APPENDIX 3

SURVEYS AND STUDIES

1 Surveys

1.1 Scope of the Surveys

At the beginning of the investigations a survey was conducted in parts of the region where it was expected that flood control and drainage (FCD) projects will have to be implemented: in the flood-plains (Appendix 1). It took place in May 1991. The objective was to obtain grassroots information on cropping patterns adopted by the farmers on their entire holding, highland and lowland; yields; the situation regarding farm power for tillage, and labour to meet peak-season demands. Only a small sample was collected from the Himalayan Piedmont (the old Dinajpur district) for comparison, and none from the Barind tract. The area between the northern border and the Teesta, except for Kurigram, was also excluded: its location is such that little if anything can be done there to control flooding. The 423 farmers interviewed operated about 500 ha, 0.07% of the cultivable area of the floodplains. Farmers in Bangladesh aim to operate on many parcels, located at different parts of the landscape, to escape the hazards inherent in any one elevation: highlands suffer from drought in years like 1992 and lowlands from destructive flooding in years like 1987 and 1988. The questions the respondents were asked covered their entire holding: care was taken not to collect answers pertaining only to the piece of land on which they were interviewed. Subsequent discussions in the villages, with individuals and groups, were conducted to test, corroborate and supplement the findings of this survey and to obtain additional information, right up to August 1992. The location and number of interviews are shwn overleaf.

In 1992 a separate agroeconomic survey was carried out in the Gaibandha project area. This covered 6 villages with a sample of 35 farmers in each village, and provided much useful information on input use, yields and othert agricultural aspects. It is written up in Annex 13, Economics.

1.2 Farm Size and Ownership

The average area operated by the respondents was 1.26 ha; the average number of parcels, 4. Eighty-four percent owned their land, 37% were sharecroppers and 7% leaseholders. Many owned as well as rented land. Payments by sharecroppers were usually 50%; leases, where the lessee provided all the inputs except the land, were a fixed share of the produce, about one third of a normal crop.

Old District	New District	Numbers Interviewed
Pabna	Pabna Sirajganj	45 45
Rajshahi	Rajshahi Nawabganj Naogaon	20 20 45
Bogra	Bogra Joypurhat	45 45
Rangpur	Rangpur Gaibandha Nilphamari	45 44 45
Dinajpur	Thakurgaon Panchagarh	14 10
Total Interviewed		423

1.3 Crops, Cropping Patterns, Yields

Cropping intensities averaged 152%, ranging between 187% and 142%. A few exceeded 200%: they triple cropped some of their land. Without exception, those who triple cropped either owned draft animals or had a (two-wheel tractor (power tiller; the terms are used interchangeably). They were also well organised to obtain labour to safeguard their harvest simultaneously with planting the next crop.

Average reported yields and time taken to harvest them were as follows:

Crop	Yield (t/ha)	Duration (day/ha)	Crop	Yield (t/ha)	Harvest time (days/ha)
Boro Local	2.6	16.5	Jute	1.6	23.0
HYV	4.3	13.2	Khesari	1.2	14.0
B. Aus	1.6	14.7	Wheat	1.2	18.0
T.Aus Local	2.2	13.4	Potatoes	7.7	18.0
HYV	3.0	16.6	Mustard	0.7	13.0
aus/aman	2.7	17.8	Sugarcane	35.7	NA
T.Floating	2.3	13.8	Tobacco	1.0	26.5
B.Aman	2.0	11.6	Spices	5.5	15.0
T.Aman Local	2.5	13.7	Sesamum	0.8	12.0
HYV	3.2	13.7	Oth Pulses	0.8	15.0

1.4 Labour Availability

Preliminary enquiries have indicated likely labour shortages at peak times. The problem is not recent: it was flagged as long ago as 1928 by the Royal Commission on Bengal's agriculture, the Linlithgow Commission, as a by then long-standing, perennial issue.

About two thirds of the respondents would like to harvest faster than they are capable of at present, especially their HYV transplanted aus and aman. At the time t aus is harvested there is a definite risk of rain and the harvest of the t aman, the crop occupying the most land, the most time-consuming. The labour force used enabled respondents to harvest their rice in 14.5 days/ha; other crops took 17.5 days/ha. These did not include jute and sugarcane: with these considerations other than labour availability arise. Wheat and potato harvest took 18 days. Potatoes are not at risk by the weather and apparently in the farmers' perception neither is wheat: harvest is between mid-March and early April. As a rule only one or two people are cutting wheat at any one time, in marked contrast to neighbouring countries and other crops in Bangladesh. Harvesting mixed aus/aman took about 8 days for the aman, 10 for the aus.

The time taken to harvest a crop is important not only because of the weather hazard. Rice, especially the HYVs, shatter easily and therefore if the harvest is prolonged field losses are high. If to losses through shattering one adds the risk of loss due to rain, it becomes obvious why a speedy harvest is every farmer's major aim. Weather risks are the least with the aman harvest in November and early December. However, the different aman crops occupy by far the largest area and therefore demand a large labour force, especially if the intention is to grow a rabi crop to follow it: this must be quickly planted, to utilise residual moisture, a scarce commodity. Since FCD projects would enable farmers to grow more boro, transplanted aus and transplanted floating rice, the labour shortage at harvest would be exacerbated. Labour availability is therefore a major future farm management issue.

