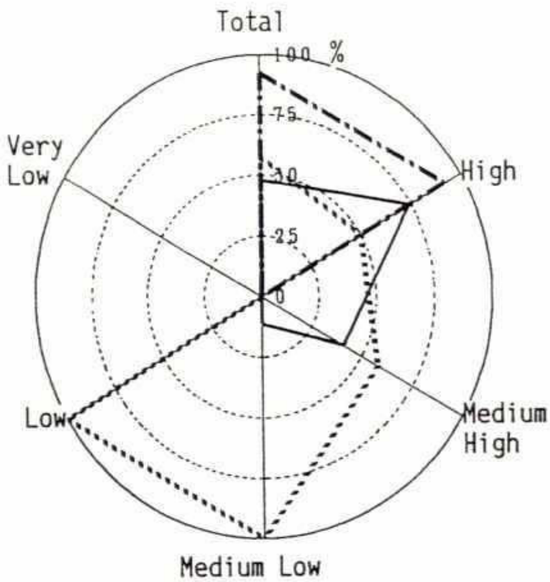
(a) Whole Season



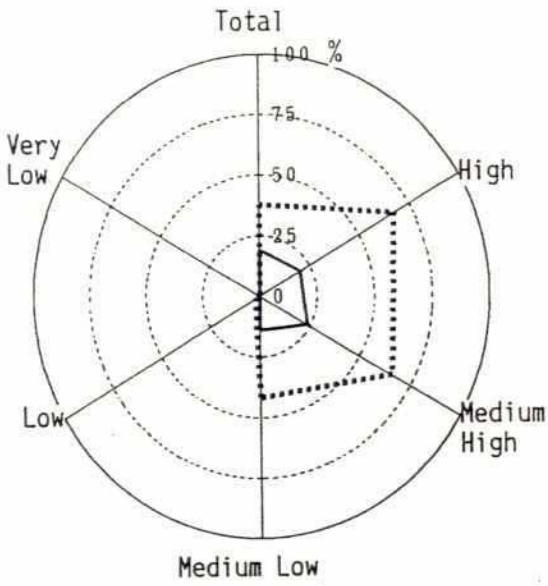
(b) Rabi/Boro Season



(c) Aus Season



(d) Aman Season

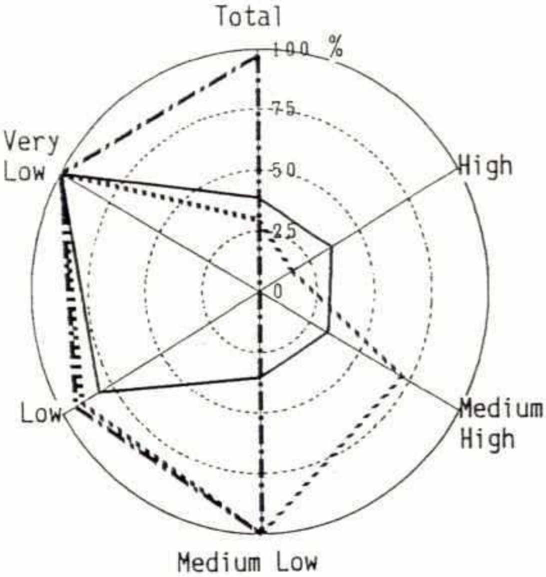


	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	88.65	53.54	5.75	29.36	————
Unprotected	5.10	4.70	0.40	-	-·-·-·-
Control	36.94	22.97	4.42	9.55	··········

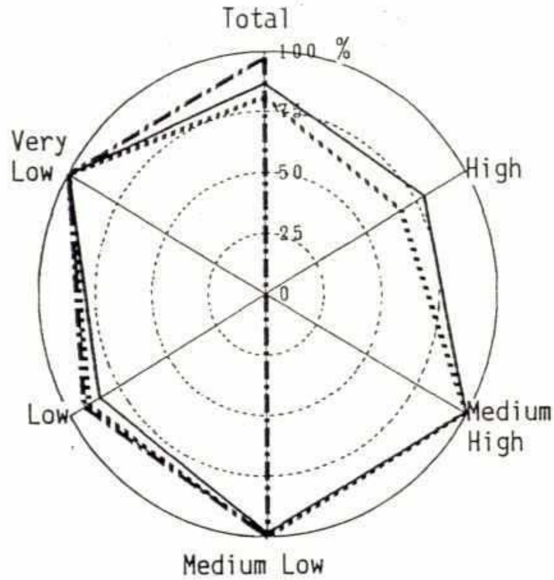
Figure G.A-3 Cropped Area under Irrigation by Flood Depth and Season (Cont'd)

(2) Kurigram South (KS)

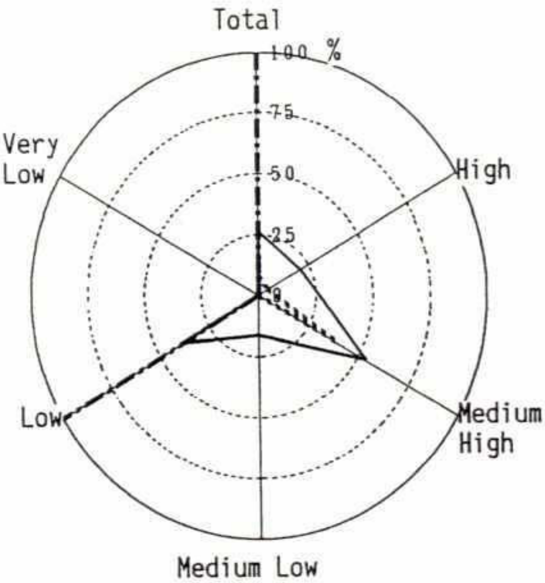
(a) Whole Season



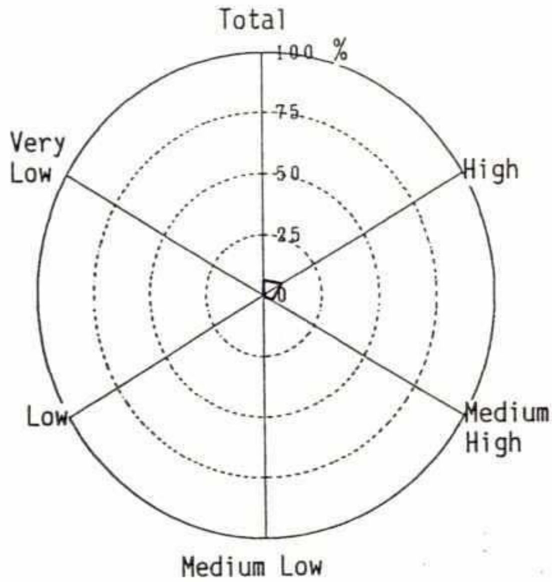
(b) Rabi/Boro Season



(c) Aus Season



(d) Aman Season

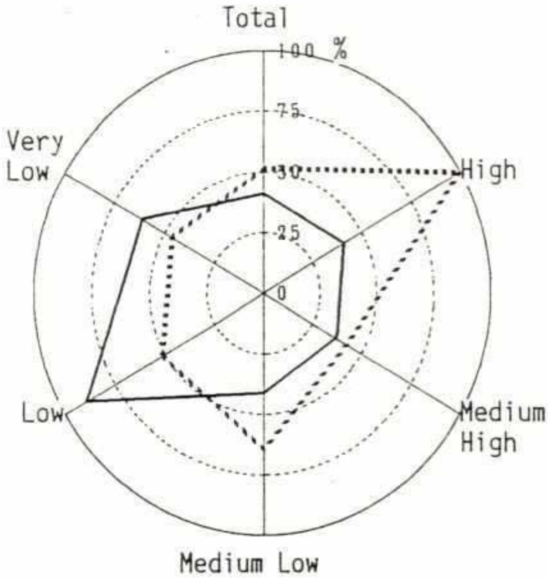


	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	97.21	36.25	11.83	49.13	———
Unprotected	2.44	2.36	0.08	-	-·-·-·-
Control	79.94	26.80	21.39	31.75	········

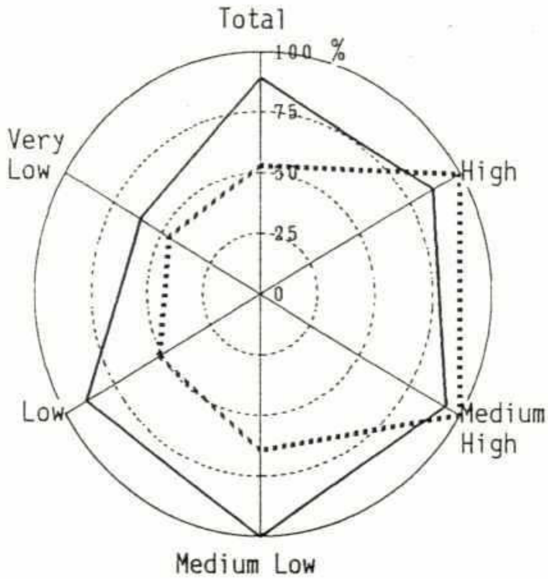
Figure G.A-3 Cropped Area under Irrigation by Flood Depth and Season (Cont'd)

(3) Meghna Dhonagoda (MDIP)

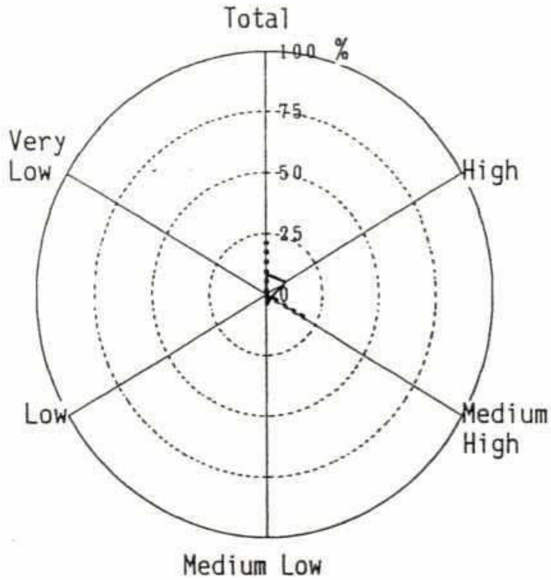
(a) Whole Season



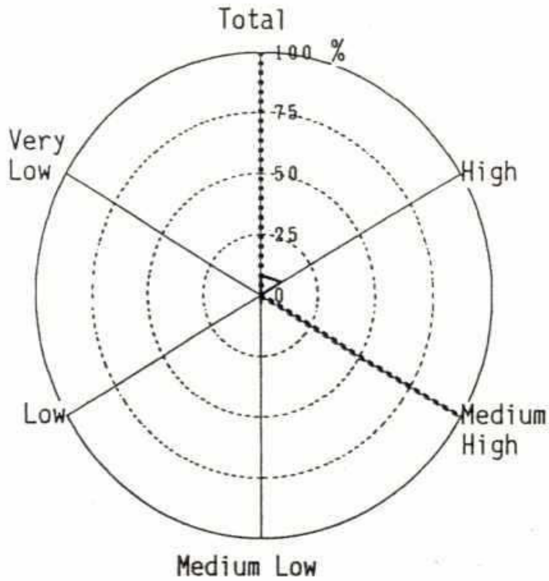
(b) Rabi/Boro Season



(c) Aus Season



(d) Aman Season

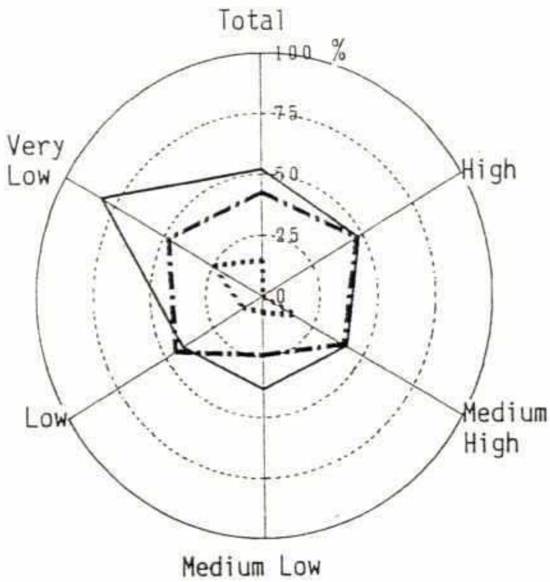


	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	104.34	42.49	21.77	40.18	————
Unprotected	n.a.	n.a.	n.a.	n.a.	
Control	12.69	11.79	0.78	0.12	········

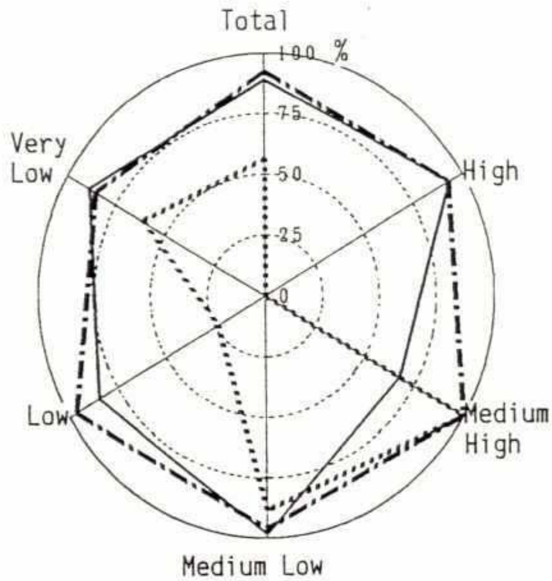
Figure G.A-3 Cropped Area under Irrigation by Flood Depth and Season (Cont'd)

(4) Zilkar Haor (ZH)

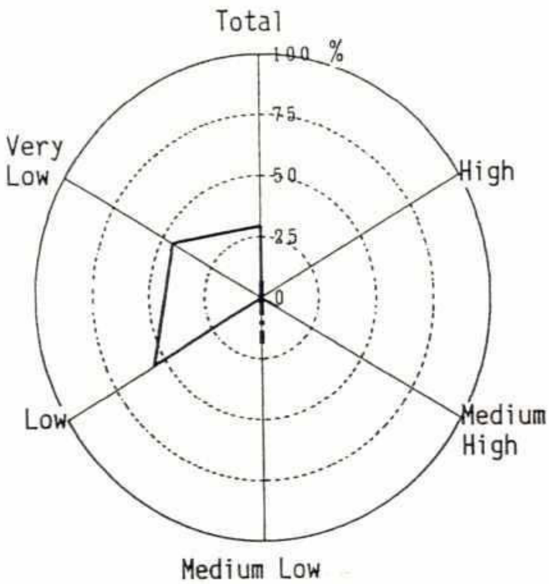
(a) Whole Season



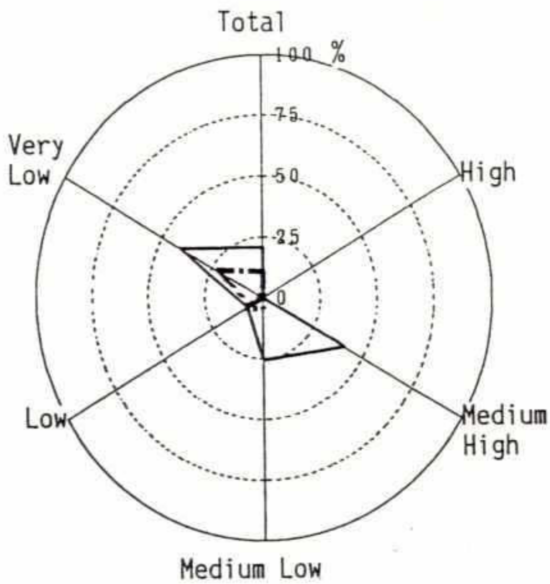
(b) Rabi/Boro Season



(c) Aus Season



(d) Aman Season



	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	111.04	50.47	7.61	52.96	————
Unprotected	76.52	29.64	7.24	39.64	-·-·-·-
Control	93.36	18.16	17.65	57.55	··········

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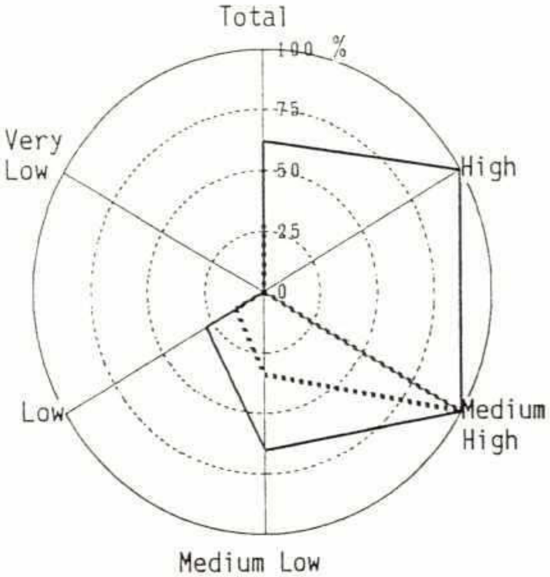
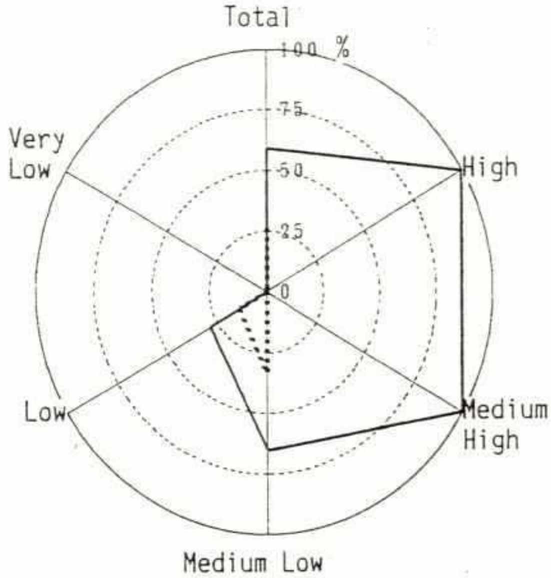
Figure G.A-3 Cropped Area under Irrigation by Flood Depth and Season (Cont'd)

(5) Kolabashukhali (KBK)

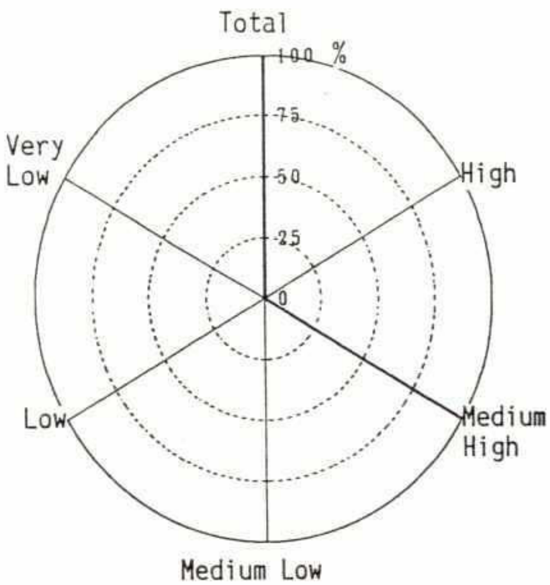
(a) Whole Season



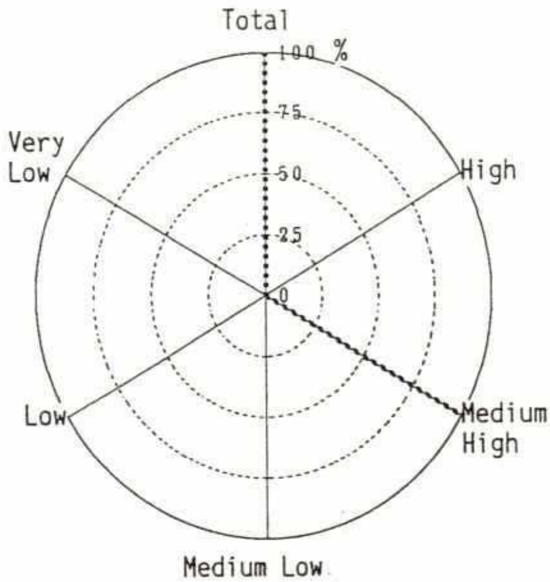
(b) Rabi/Boro Season



(c) Aus Season



(d) Aman Season



	Total Cropped Area (ha)				Legend
	Whole Sea.	Rabi/Boro	Aus	Aman	
Protected	11.34	10.52	0.82	-	————
Unprotected	n.a.	n.a.	n.a.	n.a.	
Control	9.23	9.02	-	0.21	....

APPENDIX H

AGRICULTURE

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APPENDIX H

AGRICULTURE

H1 INTRODUCTION

H1.1 Sources of Agricultural Impact

The FCD and FCD/I projects have been justified in most cases on the grounds that they will improve conditions for agriculture. More particularly, depending on the project, it is argued that:

- a reduction in normal monsoon water levels, durations, and rates of rise in water level will all encourage farmers to adopt more productive crops, basically paddy varieties, which cannot tolerate unmanaged monsoon conditions;

- damages in unusual floods will be reduced, resulting in higher average yields for a given crop;

- reduced variation in monsoon conditions resulting in protection from inundation in an area ravaged by flood previously will make the farmers less risk-averse and encourage them to adopt HYV technology, which would otherwise entail high losses in flood years because the costs of production are higher; and

- irrigation makes possible a change from low value rabi crops to more profitable and productive HYV Boro in the winter.

The eventual results of such influences will be an increase in cropping intensity, higher and more stable yields and outputs, and an expansion of cultivated area. In practice, however, many things may go wrong, and they often do.

H1.2 Limiting Factors for Agricultural Impact

In the first place, the projects may fail to achieve their flood control objectives. Embankments may simply fail or people may cut the embankment to reduce waterlogging in one place or another, inside the embankment or from the outside, causing flood water to enter the project area and thus defeat the purpose of the embankment. All these may worsen flood risk and increase crop losses. For example, in the Nagor River Project the Aman cropped area declined because the combined impact of Atrai basin FCD projects has led to regular public cuts which have worsened hydrological conditions there (RRA). In addition to Nagor River, moderate to severe public cuts and breaches were identified in 12 out of the other 16 study areas (RRA and PIE). These are Chalan Beel Polder D, Kurigram South, Meghna Dhonagoda Irrigation Project, Sakunia Beel, Silimpur-Karatia, Katakhali Khal, Halir Haor, Kahua-Muhuri, Konapara, Polder 17/2, BRE - Kamarjani and BRE - Kazipur (see Table 3.1 of FAP 12 RRA Overview).

Secondly, technical factors of a flood control project alone do not always determine the outcomes in terms of changes in agricultural activities. Economic and other factors play important roles in farmers' decision making in regard to crop choice and investment.

Thirdly, an embankment in some cases may even entail negative impacts both within and outside it. Farmers may face moisture stress on their high lands and drainage congestion in low lands. Water level in the periphery of the embankment may now become higher, hampering or even making it completely impossible to perform normal agricultural activities hitherto practised in the area.

H1.3 Evaluation Approaches

Care has been taken to note all these factors in evaluating the impacts of the present study projects, particularly during the PIEs. In the PIEs a formal sample survey investigated agriculture on the land of sample farmers during 1990-91 in the project impacted and control areas. In the RRAs group interviews with farmers were to investigate the differences between pre- and post- Project agriculture. The RRA conclusions are therefore made on the basis of farmers' assessments of trends over time, while the PIE findings are based on 'impacted' and 'control' area comparisons. Hence the findings in the two sets of projects are not necessarily comparable, although in many of the RRAs an attempt was made to estimate what would have happened without the project, or at least which differences were attributable to the project.

H1.4 Limitations on Agricultural Evaluation

It is not out of place to raise here few factors which limit the effectiveness of efforts at the evaluation of FCD/I projects. Some of these are specific to RRA, but others equally limit the more sophisticated PIE methods. These are:

- diversity of the projects in their scope and objectives is such that almost any attempt at generalisation is likely to be misleading;

- many FCD/I projects are remarkably complex in terms of their hydrological features (differing impacts on flooding in different parts of the project area for example) and it becomes extremely difficult to balance their subsequent diverse range of agricultural impacts - positive or negative, inside and outside the intended flood protected area - to arrive at an overall evaluation;

- agricultural and economic developments due to project interventions are clear in some cases, but they are unclear and debatable in others, and it is often difficult to distinguish the impacts created by other development activities in the locality, and the autonomous changes arising from trends much wider than the project, from the exclusive project impacts (especially true for RRA);

- quantification of project impacts through RRA methods in many cases is difficult; secondary data are used wherever possible, but their reliability has not been beyond question and in many cases different sources do not agree with one another; and

- the often inadequately defined project objectives, rarely quantified parameters (e.g. reduced flood frequency, depth, duration, locations and timing) and vaguely specified agricultural objectives - all make it almost impossible to compare actual and planned impacts of the projects.

These limitations are nevertheless minimized by a thorough examination of the control areas outside but sharing similar conditions with the project areas, apart from the project intervention itself. During the PIE studies the same structured questionnaire was conducted both in the impacted and the control areas. Comparisons thus between the two areas definitely improve the reliability of "with and without project" assessments.

H2 CROPPED AREAS, CROPPING PATTERN AND CROPPING INTENSITY

H2.1 Crop Areas

There are two ways in which FCD/I projects might change cropped areas: by bringing previously uncultivated areas under cultivation (impact on net cultivated area), and/or by changing the seasons in which land is cultivated (impact on gross cropped area and cropping intensity).

In relatively few project areas has there been an increase in net cultivated area since most potentially cultivable land in the projects was already cultivated in at least one season before FCD/I was provided. However, in several the area of excess monsoon water, in the form of near permanent 'beels', has been reduced for long enough to permit a crop for the first time (effectively land reclamation). In Kolabashukhali 2000-5000 ha. of the beels are now dry enough in time to prepare land for a B Aus + Aman crop following the reduction in monsoon water levels. In the submersible embankment projects (Halir Haor and Zilkar Haor) improved drainage and the embankment have permitted small areas of beel fringes to be cultivated. There has also been conversion of beel fringes to cultivation, usually for Boro, in some other projects. For example, in Sakunia Beel and Sonamukhi-Banmander this was judged to have been facilitated by the Project.

More generally, FCD/I projects have changed the incidence of seasonal cropping. However, no common trend is discernible. This is understandable as each of the project areas is unique in its own characteristics and sphere. In general, however, the least benefited season is the early monsoon (Kharif - 1 or Aus and Jute). This is mostly because the expansion of irrigation, project or non-project, has replaced these crops with more profitable HYV Boro which overlaps the traditional early monsoon growing season. Had there not been irrigation, flood protection might have benefited these crops. The exceptions are Polder 17/2, where irrigation is only just being introduced and jute expanded as salinity fell (see RRA Report on Polder 17/2), and MDIP, where there has been a major expansion of Aus (T HYV Aus mostly) as a single crop, rather than as mixed Aus + Aman, as farmers exploit the opportunities of free irrigation water and pumped drainage to the full (see PIE Report on Meghna-Dhonagoda). An interesting agronomic development in MDIP is the introduction of **broadcast** HYV Aus on farmers' own initiative. Such cropping systems are known from Thailand, where they are a response to labour shortage, but the cause in MDIP is probably shortage of seedbed areas due to the high intensity of HYV Boro cultivation. Broadcasting would also reduce labour costs, but this is not likely to be a major factor, given the high returns from HYV paddy. In the Meghna-Dhonagoda impacted area farmers cultivate land 3 times (204 percentage points) more than their counterparts in the control area in the same season (Table H.1). The extended cultivated lands are mostly of low and medium low land classes.

There have been few if any increases in the Aman season cropping intensity. In 13 out of the 17 (RRA and PIE) study areas land under Aman cultivation has effectively remained the same compared either with the pre-project situation (RRA) or with the control areas (PIE). Out of the remaining 3, in one (Polder 17/2) it has increased while in the other 2 (Nagor River and Zilkar Haor) it has gone down, though for differing for reasons. In the final case, at Kolabashukhali, there has been a substantial increase in cropped area in the Aman season, though this strictly constitutes land reclamation rather than a gain in intensity, since the areas gained were uncultivable khas land before the project.

In Kolabashukhali there has been a considerable increase in the cultivation of mixed Aus+Aman in the medium low to low land classes due to the project. This is because, on the one hand, the project has permitted, as mentioned earlier, the reclamation of between 2000-5000 hectares of beel lands which are now fit for cultivation of these crops, while on the other hand, the embankment and sluices have lessened the threat of flood damages. T. Aman (both LV and HYV) cultivation on a considerable amount of land in Kolabashukhali (about 21 per cent of cultivated land in the impacted area against only 4 per cent in the control) has also been made possible due to the prevention of saline water intrusion. This is further facilitated by the fact that rainwater washes away the residual soil salinity and is allowed to drain out through the regulators.

In the coastal areas (e.g. Polder 17/2) a distinct form of Aman cultivation has now developed. After the harvest of shrimp from the 'ghers', the land is flushed with rain water and T. Aman is planted. The shrimp cultivation allows direct transplanting of paddy as the soil remains very soft and in a puddled condition, which requires almost no or very little land preparation. Further, the use of various shrimp foods, particularly urea, makes it possible to keep the level of application of other inputs to the Aman at a very low level. The cost of production as a result is kept at a minimum. Thus, while saline water is allowed into the 'ghers' (even through public cuts) for facilitating shrimp cultivation, which in turn reduces crop yields, the net return of T. Aman due to lower costs in the area becomes positive. Although it is remote from the project's original objectives, the newly evolved 'shrimp-Aman' cropping pattern has to be seen as a reaction to the FCD project (RRA Report).

In contrast to Kolabashukhali and Polder 17/2, in Nagor River the Aman cropped area has actually fallen. Compared to the pre-project situation it has been estimated to have gone down by 22 per cent in the Project area (Table H.9). This has happened because the combined impact of the Atrai basin FCD projects has led to regular public cuts by disbenefited 'outsiders' which have worsened hydrological conditions in the monsoon there.

The reason for reduced use of land for monsoon crops in the Zilkar Haor Project area, compared with the control, is completely different from that in the Nagor River area. In the Zilkar Haor project area the lesser use of land for monsoon crops - Aus in particular - is because the farmers in the project impacted area now lay more importance on Boro cultivation which overlaps the traditional early monsoon growing season. This reflects the success of the Zilkar Haor submersible embankment which was built basically to protect the Boro crops from early flash floods (Table H.1).

Whilst expansion of Boro does not always imply an increase in winter cropping intensity, this has often been the case. In all the study areas where change in cultivated area has taken place, land under Boro crops has increased, ranging from only 8 percentage points in Kurigram to as high as 126 percentage points in Zilkar Haor (Table H.1), and 74 per cent in Kahua Muhuri (Table H.9). One project which has had little impact on Boro is Kolabashukhali, where conditions are generally unsuitable for irrigation, and there are successful traditional systems for managing the small irrigated areas actually present.

Although Boro is the most important crop in Chalan Beel, the control area cultivates more Boro than the impacted area (See Table H.1) presumably because of greater groundwater irrigation facilities available there.

Care is required, however, to avoid falsely linking project impacts and changes in Boro cultivation (this relates to cropping choices as much as to cropped areas). FAP 12 has in all cases critically examined the linkages between project interventions and benefits from Boro and in several cases (e.g. KBK, Katakhali Khal, Sakunia Beel) has excluded Boro benefits fully or partly, since some or all of the growth in small scale irrigation would have happened anyway and the projects do not protect from early floods. However, FAP 12 found three ways in which FCD/I projects did expand the Boro/rabi area:

- by providing protection against early flooding which damages Boro at harvesting time (e.g. Zilkar Haor, Halir Haor); this produces a small impact on area in Haor areas since Boro was already widespread, but a greater area impact in some beel areas depending on relative time of flooding and harvest in a given area;

- by protecting from saline flooding, enabling rabi crops and Boro to be grown, the latter depending on irrigation availability (e.g. Polder 17/2); and

- by providing or facilitating the provision of irrigation water for HYV Boro (e.g. MDIP, Kahua-Muhuri).

Even though in the case of projects with provision of irrigation facilities there is a clear ex post linkage with increased Boro area, it is necessary to assess whether irrigation could have been supplied by minor irrigation techniques not included in an FCD/I project.

Table H.1 Cropped Areas: Percentages of Cultivable Land by Level

Project	Study Area	Aus Season				Aman Season				Rabi/Boro Season			
		H	M	L	All levels	H	M	L	All levels	H	M	L	All levels
Chalan Beel	Impacted	30.41	22.93	6.81	19.10	63.17	73.46	28.73	50.29	39.13	44.03	74.30	54.69
	Control	49.15	44.93	4.56	26.67	53.33	32.22	38.39	46.72	65.27	48.11	78.73	68.55
Kurigram	Impacted	61.58	44.20	51.33	56.12	82.68	92.45	55.03	81.34	52.68	47.00	60.27	52.33
	Control	49.30	24.24	33.36	44.25	90.82	78.92	39.87	81.72	43.07	66.11	61.41	48.28
Meghna-Dhonagoda	Impacted	64.11	64.36	41.11	61.63	78.84	87.25	48.36	76.37	75.43	65.90	42.25	70.84
	Control	58.33	15.64	20.42	20.29	33.33	66.48	81.21	78.58	58.33	69.27	68.61	68.56
Zilkar Haor	Impacted	9.44	11.59	6.23	7.90	86.02	84.33	37.70	53.95	35.60	25.73	63.67	51.65
	Control	54.07	54.87	10.56	22.09	57.58	77.69	70.59	72.01	23.25	5.97	28.12	22.72
Kolabashukhali	Impacted	43.56	62.94	52.44	53.25	93.09	82.27	66.86	78.42	31.20	21.28	10.87	19.36
	Control	67.11	40.91	27.89	44.72	80.00	70.79	57.19	64.82	83.87	50.83	23.86	41.88

Source: FAP 12 PIE Surveys

Note: H = High Land (flooding upto 1'), M = Medium Land (flooding 1'-3') L = Low Land (flooding 3'+)

H2.2 Cropping Pattern

Overall, FCD/I Projects have strengthened the dominance of paddy in cropping patterns, particularly to the extent that they have promoted Boro at the expense of rabi and jute crops (e.g. Chalan Beel and MDIP), and the perennial sugarcane in some places (e.g. Kolabashukhali). To some extent Aus has been replaced by more productive HYV Boro (e.g. Zilkar Haor). Meghna-Dhonagoda is an exception where ample irrigation has made it possible to fit both crops into some areas, although this may be only a transitional phase. The dominance of paddy is however, more prominent in relatively more successful projects. The examples are Kolabashukhali and Meghna-Dhonagoda where 89 per cent and 90 per cent of their respective gross cropped land are cultivated for paddy against 63 per cent and 67 per cent of their respective control areas (see Table H.2). The trend is true for almost all the study areas including the RRA areas.

The main impact of FCD is in inducing changes within the monsoon cropping pattern, in particular from broadcast to transplanted varieties and from local to HYV varieties. Varietal change, major or minor within the paddy cropping patterns took place in all the 17 study areas after the implementation of the FCD or FCD/I projects. In BRE Kazipur, Sonamukhi-Banmander, Chalan Beel, Kurigram South and Zilkar Haor there was a major shift from local B. Aman to local T. Aman; and in Protappur, Polder 17/2 and Katakhali Khal a similar shift from local T. Aman to HYV Aman took place presumably because the embankments now ensure a safer harvest of these costlier but better yielding varieties. For the same reason the farmers have replaced B. Aus and B. Aus+Aman mixed by local T. Aman and HYV T. Aman in BRE Kamarjani, B. Aman and B. Aus+Aman mixed by local T. Aman and Boro in Kahua-Muhuri and Sakunia Beel, and Aus by Boro (both LV and HYV) in Sonamukhi-Banmander and Zilkar Haor. All these are direct reflections of a reduction in normal monsoon water levels and in the risk of higher flood levels due to the projects.

FCD projects with an irrigation component seem to have strengthened further the dominance of HYVs even within the newly evolved paddy cropping patterns in every season - monsoon or Boro. The outstanding example is Meghna-Dhonagoda, but the same feature is noted at Protappur. In MDIP the availability of ample irrigation facilities, effectively with no cost, in a large part of the area, and reduction in flood losses due to the Polder, have promoted significantly the cultivation of T. HYV Aus (also B. HYV Aus although to a lesser degree), T. HYV Aman and HYV Boro in the project impacted area. Aus crops - broadcast or transplanted, local or HYV - are basically new introductions in the area, presumably because of the project. These crops are almost non-existent in the control area and also appear to have been little cultivated in the Project area before Project construction (CIRDAP 1987). Farmers have now started producing these high yielding crops instead of the previously practised low-cost B. Aus+Aman mixed crop cultivation. Jute to some extent has also been displaced. Among the Aman crops T HYV Aman has been the most important crop in the impacted area while local B. Aman is prominent in the control area (see Table H.2). All these findings suggest that the prevailing more stable crop environment now encourages farmers to grow a variety, the production cost of which is higher, because it brings higher yield and higher returns.

Against these positive impacts of the FCD and FCD/I projects on cropping patterns, the negative impacts are however to be sought in the displaced crops and their net returns. From the above it is clear that in most cases the traditional local varieties (mostly the broadcast ones) within the paddy crop sector have been withdrawn because their yields and profitability are inferior. Among the non-paddy cash/grain crops the most disadvantaged are jute (MDIP and KBK), sugarcane (KBK), wheat (Chalan Beel, Kurigram and MDIP), potato (MDIP), and a few rabi crops such as pulses (Chalan Beel), and spices (Chalan Beel, Kurigram and MDIP). Although the new HYV paddy varieties are clearly more profitable than the displaced crops, the nutritional impact of the cropping system changes for both humans and livestock remains to be assessed.

Table H.2 Cropping Patterns
(% of Gross Cropped Land)

Crops	Chalan Beel		Kurigram		Meghna-Dhonagoda		Zilkar Haor		Kolabashukhali	
	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control	Impacted	Control
B. Aus LV	6.92	5.17	11.49	12.34	3.40	0.79	1.71	16.81	4.40	5.51
B. Aus HYV	-	-	-	-	5.64	-	-	-	-	-
T. Aus LV	0.95	0.61	0.42	0.37	0.65	-	3.16	1.74	1.34	0.14
T. Aus HYV	1.85	3.52	2.98	1.33	16.17	-	1.97	0.36	1.04	-
Jute	3.09	3.54	13.58	11.35	1.86	4.23	-	-	0.28	1.65
B. Aus/Aman mixed	-	2.12	0.68	-	3.82	14.23	-	-	51.70	22.80
B. Aman LV	15.39	14.25	0.33	1.78	0.85	35.71	4.36	32.13	10.58	19.02
T. Aman LV	21.06	4.89	35.80	42.64	2.70	1.82	41.96	29.51	10.20	2.14
T. Aman HYV	2.29	9.88	5.82	2.47	29.65	2.29	1.32	-	3.66	0.79
Boro LV	2.70	1.52	0.38	1.35	0.19	-	26.56	18.07	2.64	10.35
Boro HYV	30.16	29.32	19.34	16.62	27.04	11.90	18.83	1.38	3.11	2.04
Wheat	4.19	9.63	2.62	4.16	0.96	9.78	-	-	0.15	0.43
Potato	1.72	1.02	2.75	0.79	0.22	6.63	-	-	-	-
Sugarcane	0.15	0.36	1.50	-	1.06	-	-	-	5.22	29.18
Betel Leaf	5.34	6.80	0.09	-	-	-	-	-	-	0.84
Other Minor Crops	4.19	7.37	2.22	4.80	5.79	12.64	0.13	-	5.68	5.11
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Gross cropped area (ha.)	124.70	49.28	140.32	122.85	134.60	44.47	111.19	93.36	185.47	96.84
% under paddy	81.32	71.28	77.24	78.90	90.11	66.74	99.87	100.00	88.67	62.79

Source: FAP 12 PIE Surveys

H2.3 Incidence of HYV Paddy

It has been argued that FCD/I projects through reduced variation in monsoon conditions and protection from flood damages will make the farmers less vulnerable to flood risks and thereby encourage them to adopt HYV technology. Extension of irrigation facilities will also replace the low production rabi crops by more profitable and productive HYV Boro in the dry season. Judged from these points of view most of the projects (10 out of 17) succeeded in achieving this target as they either strengthened or introduced new HYV cultivation in their respective areas. In four RRA areas viz. Nagor River, Halir Haor, BRE - Kazipur and Konapara such effects have been either partial or small (see Table H.9). Among the PIEs the least affected areas are Kolabashukhali and Chalan Beel. At Kolabashukhali this is because continuing problems of drainage congestion render HYV Aman cultivation insecure over large parts of the area, while at Chalan Beel frequent public cuts have the same effect. The crop most affected has been HYV Boro followed by T HYV Aman. Meghna-Dhonagoda is a unique example where HYV T and B Aus, T HYV Aman and HYV Boro together occupy more than 78 per cent of the annual gross cropped land (see Table H.3). This has been made possible by the irrigation component of the project and the provision for pumping out excess water during the monsoon.

Table H.3 Incidence of Paddy HYVs
(% of Gross Cropped Land)

Projects	Impacted				Control			
	Aus HYV	Aman HYV	Boro HYV	All HYVs	Aus HYV	Aman HYV	Boro HYV	All HYVs
Chalan Beel	1.85	2.29	30.16	34.30	3.52	9.88	29.32	42.72
Kurigram South	2.97	5.81	19.33	28.11	1.33	2.47	16.62	20.42
Meghna-Dhonagoda	21.81	29.65	27.04	78.50	0.00	2.29	11.89	14.18
Zilkar Haor	1.97	1.32	18.83	22.12	0.36	0.00	1.38	1.74
Kolabashukhali	1.04	3.66	3.11	7.81	0.00	0.78	2.04	2.82

Source: FAP 12 PIE Surveys

H2.4 Cropping Intensity

Project impacts on cropping intensity are in general modest, except where (as in MDIP) irrigation breaks a soil moisture constraint in the Boro or Aus seasons. In the case of Meghna-Dhonagoda (MDIP) the increase in paddy intensity is very large (over 60 percentage points), but this is partly offset by reduced areas of non-paddy crops, resulting in an annual intensity of 209 per cent against 167 per cent in its control area (see Table H.4). However, most FCD/I projects affect only the monsoon season, when most land would be cultivated in any case.