The long time taken to harvest shows that harvest labour is short. Therefore it was necessary to learn how farmers cope. Much shattering of boro rice, estimated at about 80-100kg/ha, and to lesser extent wheat was noticed in the freshly harvested fields, indicating that there is indeed a problem which causes quite sizeable losses. It was said to be worse for aus. Because of the large area labour resources are most stretched for aman. It was disturbing to note what a slow operation wheat harvest is: large areas were uncut in April although it had obviously been ripe for some time.

Family labour helped with 98% of the rice harvests. In addition, 78% hired labour and 26% used harvest contractors. Only 2% did not participate in the harvest of their own rice. Many farmers used all three sources. 99% of those who grew other crops were involved directly in their harvest. Hired labour, either alone or working with family labour, was employed by 68% of the growers of other crops; contractors to the extent of 7%; only in three cases without family or hired labour working along with them.

The 84% who employed outside help for the harvest almost all paid by the day, 21% by the area harvested, and 5% contracted to give an agreed share of the crop. Contract labour, whether by crop shares or by area harvested, were from other re-gions who came specifically for the harvest, it being at a differ-ent time than in their home area.

The analysis of harvest labour should be examined along with the issue that most of the respondents would have liked to harvest quicker. Increasing labour shortage and its consequent increasing field losses would appear to be a distinct possibility in the not too distant future even without the intensification expected from FAP and other projects.

1.5 Draft Power: Cattle, Buffaloes, Power Tillers

The shortage and constraint of draft power for land preparation, already identified as a problem by the Linlithgow Commission in 1928 (Section I.4) is increasingly preoccupying farmers. Animal feed is getting scarcer as more land has to be devoted to grow human food. There is no prospect of growing a special fodder crop as in India and Pakistan. The only potential source are the byproducts from intensified arable crop production which would be made possible by FCD projects. However, the byproduct will be rice straw: not a good fodder. Furthermore, with an improved water regime HYV's are ex-pected largely to take over from the local ones. These may produce less straw although this is by no means certain because the expected increase in yields implies at least the same and possibly more straw than at present. However, the HYV straws are of lower digestibility than the softer straw of the traditional varieties. Consequently, according to many observers, and the farmers themselves, the strength of working animals is declining, and, with it, the quality of land preparation. While tradition and the older records speak of five or six ploughings and ladderings before transplanting, the survey found that nowadays it is usually done only three times: not from choice, say the farmers, but necessity. In view of the foregoing, it was considered essential carefully to probe this issue.

Two-thirds of the respondents had draft cattle; 3% also had buffaloes and 2% buffaloes only. In total, 71% of those interviewed owned draft animals. Only three respondents had two-wheeled tractors. This was clearly an underrecording: seemingly the owners were not people who were habitually in the fields, where all the interviews took place. Subsequent discussions in the villages, with the importers and sellers of the machines and bank managers dealing with loan applications indicated that there had to be many more. The importers report sales of 250-300 units per annum. However, the significant finding is that 30% of the respondents have to rely on draft power that is not fully under their control. It is self evident that such help will only be forthcoming after those who have animals or power tillers prepared their own fields.

As yet it does not appear too difficult to rent animals: 49% of the respondents could get someone to plough their land within a day or so of requesting help, and most of the others could get help in what they considered a reasonable time. However the issue of skimped land preparation, compared to traditional standards and expectations, remains. Perhaps more importantly, triple cropping is impossible without readily available land preparation facilities. There were cases reported of farmers having to forego planting HYV t aman because they could not get their land prepared in time: HYV t aman cannot be successfully planted after late August.

The process of land preparation was also examined from the supply side: who were the contractors and how many could satisfy all potential customers. Just over half the owners of draft animals, and all owners of power tillers, did contract work. Others who owned animals either had too much land of their own to work for others or their animals did not have the strength to undertake additional work: the issue of fodder supplies has clearly manifested itself. Only one third could meet all requests made on them.

Animals in Bangladesh do not work every day when doing land preparation, and when they work it is only for 4 or 5 hours. All respondents, without exception, emphasised that their animals must have rest days. Significantly, over 60% believed that even with better feeding rest days would be necessary. Alternate-day working in peak seasons is emphatically not the case in neighbouring countries or indeed anywhere where land preparation is done with animals. However, daily working is inevitably complemented with hand feeding, if only to make up for lost grazing time. The responses show that the work animals are not only chronically weak and underfed, but also that this situation has been going on

for so long that even the tradition of working them every day is being forgotten. The findings confirm the general perception that the time is near when further significant intensification of agricultural production cannot be achieved without mechanising land preparation.

Buffaloes (swamp buffaloes as in Thailand and Sri Lanka, not the larger water buffalo of Northern India, Pakistan and Egypt) do work every day. They are stronger than cattle and always in better condition. However, since they are not nearly as widespread as draft cattle, and since they are used for haulage more than cattle, for planning purposes the findings and conclusions recorded, even though they pertain mostly to cattle, are valid.

All draft animals were used for threshing by their owners, to trample the harvested material, typically the aman crop. 6% threshed for others, 13% were used for transport by their owners; less than 2% did contract transport. Most of the contractors were in Rajshahi and Nawabganj districts, where sugarcane is a major crop and has to taken to the factories' collecting centres. Since the alternative to animal transport would appear to be either bicycle rickshaws specially desgned to be goods vehicles or carrying goods on shoulder-poles, the low usage of draft animals for transport is surprising; it is, however, corroborated by the very few animal drawn vehicles seen on the regions roads, and the even fewer carts elsewhere in the country.