The general patterns across all project areas (Table H.4) are of 7 projects showing no change in cropping intensity under 'with' and 'without' project situations. These are Kolabashukhali (PIE data), Protappur, Konapara, BRE Kazipur, Kahua-Muhuri, Sakunia Beel, and Sonamukhi-Banmander (RRA assessments). Three projects (Nagor River, BRE Kamarjani and Chalan Beel D) have shown significant falls in intensity (18 - 22 per cent) due to problems of public cuts and/or breaches caused by erosion. There is a slight apparent decrease in annual cropping intensity at Zilkar Haor (-4 per cent) but this is not statistically significant; Boro cropping intensity at Zilkar Haor is much higher than in the control area (45 per cent, as against 19 per cent) due to the protection provided by the submersible embankment. Large increases in intensity have occurred at Katakhali Khal (from 47 per cent to 71 per cent in the monsoon, due to flood protection) and at MDIP (from an annual level of 189 to 209 per cent, due to provision of irrigation in the Boro and Aus seasons).

Table H.4 Cropping Intensity With and Without Project
(%)

Projects	With project	Without project/control	Difference
PIE Data			
Chalan Beel Polder D	124	142	-18
Kurigram South	190	174	+16
Meghna-Dhonagoda	209	167	+42
Zilkar Haor	113	117	-4
Kolabashukhali	150	150	No change
RRA Data			
Protappur Irrigation Project	NA	NA	No change
Nagor River	NA	NA	-ve; in monsoon
Halir Haor	93	86	+7
Konapara	NA	NA	No change
BRE Kamarjani	58	79	-21 (monsoon)
BRE Kazipur	NA	NA	No change
Silimpur-Karatia	190	180	+10
Polder 17/2	63	66	-3 (monsoon)
Katakhali khal	71	47	+24 (monsoon)
Kahua-Muhuri	NA	NA	No change
Sakunia Beel	NA	NA	No change
Sonamukhi-Banmander	NA	NA	No change

Source: PIE - FAP 12 PIE Surveys
RRA - FAP 12 RRA Group Discussion Estimates
Note: Figures are annual if not stated otherwise.

H.3 CROP YIELDS

Increases in average yield following flood protection arise mainly from three factors - a switch to transplanted varieties and/or HYVs, increased use of crop production inputs given lower perceived risk of crop failure, and reduced annual or periodical losses due to flood. All of these have been identified as significant during the RRAs and the PIEs. Input use, particularly the use of chemical fertilizer, has increased significantly in the case of HYV crops and Local T. Aman in all the 5 PIE areas (see sub-section H5). The case must have been similar in the RRA areas, although this could not be substantiated with solid statistical data using RRA methodology. Overall yield of paddy (the only or the most important crop for all the areas) on a weighted average basis has increased in all but one of the 17 study areas. The exception is Nagor River where monsoon crop yield recorded a fall by 0.42 mt./ha. (2.44 to 2.02 mt./ha.) due to damages caused by inflow of flood water through the severe public cuts the embankment suffered in the year of investigation.

In general the grain yield of transplanted paddy varieties (and especially the HYVs) compared to broadcast or local varieties (e.g. B. Aus vs. T. Aus, B. Aman vs. T. Aman, LT Aus vs. HYV Aus, LT Aman vs. T HYV Aman, L Boro vs. HYV Boro) is almost double or in some cases even more than double (see Table H.5). Thus, in most project areas the higher weighted mean paddy yields compared to either pre-project situations (RRAs) or control areas (PIEs) are due to farmers switching to more productive types of paddy when hydrological conditions change sufficiently to permit this (see sub-section H2.2 above).

The PIEs, do however, indicate that, in general, the yields of Aus and TL Aman paddy are higher for a given land level inside the projects compared with the control areas, which is consistent with the Projects providing greater security from fluctuations in water levels even during an approximately normal year. The examples are Zilkar Haor, Kolabashukhali, Kurigram and Meghna-Dhonagoda (see Table H.5 and for more details the respective individual PIE reports). Additionally, in Kolabashukhali B. Aman yields are better inside the Project (where they are protected from tidal fluctuations in water level). In Meghna-Dhonagoda HYV Aman yields are 1.66 times higher than in the control area, reflecting the benefits of controlled drainage. In Zilkar Haor in a year with some flood damages (1990-91) paddy yields were higher in the Project reflecting its effectiveness in a flood.

To sum up, the majority of projects have raised total paddy yields, the average gain over all varieties and seasons ranging from 0.35 mt./ha. in Kolabashukhali to 1.04 mt./ha. in Zilkar Haor and 1.85 mt./ha. in MDIP. The exceptions are the poorly planned Chalan Beel Polder D, where there is negligible yield difference (+0.19 mt./ha.) between the impacted and control areas, and the even more ill-conceived Nagor River Project, where the RRA concluded that yields had actually fallen due to deterioration of the hydrological regime.

Table H.5 Yield of Paddy Crops from the PIE Surveys
(mt./ha.)

Projects	Area	B. Aus LV	B. Aus HYV	T. Aus LV	T. Aus HYV	B. Aus/ Aman mixed	B. Aman LV	T. Aman LV	T. Aman HYV	Boro LV	Boro HYV	All paddy crops
Chalan Beel	Impacted	1.94	-	2.74	3.47	-	1.60	2.23	3.80	1.83	4.47	2.88
	Control	1.72	-	2.30	3.05	1.68	0.92	2.04	3.11	2.48	3.69	2.69
Kurigram	Impacted	1.57	-	0.25	3.89	2.61	2.24	2.24	3.54	1.63	4.28	2.84
	Control	1.28	-	5.03	4.04	-	2.61	1.95	3.39	2.18	3.04	2.19
Meghna-Dhonagoda	Impacted	2.08	3.59	2.99	4.22	1.71	1.87	3.31	4.66	3.15	5.04	4.37
	Control	2.04	-	-	-	1.14	2.04	1.29	2.80	-	4.47	2.52
Zilkar Haor	Impacted	1.75	-	1.41	2.90	-	0.86	1.75	2.20	1.68	3.70	2.08
	Control	1.30	-	1.71	0.94	-	0.65	1.10	-	1.15	3.43	1.04
Kolabashu-khali	Impacted	1.24	-	2.24	4.15	0.90	0.96	2.37	3.32	1.45	3.81	1.37
	Control	0.83	-	2.56	-	0.80	0.70	1.45	1.15	1.60	3.56	1.02

Source: FAP 12 PIE Surveys

Among the non-paddy crops jute still occupies a significant place in Kurigram followed by Chalan Beel and the control area of the MDIP (see Table H.2). Wheat is also an important crop in the control areas of MDIP, Chalan Beel and Kurigram while potato has some importance in MDIP control and Kurigram impacted areas. However, the relative yield rates, intra-project or inter-project (compared with the control), of these crops are more or less the same, reflecting almost no impact of the project on the yields of these crops. Sugarcane is a very important perennial crop for the Kolabashukhali control area, while in the impacted area this crop is produced only in a limited area of high to medium high lands. However, the yield difference between the impacted area and the control is enormous (16 mt./ha. in the impacted against only 6 mt./ha. in the control) as the embankment now protects this crop from saline water intrusion damage in the impacted area. However, in most cases the farmers in the Project area now have replaced this crop by more profitable paddy crops for the same reason of lessened tidal inflow of saline water (for more details see individual PIE Reports).

H.4 CROP PRODUCTION AND OUTPUT

As indicated earlier, paddy is by far the most important crop in the cropping patterns of all the study areas. Changes in output of paddy, annual or periodical, should therefore be considered as the major indicator of project impact. Under this consideration estimates have been made for output changes under 'with' and 'without' project situations through extrapolation of per hectare paddy yields in proportion to paddy cropped land benefited by the project. The more detailed PIE results are presented in Table H.6, and the RRA summary (together with PIE) in Table H.9. It can be seen from the tables that there have been increases in output ranging from a meagre 7 per cent in the case of monsoon paddy in Silimpur-Karatia (Table H.9), and 8 per cent in Chalan Beel (Table H.6) to as high as 95 per cent in Polder 17/2 (Table H.9), 93 per cent in Kolabashukhali (Table H.6), and 191 per cent in Meghna-Dhonagoda (Table H.6) in the 'with' project situation. The only exception is the ill-planned Nagor River Project area where output has fallen by 24 per cent (Table H.9). The increases in output in the other 16 areas have definitely been due to the combination of reduced flood hazards and the switch to HYVs. Of the three highest increases, in MDIP and Polder 17/2 there was substantial growth in HYV cultivation due to the projects, while in Kolabashukhali there was substantial land reclamation for cultivation, again due to the project. Overall the switch to HYVs together with the shift from broadcast to transplanted varieties (even local) has raised yields in the impacted areas (see sub-section H3 above). Output changes are also influenced by intensity changes, in the cases where these have been significant (see sub-section H2 above).

Table H.6 Paddy Output: With and Without Project Estimates
(mt.)

Projects	With Project mt.	Without Project mt.	Difference	
			mt.	%
Chalan Beel	107559	99492	8067	8.11
Kurigram	207746	150519	57227	38.02
Meghna-Dhonagoda	113109	38799	74310	191.00
Zilkar Haor	9861	5156	4705	91.26
Kolabashukhali	34255	17784	16471	92.62

Note: Estimated over total benefited paddy land in the respective Project area.

H5 CROP PRODUCTION INPUTS

As the FCD and FCD/I projects have generally succeeded in reducing crop losses due to flood, and farmers in the impacted areas have therefore to a considerable extent switched over to higher yielding crop varieties, more crop production inputs are now used. Farmers in 4 out of the 5 PIE areas have been found to have invested more in crop inputs - particularly in chemical fertilizers, pesticides and irrigation. The only exception is Chalan Beel Polder D where the farmers in the impacted area use fewer inputs compared to their counterparts in the control area due to the threat of crop losses because of drainage congestion and severe public cuts. In Meghna-Dhonagoda irrigation spending is less in the impacted area compared with the control as the majority of farmers in the impacted area get free water from the BWDB canal system, while control area farmers have to pay for DTW water. With these exceptions, investment in modern inputs is much higher in the impacted areas of the said 4 PIEs compared to their respective control areas. For example, farmers in the Zilkar Haor impacted area spend three times more on fertilizers (organic and inorganic) than the control area farmers. In the MDIP, Kolabashukhali and Kurigram impacted areas the farmers use double or more than double the amount of fertilizers used by their counterparts in their respective control areas. The trend is even higher in the case of irrigation (excluding MDIP) and pesticide use (Table H.7). One of the reasons for this increase is that the farmers in the impacted areas now give more weight to cultivation of HYVs and/or transplanted local varieties, particularly Local T. Aman and HYV Boro (see sub-sections H2 above), which use more of these inputs compared to broadcast and/or local varieties.

Nevertheless, in those cases where the same crop is produced in both the impacted and the control areas, with only a few exceptions the impacted areas use more production inputs than the control area. All these findings reflect the fact that the farmers in the impacted area face reduced risk due to the Projects' successes in reducing crop losses due to floods. It may be inferred from the PIE findings that the same trends also prevail in the RRA areas.

Table H.7 Production Input Costs from the PIE Surveys
(Tk./ha.)

Projects	Area	Inputs						
		Sees/ Seedlings	Human Labour	Animal Labour[1]	Fertilizer	Irrigation water	Pesticides and others	Total
Chalan Beel	Impacted	604	2898	1665	1349	1359	277	8152
	Control	649	2724	1439	1490	2387	351	9040
Kurigram	Impacted	629	3020	1505	1220	1418	166	7958
	Control	658	2919	1342	1068	1089	73	7149
Meghna-Dhonagoda	Impacted	732	2814	1705	2103	521	616	8491
	Control	902	3773	1257	930	803	142	7807
Zilkar Haor	Impacted	711	5428	1785	745	258	409	9336
	Control	835	4852	2119	242	22	36	8106
Kolabashukhali	Impacted	649	3145	1488	447	1037	73	6839
	Control	700	3201	1386	293	72	76	5728

Source: FAP 12 PIE Surveys

Note: [1]Includes associated human labour (e.g. ploughman)

H6 VALUE OF CROP OUTPUT AND NET RETURN

The annual aggregate net output value of crops, including the value of by-products, is much higher in the impacted areas of the 5 PIEs than in their respective control areas. Although increase in input use is expected to have a bearing upon increase in value of output, the proportionate increase in output value is much higher than the increase in input costs, indicating that farmers in the impacted areas obtain better returns to inputs. This is again indicative of greater security, as well as of the switch to varieties which utilise inputs more productively. In four of the PIE project areas the difference in output value between impacted and control areas ranges from more than 200 per cent in Meghna-Dhonagoda and Kolabashukhali to 44 per cent in Chalan Beel and 23 per cent in Kurigram (Table H.8), against differences in production costs of less than 20 per cent. In Zilkar Haor the difference in production costs was of the same order, but output value was 10 times higher in the impacted than in the control area. This was however a seasonal effect, caused by flood damage to the 1990 Boro crop in the control area. The major impact in Zilkar Haor in the study year was clearly created by protection of crops from flood damage.

This conclusion is strengthened by findings on net output value in some of the control areas. In 1990 in the Zilkar Haor control area, for example, farmers incurred financial losses (with family labour costed at the market wage) in Local Boro and B Aman production, the two major crops produced in the area, and in the Kolabashukhali control area the farmers incurred a financial loss in B Aman production, the most important crop produced, in 1990-91 although the year was a typical flooding year for both the impacted and control areas. It is not, of course, likely that the majority of farmers made an overall cash loss, since family labour comprises the major input, but it is clear that in the control areas such labour was much more poorly rewarded than in the impacted areas. It should be mentioned here that in estimating the output values the same prices have been used for both the impacted and the control areas, to avoid possible distortion of the comparison.

Table H.8 Annual Net Return to Paddy Crops
(Tk./ha.)

Project	Impacted (Taka)	Control (Taka)	Difference	
			Taka	%
Chalan Beel	10166	7066	3100	43.87
Kurigram	11900	9704	2196	22.63
Meghna-Dhonagoda	21186	6924	14262	206.00
Zilkar Haor	7040	660	6380	966.00
Kolabashukhali	7350	2070	5280	255.00

Source: FAP 12 PIE Surveys

H7 SUMMARY OF PROJECT AGRICULTURAL IMPACTS

H7.1 Changes in Conditions for Agriculture

From the above discussions it may be concluded that the FCD and/or the FCD/I projects have created little or no impact on the cultivated area. This is because almost all the potential cultivable land in the projects was already cultivated in at least one season before FCD/I was provided. The exceptional case is Kolabashukhali where 2000-5000 ha. of beels have been reclaimed and brought under cultivation due to the project's success in controlling tidal inflow of water and salinity. Project impacts on cropping intensity have occurred mainly where irrigation components have overcome a soil moisture constraint in the rabi and/or early kharif seasons (notably at MDIP). However, the projects in general have achieved considerable success in changing cropping patterns from broadcast varieties to transplanted varieties and from local to HYV varieties, particularly from Local B. Aman to Local T Aman and from Local Boro to HYV Boro because the projects now ensure safer harvest of these costlier but higher-return crops. Yield rate on an average is now higher in all the project areas, the increase ranging from only 0.39 mt./ha. in Kolabashukhali to as high as 1.85 mt./ha. in MDIP. Consequent upon these impacts, output of paddy (the only or the most important crop for all the areas), as well as net return from paddy have increased in an impressive manner in almost all the project areas excluding the poorly planned Nagor River Project (where output has fallen by 24 per cent) and Chalan Beel (where output increase is only 8 per cent). All these agricultural impacts are summarised in Table H.9.

H7.2 Impacts by Project Type

Based on the five types of flooding and project types discussed in Volume 1, Section 3.4 of this Report, the following agricultural benefits and limitations on their achievement have been found.

a) Projects Protecting Against Major River Monsoon Floods

Typically these projects protect transplanted Aman, and may induce the same changes as the next category. They did not appear to protect Boro in the cases studied. Limiting factors are drainage facilities and the risk of embankment breaches and erosion which may remove the intended sense of security.

b) Projects Protecting Against Local Flooding and Congestion of Internal Drainage Basins

The main benefits are from Aman cultivation - encouraging a change from B Aman to TL Aman and from TL Aman to HYV Aman. Also, yields may be more secure and on average higher. The expansion of Boro did not appear to be due to the projects, although they may provide flood protection at harvest time. The main limitation is drainage facilities, but problems of external impacts and public cuts (by outsiders and insiders) are particularly acute in this project type.

c) Projects Protecting Against Flash Floods

Embankments protecting against flash floods typically protect both Boro (from early floods) and monsoon season crops (from flood peaks during the main monsoon). This may permit Boro to be grown (compared with rabi crops which are harvested earlier) and typically increases the average yield achieved for T Aman; the security may also encourage HYV Aman cultivation. Limiting factors are the availability of irrigation, and the risk of failure of the embankments.

d) Projects in Haor areas

Submersible embankments generally result in higher average annual yields for L Boro, and may result in increased areas under Boro cultivation and a switch to HYV Boro where there is greater security for irrigation expansion. Limiting factors are the risk of early overtopping (embankment design and maintenance), and post-monsoon drainage facilities.

e) Projects Protecting Against Tidal Flooding

On higher land the coastal polders encourage increased winter cropping intensity by eliminating saline water and gradually reducing soil salinity levels, while in lower areas the main gains may be to monsoon season cropping - either by an expanded area, protection from floods, or a switch to higher yielding varieties. Limiting factors are the slow reduction in salinity levels and shrimp farming, which requires controlled inflows of saline water.

To these types must be added the influence of irrigation in projects which include an irrigation component. This is invariably used for HYV Boro cultivation (MDIP, Kahua-Muhuri, Polder 17/2) and occasionally for HYV Aus (MDIP), but may help to secure a T Aman crop in relatively dry areas (Protappur).

Table H.9 Summary of Project Agricultural Impacts

Project	Change in Cultivated Area	Change in Cropping Pattern	Change in Cropping Intensity	Change in Paddy Yield	Change in Paddy Output	Change in Input use	Change in Value of Output
RRA Data							
Protappur	No change	Shift from TL Aman to HYV T Aman	No change due to project (annual)	+ve; 2.5 to 4.5 mt/ha (monsoon paddy)	+5417 mt (57%)	NA	NA
Nagor River	-1370 ha. (22%) in monsoon. Increase in boro/rabi only marginally due to Project	Partial shift from B Aman to T Aman. Marginal influence on growth of HYV Boro	-ve in monsoon	-ve; 2.44 to 2.02 mt/ha (monsoon paddy)	- 2902 mt (24%)	NA	NA
Halir Haor	+6%	Small shift to HYV Boro	+ 7%	+ve; 1.1 to 1.37 mt/ha (all paddy)	+ 2253 mt (33%)	NA	NA
Konapara	No change	Partial shift from LT Aman to HYV Aman	No change due to project	+ve; 1.92 to 2.48 mt/ha (monsoon paddy)	+2095 mt (17%) (monsoon paddy)	NA	NA
BRE Kamarjani	No change	Shift from B Aus & Aus/Aman to LT & HYV Aman	-ve; 79% to 58% (monsoon)	+ve; 1.82 to 2.38 mt/ha (monsoon paddy)	+ 444 mt (11%)	NA	NA
BRE Kazipur	No change due to project	Shift from B Aman to T Aman	No change due to project	+ve; 1.82 to 2.38 mt/ha (monsoon paddy)	+2710 mt (26%) (monsoon paddy)	NA	NA
Silimpur-Karatia	None	Partial shift from B Aman to L & HYV T Aman	+ve; 180% to 190% (annual)	+ve; 1.31 to 1.48 mt/ha (monsoon paddy)	+77 mt (7%) (monsoon paddy)	NA	NA
Polder 17/2	small +ve impact	Shift from fallow or shrimp to rabi-Boro, from TL Aman to HYV T Aman	+ve: 100% to 143% or 152% to 176% (including shrimp) (annual)	+ve; 1.95 to 2.97 mt/ha	+4770 mt (95%) (all paddy)	NA	NA
Katakhali Khal	None definitely due to Project	Shift from B Aman to L & HYV T Aman	+ve; 47% to 71% (monsoon)	+ve; 2.18 to 3.22 mt/ha (monsoon paddy)	+1492 mt (50%)	NA	NA
Kahua-Muhuri	+1200 ha. (74%) in Boro	Shift from B Aman & Aus/Aman to T Aman/HYV Boro	No change	+ve; 3.24 to 4.08 mt/ha (all monsoon paddy & Project-influenced Boro)	+10356 mt (50%)	NA	NA
Sakunia Beel	+540 ha. (12%) in Boro	Shift from B Aman & Aus/Aman to T Aman/HYV Boro	No change	+ve; 1.64 to 1.90 mt/ha (all seasons)	+1311 mt (14%) (all paddy) Wheat +332 mt (64%)	NA	NA
Sonamukhi-Banmander	+405 ha. in Boro	Shift from Aus to Boro; from B Aman to T Aman; from TL Aman to HYV Aman	No change (monsoon)	+ve 1.54 to 3.92 mt/ha (monsoon paddy)	+20721 mt (monsoon and reclaimed boro land)	NA	NA
PIE Data							
Chalan Beel	+11% in monsoon -20% in Boro/Rabi	Shift from B Aman LV to T Aman LV	-ve; 142% to 124% (annual)	+ve; but slight; 2.69 to 2.88 mt/ha (all paddy)	+8067 mt (8%)	-10% in agg. (annual)	44% (annual)
Kurigram	+25% in Aus +8% in Boro/Rabi	Shift from B Aman LV to T Aman LV	+ve; 174% to 190% (annual)	+ve; 2.19 to 2.84 mt/ha (all paddy)	+57227 mt (38%)	+14% Ch. Fert +126% Post. +30% Irrig.	+23%
Meghna-Dhonagoda	+204% in Aus -6% in Aman, No change in Boro/rabi	Significant shift to T Aus HYV & marginally to B Aus HYV from B Aus LV & Boro LV & to T Aman HYV from B Aman LV to Boro HYV from Boro LV & Wheat	+ve; 167% to 209% (annual)	+ve; 2.52 to 4.37 mt/ha (all paddy)	+74310 mt (119%)	+126% Ch. Fert. +300% Pesticides	+206%
Zilkar Haor	-25% in monsoon +136% in Boro	Shift from B Aman LV to T Aman LV and Boro LV to Boro HYV (Boro LV is still imp.)	+ve; 19% to 45% in Boro, -ve; but slight: 117% to 113% (annual)	+ve; 1.04 to 2.08 mt/ha (all paddy)	+4704 mt (91%)	+800% Ch. Fert. +160% Post. +600% Irrig.	+966%
Kolabashu-khali	+74% in Aus +52% in Aman -40% in Boro/Rabi	Shift from Jute to Aus/Aman mixed & from B Aman LV to T Aman LV	No change	+ve; 1.02 to 1.37 mt/ha. (all paddy)	+16471 mt (93%)	+50% Ch. Fert. +1300% Irrig.	+255%

Source: Consultant's estimates

APPENDIX I

IMPACTS OF THE FCD/I PROJECTS ON LIVESTOCK

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APPENDIX I

IMPACTS OF THE FCD/I PROJECTS ON LIVESTOCK

I1. INTRODUCTION

In general, agriculture is the main occupation of the people in all the FCD/I Project areas and around 70 per cent of all households are farm households. However, the number of farm households varies with the Project depending on the size of the lowlying areas. Livestock is an integral part of the farming system in all the Projects. Animals are kept primarily as a supporting activity to crop production and secondarily as a source of animal protein (milk, meat, eggs) and cash income for the farm households. Most farm households keep a small number of livestock as scavenging animals.

The most numerous animals in the Project areas are cattle, goats, chickens and ducks. A few buffaloes and sheep are kept in some areas but horses are very rare. According to the Census of Agriculture and Livestock 1983-84, about 53 per cent of all households own bovines, 38 per cent own sheep and goats, and 74 per cent own chickens and ducks.

Economically, cattle are the most important livestock in all the projects. Bullocks are kept mainly for draught power and cows for milk and calves. However, during the peak ploughing season cows are also used as draught animals to overcome draught power shortage by all types of farm households.

The projects studied generally had no explicit objectives related to livestock development. However, it is expected that FCD/I projects would increase crop production, particularly paddy production, by changing cultivated area, cropping pattern and cropping intensity. Those projects, which have increased the cropped area and cropping intensity, have led to a reduction of fallow land and grazing area for livestock on the one hand, and have increased the requirement for draught animals on the other hand. It could have been anticipated that any change in the availability of feeds would lead to a change in production cost and livestock output. The planners, at the time of project planning, rarely considered project impacts on the inputs and outputs of livestock, particularly draught power requirements, and how to meet the increased demand for draught power for timely land preparation.

Although FCD/I projects should not have direct impacts on livestock production parameters, it is expected that they would have an effect on livestock feed resources and disease occurrence, which will in turn influence livestock production in the area. In the FCD/I projects investigated, indirect livestock impacts have been observed on the following parameters:

- Livestock holding (number of households and herd/flock size)
- Livestock feed resources
- Draught power availability and demand
- Livestock output
- Livestock health and incidence of diseases.

In the following pages an attempt is made to analyze the available household survey data of the five PIE Projects as well as RRA findings in order to estimate the impacts of FCD/I Projects on the above mentioned areas.

I2 IMPACTS ON LIVESTOCK HOLDING

I2.1 Incidence of Livestock Owning Households

The results of the PIE household survey indicate that bovines are the most important livestock in all the projects. About 50-60 per cent of all households keep bovines in small numbers primarily as draught animals (Table I1). Cattle are the most important species of bovine and buffaloes are rarely kept in any of the Projects, except by a few medium and large farm households.

Table I1 Percentage of Households Owning Livestock in PIE Study Areas.

Species	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	P	U	C	P	U	C	P	U	C	P	U	C	P	U	C
Bovine	53	57	50	57	43	62	54	-	43	63	59	64	56	-	59
Cattle	53	57	50	56	43	61	54	-	43	60	59	61	56	-	59
Buffaloes	0.1	0	0	2	0	5	0	-	0	4	0	3	1	-	0
Ovine (sheep/goats)	42	21	45	46	38	56	18	-	26	4	3	5	10	-	7
Poultry	77	64	80	76	67	82	79	-	83	62	61	79	73	-	82
Chicken	71	64	74	76	67	80	78	-	80	62	59	79	71	-	76
Ducks	43	36	51	43	48	51	34	-	64	38	39	21	39	-	47

Note: P = Protected area, U = Unprotected area, C = Control area
Source: PIE Household Survey

The PIE results provide a clear indication that the number of bovine holding households increases with increasing farm size (Table I2). It can be seen from Table I2 that only 10-15 per cent of landless households and around 50-70 per cent of marginal and small farm households have cattle. In contrast, about 95-100 per cent of medium and large farm households possess cattle and buffaloes except in Kolabashukhali Project, in which about 80 per cent of medium and large farm households have bovines. The increased number of bovine holding households with increasing farm size may be due to higher demand for draught animals for land preparation combined with larger available resources for their purchase. Moreover, medium and large farm households may have more feed resources for maintaining livestock, particularly bovines.

Table I2 Distribution of Bovine Owning Households by Farm Size
(% of households)

	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L
Protected Area	16	57	96	10	72	95	13	67	100	4	73	97	7	71	77
Unprotected Area	25	25	100	0	54	100	-	-	-	15	69	86	-	-	-
Control Area	17	57	100	8	70	100	8	50	100	13	61	100	11	82	83

Note: L = Landless household, M+S = Marginal and Small household having operated land between 0.01 and 2.50 acre, M+L = Medium and Large household having operated land of 2.51 acre and above.
Source: PIE Household survey.

The PIE results further indicate that there is no general trend of change in the number of bovine owning households between the protected and the control areas. In MDIP there is a higher percentage of bovine owning households in the protected area than the control area, but in other PIE Projects the difference in the percentage of bovine owning households is very small and mostly in the reverse direction.

The PIE results indicate that ovines (goats and sheep) are important only in Kurigram South and Chalan Beel D Projects in which about 40-55 per cent of the total households possess ovines, particularly goats, in small numbers as scavenging animals (Table I1). In Zilkar Haor and KBK projects goats and sheep are of minor importance, and only 5-10 per cent of households possess ovines. However, the results show clearly that the percentage of goat owning households was lower in the protected areas than in the control areas. This gives some reason to believe that goat production has been negatively affected by FCD/I projects. However, the RRA results give a mixed impression regarding the impacts of the projects on goat production.

Regarding poultry, the PIE results show that about 70-80 per cent of households possessed poultry, and chickens were the predominant species of poultry in all the areas. Only 40-50 per cent of households keep ducks. The household survey results give a clear indication that the number of poultry holding households increases with increasing farm size (Table I3). About 30-50 per cent of landless households and 50-90 per cent of the marginal and small farm households keep poultry. However, about 90-95 per cent of the medium and large farm households possess poultry. PIE results also indicate that the number of poultry owning households is smaller in the protected areas than in the control areas. However, the differences in the proportion of poultry, particularly chicken, owning households between the protected and the control areas are small and may not be significant in most of the cases (Table I1). Likewise, the percentage of duck owning households is, in general, smaller in the protected areas than the control areas, except in Zilkar Haor where the number of duck owning households appears to be significantly higher in the protected area.

One hypothesis to explain the somewhat surprising lower ownership of small stock in project areas is that they are less important in making a quick recovery once there is flood protection, whereas in flood prone control areas households prefer small stock which reproduce quickly and enable the household to regain a livestock holding after serious floods, and which can be sold for cash in times of necessity (after floods). However, further research would be needed to confirm whether this difference is general, and whether small stock holdings fluctuate more widely in floodprone areas.

Table I3 Distribution of Poultry Holding Households by Farm Size
(% of households)

	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L
Protected Area	45	87	96	50	85	95	47	91	100	16	76	82	7	99	95
Unprotected Area	50	50	83	0	92	100	-	-	-	30	66	90	-	-	-
Control Area	54	88	100	50	91	100	54	94	100	39	87	100	56	94	96

Note: L = Landless household, M+S = Marginal and Small household having operated land between 0.01 and 2.50 acre, M+L = Medium and Large household having operated land between 2.51 acre and above.

Source: PIE Household survey.

I2.2 Size of Livestock Holding

The PIE household survey data, as well as RRA information, show that the size of livestock holding per household is quite small and that it varies with a number of factors: between the Projects, between protected and control areas, between farm and nonfarm households etc. However, a large number of farm households and a small number of non-farm household keep livestock in small numbers as scavenging animals.

The PIE results confirm that economically bovines are the most important type of livestock for the farm households. Average size of bovine holding is very small, around 1.7 head per household, which varies between the projects and between control and protected areas. It also varies with the farm size. Among the PIE projects, MDIP has the lowest number of bovines per household (1.24 head/HH) and Zilkar Haor has the highest number of bovines per household (2.44 head/HH). These results correspond with the relevant District figures of the Agricultural and Livestock Census 1983/84.

The PIE results indicate no clear pattern of change in the size of bovine holding between protected and control areas. At Chalan Beel, MDIP and KBK the size of bovine holding is bigger in the protected area than in the control area, but the reverse is true in Kurigram South and Zilkar Haor. The difference in holding size between the protected and the control areas is substantial in Chalan Beel D and MDIP but quite small in Zilkar Haor, KBK and Kurigram South (Table I4). The RRA results show a similar trend of change in the bovine holding over time except in Kurigram South (Table I5). However, there is a difference in the basis of the PIE and RRA results. The RRA results indicate the changes that occurred between the pre-project and post-project conditions with a time gap of 5 to 10 years or more, but the PIE results present the differences that occur between the protected and control areas (i.e. with and without project conditions) at the same point in time. Data were not collected on earlier livestock holdings in Project and control areas to assess how well the control areas were matched on this parameter, but to the extent that pre-project agricultural conditions were comparable, the livestock holdings might also be expected to have been comparable.

Table I4 Mean Number of Livestock per Household in the Protected and Control Areas.

Species	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	P	U	C	P	U	C	P	U	C	P	U	C	P	U	C
Bovine	1.7	2.3	1.2	1.8	1.1	2.4	1.4	-	0.9	2.4	2.0	2.9	1.7	-	1.6
Cattle	1.7	2.3	1.2	1.7	1.1	2.3	1.4	-	0.9	2.3	2.0	2.8	1.7	-	1.6
Buffaloes	0.1	0	0	0.3	0	0.1	0	-	0	0.1	0	0.1	0	-	0
Ovine (sheep+goats)	1.2	0.2	1.4	1.1	1.0	1.3	0.3	-	0.5	0.2	0.1	0.2	0.2	-	0.1
Poultry	11.0	8.8	8.1	8.2	7.2	10.5	6.9	-	7.4	6.2	7.4	6.2	7.1	-	6.9
Chicken	7.9	7.4	5.7	6.3	4.7	7.3	5.3	--	5.2	4.4	4.2	5.5	5.1	-	4.8
Ducks	3.1	3.4	2.4	1.9	2.6	3.3	1.6	-	2.2	1.8	3.2	0.7	2.0	-	2.1

Note: P = Protected area, U = Unprotected area, C = Control area.
Source: PIE Household Survey

Table I5 RRA Data on Impacts of FCD/I Projects on Feed Resources and Livestock Performance

Project No.	Project Name	Change in Livestock Feed				Change in Draught Power Availability				Change in Livestock Population				Change in Milk output	Change in disease incidence
		Grazing Area	Straw Availability		Green forage/ feed	Draught power demand	Draught animal availability	Use of cows	Power tiller use	Cattle and Buffaloes	Goats and Sheep	Chicken	Ducks		
			Quantity	Quality											
1.	Chalan Beel Polder-D	↓	↑	▲ due to HYV	NA	↑	↓	↑	NA	↑	↑	↑	↑	↓	NA
2.	Kurigram Project (South)	↓	↑	▲	↓	↑	↓	NA	NA	↑	↑	↑	↓	↑	↑
3.	Meghna-Dhonagoda	↓	↑	▲	↓	↑	↓	NA	↑	NA	NA	↑	↓	NA	NA
4.	Zilkar Haor	↓	↑	▲	NA	NA	NA	NA	NA	↓	NA	NA	NA	↓	NA
5.	Kolabashukhali	↓	↑	▲	↓	↑	↓	↑	NA	↓	No Change	↑	↓	↓	↑ Parasitic
6.	Protappur	↓	↑	▲	↑	↑	↓	↑	↑	↑	↓	↑	NA	NA	↓ due to vaccination
7.	Nagor River	↓	↓in Lowland ↑in Highland	▲ due to HYV	↓	↑	↓	↑	↑	↓	Seasonal ↑	↑	↑	↓	↑
8.	Sonamukhi	↓	↑	▲	↓	↑	↓	NA	↑	↓	↑ Goats	↑	NA	NA	↓
9.	Sakunia Beel	↓	↑	▲	↓	↑	↓	↑	↑	↓	↑	↑	NA	↓	↑
10.	Silimpur-Karatia	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11.	Katakhali Khal	↓	↑	▲	NA	↑	↓	↑	↑	↓	↑	↑	↑	↓	NA
12.	Halir Haor	↓	↑	▲	NA	↑	↓	↑	↑	↓	No Change	↑	↑	↓	↑
13.	Kahua-Muhuri	↓	↑	▲	↓	↑	↓	NA	↑	↓	↓	↑	↑	↓	↑ Parasitic infestation
14.	Konapara Embankmnt	↓	↑	NA	↓	↑	↓	↑	↑	↓	↑	↑	NA	↓	
15.	Polder 17/2	↓	↑ in non-gher area	▲	↑	↑	↓	NA	↑	↓	↓	NA	↓	↓	↓ in non-gher, ↑ in gher area
16.	BRE-Kamarjani Reach	↓	↑	▲	↓	↑	↓	↑	↑	↓	↑	↑	↑	↓	↑
17.	BRE- Kazipur Reach	↓	↑	▲	Pulse Prod ↓	NA	NA	NA	NA	↓ Since 1984	↓ Since 1984	↑	NA	↓ Since 1984	↑

Note: ↑ - Increased; ↓ - Decreased; NA - Not Available; ▲ - Deteriorated
Source: RRA Results

Table I6 shows the average size of bovine holding per owning household. There are around three head of bovines per owning household, which shows a great variation among the Projects. MDIP has the smallest number of bovine (about 2.3 head/owning HH) and Zilkar Haor has the highest number (around 4.2 head) per owning household. This has some relationship with the land holding of the farm households - in general holdings are smallest in MDIP and largest in Zilkar Haor, although the gross cropped area per household may not be so different.

Table I6 Mean Number of Livestock per Owning Household in the Protected and Control Areas

Species	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	P	U	C	P	U	C	P	U	C	P	U	C	P	U	C
Bovines	3.2	4.0	2.4	3.1	2.7	3.9	2.6	-	2.1	3.8	3.4	4.6	3.1	-	2.8
Cattle	3.2	4.0	2.4	3.1	2.7	3.8	2.6	-	2.1	3.8	3.4	4.5	3.1	-	2.8
Buffaloes	2.0	0	0	1.7	0	2.2	0	-	0	3.3	0	6.0	3.0	-	0
Ovines (sheep & goats)	3.0	1.0	3.2	3.4	2.6	2.4	1.4	-	1.9	2.8	2.0	4.8	1.8	-	1.7
Poultry	14.3	13.7	10.2	10.8	10.9	12.8	8.8	-	8.9	10.0	12.0	7.9	9.7	-	8.5
Chickens	11.1	11.6	7.9	8.3	7.0	9.1	6.9	-	6.5	7.0	7.2	7.0	7.2	-	6.3
Ducks	7.3	3.8	4.7	4.5	5.4	6.4	4.6	-	3.5	4.8	8.2	3.7	5.1	-	4.6

Note: P = Protected area, U = Unprotected area, C = Control area.
Source: PIE Household Survey

The PIE results show a general trend that the average number of bovines is higher in households with larger operated landholdings (Table I7). Thus, landless households typically own from 0.1 to 0.5 head of bovines per household, with the highest number in Chalan Beel and the lowest number in Kurigram South; marginal and small farm households, own around 1.5-2.0 head of bovines per household, with the highest number in KBK and the lowest number in MDIP; and the medium and large farm households own around 3.5 - 4.5 head of bovines per household with the highest in Kurigram South (about 5 head per household) and lowest in KBK (2.5 head per household). However, there are no systematic differences in the ownership of bovines between protected and control areas, indicating that the projects have had no discernable impact on size of holding.

Table I7 Size of Bovine Holding by Farm Size

	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L
Protected Area	0.3	1.6	4.2	0.1	2.0	4.5	0.2	1.7	3.3	0.2	2.0	4.6	0.1	2.2	2.5
Unprotected Area	0.5	0.5	4.7	0	1.1	5.0	-	-	-	0.3	2.0	3.5	-	-	-
Control Area	0.3	1.2	3.3	0.1	1.7	5.4	0.8	0.9	3.0	0.4	2.0	5.2	0.2	2.3	2.4

Note: L = Landless household, M+S = Marginal and Small household having operated land between 0.01 and 2.50 acre, M+L = Medium and Large household having operated land of 2.51 acre and above.

Source: PIE Household survey.

The results of the PIE household survey on the size of the sheep and goat (ovine) holdings in the five projects are presented in Table I4. Mean ovine holding per household reflects the pattern of ownership already discussed: in Chalan Beel and Kurigram South there is more than one head of goats per household whereas in Zilkar Haor and KBK there is only 0.1 - 0.2 head of goats per household. The average sheep and goat holding per owning household is shown in Table I6. The results show that the sheep and goat holding per owning household is quite high at between 1.7 and 4.8 head per owning household in most cases. The PIE results indicate a general trend that the size of sheep and goat holding is lower in the protected area than the control area. The RRA results indicate that the sheep and goat population has increased in most of the projects when compared with the pre-project condition. At the national level the goat and sheep population has increased annually at the rate of around 2 per cent.

Household survey results on poultry are presented in Tables I4 and I.6. On average there are about 7.9 birds per household of which around 5.8 are chickens and 2.1 are ducks. However, average poultry holding per owning household is around 10.2 of which about 7.7 are chickens. The results do not provide any clear pattern of change in the size of poultry holding between the protected and control areas. The poultry holding in the protected area is bigger in Chalan Beel and KBK and smaller in Kurigram South and MDIP than the control area. There is no difference in the holding size between the protected and control areas in Zilkar Haor. However, the duck holding size in the protected area is bigger in Chalan Beel and Zilkar Haor and smaller in Kurigram South, MDIP and KBK. This change may be related to the change in the surface water area and natural duck feeds. RRA results provide a clear indication that the chicken population has increased in all the projects when compared with the pre-project condition. However, duck population has increased in some of the projects where surface water and natural duck feeds are available. This result also corresponds with the results of the Agriculture and Livestock Census 1983/84 in which poultry population has increased annually at the rate of 6 per cent.

The PIE results also show that the size of poultry holding is higher in households with large operated land holdings (Table I8). The landless households possess only 2.5 - 3.0 birds per household, while marginal and small farm households possess 7-9 birds and medium and large farm households have around 12-16 birds per household. However, there is a big variation between the Projects.

Table I8 Size of Poultry Holding by Farm Size

	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L	L	M+S	M+L
Protected Area	2.9	10.6	24.6	3.7	8.6	16.1	2.5	8.0	14.3	1.3	5.8	10.3	0.6	8.9	10.1
Unprotected Area	3.3	5.0	15.0	0	8.3	22.0	-	-	-	1.7	7.1	13.1	-	-	-
Control Area	3.6	8.5	18.2	2.7	9.8	18.4	3.2	8.6	12.0	3.0	7.0	7.8	3.8	6.8	10.8

Note: L = Landless household, M+S = Marginal and Small household having operated land between 0.01 and 2.50 acre, M+L = Medium and large household having operated land between 2.51 acre and above.

Source: PIE Household survey.

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I3. IMPACT ON DRAUGHT POWER

I3.1 Draught Power Requirement

It is anticipated that the FCD/I projects would have some impacts on draught power requirement in the project. Improved FCD and irrigation facilities in the project area would lead to changes in the cropping pattern and cropping intensity. They would also lead to change in the cropped area in different cropping seasons. The change in cropped area in different seasons, due to the project, should cause a change in draught power requirements for land preparation.