1.6 Feeding Draft Animals

Cattle and buffaloes are fed rice straw, weeds, oilcakes and wheat chaff, but have been observed to eat almost anything, even water hyacinths. The feeding of a urea-molasses preparation along with rice straw was known to many respondents but not practised. Some of those who tried it reported deaths: easily occurring if instructions how to wean cattle onto the mixture are not strictly followed. The pods of trees, mainly those of Acacia arabica (babla) and Leucaena leucocephala (ipil-ipil) are also fed. Both are common on roadsides; the ipil-ipil is an introduction but thrives well. In view of the acute fodder shortage it was decided to learn how farmers deal with the situation.

Over 70% kept all the rice straw they produced, - only a little was used for fuel-, 13% sold part of their production and 14% had to give a share to the landlord. 45% purchased one or more kind of fodder: 34% oilcakes, 8% rice straw, 23% wheat chaff and 2% weeds pulled up by others than the owner of the animals.

1.7 Cost of Hiring Draft Animals

About 25% paid by the area tilled, the rest by the day, which, as noted, is about 4-5 hours. All renters of power tillers paid by area. To satisfy the perceived requirements of the renters as to the acceptable - and affordable - quality of land preparation, the local version of the barpoint plough, one with a thick sole to plaster a pan that slows water penetration, had to make two to three passes; usually but by no means invariably, with a laddering between passes. The power tiller, equipped with a rotovator and wheels with spade lugs, completed the job in one pass, supplemented occasionally with a laddering.

Oxen and cows plough about 1 bigha (33 decimals per bhiga; 3 bighas per acre; about 7.5 bhigas per ha); buffaloes about 50 decimals. Contractors charged Tk. 43 per day for oxen, more for buffaloes. Costs came to about Tk 45/bhiga. The power tiller cost Tk 110/bhiga for a pass, which was deemed to equal

two passes of the plough. The reported range of charges for animals was between Tk. 25 and Tk. 70 per day (this latter in one case only); for the power tiller, preparing the land for rice, between Tk. 70 (one case only) and Tk. 150 (also only in one case) per bhiga. Generally land preparation for non-rice crops with a power tiller cost double that charged for riceland preparation. The problems of land preparation perceived by farmers and agricultural engineers are further discussed in the next Section.

2. Studies

2.1 Introduction

In the course of our investigations the agricultural staff have toured the region at different times of the year, to learn the farmers' problems and their reaction and responses to them. An outstanding feature of the discussions was the clear and erudite explanation given by almost every single person interviewed, and the willingness and courtesy with which they answered questions and offered explanations of their actions and reactions to the circumstances encountered in different years. It is important to note however that the explanations were mostly responses to ongoing situations rather than perspective. This is readily understandable and makes it all the more necessary to extend agricultural investigations of the kind necessary for studies like the FAP over more than one season. It was fortuitous that 1991, the first year of the study, was more or less "normal" in most of the region, while 1992 was very dry. This evoked responses not usually identified or expected. The contrasting years were fortunate in the sense of making the review of farming and farm planning practices more meaningful and possibly enabling more valid explanations to projections to be made of likely responses and problems under project conditions.

2.2 Land Preparation

The fact that land preparation is likely to be an issue became apparent in the course of the very first field visit. With the benefit of the agriculturists' experience in the region extending over more than 20 years, it was striking to note how much smaller and weaker the draft animals have become. This was the main reason why the issue was extensively probed during the survey (Sections I.5-I.6). Susequent discussions focussed on farmers' actions and opinions on overcoming the problems caused.

There seemed little doubt in the minds of all respondents that standards of land preparation are declining. This is causing considerable concern. It is widely appreciated in farming circles that the only possible solution is the increasing use of two-wheeled tractors, of which, as noted, there are already several about. However, without exception, farmers were not satisfied with the quality of their work: in their view they did not control weeds as well as the traditional plough nor did they prepare land for non-rice crops as well.

The two-wheeled tractors worked in the fields with spadelug wheels and used only rotary tillers. No cage wheels, an essential tool to puddling, the creation of liquid mud into which rice is to be transplanted, were seen either in the field or at the importers' premises. No tyned cultivators were used to bring the roots of weeds to the surface. These implements were not known to them and as far as could be ascertained none have ever been brought in. In contrast, in India four-wheel tractors often prepare land for rice, already ploughed, without implements of any kind, only with four carefully designed and spaced cagewheels. Identifying the right implements for the two-wheel tractors for land preparation deserves the urgent attention of competent agricultural engineers. If not addressed, the inevitable further decline in the number of draft animals will lower the quality of land preparation perhaps to a point where it may act as an impediment to obtaining the kind of yields which other inputs would enable to achieve.

2.3 The Labour Situation

The need for adequate labour for harvest and for the rapid turnover between crops required to increase cropping intensities has also been studied in detail (Section I.4) Little can be done to influence the situation but it has to be faced. There is a considerable migratory labour force engaged in the harvest: they come from other parts of the country where the seasons are slightly different. The issue has to be faced whether this pool of labour will still be available if and when these areas implement their own FCD projects which, as in the North-West, will also lead to increased farming intensities. The problem was already idetified in 1928 and since then has not eased. Its examination, if the issue is indeed as important as many farmers have pointed out, must necessarily be conducted outside the North-West.

Providing communal help, a regular feature in farming communities in the sub-Continent, has been examined. It appears that it is usual for transplanting, especially the aman crop, but not for other operations: harvesting has to be done at the same time by all whereas transplanting can not only be allowed to spread out, but it is a great advatage for all to finish a field quickly, to enable proper water management to be introduced virtually the same day. The issue of communal help is discussed in Annex 16, Health, Navigation and Cultural Heritage.

2.4 Drying The Harvest

The problem of drying the freshly harvested grain, - and the retted jute -, has been an issue for a long time. A recent solution is the construction of drying floors which are rented out to growers. However, there are not enough of them. Drying rice on public roads is increasing, with all its inherent losses through scattering by passing vehicles. Many farmers drew attention to this problem which deserves to be seriously addressed.

2.5 Seed Supplies; Nurseries

2.5.1 Seeds

1992 has been an exceptional year in that it was possible, for the first time in 10 years, to broadcast deep-water rice after the boro harvest (See Appendix 2). However, many farmers stated that there was no seed available. In the normal course of events this is entirely reasonable: b aman is planted in April and to consume leftover grain afterwards, before starting on the boro crop, is sound management. However, it implies that there are no seeds of deep water rice for planting in June if it is found prudent to do so, as it was in 1992. This scarcity has exercised farmers considerably and will undoubtedly reduce potential rice production in 1992.

2.5.2 Nurseries

Growing seedlings is not always convenient, especially for small-scale growers. The problem is more serious in the Chalan Bheel area than elsewhere. In response to this situation a flourishing trade of commercially growing seedlings by specialists has developed who have access to good seeds and have the right facilities to grow them. The FAP 12 studies have reported from other regions that seedlings for HYV t aus, not a common crop, were not readily avail-able and therefore many growers had to broadast

it. This has many disadvantages, not least that the crop requires field care for about a month longer, and there is evidence that the HYVs yield better when transplanted. As noted in Appendix 2, HYV t aus may well become a major crop for farmers who can overcome land preparation and labour constraints, and for them the extension of this service would be a boon. Investigations have shown that farmers increasingly rely on nursery growers who provide a reliable service; these growers in their turn were encountering problems in getting sufficient seed of a satisfactory quality. Easing these channels may well have a significant effect on future production when cropping intensities are expected to increase.

Further to highlight the need, if not the present demand, for such a service, many observers noted that seedlings are often too old when transplanted. The HYVs are particularly sensitive to this kind of delay, more so than local varieties. Buying seedlins from a professional grower would go a long way to ensure that when the farmer needs seedlings they will be of optimum age.

Another observation was the many yellowing, clearly too stressed nurseries. While a small degree of stressing seedlings is advantegous, the ones seen gave the impression, confirmed by owners interviewed, that they were stressed too much for retaining maximum quality and vigour.

2.6 Fodder and Feeds

The chronic and increasing fodder shortage has been highlighted in the course of the survey (Section I.5). It was noted that supplementing rice straw with a urea-molasses mix has been tried but that it often resulted in death of animals. This is by no means uncommon if not properly applied and too rapidly introduced. While not easy, and for extension work quite laborious and paistaking to popularise on any scale, it is believed that it deserves considerable advisory resources to be devoted to it as one way to possibly ease the shortage of farm power for land preparation. With both urea and molasses produced in Bangladesh in abundance, - as opposed to imported machinery and fuel, - while clearly not a complete solution to the problem, it would undoubtedly help it.

An interesting feature is the feeding of water hyacynth. This is known to be an unsuitable feed because of its oxalic acid content and animals will not eat it unless absolutely forced to do so. 1991 was such a year when it was noted that not only did stock wade into water to browse on it, but owners actually had to collect it for stallfeeding. If at all feasible it would be useful line of investigation to render water hyacynth a more palatable and less harmful fodder. While the problem may well appear as an anathema to livestock experts, the need for it, and the likely rewards of even partial success, would be considerable.

It was noticed in the monsoon of 1991, which is considered a more or less average year, that farmers were actually mutilating their rice, by cutting off parts of the flagleaf for fodder. It is well known that this reduces yields, but the stock owners advised that, notwithstanding this effect, they had no choice. In contrast in 1992, when the floods came late and were shallower than usual, the boro stubbles, not normally cultivated during the monsoon because of the expected depth of water, have ratooned and produced abundant fodder. Cattle and buffaloes waded into at least 1 m deep water and browsed on this regrowth. They were in far better condition than at the same time in 1991, feeding on water hyacynths.

2.7 Growing Pulses and Oilseeds

Pulses and oilseeds are grown at present on considerable areas; in the past, the area devoted to them was even larger. The provision of irrigation has largely replaced them with boro rice on all but the most permeable soils (Appendix 2). The boro in its turn followed t aman. From a nutritional point this seems a harmful development and therefore during field visits the issue was extensively probed. It appeared that farmers consciously gave up growing these crops in favour of rice which was more profitable, and that those who as a result of doing so had rice to sell, had no difficulties in obtaining all the pulses needed, at reasonable prices, from local merchants quite near their homes. The merchants advised that a considerable part of their supplies came from India, from areas where there was no irrigation and therefore no means to change to crops requiring it. There did not appear to be any apprehension that this supply will be impeded.