The PIE results indicate that the average operated area per household varied between the protected and control areas as well as between the projects (Table I9). The operated area per household is highest in Zilkar Haor (1.03 ha in the protected area and 1.0 ha in the control area) and the lowest in MDIP (0.38 ha in the protected area and 0.32 ha in the control area). The PIE results show a general trend that the operated landholding per household is higher in the protected area than in the control area in all the projects except in Kurigram South. This is unlikely to have any direct relationship with the projects themselves and the differences are small in all but Chalan Beel and Kurigram Projects. However, this factor must be taken into account in the assessment since it implies that there would in any case be a higher demand for draught power per household inside the project, irrespective of cropping intensity impacts.

The PIE results further indicate that the area of land operated per household varies with the season of the year, i.e. with the cropping season. In general, the operated area per household is highest in the Aman season and lowest in the Aus season. Although there is no consistent difference in the size of the operated area per household between the protected and control areas, there is evidence that the cropped area per household is higher in the protected area than the control area in all the projects except Kurigram (Table I9).

Differences in cropping intensity are likely to result in changes in draught power demand, but indicate that only in MDIP and perhaps Kurigram has the project increased draught power demand.

I3.2 Draught Animal Availability

Supply of draught power for land preparation is the most important contribution of livestock to the farm economy in all the projects. As already shown in sections I2.1 and I2.2, the number of bovine owning households and the size of bovine holding varies between the projects and with farm size (Tables I4, I.6, I.7). Bullocks are the most important type of animal used for draught power. Buffaloes and bulls are also used for draught power whenever available, but cows are normally used when there is a shortage of draught power in the household.

The composition of bovine holding of the household in the protected and control areas of different projects is shown in Table I10. In general there are about 40 per cent of bullocks and bulls, 30 per cent cows, 28 per cent calves and 2 per cent buffaloes. However, there are some variations in the composition and type of bovine animals between the projects and between protected and control areas. The proportion of bullocks and bulls among bovines is high in Zilkar Haor, Kurigram South and Chalan Beel (around 45 per cent) and low in MDIP (29 per cent) and KBK (37 per cent). The proportion of cows is highest in MDIP (37 per cent) and lowest in the Chalan Beel project. The data seem to indicate that where there are smaller landholdings a higher proportion of bovines are cows. It is not clear if this is a causal relationship, given that the cropping intensity, and hence draught demand, is relatively high in MDIP where the holding sizes are relatively small.

Table I9 Operated and Cropped Area per Household in the PIE Projects (acres)

Project	Total operated land/household	Cropped area per household				
		Aus Season	Aman Season	Boro Season	Total Cropped Area	Cropping Intensities %
Chalan Beel						
Protected Area	1.60	0.30	0.81	0.87	1.98	124
Unprotected Area	2.36	0.40	1.52	0.83	2.75	117
Control Area	1.02	0.28	0.48	0.71	1.47	144
Kurigram South						
Protected Area	1.24	0.70	1.01	0.65	2.36	190
Unprotected Area	0.96	0.35	0.72	0.67	1.74	181
Control Area	2.07	0.93	1.69	1.00	3.62	175
Meghna-Dhonagoda						
Protected Area	0.94	0.61	0.72	0.67	2.00	213
Unprotected Area	-	-	-	-	-	na
Control Area	0.79	0.16	0.63	0.58	1.37	173
Zilkar Haor						
Protected Area	2.55	0.20	1.38	1.32	2.90	114
Unprotected Area	2.32	0.26	1.41	1.06	2.73	118
Control Area	2.47	0.53	1.75	0.52	2.80	113
Kolabashukhali[1]						
Protected Area	1.86	0.98	1.48	0.36	2.80	152
Unprotected Area	-	-	-	-	-	na
Control Area	1.80	0.71	1.16	0.84	2.71	151

Source: PIE Household Survey

Note: [1] Although the cropping intensity appears high most of the area cropped in the Aus and Aman season is mixed B Aus + Aman requiring draught power only in one season.

[2] Aman season means T. Aman Season. B. Bman is included in Aus Season.

Table I10 Composition of Bovine Holding in the PIE Projects.

Project	No of cattle/Household			Buffaloes/ Household	Total bovine/ Household
	Bullock+Bull	Cows	Calves		
Chalan Beel					
Protected Area	0.85	0.44	0.39	0.13	1.81
Unprotected Area	0.57	0.79	0.93	0	2.29
Control Area	0.57	0.32	0.29	0	1.18
Kurigram South					
Protected Area	0.76	0.61	0.40	0.03	1.80
Unprotected Area	0.57	0.38	0.19	0	1.14
Control Area	1.10	0.75	0.48	0.11	2.44
Meghna-Dhonagoda					
Protected Area	0.38	0.53	0.51	0	1.42
Unprotected Area	-	-	-	-	-
Control Area	0.30	0.32	0.27	0	0.89
Zilkar Haor					
Protected Area	1.11	0.65	0.51	0.14	2.41
Unprotected Area	0.97	0.61	0.40	0	1.98
Control Area	1.24	0.88	0.64	0.15	2.91
Kolabashukhali					
Protected Area	0.67	0.57	0.46	0.04	1.74
Unprotected Area	-	-	-	-	-
Control Area	0.58	0.47	0.59	0	1.64

Source : PIE Household Survey.

Comparison of Table I9 and I10 indicates that there is a strong positive relationship between bovine holding and operated landholding per household (R^2 = 0.83 for impacted areas and 0.94 for control areas); this is not surprising, since bovines are still the most important source of draught power. Both the correlation and the rate at which bovine numbers respond to holding size are greater for the control areas, though it is not clear why this should be so.

Since there is variation in the composition of bovine herds, and the different classes of animal differ in their draught power ability, it is necessary, for comparison, to convert all types of bovines into Draught Animal Units (DAU) by using the following conversion factor:

2бо

$$DAU = 1 \times (Bullock + Bull) + 0.5 \times Cow + 2 \times Buffalo$$

The available DAU per household in different projects are shown in Table I11. The results show a clear trend that there are more DAU per household where operated land holdings are higher. This result confirms the findings in Table I7.

Table I11 Availability of Draught Animal Units (DAU) in the PIE Projects

Project	Operated land/HH	Bullock+Bull/HH	Dry+Milking cow/HH	Buffaloes/HH	DAU/HH	DAU/operated land (acre)
	(acre)	No.	No.	No.	No.	No.
Chalan Beel						
Protected Area	1.61	0.85	0.44	0.01	1.09	0.68
Unprotected Area	2.36	0.57	0.79	0	0.96	0.41
Control Area	1.02	0.57	0.32	0	0.73	0.72
Kurigram South						
Protected Area	1.24	0.76	0.61	0.03	1.13	0.91
Unprotected Area	0.96	0.57	0.38	0	0.76	0.79
Control Area	2.07	1.10	0.75	0.11	1.68	0.81
Meghna-Dhonagoda						
Protected Area	0.94	0.38	0.53	0	0.64	0.68
Unprotected Area	-	-	-	-	-	-
Control Area	0.79	0.30	0.32	0	0.46	0.58
Zilkar Haor						
Protected Area	2.55	1.11	0.65	0.14	1.71	0.67
Unprotected Area	2.32	0.97	0.61	0	1.28	0.55
Control Area	2.47	1.24	0.88	0.15	1.98	0.80
Kolabashukhali						
Protected Area	1.86	0.67	0.57	0.04	1.02	0.55
Unprotected Area	-	-	-	-	-	-
Control Area	1.80	0.58	0.47	0	0.81	0.45

Note: DAU = Draught Animal Unit, HH = Household
Source: PIE Household Survey

To find out the exact relationship between the operated landholding and DAU holding, the data are analyzed based on DAU per acre of operated land and the results are presented in Table I11. It can be seen from the table that the DAU/acre of operated land vary considerably between the projects and much less between protected and control areas. The DAU per acre of operated land are highest in Kurigram South and the lowest in KBK. That suggests that KBK has the greatest shortage of draught power for land preparation; interestingly, the KBK Feasibility Report (in a rare exception to the normal disregard for livestock issues) noted that the Project area was short of draught power. However, cropping pattern and seasonality of cropping also play an important role in determining the shortage of draught power.

I3.3 Draught Power Demand and Supply

The demand for draught power will vary with the operated land area of the household and with the cropped land area in different cropping seasons. As already shown in Table I9, the operated land per household varies between projects as well as with the cropping seasons. The area of operated land per household is higher in the Aman season and lower in the Aus season. In general, a pair of DAU will require 15-18 days for cultivation of one acre (0.40 ha) of land. The cultivation of land includes ploughing (4-5 times) and laddering (levelling). A pair of DAU can cultivate 2 acres of land in 30 days. The time available for land preparation is dependent on the crop season and natural rainfall. In the Boro season, when irrigation water is used, the time available for land preparation is quite long, around 45-60 days, but in the Aus and Aman seasons, when land preparation and sowing/planting are dependent on natural rainfall, the time available for land preparation and sowing/planting is short, usually 25-30 days. Consequently, in the Aman season, when more land has to be cultivated in a short period of time, the supply of draught power for land preparation will be inadequate, particularly for medium and large farm households, which have higher acreages.

Table I9 showed that the cultivated area was the highest in the Aman season in 11 out of 13 areas studied in the PIEs. Hence, in assessing the adequacy of supply of draught power this was taken to be the critical period, particularly as the time when conditions are suitable for land preparation is relatively short. Table I12 considers draught power demand at this critical season for all households, and for medium-large land holders (since on average these appeared to face a greater draught power shortage). Table I12 shows that large landowners do face a shortage of draught power relative to all households, but the difference is slight with the exception of MDIP protected area, Zilkar Haor and Kolabashukhali. There is also a relatively greater shortage in the protected areas in three projects (Chalan Beel, MDIP and Zilkar Haor) compared with control areas. Even so the critical factor is whether there are more or less than 2 acres of land to cultivate in the Aman season per DAU pair, since this is the maximum area which a pair can cultivate in the 30 days available in that season. Table I12 indicates that only in MDIP and KBK is there a serious shortage (and this affects project and control areas alike). The shortage in the unprotected impacted area of Zilkar Haor is unlikely to be related to the project.

In order to find out the extent of shortage of draught power in the FCD/I projects, the PIE survey data are analyzed based on actual requirement of days for cultivation of the operated areas with the available DAU of various categories of households and the results are presented in Table I13. In this calculation an assumption is made that a pair of DAU will require 15 days to cultivate one acre (0.40 ha) of operated or cropped land. It can be seen from the table that there is no significant shortage of draught power to cultivate operated land in Chalan Beel and Zilkar Haor within 30 days. In KBK and MDIP there is a significant shortage of draught power to cultivate the operated land within the required time. Moreover, in these projects (except for the MDIP control area) there is a greater shortage of draught power among the larger landowners. Other things being equal, this might be expected to moderate the unequal distribution of benefits from FCD/I projects, since larger land owners have the resources to compensate for one substandard input, for example by better access to irrigation water and increased application of fertilizer. Research showing the yield response to varying tillage rates would help to clarify this issue.

Table I12 Draught Power Requirement and Supply in Critical Season for Medium and Large Farms.

Project	DAU/HH	Acre/pair DAU	Acre/pair DAU for M+L farm (acre)	Acre/pair DAU in Aman season	Acre/pair DAU in Aman season for M+L farm (acre)
	No	(acre)	(acre)	(acre)	(acre)
Chalan Beel					
Protected Area	1.09	2.95	3.51	1.48	1.73
Unprotected Area	0.96	4.89	4.64	3.15	2.97
Control Area	0.73	2.79	3.13	1.32	1.38
Kurigram South					
Protected Area	1.13	2.21	2.57	1.82	2.20
Unprotected Area	0.76	2.51	3.86	1.88	3.17
Control Area	1.68	2.46	2.56	2.01	2.15
Meghna-Dhonagoda					
Protected Area	0.64	2.94	4.66	2.24	3.46
Unprotected Area	-	-	-	-	-
Control Area	0.46	3.46	3.58	2.73	2.72
Zilkar Haor					
Protected Area	1.71	2.99	3.28	1.62	1.72
Unprotected Area	1.28	3.64	5.05	2.21	3.03
Control Area	1.98	2.50	2.62	1.77	1.89
Kolabashukhali					
Protected Area	1.02	3.63	5.68	2.84	4.43
Unprotected Area	-	-	-	-	-
Control Area	0.81	4.42	7.92	2.84	4.87

Source: PIE Household Survey.

The demand for draught power appears to have increased in all the RRA project areas when pre-project and post-project conditions are compared. However, there are some indications that there is no significant increase in draught power demand in the protected area over the control area in most of the PIE projects. The data indicate that the draught power requirement was higher in the Aman season and lower in the Aus season in all the projects, and medium and large farmers have a greater shortage of draught animals during this period in these projects. To meet the shortage of draught animal power, large and medium farm households are increasingly using power tillers for land preparation. Both RRA and PIE studies also show that cows have been increasingly used for draught power for land preparation.

Table I13 Time Required for Cultivation of Operated Land, by Farm Size Group and Cropping Season
(days)

Farm Household	Time required for cultivation of operated land per household in different crop season (in days)														
	Chalan Beel			Kurigram South			Meghna-Dhonagoda			Zilkar Haor			Kolabashukhali		
	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro	Aus	Aman	Boro
Protected Area															
Marginal+Small	9	19	24	31	17	24	26	30	26	3	21	22	17	23	5
Medium+Large	8	26	25	23	21	21	44	52	54	4	26	24	43	66	17
All Types	8	22	24	19	27	17	29	34	31	4	24	23	29	43	11
Unprotected Area															
Marginal+Small	60	160	139	16	21	16	-	-	-	6	33	25	-	-	-
Medium+Large	10	45	22	8	48	53	-	-	-	9	46	31	-	-	-
All Types	12	47	26	14	28	26	-	-	-	6	33	25	-	-	-
Control Area															
Marginal+Small	12	20	29	14	25	21	9	42	35	3	21	12	16	24	16
Medium+Large	13	21	32	18	32	17	13	41	44	9	28	7	44	73	55
All Types	12	20	29	17	30	18	10	41	38	8	27	8	28	43	31

Source : PIE Household Survey.

I4. IMPACTS ON LIVESTOCK FEEDS

It is anticipated that due to the FCD/I Projects there would be some impacts on livestock feed resources, particularly on fallow land and grazing area and thereby on availability of green feedstuffs. It is further anticipated that with the increased production of paddy there will be a concomitant increase in output of paddy straw and rice bran for bovine animals. The RRA results indicate that in virtually all the FCD/I projects the grazing area has been reduced due to conversion of fallow land into crop land (Table I5). Moreover, cultivation of pulses has fallen, as these have tended to be replaced by Boro paddy, which has been encouraged by some FCD/I Projects.

The RRA results provide further indication that straw production has increased in all the projects, except in Nagor River where crop damage is caused by frequent public cuts. There is a general complaint from the farmers that palatability and digestibility of straw have declined due to the production of HYV rather than LV paddy. It is assumed that with the increased production of paddy there would be increased production of rice bran in the Project areas.

In order to investigate the exact status of livestock feeds in the PIE Projects, the surveys attempted to ascertain the percentage of households that spent cash on feeding their bovine animals; the results are presented in Table I14. It can be seen from the table that the percentage of households which spent money for feeding their livestock varies with the Projects. More than 50 per cent of households in Kurigram South, MDIP and KBK Projects spent money for green feeds. The percentage of household who spent money for green feeds is the smallest in the Zilkar Haor and the highest in Kurigram South Project. There is little variation in the percentage of households spending money on feedstuffs between the protected and control areas.

Table I14 Percentage of Households Buying Feeds for Bovines in Last 12 Months (1990-91).

Project	Type of Feeds		
	Green feedstuff (% HH)	Dry feedstuff (% HH)	Concentrate Feed (% HH)
Chalan Beel			
Protected Area	24	49	45
Unprotected Area	14	57	64
Control Area	23	51	48
Kurigram South			
Protected Area	61	57	59
Unprotected Area	43	43	38
Control Area	62	62	62
Meghna-Dhonagoda			
Protected Area	59	55	51
Unprotected Area	-	-	-
Control Area	50	46	35
Zilkar Haor			
Protected Area	7	43	53
Unprotected Area	4	39	44
Control Area	3	45	39
Kolabashukhali			
Protected Area	51	56	50
Unprotected Area	-	-	-
Control Area	53	57	55

Note: HH = Household

Source: PIE Household Survey.

Regarding dry roughage, more than 50 per cent of households spent money on paddy straw in all the Projects, with the highest number of households in Kurigram South and the lowest number in Zilkar Haor. However, about 90-100 per cent of the bovine owning households have their own dry roughage at least a part of the year both in the protected and control areas. A similar percentage of total households also use their own concentrate feeds, mainly rice bran and wheat bran, both in the protected and control areas. However, a higher percentage of households buy oilcakes in the protected area than the control area.

In order to find out the amount of money spent by the average household for feeding bovine animals, the PIE survey data have been analyzed based on the above factors and the results are presented in Table I15. It can be seen from the table that in all the projects the highest amount is spent by the households for feeding dry roughage, mainly rice straw, for maintaining the bovine animals. However, the amount spent per household varies with the projects and between the protected and control areas. The highest amount is spent by the households in KBK and the lowest in Zilkar Haor. The average household spent more money in the protected areas of MDIP, Zilkar Haor and Chalan Beel than in the control areas. The results show that the more successful the Project, the higher is the spending on feeds for maintenance of the bovine animals. It is not entirely clear whether this is due to project induced shortage of feedstuffs, or to greater purchasing power in successful projects, though the tendency for the additional expenditure to be weighted towards concentrate feeds suggests the latter.

Table I15 Amount Spent per Household for Feeding Bovine Animals in Last 12 Months (1990-91).

Project	Type of Feed Bought					
	Green Feed		Dry Roughage		Concentrate Feed	
	Amount per HH (Tk.)	Amount per purchasing HH (Tk.)	Amount per HH (Tk.)	Amount per purchasing HH (Tk.)	Amount per HH (Tk.)	Amount per purchasing HH (Tk.)
Chalan Beel						
Protected Area	97	403	561	1152	323	684
Unprotected Area	50	350	1443	2525	554	761
Control Area	104	461	620	1210	264	526
Kurigram South						
Protected Area	288	476	610	1068	293	501
Unprotected Area	240	561	367	856	129	338
Control Area	347	540	788	1226	420	619
Meghna-Dhonagoda						
Protected Area	242	410	592	1069	379	749
Unprotected Area	-	-	-	-	-	-
Control Area	145	289	284	611	141	409
Zilkar Haor						
Protected Area	45	614	425	985	442	839
Unprotected Area	23	533	347	900	413	932
Control Area	6	250	338	751	191	493
Kolabashukhali						
Protected Area	317	615	828	1489	396	782
Unprotected Area	-	-	-	-	-	-
Control Area	256	483	636	1123	284	509

Note: HH = Household
Source: PIE Household Survey

5. IMPACT ON LIVESTOCK HEALTH

It is expected that FCD/I projects might have some impact on livestock health and incidence of diseases. During pre-project conditions there was regular occurrence of flood which washed away all debris and other polluted materials and thereby reduced incidence of diseases, but after the Project the stagnation and low depth of water in the water bodies may facilitate growth of some types of parasites.

The RRA results show that there is a general deterioration of cattle health mainly due to shortage of nutritious feed, extreme seasonal fluctuation of feed supply and seasonal over work of the animals.

The PIE results indicate that about 30-40 per cent of the households use veterinary treatment facilities for treating their animals (Table I16). There is no great difference in use of veterinary facilities between the Projects and between protected and control areas except in Zilkar Haor and KBK. The use of veterinary treatment facilities is dependent on many factors, particularly the location of the veterinary hospital or dispensary, distance from the household, seriousness of the disease and fee of the veterinarian. Nevertheless, a much higher percentage of households in KBK has been using veterinary facilities for their animals. This may indicate higher incidence of diseases in the project compared to the control areas, or greater ability to pay fees, or better access to veterinary treatment.

Table I16 Percentage of Households Using Veterinary Treatment in Last 12 Months (1990-91).

Project	Impacted Area		Control Area (% HH)
	Protected (% HH)	Unprotected (% HH)	
Chalan Beel	31	21	27
Kurigram South	34	24	31
Meghna-Dhonagoda	33	-	27
Zilkar Haor	42	27	53
Kolabashukhali	66	-	27

Source: PIE Household Survey.

Table I17 Amount Spent per Household for Livestock Treatment (in Tk.) in Last 12 Months (1990-91).

Project	Impacted Area				Control Area	
	Protected Area		Unprotected Area			
	per HH	per owning HH	per HH	per owning HH	per HH	Per owning HH
Chalan Beel	26	87	25	117	43	158
Kurigram South	22	65	6	25	35	113
Meghna Dhonagoda	26	78	-	-	34	125
Zilkar Haor	122	291	89	327	117	223
Kolabashukhali	45	116	-	-	47	145

Source: PIE Household Survey.

The amount of money spent by the households for livestock treatment is shown in Table I17. The results indicate that a slightly higher amount of money is spent by the household for treatment of their animals in the control area than in the protected area in most of the projects. However, this difference is not significant. This indicates that there is no significant impact by the FCD/I projects on the incidence of diseases. Poor feed supply and nutrition of the animals in the control area may be the cause of higher spending of money for vaccination and treatment of the animals.

I6. HOUSEHOLD INCOME FROM LIVESTOCK

Average household income from sale proceeds of live animals is shown in Table I18. The results indicate that in most projects the average household income from the sale of live animals varies relatively little between protected and control areas. Average household income from this source is higher in the protected area in Zilkar Haor, MDIP and Kurigram South and lower in Chalan Beel and KBK, compared with their respective control areas. High sales of live animals are often a forced response to crop losses, and it is notable that the three control areas with sales over T.1000 are all known to have had poor conditions (as assessed by farmers) during the survey year.

Table I18 Average Household Income from Sale of Live Animals (Tk).

Project	Impacted Area		Control area
	Protected Area	Unprotected Area	
Chalan Beel	1410	1374	1693
Kurigram South	895	590	830
Meghna-Dhonagoda	1019	-	772
Zilkar Haor	1141	662	1082
Kolabashukhali	948	-	1551

Source: PIE Household Survey.

Average household income from sale of livestock products in the five PIE projects is shown in Table I19. In general the average household income from the sale proceeds of livestock products is higher in the protected areas than the control areas. However, the highest income is recorded in KBK and the lowest in Chalan Beel. This shows a general relationship with the crop production of the project, i.e. the higher the crop production, the higher is the production of livestock products and thereby the higher is the household income.

Table I19 Average Household Income from Sale of Livestock Products (Tk.)

Project	Impacted Area		Control Area
	Protected Area	Unprotected Area	
Chalan Beel	780	1563	394
Kurigram South	747	522	848
Meghna-Dhonagoda	1018	-	415
Zilkar Haor	1131	931	909
Kolabashukhali	1375	-	1198

Source: PIE Household Survey.

The net household income from livestock sources in the protected and control areas of all five PIE projects are shown in Table I20. Average net income is the highest in Zilkar Haor and lowest in Kurigram South. It can be seen from the table that the gross income from livestock and total cost for feeds and treatment per household are highest in KBK. However, the net income per household is higher in the control area of KBK, Zilkar Haor and lower in Kurigram South, MDIP and Chalan Beel than in the protected area. This gives an indication that livestock production is no more profitable in the project areas than in the control areas.

Table I20 **Net Income per Household from Livestock Sources in Last Year (1990-91).**

Project	Gross Income/HH (TK)	Cost of feed and treatment/HH (TK)	Net Income/HH (TK)
Chalan Beel			
Protected Area	2190	1008	1182
Unprotected Area	2937	2072	866
Control Area	2087	1031	1056
Kurigram South			
Protected Area	1642	1213	429
Unprotected Area	1112	742	370
Control Area	1678	1590	88
Meghna -Dhonagoda			
Protected Area	2037	1239	798
Unprotected Area	-	-	-
Control Area	1187	604	583
Zilkar Haor			
Protected Area	2272	1034	1238
Unprotected Area	1593	872	721
Control Area	1991	652	1339
Kolabashukhali			
Protected Area	2323	1586	737
Unprotected Area	-	-	-
Control Area	2749	1223	1526

Source: PIE Household Survey

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APPENDIX J

FCD IMPACTS ON THE FISHERIES SECTOR

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APPENDIX J

FCD IMPACTS ON THE FISHERIES SECTOR

J 1 INTRODUCTION

There has been growing awareness amongst the authorities in Bangladesh and the donor community, that FCD/FCDI developments and polder type projects, have been having a cumulative negative impact on the fisheries sector. Concurrently with the implementation of FCD projects, local fishermen and Fisheries Department (DOF) staff have reported falling catch rates from the inland capture fisheries in rivers, beels and floodplains virtually throughout the country, and increasing hardship amongst the fishing communities dependent on these fisheries.

However, there is a general lack of basic information for assessing the scale of the problem, or for monitoring changes which continue to occur. A fisheries component was therefore included in the Terms of Reference for the FAP 12 Rapid Rural Appraisal (RRA) and Project Impact Evaluation (PIE) studies, with the aim of improving understanding of FCD related fisheries sector problems.

Seventeen RRA surveys were carried out during the period from late April until mid-July, which coincided with the first half of the 1991 monsoon flood season. The five PIEs took place during the peak and second half of the monsoon, from June to October which is also the peak time for subsistence floodplain fishing. Timing of these studies was dictated by circumstances rather than by choice, even though fish production is lowest during the early monsoon. Nevertheless, it was useful to see conditions during the flood season despite the added difficulty in travelling to contact fishermen and pond owners.

The overall conclusion of the 17 RRAs was that pond fish farming usually benefited from FCD, whereas the rivers, beels and floodplain fisheries were almost invariably damaged. The benefits from fish farming accrued mainly to land owners and farmers, whose land holdings also benefited from positive agricultural impacts, whereas the impact on the inland capture fisheries adversely affected large numbers of full time, and mostly landless, fishermen. The net impact was negative in almost all cases.

PIE coverage was limited to five of the seventeen projects and included interviews with 96 fishermen, 61 pond owners and 16 fish market traders in the five project impacted areas, and 80 fishermen, 20 fish farmers and 13 traders in the control areas. Data collection was undertaken by enumerators who, perforce, had to cover several disciplines within very limited timescales. Interviews had to be on the basis of one-off question and answer sessions, with little or no opportunity to verify the responses, for example, by observing and weighing actual catches, cross-checking fish prices with other traders and their customers, or by trial fishing to confirm fish pond stocking and production rates.

The outcome, as described in this report, adds to the understanding of the fisheries sector and confirms some of the beliefs concerning the effects of FCD, but coverage was constrained by available resources and the very restricted time allocation, such that the results have to be regarded as indicative. The study has not resolved the data shortage issue and does not obviate the urgent need for more comprehensive resource assessment and studies of aquaculture, capture fisheries technology and fish marketing. Proposals for the inclusion of such studies under FAP 17 are fully endorsed, as being the best means by which the present general lack of reliable fisheries data can be rectified.

J 2 Impacts on the Capture Fisheries and Fishing Community

J 2.1 Numbers of Fishermen and Fishing Effort

Data regarding the size and distribution of the fishing communities in and around project areas, was generally lacking or at best very imprecise. During the earlier round of RRA studies it was possible, in some cases, to obtain background data from Upazila fishery offices showing numbers per Upazila but, as project and upazila boundaries rarely coincided, the numbers per project and control areas had to be estimated tentatively, on the basis of observation and such evidence as existed. The PIE survey teams had neither the time nor resources to rectify this lack and in consequence, the size of the PIE survey samples, relative to their respective parts of the fishing industry, is uncertain in most cases. The numbers of fishermen interviewed and estimated total numbers are listed in Table J.1.

Table J.1: Numbers of Fishermen

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Fishermen interviewed	17	21	18	20	20
Estimated Total No. of fishermen	2500	1500	3000	400	2000
Control Area					
Fishermen interviewed	15	15	16	15	19
Estimated Total No. of fishermen	500	1000	1000	500	800

Sources : FAP 12 Surveys

A significant finding of the RRAs in all areas except Zilkar Haor, was that large numbers of fulltime professional fishermen were forced out of business by the negative impact of FCD works on capture fish stocks and catch rates. Unfortunately, the PIE teams were unable to throw any further light on this issue or on the reported corresponding increase in numbers of part time fishermen, but were able to confirm reports of much reduced catches of fish from the open water fisheries.

Fishing effort, expressed as the average number of fishing days per fisherman per year, is detailed in Table J.2.

Table J.2: Average Number of Fishing Days per Fisherman per Year.

	Chalan Beel Polder D	Kurigram South	Zilkar Haor	Meghna Dhonagoda	Kolabashukhali
Impacted Area-Now					
Peak Period	97	113	136	126	131
Lean Period	49	130	63	150	98
Total	146	243	199	276	229
Impacted Area-Before					
Peak Period	115	120	164	118	129
Lean Period	62	144	80	134	85
Total	177	264	244	252	214
Control Area-Now					
Peak Period	119	102	123	122	90
Lean Period	63	155	64	133	119
Total	182	257	187	255	209
Control Area-Before					
Peak Period	124	100	142	119	94
Lean Period	68	155	66	126	116
Total	192	255	208	245	210

Sources : FAP 12 Surveys

Even in Zilkar Haor where fish stocks were reportedly least affected by FCD, fishing effort has declined by nearly 20 per cent in the impacted area since before the project, compared with a decline of only 10 per cent in the control area. This is most likely the effect of reduced flood duration inside the project area, which is also demonstrated in Table J.3 in which the impacted area fishing periods for Zilkar Haor are shown to start and finish a month later than in the control. The other project areas show a variety of differences but no particular pattern.

Table J.3: Duration of Peak and Lean Fishing Periods

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area-Now					
Peak Period	Sept/Jan	Jun/Jan	Apr/Dec	Aug/Dec	July/March
Lean Period	Jan/Aug	Feb/May	Dec/Mar	Jan/July	April/June
Control Area-Now					
Peak Period	Sept/Feb	July/Dec	Aug/Nov	July/Nov	Oct/March
Lean Period	Feb/Aug	Jan/June	Dec/July	Dec/June	Apr/Sept
Impacted Area-Before					
Peak Period	July/Jan	June/Jan	Apr/Dec	Aug/Jan	July/Feb
Lean Period	Feb/March	Feb/May	Dec/March	Feb/March	Mar/July
Control Area-Before					
Peak Period	No data	No data	No data	No data	No data
Lean Period	No data	No data	No data	No data	No data

Sources : FAP 12 Surveys

J 2.2 Fish Production from the Open Water Capture Fisheries

Given the general lack of historical data on fisheries in the different project areas and the difficulty, therefore, in comparing pre and post project conditions, the approach was to establish current levels of production and then to obtain fishermen's views on how these compared with the past. RRA findings in this regard were that capture fishery landings had fallen by up to 75 per cent in all the full FCD and polder type project areas but that the decline was much less severe in the submersible or non-embanked areas such as Zilkar Haor.

Tables J.4 and J.5 show average catch data per fisherman, based on information provided by the fishermen interviewed by PIE enumerators. Table J.6 displays the opinions of fishermen on changes in species composition in the catch.

Table J.4: Average Catch per Fisherman per Day (kg.)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Now	3.8	2.3	2.7	2.6	1.2
Before	5.1	4.7	4.4	3.7	2.7
Control Area					
Now	3.6	2.2	2.3	2.2	1.8
Before	4.3	3.0	3.5	2.6	3.0

Sources : FAP 12 Surveys

Table J.5: Average Capture Fishery Catch per Fisherman During 1990/91 (kg.)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Major Carps	91	56	47	33	18
Aeir/Boal/Pangus	145	25	52	35	16
Hilsa	-	3	195	52	4
Shol/Gajar	53	46	-	43	52
Tilapia	-	-	1		-
Chital/Fali	13	10	-	3	18
Shing/Magur/Koi	40	85	15	40	101
Shrimp	100	117	68	94	35
Others	108	214	302	102	130
Total Capture Fish	550	556	680	402	374
Pond Fish (Mainly Carp)	260	33	-	-	44
Overall Total Catch	810	589	680	402	418
Control Area					
Major Carps	150	15	42	5	38
Aeir/Boal/Pangus	96	19	45	29	17
Hilsa	-	2	16	13	8
Shol/Gajar	88	30	65	13	142
Tilapia	-	2	6	-	-
Chital/Fali	13	2	10	-	10
Shing/Magur/Koi	46	87	91	15	132
Shrimp	70	70	42	51	32
Others	199	326	307	103	92
Total Capture Fish	662	553	624	229	471
Pond Fish (Mainly Carp)	562	-	353	-	61
Overall Total Catch	1224	553	977	229	532

Source : FAP 12 Surveys

Table J.6: Changes in Species Composition in the Catch
(Nos of fishermen responding - Control Area responses in brackets)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Major Carps					
-Up to 25% decrease	1(1)	1	1(4)	4(7)	1
-More than 25% decrease	11(7)	11(10)	9	8	6(6)
-Same as before	-(1)		(1)	1(1)	-
-Up to 25% increase	2(5)	1			-(1)
-Above than 25% increase	5(3)	4			2
Hilsa					
-Up to 25% decrease	-	(1)	3	-(1)	-
-More than 25% decrease	-		4(1)	-	1(2)
-Same as before	-		-	-	-
Boal/Aeir/Pabda/Pungus					
-Up to 25% decrease	1(6)	1(2)	1(1)	2	1(2)
-More than 25% decrease	10(6)	8(5)	9(3)	-	8(5)
-Same as before	-	-	(1)	-	-
-Up to 25% increase	2	-	-	-	-
-More than 25% increase	1	-	-	-	-
Shing/Magur/Koi					
-Up to 25% decrease	2(3)	-	1(2)	(2)	-
-More than 25% decrease	9(2)	7(5)	2(3)	1	9(9)
-Same as before	-	-	(1)	-	
-Up to 25% increase	-	-	-	-	1(1)
-Above than 25% increase	-	-	-	-	3(2)
Small Fish					
-Up to 25% decrease	1		-	1(1)	(2)
-More than 25% decrease	7(2)	2(2)	(4)	2	6(3)
-Same as before	-			-	-
Other Species (Shol, Gagar etc.)					
-Up to 25% decrease	(7)	(2)	2(2)	(1)	7(2)
-More than 25% decrease	4(4)	10(8)	10(9)		6(8)
-Same as before	-	1	1	-	(1)
-Up to 25% increase	-	-	-	-	-
-More than 25% increase	1		-	-	-
Total respondents	17(15)	21(15)	18(16)	20(15)	20(19)

Sources : FAP 12 surveys

According to Table J.4, daily catches per fisherman in the Zilkar Haor impacted area appear to have declined by about 30 percent, in contrast to only a 15 per cent decline in the control area. The catch composition table (Table J.6) provides further confirmation of the especially strong negative impact of all forms of FCD construction on the migratory carp species group. In other project areas the pattern is broadly the same.

Project impact on current and pre-project catches and fishermen's opinions about the causes of these changes are further explored in Tables J.7, J.8 and J.9. The results show that fishermen consider catches to have been more severely affected in the in the project areas than in controls and that the primary cause of the downward change in both areas is said to be the FCD projects. However, they do also recognise other contributory factors, such as use of pesticides, illegal fishing nets and fish disease, which are not directly related to FCD developments.

Table J.7: Comparison of 1990/91 and Pre-Project Catches
(Nos of fishermen responding)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Catch much more (25%+)	-	-	-	-	-
Catch up to 25% more	1	2	-	-	-
Catch unchanged	2	2	-	1	-
Catch up to 25% less	2	1	7	6	9
Catch much less (25%+)	12	14	10	13	7
Total respondents	17	21	18	20	20
Control Area					
Catch much more (25%+)	3	-		-	-
Catch up to 25% more	6	-	1	-	1
Catch unchanged	1	2	1	-	1
Catch up to 25% less	3	3	10	10	2
Catch much less (25%+)	2	10	4	5	15
Total respondents	15	15	16	15	19

Source : FAP 12 Surveys

Table J.8: Fishermen's Opinions about Project Impact
(Nos of fishermen responding)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Project affected catches	15	11	15	16	16
Project did not affect catch	2	5	-	2	-
Not sure/Do not know		5	2	2	4
Total	17	21	18	20	20
Control Area					
Project affected catches	9	11	9	13	12
Project did not affect catch		-	-	1	2
Not sure/Do not know	3	4	3	1	5
Total	15	15	16	15	19

Source: FAP 12 Surveys

Table J.9: Fishermen's Views on Causes of Project Impact
(Nos of fishermen responding - Control Area responses in brackets)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Fish access blocked, embankment	16(3)	3(2)	10(1)	7	12(6)
Excessive use of fertiliser and pesticide	1	(2)		7(1)	1
Use of current nets	(3)	5(7)	(7)	1(6)	2(1)
Fish Disease	3(2)	17(9)	(8)	2(12)	1(4)
Excessive capture of fish fingerlings	1(3)	3(6)	(2)	3(8)	3(1)
Drying of water bodies	5(4)	2(8)	4(1)	4(2)	7(4)
Difficulty of water transport	1			1	1
Decrease in fishing area	2(2)		7(1)	1	3(2)
God's will	-	7(5)	1	1(1)	(1)
More fishermen catching fish	-	-		-	4
Tidal water cannot enter	-	-		-	1
More pond culture	-	1(2)		-	-
Less fish	-	-	1	-	-
Total respondents	17(5)	21(15)	18(16)	20(15)	20(19)

Source: FAP 12 Surveys

J 2.3 Fish Prices and Fishermen's Earnings

It is known from other sources and from the RRA results, that fish prices vary widely from one species to another and also even for the same kind of fish in different parts of the country. In such circumstances it was felt that fishermen's recollections of price levels from 5 to 10 years earlier, would not be very useful. Nevertheless it was considered of importance to record current prices and earnings for comparison of impacted and control area differences. Average current fish prices, by species groups are listed in Table J.10 and fishermen's income and expenditure figures are in Table J.11.

Table J.10: Average Fish Prices During 1990/91 (Tk/Kg.)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Major Carps	31	49	69	57	41
Aeir/Boal/Pangus	24	34	49	59	29
Hilsa	-	33	35	40	53
Shol/Gajar	14	25	-	32	28
Tilapia	11	26	32	-	-
Chital/Fali	27	27	-	28	39
Shing/Magur/Koi	43	34	48	48	44
Shrimp	11	20	36	28	40
Others	11	15	16	33	17
Average (Weighted)	23.0	24.7	30.4	38.3	31.6
Control Area					
Major Carps	32	50	39	72	33
Aeir/Boal/Pangus	36	35	29	67	32
Hilsa	-	43	41	42	22
Shol/Gajar	28	28	22	50	21
Tilapia	14	21	27	-	-
Chital/Fali	28	21	31	-	19
Shing/Magur/Koi	47	35	39	60	37
Shrimp	8	12	86	31	62
Others	38	15	16	38	15
Average (Weighted)	32.6	20.4	30.2	43.2	28.0

Note: Pre-project figures not available from fishermen, but data from traders (see Section J 4.3) suggests they would have been about 60 per cent less than current levels.

Source : FAP 12 Surveys

Table J.11: Fishermen's Income and Expenditure, 1990/91

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Average catch (kg)	810	589	680	402	418
Consumed (kg)	67	45	41	47	30
Quantity Sold (kg)	733	544	639	355	388
Mean Value (Tk/Kg)	23.0	24.7	30.4	38.3	31.6
Gross Income (Tk)	17089	13437	19426	13596	12261
Boat costs	509	709	1597	1410	230
Netting costs	1638	1105	1445	1640	810
Licences and Other costs	59	510	506	550	500
Total Costs	2750	2324	3548	3600	1540
Net Income	14340	11,113	15878	9996	10721
Control Area					
Average catch (kg)	1224	553	978	229	532
Consumed (kg)	103	35	54	24	43
Quantity Sold (kg)	1121	518	924	205	489
Mean Value (Tk/Kg)	32.6	20.4	30.2	43.2	28.0
Gross Income (Tk)	36545	10567	27905	8860	13692
Boat costs	650	199	912	880	240
Netting costs	2280	1198	3327	675	1170
Other costs	7700	769	5400	15	430
Total Costs	10630	2166	9639	1570	1840
Net Income	25915	8401	18266	7290	11852

Source : FAP 12 Surveys

These results again support the general pattern that at least some fishermen are better off inside the projects rather than outside despite the damage caused to fish stocks and catch rates, although this might not have been the case had not so many project area fishermen moved away to seek other work.

J 2.4 Labour Employment in Capture Fisheries

Artisanal fishing, or professional fishing as it is termed in Bangladesh, is essentially a family occupation with skills handed down from one generation to the next. Some fishing operations only involve members of one family, whereas others may require two or more families to combine their efforts. Additional labour may be engaged on a casual basis, eg to haul in a large seine net, usually for a very small part of the catch rather than for cash. Table J.12 records the involvement of family members in their fishing business.

Table J.12: Involvement of Family Members in Fisheries Work
(Percentage of total fisheries work by Family Members)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Men					
Fish catching	21	25	22	17	24
Boat and gear repairs	32	37	46	21	40
Fish processing	7	1	-	2	-
Fish trading	20	19	18	22	24
Women and Children					
Fish catching	1	-	1	2	-
Boat and gear repairs	15	17	12	28	12
Fish processing	3	1	-	3	-
Fish trading	1	-	1	5	-
Total %	100	100	100	100	100
Control Area					
Men					
Fish catching	21	15	27	13	23
Boat and gear repairs	35	38	44	33	43
Fish processing	3	1	-	1	3
Fish trading	19	16	20	18	18
Women and Children					
Fish catching	-	-	-	1	-
Boat and gear repairs	20	30	9	27	12
Fish processing	2	-	-	7	1
Fish trading	-	-	-	-	-
Total %	100	100	100	100	100

Source : FAP 12 Surveys

It is of interest to note the large amount of time spent by fishermen in trading the fish which, presumably they have themselves caught. The crucial role of wives and children in maintaining the family fishing nets is also apparent. There is no significant difference in the pattern between impacted and control areas.