2.8 Irrigation

The rapid development of irrigation, and its expected scope, is discussed in Annex 11, Hydrology and Groundwater. Discussions with farmers have left no doubt that its importance and potential for increasing production and income is fully appreciated. The spread of shallow tubewells, and their organisation into irrigator groups, is a well known and documented development. In 1992 two interesting aspects, one positive and one that at times is negative, were noted:

(a) On the positive side: groups operating shallow tubewells, be they surface-mounted or deepset, have begun to encounter problems towards the end of the rabi. These were not serious in the sense that they were not short of water, but had to resort to pumping for a few hours only and allowing the water-table to recover. Since the Bangladeshi tradition does not cater for night irrigation, unlike North India and Pakistan, this can be if not a hardship then at least an impediment. Groups have been overcoming it by abandoning shallow tubewells and investing in a deep tubewell. They are encouraged by the fact that at the beginning of the rabi the groundwater leves do not appear to have changed, i.e. they expect that the deeper drawdown will be recovered during the monsoon. Bank managers advise that until a recent sharp rise in the cost of deep tubewells demand for loans for the conversion have been increasing.

(b) The negative aspect became apparent in the dry year of 1992. Routinely, tubewell operators seal their wells after the boro harvest and find alternative use for the engines, almost always on boats. In 1992 the dry weather made it necessary to irrigate, to supplement rainfall in preparing land for HYV t aman, but the pumps could not be activated: the engines were otherwise committed. Hopefully 1992 connditions will not recur for many years, but when they do, they will increasingly cause hardship and avoidable loss of production. Also, to maintain normal yields, farmers are increasingly relying on irrigation for their HYV t aman. But since in normal, or near-normal, years this need does not arise until October, the traditional mechanism for reactivating the wells by then, - when boat transport itself becomes more constrained, - operates effectively and will cope with rising demands.

A final observation on irrigation is the impression by farmers and local extension workers that the area already irrigated is greater than suggested by the records. This could not be corroborated during our investigations, but it should be noted: if indeed correct, then the limits of irrigation development, detailed in Annex 11, would be reached earlier than expected, and thereby also limit future agricultural production expansion. If found correct, then the case for flood control is considerably strengthened, since alternative means of increasing production, - irrigation expansion has always been listed amongst the easiest and most self-evident, - are reaching their limit faster than the irrigation data would suggest.

APPENDIX 4

CROPPING PATTERN CALCULATIONS

1. Calculating Cropping Patterns

The derivation of present, without-project and with-project cropping patterns, is shown in 24 tables. All calculations are based on the assumed 1:5 year water levels.

Table I assumes that the entire net cultivable area is irrigated. The area under each of the rice crops and what can be cropped in the rabi with other than boro rice is calculated according to the criteria set out below. The periods indicated are "decads", ten-day periods, of calendar months This assumes that each month consist of 30 days: February/1 is the 1st to the 10th; February/2 the 11th to the 20th, and so on. The calculations were done on agronomic assumptions, given below, as to the water levels tolerated by crops at different stages of their development.

HYV Boro: 0-30 cm between February/1 and May/1, not above 70 cm until June/1.

HYV t aman: either: 0-30 cm between August/1 and September/3. Not above 70 cm until November/3. This will be late HYV t aman.

or: 0-30 cm between July/2 and August/2, not more than 70 cm until November/3. This will be early HYV t aman.

L t aman: either: 0-30 cm between August/3 and October/1, not more than 70 cm until October/3 and 100 cm until November/3. This will be late l t aman.

or: 0-30 cm between July/2 and August/3, not more than 70 cm until September/3 and 70-100 cm until November/3. This will be early l t aman.

TDW aman: 0-30 cm between June/1 and July/2, not more than 300 cm until November/3.

rabi crops: 0-30 cm in November/2 and not cropped in September/November/1.

The reason why the water levels used differ slightly from MPO's are agronomic:

(a) the 0-30 cm, identical to F0 defined by MPO, indicates that freshly transplanted rice will thrive under these conditions. While b aus and b aman obviously requires completely water-free land at planting time, - rice will emerge either from under water or under soil, but not both, - it will tolerate 30 cm of water within a few weeks of emergence.

(b) The 70 cm level for HYV boro and HYV t aman is defined as the maximum submergence it will stand when fully grown: the water will then reach the base of the panicle. If this happens after the grains are fully formed, it will not affect yield materially.

(c) The 100 cm level for l t aman and b aus are specified for the same reason as the 70 cm level for the HYVs.

(d) The 150 cm level is tolerated by jute once it has grown to that height. This is why it can be grown on land where the water rises above 100 cm and b aus would be killed.

(e) Transplanted deep-water (TDW) aman will stand up to 3 m of water after it is properly established; the same applies to b aman.

Table II assumes that none of the area is irrigated. The cropping pattern under these conditions, considering rice, jute and rabi crops where there is no irrigation, are calculated as follows:

b. aus: 0-30 cm between March/2 and May/3, mot more than 70 cm until June/3 and not more than 100 cm until August/1.

jute: 0-30 cm between March/2 and May/1, not more than 70 cm until May/2 and not more than 150 cm until August/2.

HYV t aman: 0-30 cm between August/1 and September/3. Not above 70 cm until November/3. It will be noted that this corresponds to "HYV t aman (late)" in the irrigated scenario.

l t aman: 0-30 cm between August/3 and October/1, not more than 70 cm until October/3 and not more than 100 cm until November/3. This corresponds to "l t aman (late)" in the irrigated scenario.

b aman: 0-30 cm between March/2 and April/3, not more than 70 cm between May/1 and June/2 and not more than 300 cm until November/2

rabi crops: 0-30 cm in November/2 and not cropped in September/November/1.

The model runs overestimate the b aus area. This has an agronomic reason. In many years the western part of the region, and occasionally also in other parts, the rain does not begin soon enough (1992 was such a year), to enable the b aus to be planted in time to follow it with t aman, HYV or local. Therefore farmers consciously do not plant b aus so as to enable them to plant t aman, the potentially more profitable crop, and to escape a possible dry spell in October. Proof of this contention is that where there are irrigation facilities and t aman is planted after boro, the t aman receives supplementary irrigation on increasingly large areas. There are no similar problems with other crops: the area of HYV boro is determined by the extent of irrigation and the t aman figures show almost complete agreement with recorded cropping patterns Section I).

The agronomic reason for specifying only late t amans in the non-irrigated scenario is that they would follow either b aus or jute, neither of which vacates the land in time to enable the early options to be taken up.

Table III (a) and (b) blend the fully irrigated with the fully unirrigated calculations according to the recorded extent of irrigation in the area under consideration.

Table IV combines Tables III (a) and (b).

Table V makes an allowance for homesteads, roads, water bodies and other non-agricultural uses: the gross cultivable area (GCA) is converted into the net cultivable area (NCA). The NCA is as determined by MPO. Since most of the difference will be taken up by homesteads and roads, the driest, least flood-prone land is allocated. Tables I and II allocated b aus and HYV t aman to such lands. Therefore the area under these crops will be reduced by the difference between the gross and nett cultivable area.

Table VI allocates land, within the cropping pattern developed in Table V, for crops other than rice and jute and designates crops shown as "rabi". The method of this allocation is shown in Section IV.

Table VII shows the cropping pattern of the area by BBS in 1989.

Table VIII is the cropping pattern adopted for planning purposes: this is a blend of the calculated and recorded findings.

The major difference expected between the calculated and actual cropping patterns, other than the point made regarding b aus may be the following:

(a) The calculated jute area is lower than the records show. This is agronomically possible, since jute can be grown where b aus would thrive (but not the reverese) and can therefore replace it. Consequently it is an economic and marketing decision whether there is any such substitution, which calculations based on water levels cannot show. In all cases the recorded jute area has been adopted for the present cropping pattern and the difference deducted from the area of b aus. In the future-without and future-with scenarios a degree of judgement was used to estimate likely changes.

(b) L t aman may occupy a larger area than calculated although the sum of the two is within a few percentage points of the recorded cropping patterns. This is because l t aman can replace HYV t aman. Some farmers prefer to do so on account of taste, the need for lower inputs or because they did not have access to land preparation facilities in time for HYV t aman.

2. Future-Without-Project Cropping Pattern Calculations

Since the Future-Without-Project water regime is expected to be different from the present because of the planned repairs, the calculations will have to be substabtially the same.

- Tables IX and X calculate possible irrigated and non-irrigated cropping patterns under the changed water regime;
- Tables XI and XII will correspond to Tables III and IV, reflecting the expected increase in the irrigated area over time. They will correspond to Tables II and IV;
- Table XIII corresponds to Table V;
- Table XIV introduces the other crops. The area will be different from that in Table VI because with increased irrigation some of the low-value crops will be reduced in area, as noted by the FAP 12 and our own studies;
- Table XV repeats, for ease of reference, Table VIII;
- Table XVI will be the projected cropping pattern in the future-without-project scenario.

3. Future-With-Project Cropping Patterns

The entire process described in Section I has to be repeated in Tables XVII to XXIV for the changed water regime due to the project. Table XXIII will be a repeat of Table XVI to enable an easier comparison between the future-without-project and future-with-project scenario.

4. Allowance for Crops Other than Rice and Jute

4.1 Rationale of Growing the Other Crops

Other crops: oilseeds, pulses, all vegetables, sugarcane, wheat, tobacco and orchards, are grown for some or all of the following reasons:

(a) economic: the growers expect them to pay better than rice and jute;

(b) to meet household needs: pricipally in case of pulses and to a lesser extent oilseeds (for cooking oil and oilcake for feed);

(c) soil conditions do not readily lend themselves to grow other crops.

Further to elaborate (c):

(i) Field investigations have shown that even where well irrigation is relatively easy because of a high watertable, it will not be installed where the soil is sandy: infiltration losses would be high and therefore many more pumping hours would be needed than on less permeable soils. In such areas the crops are usually sugarcane which can stand a much greater depth of water than t aman and still yield more income that alternatives, notably floating rice.

(ii) Oilseeds and pulses are often grown under non-irrigated conditions following b aus which could not be followed by t aman because of depth of flooding or its late maturing due to late planting because of late rain. Given the availability of irrigation, both would be replaced by boro [unless the soils are too permeable see (i) above] and farmers purchase their pulse, vegetabe oil and more of their oil cake requirements on the proceeds of the additional rice they grow. The same applies to wheat which in most part of the region is very much a secondary crop (see Appendix 2).

These points must be taken into account in devising "future" cropping patterns, because of the increase in the irrigated area.

4.2 Including Other Crops in the Cropping Pattern

The crops for which the area has not been calculated will be accomodated as follows.

(a) Oilseeds and pulses will be taken out of "rabi". If this is not enough, the balance has to be deducted from floating rice and b aus.

(b) Wheat will be deducted from "rabi"; if not enough left, from floating rice; if still not enough, from b aus. The rationale is that farmers may regard wheat, oilseeds or pulses as safer crops than b aus and will follow them with t aman.

(c) Potatoes come off b aus.