J 2.5 Problems Affecting Capture Fisheries

Fishermen were asked to identify the main problems which affected their operations, with the results set out in Table 3.713. Interestingly, none of the matters raised can be regarded as project related except for the point about boats not being able to ply in the project areas because access is blocked.

Table J.13: Problems Affecting Capture Fisheries
(Nos of fishermen responding)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Fish Catching Problems					
Cooperatives limit fishing for members only	-	-		6(4)	1
Leaseholders demand excessive fees for fishing rights	1(3)	2(1)	2(1)	1	5(4)
Leaseholders refuse credit	(2)	1(4)		1(4)	1
Lack of fishing boat	1(1)	(6)	2(1)	1	
Engine boats destroy nets	1(2)			1	
Boats cannot ply	-	-	1	(2)	1
Net thefts			2(1)		
Problems in Getting Leases					
Lack of capital	3	5(7)	2	1(3)	7(2)
Leasing dates kept secret		(2)		4(2)	(1)
Bribery	3(3)	3	3	2(1)	(2)
Non-fishermen can afford to pay higher lease charge	1(1)	1(1)	1	4	1
Leases given to non-fishermen	1(2)	1		-	3
Influence of local elits	-	12(13)	7(6)	-	8(7)
More money for sub leases	-	(3)	3(1)	-	-
Problems in Marketing					
(Nature of problem not stated)	1(2)	(6)	3	1(1)	2
Bad road communication	2(3)	(1)	-	-	3
Lack of storage and ice	4(2)	1(1)	4	-	-
Local "Mastan"	-(2)	1(4)	2(1)	-	6(1)
Middlemen	-	1(1)	3(3)	-	2(2)

Source : FAP 12 Surveys
Note: Control Area responses in brackets

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J 3 Impacts on Aquaculture and Pond Fish Production

J 3.1 General State of Aquaculture in PIE Project Areas

RRA findings generally supported the view that flood protection developments can create conditions in which fish farming can flourish, whereas prior to the start of FCD the annual monsoon flood overtopped ponds in all but the highest ground. This militated against new investment in pond rehabilitation or restocking with quality fish species and only low levels of production were possible, from harvesting such wild fish as remained in the pond water when the floods receded. It was further understood that in the past the majority of ponds were dug for reasons other than fish production, such as for material to construct household mounds and other purposes. However RRA studies in 13 project areas including Kolabashukhali, Protappur, Sakunia Beel, Kahua-Muhuri and Chalan Beel, found signs of new pond construction since project completion, aimed directly at fish farming and indicating that farmers are starting to take advantage of the opportunity for aquaculture expansion.

It was found that the expected benefits did not occur in parts of some project areas because of the negative impact of rain water flooding caused by inadequate drainage provision or because of frequent embankment breaches, for example in parts of BRE, Nagor River and Kurigram projects. In most of the other cases it was found that benefits have fallen short of their potential. There was a lack of fisheries involvement during project planning with the result that fisheries objectives were rarely, if ever set and no effort was made to marshal the necessary extra resources. DOF extension staff and limited recurrent funding proved unequal to the task of technology transfer to pond owners on the scale required, and the scarcity of low-interest rural credit for pond rehabilitation was also said to be a constraint. The supply of good quality fish fingerlings was also an initial problem but this has been largely resolved by the establishment of numerous public and private sector fish hatcheries and nurseries to augment the supply of carp fry from the principal rivers.

Current information on the numbers and distribution of ponds in the project areas is generally lacking. The best data presently available details pond distribution down to Upazila level and is based on SPARRSO water body surveys in 1983/84 but by now is in need of up-dating. Extrapolations from PIE findings should therefore be viewed with caution.

Fish ponds were found in four of the PIE study areas. The exception is Zilkar Haor project and control area, where it appears that there are no stocked fish ponds because flood depths are too great. Data on pond numbers, areas and ownership status, for the other four project areas under study, are listed in Table J.14.

These results accord with DOF data in that they show average pond size as being between 0.1 and 0.2 ha, which is about the national average, the larger ones being in the Chalan Beel and MDIP areas. Exceptionally, one of the three Kurigram control area ponds proved to be a 2.2 ha excavated section of formerly water-logged ground, now three years old, which was started with technical guidance from the Upazila Fishery Officer (UFO) and other assistance from an NGO. This privately owned large pond is now producing about 70 maunds per annum, or about 1190 kg/ha. Average pond productivity rates in the four project areas are detailed in section (d).

The motives of pond owners for digging or re-excavating ponds and for their manner of utilisation were investigated as set out below in Table J.15.

Table J.14: Numbers of Ponds & Ownership Status

	Chalan Beel 'D'	Kurigram South	Meghna-Dhonagoda	Kolabashu khali
Impacted Area				
No. of pond owners Interviewed	32	17	5	7
No. of Ponds involved	43	18	5	7
Area of Ponds owned (ha)	10.4	2.8	0.93	0.7
Average Pond size (ha)	0.2	0.1	0.2	0.1
Single Owner ponds (no)	12	6	1	2
Jointly owned ponds (no)	31	11	4	5
Leased ponds	-	-	-	-
Estd. total pond area (ha)	910	492	404	280
Control Area				
No. of pond owners Interviewed	8	3	5	4
No. of Ponds involved	11	3	5	4
Area of Pond owned (ha)	3.6	2.35	1.48	0.8
Average Pond size (ha)	0.3	0.1(*)	0.3	0.2
Single Owner ponds (no)	2	2	-	1
Jointly owned ponds (no)	9	1	5	3
Leased ponds	-	-	-	-
Est'd. total pond area (ha)	150	120	539	60

Note: (*) Average pond size for Kurigram control area excludes one exceptionally large pond.

Source: FAP 12 Survey data and consultants estimates based on DOF water area statistics, Fisheries Information Bulletin Vol.3, No.1.

Table J.15: Reasons for Pond Excavation & Utilization
(Control area responses in brackets)

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Ponds excavated				
-for fish culture	13(4)	9(3)	1	3(2)
-for house construction	8(1)	4	1	4
-for other purposes	2-	1		-(2)
Ponds utilisation				
-for fish culture only	2(2)	-	-	2-
-also for household use	29(5)	15(2)	5(5)	4(4)
-also for livestock	8(1)	5(2)	1(1)	1(1)
-also for irrigation	4(3)	2	(2)	-
Total respondents	32(8)	17(3)	5(5)	7(4)

Source : FAP 12 Surveys.

About 50 per cent of pond owners stated that their ponds were dug for fish cultivation, but very few were in fact using the ponds only for rearing fish. The majority of ponds were also being used for household purposes or for livestock washing and watering. It has to be noted that such multi-use of pond water and in particular, any resulting build up of detergents or other chemicals could prove harmful to fish particularly at higher stocking densities. There are of course recognised polyculture systems such as carp/duck combinations which are highly productive.

J 3.2 Risks of Flooding

The vulnerability of ponds to being over-topped by flood water and thereby losing any fish which may have been stocked, has been a major disincentive to pond owners who may be contemplating investments in fish farming. It was expected that FCD projects would encourage an expansion of pond culture, as a direct consequence of protection against flooding from the rivers, but as found by RRAs in several projects or parts of projects, the response to date has been disappointing. Pond owners views about flood risks prior to and since the project concerned, are examined in Table J.16.

Table J.16: Pond Owners' Assessment of Flooding Risks
(Control area responses in brackets)

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Ponds flooded before	18(2)	6	4(4)	2(2)
Ponds flooded now	12(2)	3	(3)	-
Total respondents	32(8)	17(3)	5(5)	7(4)

Source: FAP 12 Surveys.

The large number of pond owners inside Chalan Beel Polder D, whose ponds are still liable to flooding is a disappointing feature. In some parts this is a result of embankment breaches or public cuts and in others it is caused by rain water congestion. However, it is a reasonable conclusion in other cases, that ponds within FCD project areas which are no longer at risk of flooding, are thereby benefiting from the project. Unless there are other reasons to the contrary, control area ponds should not be any less vulnerable now than in the past. In the case of KBK control area which is in the process of being embanked, but was considered still to be open enough to serve as a valid control, it is presumed that the two respondents have their ponds in parts of the control area which must already benefit from some flood protection.

J 3.3 Changes in Culture Technology Employed

Indicators of the extent to which pond owners have adopted modern aquacultural technology, are the degree of pond preparation before stocking, the species mix and stocking densities and the level of supplementary feeding, all of which affect pond productivity. The nature and extent of pond preparation and responses by pond owners concerning fish culture technology are listed in Tables J.17, J.18 and J.19.

Table J.17: Extent of Pond Preparation

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Ponds dried and cleaned	19(6)	5(2)	5(1)	3(3)
Predatory fish killed	11	1	1(1)	1
Ponds reexcavated	2	12(1)	3(1)	2(1)
No preparatory work done	(2)	4(1)	(2)	3(1)
Total respondents	32(8)	17(3)	5(5)	7(4)

Source: FAP 12 Surveys.
Note: Control area respondents in brackets

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Table J.18: Fish Species and Stocking Densities
(Nos. of respondents)

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
a) Stocking of Fish Fingerlings -Species used				
Major & Exotic Carps	32(8)	17(3)	5(5)	6(4)
Catfish	(1)	1	-	-
Tilapia	1-	2(1)	-	3
Shrimp	-	1	-	3
Others	-	-	-	-
b) Source of Fingerlings Stocked				
Fingerlings Dealer	26(6)	16	5(5)	6(3)
Government hatchery	-	(1)	-	-
Private hatchery	7(2)	1(1)	-	1(1)
Fishermen	-	5(3)	-	-
Caught from river	-	-	-	-
Other sources	1(1)	-	-	-
Total respondents	32(8)	17(3)	5(5)	7(4)
c) Stocking Densities (kg/ha)				
Impacted Area				
Major & Exotic Carps	35	25	33	62
Catfish	-	4	-	-
Tilapia	0.4	1	-	12
Shrimp	-	4	-	4
Others	-	-	-	-
Control Area				
Major & Exotic Carps	43.2	42	30	104.0
Catfish	0.9	-	-	-
Tilapia	-	2	-	-
Shrimp	-	-	-	-
Other	-	-	-	-

Note: Depending on average length, 1 kg. of fingerlings contains between 200-300 fish. (Control area responses in brackets)

Source: FAP 12 surveys.

Table J.19: Use of Fertilisers and Fish Foods
- nos. of respondents

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Cow dung	12(4)	9(3)	1(1)	2(1)
Chemical fertiliser	6(6)	4(2)	4(3)	1
Bran and /or oilcake	11(8)	12(3)	5(3)	2(4)
Other materials	(1)	-	(1)	1
Nothing	-	-	-	4
Total respondents	32(8)	17(3)	5(5)	7(4)

Source : FAP 12 Surveys.

Note: Control area responses in brackets

These results support earlier RRA findings that a positive response from pond owners can be expected to follow the establishment of effective flood control. However the numbers reporting that they use feeds and fertiliser is surprisingly high compared with RRA observations which were that DOF's inability to sustain an effective extension effort was inhibiting pond owners' adoption of improved technology. On the whole, PIE interviewees considered the extension service to be at least as good as in the past, as is shown in Table J.20.

Table J.20: Effectiveness of DOF Aquaculture Extension Work
- nos. of respondents

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Extension effort improved	10	8(2)	3(1)	5(1)
About the same	20(2)	8(1)	-	2(2)
Extension worse now	1	1	2(1)	-
Total respondents	32(8)	17(3)	5(5)	7(4)

Source : FAP 12 Surveys.

Note: Control area responses in brackets

J 3.4 Fish Pond Productivity in Impacted & Control Areas

The results of pond owners' responses to enquiries concerning pond fish production, converted to standard units of kilograms per hectare, are shown in Table J.21.

Table J.21: Average Productivity of Fish Ponds (kg./ha.)

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashu khali
Impacted Area				
Carps	563	1733	1263	721
Catfish	5	80	10	-
Tilapia	4	13	80	174
Shrimp	7	27	-	110
Other spp.	15	133	39	-
Control Area				
Carps	534	1206	1209	934
Catfish	4	-	-	-
Tilapia	11	-	-	-
Shrimp	-	16	-	-
Other spp.	21	16	-	351

Source : FAP 12 Surveys.

Encouraging responses concerning the adoption of improved fish farming methods and supplementary feeding, have been supported, except in the case of Chalan Beel, by productivity rates close to or above the national average. This is currently around 1400 kg/ha for cultured carp ponds (DOF Annual Fish Catch Statistics for 1988/89), but is much less than that when ponds are also being used for shrimp cultivation, as is the case in parts of the Kolabashukhali protected area.

Pond productivity in the Chalan Beel area is disappointing but not unexpected, considering the high proportion of ponds which are still at risk of over-flooding.

Opinions of pond owners were rather mixed in respect of the causes and extent of changes in farmed fish production, as is shown in Table J.22 and J.23.

Table J.22: Trends in Farmed Fish Production
- Nos. of respondents

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Decreased more than 25%	2(1)	1	-	-
Decreased upto 25%	4	1	-	(1)
Not changed	14(3)	2	(2)	1(1)
Increased upto 25%	5(1)	6	2	1
Increased more than 25%	5(1)	3(1)	2(2)	4(1)
Total respondents	32(8)	17(3)	5(5)	7(4)

Source: FAP 12 Surveys.
Note: (Control area responses in brackets)

Table J.23: Pond Owners' Views on Reasons for Change
- Nos. of respondents

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashukhali
Causes of Increase				
Protection from flooding	4	2	2	1
Higher fish prices and profit	3	5	(1)	2
Availability of good fish seed	3(1)	4	2	1(1)
Improved technology	(1)	4(1)	(1)	-
Increased demand for fish	-	-	1	2
New Venture	-	-	-	1
More awareness of nutritional value of fish	-	1	-	-
More awareness of fish culture	-	-	(2)	-
Causes of Decrease				
Fish Disease	3(1)	1	-	-
Embankment breaches	2	-	-	-
Drainage water stagnation	1	-	-	-
Decreased water depth	-	1	-	-
Total respondents	32(8)	17(3)	5(5)	7(4)

Source : FAP 12 Surveys.
Note: Control area responses in brackets

In Chalan Beel the largest groups, both in the project and control areas considered that there has been no change, whereas in Kurigram, Kolabashukhali and Meghna Dhonagoda the reaction was more favourable. The principal causes of the general trend towards greater productivity are given as:

- increased profitability as a result of higher fish prices;
- improved availability of good fish seed; and
- protection from flooding.

The epidemic "Ulcerative Syndrome" fish disease was given as the main reason by those pond owners who considered that pond production was declining.

J 3.5 Prices of Farmed Fish and Pond Profitability

PIE survey findings concerning pond-side prices for farmed fish are detailed in Table J.24.

Table J.24: Average Pond-side Farmed Fish Prices (Tk./kg.)

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashu khali
Impacted Area				
Carps	33	38	40	40
Catfish	40	51	64	-
Tilapia	27	20	32	32
Shrimp	21	27	-	286
Others	20	15	27	-
Control Area				
Carps	35	39	39	30
Catfish	75	-	-	-
Tilapia	32	-	-	-
Shrimp	-	27	-	-
Others	27	16	-	21

Source : FAP 12 Surveys.

Prices appear to be reasonably consistent with a few interesting indications. Catfish are clearly in high demand in the Chalan Beel, Kurigram and Meghna Dhonagoda areas, indicating that diversification into catfish farming on a greater scale could be a worthwhile development. Secondly, small incidental quantities of mixed size shrimp have relatively little market value, in contrast to the

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shrimp farms in the Kolabashukhali/Khulna area which are stocked with shrimp on a large enough scale to command much higher prices from the processing and exporting companies.

An assessment of pond culture profitability, based on pond owners' responses is shown in Table J.25.

Table J.25: Average Fish Pond Profitability ('000 Tk./ha.)

	Chalan Beel 'D'	Kurigram South	Meghna Dhonagoda	Kolabashu khali
Impacted Area				
Number of interviews	32	17	5	7
Sales Income	19.6	72.4	55.5	47.1
Expenditure-stocking Feeding, harvesting etc.	7.6	32.6	18.8	15.0
Net income	12.0	39.8	36.7	32.1
Control Area				
Number of interviews	8	3	5	4
Sales Income	17.8	47.6	47.3	37.2
Expenditure-stocking Feeding, harvesting etc.	6.2	15.9	13.2	9.0
Net income	11.6	31.7	34.1	28.2

Source : FAP 12 Surveys.

These results are in line with specimen pond culture budgets obtained during RRA investigations of the Protappur FCD Project in Bogra District during June 1991. There appears to be a modest net benefit to profitability from the project to ponds in the impacted areas, except for Chalan Beel where, as noted earlier in Table J.16, many of the ponds still remain at risk of flooding.

J 3.6 Problems Affecting Fish Pond Owners

Problems affecting fish farming, as identified by pond owners are listed in Table J.26. The risk of ponds being overflooded is the only issue directly related to project impacts and is again clearly identified as being particularly troublesome for pond owners in the Chalan Beel project area.

Had FCD/I projects in the past included mitigatory fisheries development components, many of the issues now being raised would have been attended to as part of such fisheries work.

Table J.26: Pond Fish Culture Problems

	Chalan Beel 'D'		Kurigram South		Meghna Dhonagoda		Kolabashukhali	
	Now	Before	Now	Before	Now	Before	Now	Before
Pond ownership conflicts	9	9	-	-	-	-	-	-
Credit availability	-	-	2(1)	1	1(2)	1(2)	1	1
Uncooperative Govt. staff	4(2)	6(2)	4	2	1(5)	1(3)	3(1)	3(1)
Quality fish fingerling supply	8(2)	4(2)	5(3)	5	3	1	1(1)	1(1)
Harvesting difficulties	(1)	(1)	-	-	-	-	-	-
Getting technical advice	5(4)	5(5)	2(1)	2	1(3)	1(2)	2	2
Fish Feed supply	3	3	1	-	1	1	-	-
Poaching/theft of fish	5(1)	3	2(1)	3	(1)	(1)	1	-
Over flooding of ponds	5	7(1)	1	1	(2)	2(2)	-	1
Fish Disease	27(5)	7	16(2)	-	4(4)	-	5(2)	-
Other problems	-	-(1)	1	-	-	-	-	-

Source: FAP 12 Surveys.

J 4 Impacts on Fish Marketing and Traders

J 4.1 Numbers of Traders

DOF annual fisheries statistics contain very little information on fish marketing and virtually no data on the numbers of fish traders or on their activities. Among the findings of the earlier round of RRA studies, it was noted in several places that a number of former full-time fishermen had taken up fish trading in addition to, or in place of their catching operations, as one response to the decline in catch rates consequent on FCD developments. Table J.27 suggests that the number of fish traders attending impacted area markets has increased in most cases by between 45 per cent and 150 per cent. Some control area markets show similar trends but others have not changed or have even declined. It is not certain if these changes are all project related or if they result from more general economic changes in the areas concerned.

Table J.27: Changes in Numbers of Fish Traders

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Impacted Area					
Markets Sampled	3	3	4	3	3
Traders interviewed	3	3	4	3	3
Av. No. Traders per Market (before)	43	33	23	29	10
Av. No. Traders per Market (now)	86	71	21	42	24
Change in Trader nos (%)	+100	+115	-9	+45	+140
Interview Sample (%)	1.2	1.4	4.8	2.4	4.2
Control Area					
Markets Sampled	3	3	3	2	2
Traders interviewed	3	3	3	2	2
Av. No. Traders per Market (before)	9	16	28	37	58
Av. No. Traders per Market (now)	64	20	30	37	56
Change in Trader nos (%)	+611	+25	+7	0	-3.5
Interview Sample (%)	1.6	5	3.3	2.7	1.8

Source : FAP 12 Field Surveys.

Although it was possible to conduct only a small number of fish trader interviews during the PIE field surveys, they totalled 29 in all and were equivalent to between 1.2 per cent and 4.8 per cent of traders using the markets concerned. The results are reasonably consistent and consequently the views of traders on the nature and causes of changes in fish production, market supplies and prices, are regarded as important for cross-checking statements made by the primary producers. Their views also generally accord with the earlier RRA findings.

J 4.2 Changes in Volume of Trade and Fish Production

It has been argued in the RRA studies and elsewhere that FCD developments have had adverse impacts on fish stocks in general and not only on fish located within the boundaries of FCD/I Projects. Table J.28 provides additional evidence in support of this argument, in that the quantity of fish traded per day at the markets (hat) both within the impacted areas and outside, has declined since pre-Project times by as much as 65 per cent, notwithstanding that the number of traders has increased. The quantity of fish sold per trader has also decreased by up to nearly 60 per cent, although in the Kolabashukhali project and control area the decline appears to have been much less severe, as is shown in Table J.29.

Table J.28: Quantity of Fish (mt.) Traded per Hat/Day

		Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Peak Period						
Impacted	Now	0.38	1.66	0.71	1.4	0.69
	Before	1.08	1.80	1.21	1.8	1.10
	% Change	- 64.8	- 7.7	-41.3	- 22	- 37.3
Control	Now	1.60	1.49	0.67	0.9	4.3
	Before	2.20	2.04	0.88	1.3	8.28
	% Change	- 27.3	- 27.0	-23.9	-30.8	- 48.1
Lean Period						
Impacted	Now	0.12	0.62	0.33	0.57	0.26
	Before	0.36	0.82	0.50	0.73	0.42
	% Change	- 66.7	- 24.4	-34.0	-21.9	- 38.1
Control	Now	1.00	0.75	0.31	0.52	2.16
	Before	1.29	0.83	0.45	0.76	6.24
	% Change	- 22.5	- 9.6	-31.1	-31.6	- 65.4

Source : FAP 12 Field Surveys.

Table J.29: Quantity of Fish (mt.) Traded per Trader During Peak and Lean Periods.

		Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
During Peak Period						
Impacted	Now	13.20	1.78	11.85	5.65	2.06
	Before	18.08	4.66	20.06	7.97	2.40
	% Change	-27.0	-61.8	-40.9	-29.1	-14.2
Control	Now	8.96	3.36	6.48	0.54	3.60
	Before	12.05	4.85	9.00	0.70	3.60
	% Change	-25.6	-30.7	-28.0	-22.8	0
During Lean Period						
Impacted	Now	2.40	1.54	5.3	0.91	1.67
	Before	3.70	3.31	9.6	1.49	1.90
	% Change	-35.1	-53.5	-44.8	-38.9	-12.1
Control	Now	1.55	4.41	3.71	0.23	2.04
	Before	2.25	5.35	5.21	0.30	2.84
	% Change	-31.1	-17.6	-28.8	-23.3	-28.2
Total						
Impacted	Now	15.60	3.32	17.15	5.56	3.73
	Before	21.78	7.97	29.66	9.46	4.30
	% Change	-28.4	-58.3	-42.2	-30.6	-13.2
Control	Now	10.51	7.77	10.19	0.77	5.64
	Before	14.30	10.20	14.21	1.00	6.44
	% Change	-26.5	-23.8	-28.3	-23.0	-12.4

Source : FAP 12 Field Surveys

Efforts to analyse these data further, for example to estimate changes in annual fish supply from project and control areas, using the numbers of traders and sales volumes per trader, were frustrated by the realisation that many of the traders attend several different markets and draw their supplies from a variety of sources within and outside the FCD project areas. This may be the explanation of the stronger position of the KBK traders who are close enough to the sea to obtain some of their supplies from the estuarine fisheries which are not directly affected by FCD. The overall position is summarised in Table J.30 which presents the traders' general assessment of the fish production situation and in Table J.31, which identifies the more important fish species or species groups affected, as perceived by the market traders.

Table J.30: Traders' Assessment of Fish Production Trends

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali	Overall
Total Traders Interviewed						
	6	6	7	5	5	29
Production Increased						
Impacted Area	-	-		-	-	-
Control Area	-	1	1	-	1	3
Production Decreased						
Impacted Area	3	2	4	3	3	15
Control Area	2	1	2	2	1	8
Production Unchanged						
Impacted Area	-	-	-	-	-	
Control Area	-	1	-	-	-	1
No Response	1	1				2

Source : FAP 12 Surveys

Although some traders in the KBK area claimed that their volume of trade had not changed since the Project, only one of the five suggested that there had been any increase in production. He identified the fish species which had increased as the small air breathing catfish, Shing and Magur, together with the small perch, Koi and some introduced exotic Tilapia species. His colleagues and most of the traders in the other areas warned about reductions in fish production and declining stocks of all the major species groups, including Shing, Magur and Koi.

Table J.31: Changes in Abundance of Fish Species/Groups
(Nos. of traders responding)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Increased					
Major Carps		1	(1)		
Shing/Magur/Koi					(1)
Tilapia					(1)
Small Fish		1	(1)		
Decreased					
Major Carps	1(1)	1	2(1)	1	2(1)
Boal/Pabda	1(3)			2	1(2)
Ilish (Hilsa)				1	
Baim	2		1	(2)	
Chital/Fali	1(1)	1		2	(1)
Shing/Magur/Koi	1(2)		3(1)	1(2)	(1)
Snake-head	3(1)	2(1)	2		1
Aeir					1
Veda/Meni					1
Pangus					1(1)
Small Fish	2(1)	1(1)	1	2	1(1)
Shrimp	(1)		2		1
Other species	3(1)				
Total Respondents	3(3)	3(3)	4(3)	3(2)	3(2)

Source: FAP 12 Surveys
Note: Control area responses in brackets

Most of the traders had decided views about the causes of change in fish stocks and considered that the two principal factors were the effects of FCD structures in blocking the spawning migrations of fish into and out of Project areas and the effects of the current epidemic "ulcerative syndrome" fish disease. Other causes included illegal fishing methods and the excessive catching of fish fry and juveniles. Three respondents noted an increase in supplies of farmed carps and tilapia in the Kurigram, Meghna-Dhonagoda and Kolabashukhali areas, whilst the beel restocking programme is starting to revive carp catches in parts of the Kurigram

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Project area and MDIP control area. However, the quantities involved are small in comparison to the FCD losses. These and other causes are listed in Table J.32.

Table J.32: Traders' Views on Causes of Fish Stock Changes
(Nos. of traders responding)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Embankments stop fish entry	1	1	(1)	1	2(2)
Decrease of production area			1(1)	1	
Drying of water bodies		1(1)	3(1)	(1)	
Catching juvenile fish	(1)		1	2(1)	2(1)
Use of illegal nets	(2)	2	1	1	1(1)
More fishermen	(1)		(1)	1	
Fish Disease	3(2)	1(1)	3(1)	(2)	1
Excessive fertilizer				(1)	1
Pond Fish Culture Increased		1	(1)		(1)
Restocking carp in beels		1			
Total Respondents	3(3)	3(3)	4(3)	3(2)	3(2)

Source: FAP 12 Surveys
Note: Control area responses in brackets

There is no evidence to suggest any direct connection between FCD and the fish disease epidemic but it is understandably a major problem to the fish trade because the unsightly ulcers which develop on mature fish render them generally unsaleable and there have been reports of large scale mortalities of juvenile fish showing signs of the disease.

J 4.3 Changes in Prices of Fish

The findings of the five PIE field surveys on current fish prices are set out in Table J.33. Fears that respondents would not be able accurately to recall price levels of up to ten years beforehand proved correct. Average figures for 1982/83 obtained independently from DOF are therefore listed in Table J.34 for comparison. Trader's mark-up and some of the current prices seem rather low compared with published main urban market values, particularly for high quality fish such as the major carps. However, as most of the markets surveyed were village level "hat" rather than urban "bazar" where higher price levels would prevail, the outcome is considered to be reasonably consistent.

Table J.33: Average 1990/1991 Buying & Selling Prices for Fish (Tk. per kg.)

Fish Species/Groups		Impacted Area					Control Area				
		Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Major carps	buying	27	43	96	54	42	35	30	67	54	40
	selling	32	48	108	59	47	41	35	83	59	46
Live fish	buying	57	35	50	54	72	50	30	42	-	80
	selling	67	40	65	59	91	60	35	50	-	93
Catfish	buying	32	27	46	68	-	-	27	34	19	-
	selling	37	30	52	79	-	-	32	39	27	-
Snakeheads	buying	-	-	43	29	-	-	13	35	-	-
	selling	-	-	51	32	-	-	16	40	-	-
Hilsa	buying	-	38	36	35	51	58	27	-	43	43
	selling	-	41	40	43	58	60	32	-	54	48
Small fish	buying	18	11	18	33	31	-	16	13	11	27
	selling	24	13	23	38	35	-	21	21	18	32
Shrimp	buying	8	8	188	21	21	-	-	214	8	32
	selling	10	11	208	27	25	-	-	295	15	40

Note: Live fish includes Shing, Majur & Koi; Catfish include Boal and Pabda; Snakeheads include Shol & Gajar; Small fish include Puti, Chela, Mola & Tengra.

Source: FAP 12 Field Surveys.

Table J.34 : Average Wholesale & Retail Fish Prices, 1982/83 (Tk./kg.)

	Wholesale Price	Retail Price
Carps	21.97	24.40
Catfish	21.41	25.87
Live fish	27.65	32.47
Hilsa	19.37	21.03
Shrimp (small)	22.48	24.83
Other spp.	14.20	16.62

Source : DOF Annual Report, 1982/1983

Table J.33 shows that there is a wide range of fish prices across the country, even for the same species of fish. The data was collected, during the monsoon flood season when supplies fluctuate and prices are generally high.

The pre and post project price comparison shows increases generally of between 40 per cent and 90 per cent although there are wider variations, both up and down for particular species. However, the overall pattern of fish prices does indicate a higher average price level in the impacted area markets than in the control areas. This probably stems from shortfalls in supply coupled with progressively greater demand for fish in the flood protected areas created by increased affluence amongst benefitting land-owners and the increased in-migration of landless people from the surrounding country side into FCD areas in search of work, which was also observed during the RRA studies. The rise in fish prices over time appears less than has been suggested in other reports. For example, the World Bank Fisheries Sector Review of October 1990, quoting Bangladesh Bureau of Statistics annual retail prices data, noted that increasing scarcity was driving fish prices up at a faster rate than other food commodities and that the average annual increase during the 12 years 1975/76 to 1987/88 was 15.6 per cent for fish, 13.7 per cent for chicken and 10.3 per cent for rice.

J 4.4 Fish Traders' Sources of Supply

The response to enquiries about the fish traders' sources of supply are shown in Table J.35 and confirm that most fish are purchased directly from professional fishermen and subsistence level villagers, with few if any intermediaries. There appear to be no significant changes in supply source for this level of marketing since pre-Project times. Sales further along the marketing chain, at township and city urban markets, would involve a variety of additional middlemen and wholesalers. The PIE interviews do not appear to have included any of the fishermen who, as noted in Section 3.7.1(d) now spend as much time in marketing their own fish as they do in catching them.

Table J.35: Fish Traders' Sources of Supply
(Nos. of traders responding)

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
		Now			
Direct from fishermen	2(2)	3(3)	4(3)	2(2)	3(2)
From Aratdar	1	1	1(1)	1(2)	-
From Bepari/Wholesaler	-	1(1)	1	1	1(1)
From Village People	3(3)	(2)	2(2)	2	1
From Cooperatives	(1)	-	-	-	1
From Other sources	-	-	-	1	-
		Before			
Direct from fishermen	2(2)	3(3)	4(3)	(2)	3(2)
From Aratdar	1	-	1(1)	(2)	-
From Bepari/Wholesalers	-	1(1)	1	1	1(1)
From Village people	3(3)	(2)	2(2)	2	1
Cooperatives	(1)	-	-	-	1
From Other sources	-	-	-	-	-
Total Respondents	3(3)	3(3)	4(3)	3(2)	3(2)

Source: FAP 12 Surveys
Note: Control area responses in brackets

J 4.5 Changes in Traders' Income

Traders' assessment of their income trends and the reasons for changes in income levels, are shown in Tables J.36 and J.37. Most considered that incomes had declined and that the principal cause was the increase in numbers of traders having to compete for smaller quantities of fish. Only a few said they were better off because of the increased demand for higher priced fish.

Table J.36: Fish Traders' Income Trends

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Income much better now	-	-		-	-
Income better now	-	(2)	(1)	-	1(1)
Income the same now	-	-		-	1(1)
Income less now	2(2)	2(1)	2(2)	3(1)	1
Income much less now	(1)	1	2	(1)	-
Total Respondents	3(3)	3(3)	4(3)	3(2)	3(2)

Source : FAP 12 survey
Note: Control area responses in brackets

Table J.37: Reasons for Changes in Fish Traders' Income

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Decrease in fish quantity	3(2)	1(1)	4(1)	2(1)	-
Increase in Nos. of traders	1(3)	2(2)	1(1)	3(1)	-
Decrease in buying capacity	-	1	2(1)	2(2)	1
Increase in Nos. of buyers	-	-	-	-	1
Increase in buying capacity	-	-	-	-	(1)
Increase in price of fish/ more profit		(1)	(1)		
Increase in demand		(1)	-		
Total Respondents	3(3)	3(3)	4(3)	3(2)	3(2)

Source : FAP 12 Survey

J 4.6 Problems Affecting the Fish Trade

Finally, the problems affecting fish trading, as perceived by the traders, are set out in Table J.38. Problems of management, lack of capital/credit and lack of storage facilities appear to be more troublesome now than in the past. Interestingly, nobody specifically mentioned shortage of ice as a problem, although it could be taken as included in the storage problem. Ice supply was raised as an issue in several centres during the earlier round of RRA studies.

Table J.38: Problems Affecting Fish Trading

	Chalan Beel Polder D	Kurigram South	Meghna Dhonagoda	Zilkar Haor	Kolabashukhali
Now					
Management problems			2		
Transport difficulties			(1)		
Lack of Capital			3		
Excessive Tolls	2(2)	3(3)	(1)	2(2)	3(2)
Lack of storage facilities	1	1	1(2)	1(2)	-
High Prices	-	1(1)	2	1	1(1)
Tolls to Mastan	3(3)	(2)	-	2	1
Too many traders	-(1)	-	-	-	1
Lack of security	-	-	-	1	-
Before					
Management problems	2(2)	3(3)	2	(2)	3(2)
Transport difficulties	1	-	(2)	(2)	
Lack of Capital	-	1(1)	-	1	1(1)
Excessive Tolls	3(3)	(2)	-	2	1
Lack of storage facilities	(1)	-	3(1)	-	1
Total Respondents	3(3)	3(3)	4(3)	3(2)	3(2)

Source : FAP 12 Surveys
Note: Control area responses in brackets

J 5 CONCLUSIONS

J 5.1 Size of the Fishing Communities

As was found during the earlier round of RRA studies, data concerning the size and distribution of fishing communities was generally lacking, or at best imprecise. The PIE teams fared no better as regards the availability of total area data. In consequence, the relative size of the PIE survey samples is uncertain in most cases, making it difficult if not impossible, to extrapolate from the sample data with any confidence. It is considered essential, as and when new FCD projects are being planned, to conduct base-line studies in which the numbers and distribution of the various sections of the population will include fishermen and their families. Subsequent changes during and after project implementation should be monitored.

A significant feature of the RRA findings, arising from the negative impact on fish stocks and, consequently on declining catch rates in the capture fisheries, was a reduction in numbers of full time professional fishermen. This particularly affected Hindu communities who traditionally provided the bulk of the full time fishery work force. They found that their former fishing grounds in the beels were being destroyed by FCD embankments blocking fish migration routes, and in many cases by the almost total drainage of the beel areas. When forced to concentrate on fishing in the rivers, their catch rates and earnings soon fell, to the extent that many were forced to seek other part time paid employment, and others had to give up altogether and migrate elsewhere in search of work. In several cases the fall in numbers was reported to be as high as 50 per cent.

It was further reported that in their place at least equal numbers of other landless people, many of them Muslims and some being people whose land has been compulsorily acquired in the course of project implementation, have come into part time commercial fishing for the first time. There are no records of any of these changes but they suggest that there may not have been any substantial increase in total fishing effort since the late 1980s, but neither has there been any significant reduction.

J 5.2 Fish Resources

FCD is unquestionably implicated in the decline in fish stocks because of the physical barriers to migrations, spawning, floodplain recruitment and the reduction in areas of beels and other water bodies. Given the smaller fish stock size, even an unchanged level of fishing effort can cause overfishing. Detailed evidence is far from adequate but there are alarming signs of a near collapse of riverine fish species, and the present widespread use of illegal small mesh nets only makes matters worse. Many water bodies which could hold water throughout the year and thus support breeding populations of resident fish species, are drained or pumped dry to create land for another rice crop or for irrigation water, instead of being managed for fish production on a sustainable basis.

The RRA results suggested that submersible embankment schemes do less harm to capture fisheries than full FCD projects and this conclusion was generally supported by the Zilkar Haor PIE findings. The evidence is not conclusive but the delayed flooding approach does seem to be worth further investigation for possible wider application.

J 5.3 Fish Farming

There were positive benefits to fish farming in most of the projects studied, except for the two submersible embankment cases and those parts of other projects where flooding still persists because of breaches or drainage problems. Further development is possible and urgently needed but is constrained by a general lack of low cost credit to finance pond construction or rehabilitation and by inadequate technical know-how in several areas. The potential for farmed fish production is considerable and FAP 12 findings confirm that it is economically competitive with other land uses, but it would not be reasonable to expect that aquaculture can fully replace the losses to national fish supply resulting from the decline in capture fishing.

J 5.4 Recommendations

It is clear from all the FAP 12 studies that a considerable amount of avoidable damage has been inflicted on the inland capture fisheries, and that it will probably not be possible to fully restore the fish stocks and rebuild production to earlier levels. However, it is also clear that the two principal causes of the decline, namely FCD and illegal overfishing, both have the potential to do even more damage in future unless appropriate action is taken.

Accordingly, it is recommended that DOF and the Ministry of Fisheries and Livestock given urgent consideration to strengthening the fisheries inspectorate responsible for enforcing the existing protective legislation, with the aim of stopping the present widespread and blatant use of illegal fishing methods.

Consideration should also be given to the need to reduce fishing effort commensurate with the present low state of the fish stocks. Restrictive licensing, close seasons, further restrictions on fishing gear and net mesh sizes and the imposition of stricter controls on the collection of wild spawn and fry from the rivers, may all prove necessary. It is considered that top priority should be given to preventing any further deterioration of the fish stocks, especially in the rivers, as a preliminary to their restoration.

Research will be needed into the most effective means and the best species to use, to start restocking the rivers in the hope of restoring their reproductive capacity. For example, stocking large numbers of fingerling carp into rivers may not be very effective because such juvenile stages are normally to be found in the floodlands and beels. It may be necessary to create conditions in which fish can grow to maturity before being released into the river.

It is recommended that all remaining public beels and other khas water bodies, should be preserved against drainage and improved by re-excavation and other means to increase their water holding capacity and fish productivity; that all such water bodies be made subject to the New Fisheries Management Policy and leased only to bona-fide fishermen, with suitable arrangements for supervision, such as by NGOs.

It is urged that all future FCD project planners give particular consideration to fisheries impacts and make appropriate adjustments to the designs of structures so as to minimise any adverse effects. In addition all such projects should include specific mitigatory provision to assist affected fishing communities. DOF must be fully involved throughout project planning and implementation and where necessary, assistance should be included to enable DOF to deploy the required staff and other resources. The project should include provision for the rehabilitation of publicly owned water bodies and optimising fish production. Finally, the

Project management system should be designed to manage the flows of water into and out of the impacted the area, in such ways as to minimise conflicts between fishermen and other interests.

It is strongly recommended that the provision for fish farming extension services throughout the country be reviewed and strengthened where necessary, to take maximum advantage of the opportunities provided by FCD for expanding and developing fish farming.

Finally, it is also recommended that the present data collection and analysis process be reviewed and broadened to enable FCD planning and future fisheries development planning to be more firmly based on reliable information. The process should also serve as the principal means of monitoring progress year by year. There is urgent need to update the existing water body area statistics, which is likely to involve the need for donor assistance.

Annex 1

Methodology for Calculation of Capture Fishery Losses

1 Introduction

The FAP 12 RRAs indicate that there have been large declines in capture fishery productivity, and large changes in the species composition of catches, in all the FCD/I projects studied which had a significant pre-project capture fishery. These changes agree well with the expected impact of flood control embankments and structures on the main floodplain species in Bangladesh. However, because the RRAs used a pre- vs. post-project comparison, and it is known that there have been other adverse impacts on fisheries (including use of nets of illegal mesh, and the epidemic of ulcerative syndrome fish disease) it is not certain how much of the decline is due to project effects.

Clarification could in principle have been obtained from the PIE surveys, which used a with- vs. without-project comparison based on control areas, but in practice the gain in information from this source is limited. The fisheries module of the PIE surveys was administered only to a limited number of case study respondents, and the capacity to extrapolate project impacts from their responses is therefore limited. In addition, the control areas used for comparison are in several cases unavoidably quite close to the areas protected by FCD works, and it is likely that fishermen in the project and control areas are fishing essentially the same stocks.

For these reasons, while there is strong evidence for adverse impacts on capture fisheries, there remains considerable uncertainty over the precise magnitude of the fishery impacts of the projects. The approach adopted for economic assessment of fishery losses has therefore been based on use of standard loss coefficients for different classes of water body, except where there were strong indications that these did not apply in particular local circumstances (for example, at Polder 17/2 where a highly productive estuarine fishery was almost destroyed).

The coefficients used are described below.

2 Calculation of Volume Lost

Type of Water Body	Loss
Seasonally flooded land (flooded to at least 30 cm pre-project)	37 kg./ha.
Reduction on remaining flooded land within embankment protected area	20 kg./ha.
Area completely lost to beels	400 kg./ha.
Reduction on residual beel areas	150 kg./ha.
Reduction on rivers and khals	15 kg./ha.

The source of these coefficients is MPO Technical Paper No.17, 'Fisheries and Flood Control, Drainage and Irrigation Development'. Where there is significant annual variation in the extent of protection provided, or where (as in some cases) there are different estimates of the protected area, 'high' and 'low' loss estimates have been made reflecting the range of variation.

3 Valuation of Fishery Losses

Unless there were very good local data, the following estimates were used:

	1991 Prices	
	Financial (Tk./kg.)	**Economic (Tk./kg.)**
Average value of fish caught	55.00	55.00
Depreciation of equipment	10.00	7.10
Labour	30.00	21.30
Net value of catch	15.00	26.60