(d) Veg/spices, which are grown the year round and require flood-free conditions, come off both HYV t aman and b aus. If small enough, the area of orchards can also be included, see (g).

(e) Tobacco comes off b aus.

(f) Sugarcane comes off floating rice. Cane can be grown in quite deep water and would take the place of the floating rice on the relatively less deeply flooded lands designated for it.

(g) Orchards if less than 1% will be added to veg/spices. If more, it will come off b aus and HYV t aman, since it is assumed they are not irrigated. The exception is bananas: if a sizeable portion of "orchards" is bananas, the area has to be deducted not from b aus but from boro.

(h) Jute, if the area recorded is larger than calculated, has to be taken from b aus, as per the note in Section I.

The summary of the criteria to accomodate crops not part of the calculations is as follows:

oilseeds and pulses:	(1) "rabi", (2) b aman, (3) b aus.
wheat:	(1) "rabi", (2) b aman, (3) b aus.
potatoes:	b aus
veg/spices:	HYV t aman and b aus
tobacco:	b aus
sugarcane:	b aman
orchards:	b aus or boro, and HYV t aman

The method described will be used wherever there is sufficient information from BBS data to follow it. It is necessary for project preparation, therefore if the required information is not readily available, it must be obtained.

The 24 tables that have to be prepared are in Schedule 1 of this Appendix. They are meant to show how the process works; the data they include may have to be amended in the light of continuing studies of water levels and timings used for project planning.

28-Sep-92

Analysis for GAIBANDHA
Water levels based on 1:5 year levels.

Gross Cultivated Area (GCA) 57600 (ha)
Net Cultivated Area (NCA) 49130 (ha)

Present Cropping Pattern Calculations

I. Assuming all Irrigated

Crop		Area(ha)	Percentage
Boro		57485	100
HYV T Aman	(late)	34560	60
	(early)	14746	26
Local T Aman	(late)	2074	4
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
Rabi		6106	11
Total		114970	200

II. Assuming none Irrigated

Crop		Area(ha)	Percentage
B Aus		55526	96
Jute		1382	2
HYV T Aman	(late)	49306	86
Local T Aman	(late)	2074	4
B Aman	(< 3m)	461	1
	(> 3m)	0	0
Rabi		5645	10
Total		114394	199

III. Adjusted for Recorded Irrigation : 14256 (ha) 25 %

a) Irrigated Portion

Crop		Area(ha)	Percentage
Boro		14256	25
HYV T Aman	(late)	8554	15
	(early)	3650	6
Local T Aman	(late)	513	1
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
Rabi		1511	3
Total		28483	49

b) Non-Irrigated Portion

Crop		Area(ha)	Percentage
B Aus		41784	73
Jute		1040	2
HYV T Aman	(late)	37102	64
Local T Aman	(late)	1560	3
B Aman	(< 3m)	347	1
	(> 3m)	0	0
Rabi		4248	7
Total		86081	149

IV. Tables III(a+b) Combined

Crop		Area(ha)	Percentage
Boro		14256	25
HYV T Aman	(late)	45656	79
	(early)	3650	6
Local T Aman	(late)	2074	4
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
B Aus		41784	73
Jute		1040	2
B Aman	(< 3m)	347	1
	(> 3m)	0	0
Rabi		5759	10
Total		114565	199

V. Adjusted for Homesteads

Deduct = GCA - NCA = 8470 (ha)

Crop		Area(ha)	Percentage
Boro		14256	29
HYV T Aman	(late)	37186	76
	(early)	3650	7
Local T Aman	(late)	2074	4
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
B Aus		33314	68
Jute		1040	2
B Aman	(< 3m)	347	1
	(> 3m)	0	0
Rabi		5759	12
Total		97625	199

VI. Present Calculated Cropping Pattern, Including Other Crops(1989 BBS data)

Crop		Area(ha)	Percentage
Boro		14256	29
HYV T Aman	(late)	36527	74
	(early)	3650	7
Local T Aman	(late)	2074	4
	(early)	0	0
Deep water rice		0	0
B Aus		21747	44
Jute		1040	2
Oilseeds/pulses		2623	5
Wheat		4398	9
Potato		459	1
Veg/Spices		637	1
Tobacco		452	1
Sugarcane		240	0
Orchards		22	0
Total		88125	179

VII. Cropping Pattern recorded by BBS, 1989

Crop	Area(ha)	Percentage
Boro	14256	29
HYV T Aman	20121	41
Local T Aman	21052	43
Deep water rice	244	0
B Aus	10166	21
Jute	9081	18
Oilseeds/pulses	2623	5
Wheat	4398	9
Potato	459	1
Veg/Spices	637	1
Tobacco	452	1
Sugarcane	240	0
Orchards	22	0
Total	83751	170

VIII. Cropping Pattern adopted as "Present" for Planning

Crop	Area(ha)	Percentage
Boro	14256	29
HYV T Aman	20100	41
Local T Aman	21000	43
Deep water rice	244	0
B Aus	10000	20
Jute	9100	19
Oilseeds/pulses	2623	5
Wheat	4398	9
Potato	459	1
Veg/Spices	637	1
Tobacco	452	1
Sugarcane	240	0
Orchards	22	0
Total	83531	170

28-Sep-92

Future-Without-Project Cropping Pattern Calculations

IX. Assuming all Irrigated

Crop		Area(ha)	Percentage
Boro		57485	100
HYV T Aman	(late)	34560	60
	(early)	14746	26
Local T Aman	(late)	2074	4
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
Rabi		6106	11
Total		114970	200

X. Assuming none Irrigated

Crop		Area(ha)	Percentage
B Aus		55526	96
Jute		1382	2
HYV T Aman	(late)	49306	86
Local T Aman	(late)	2074	4
B Aman	(< 3m)	461	1
	(> 3m)	0	0
Rabi		5645	10
Total		114394	199

XI. Adjusted for Projected Irrigation Percentage : 23650 (ha) 41 %

a) Irrigated Portion

Crop		Area(ha)	Percentage
Boro		23650	41
HYV T Aman	(late)	14190	25
	(early)	6054	11
Local T Aman	(late)	851	1
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
Rabi		2507	4
Total		47253	82

b) Non-Irrigated Portion

Crop		Area(ha)	Percentage
B Aus		32728	57
Jute		815	1
HYV T Aman	(late)	29061	50
Local T Aman	(late)	1222	2
B Aman	(< 3m)	272	0
	(> 3m)	0	0
Rabi		3327	6
Total		67425	117

XII. Tables XI(a+b) Combined

Crop		Area(ha)	Percentage
Boro		23650	41
HYV T Aman	(late)	43251	75
	(early)	6054	11
Local T Aman	(late)	2074	4
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
B Aus		32728	57
Jute		815	1
B Aman	(< 3m)	272	0
	(> 3m)	0	0
Rabi		5834	10
Total		114677	199

XIII. Adjusted for Homesteads

Deduct = GCA - NCA = 8470 (ha)

Crop		Area(ha)	Percentage
Boro		23650	48
HYV T Aman	(late)	34781	71
	(early)	6054	12
Local T Aman	(late)	2074	4
	(early)	0	0
TDW Aman	(< 3m)	0	0
	(> 3m)	0	0
B Aus		24258	49
Jute		815	2
B Aman	(< 3m)	272	1
	(> 3m)	0	0
Rabi		5834	12
Total		97737	199

XIV. Future-Without-Project Cropping Pattern, Adjusted for BBS 1989 records

Crop		Area(ha)	Percentage
Boro		23650	48
HYV T Aman	(late)	34121	69
	(early)	6054	12
Local T Aman	(late)	2074	4
	(early)	0	0
Deep water rice		0	0
B Aus		13312	27
Jute		815	2
Oilseeds/pulses		2400	5
Wheat		4000	8
Potato		460	1
Veg/Spices		640	1
Tobacco		450	1
Sugarcane		200	0
Orchards		20	0
Total		88196	180

XV. Cropping Pattern adopted as "Present" for Planning

Crop	Area(ha)	Percentage
Boro	14256	29
HYV T Aman	20100	41
Local T Aman	21000	43
Deep water rice	244	0
B Aus	10000	20
Jute	9100	19
Oilseeds/pulses	2623	5
Wheat	4398	9
Potato	459	1
Veg/Spices	637	1
Tobacco	452	1
Sugarcane	240	0
Orchards	22	0
Total	83531	170

XVI. Cropping Pattern adopted as "Future without Project" for Planning

Crop	Area(ha)	Percentage
Boro	23650	48
HYV T Aman	23000	47
Local T Aman	20500	42
Deep water rice	250	1
B Aus	4400	9
Jute	8400	17
Oilseeds/pulses	2400	5
Wheat	4000	8
Potato	460	1
Veg/Spices	640	1
Tobacco	450	1
Sugarcane	200	0
Orchards	20	
Total	88370	180

Future-With-Project Cropping Pattern Calculations

XVII. Assuming all Irrigated

Crop		Area(ha)	Percentage
Boro		57312	100
HYV T Aman	(late)	16589	29
	(early)	33869	59
Local T Aman	(late)	1037	2
	(early)	0	0
TDW Aman	(< 3m)	1325	2
	(> 3m)	0	0
Rabi		4723	8
Total		114854	199

XVIII. Assuming none Irrigated

Crop		Area(ha)	Percentage
B Aus		56218	98
Jute		864	2
HYV T Aman	(late)	50054	87
Local T Aman	(late)	1037	2
B Aman	(< 3m)	173	0
	(> 3m)	0	0
Rabi		6278	11
Total		114624	199

XIX. Adjusted for Projected Irrigation Percentage : 23650 (ha) 41 %

a) Irrigated Portion

Crop		Area(ha)	Percentage
Boro		23650	41
HYV T Aman	(late)	6811	12
	(early)	13906	24
Local T Aman	(late)	426	1
	(early)	0	0
TDW Aman	(< 3m)	544	1
	(> 3m)	0	0
Rabi		1939	3
Total		47276	82

b) Non-Irrigated Portion

Crop		Area(ha)	Percentage
B Aus		33135	58
Jute		509	1
HYV T Aman	(late)	29503	51
Local T Aman	(late)	611	1
B Aman	(< 3m)	102	0
	(> 3m)	0	0
Rabi		3701	6
Total		67561	117

XX. Tables XIX(a+b) Combined

Crop		Area(ha)	Percentage
Boro		23650	41
HYV T Aman	(late)	36314	63
	(early)	13906	24
Local T Aman	(late)	1037	2
	(early)	0	0
TDW Aman	(< 3m)	544	1
	(> 3m)	0	0
B Aus		33135	58
Jute		509	1
B Aman	(< 3m)	102	0
	(> 3m)	0	0
Rabi		5640	10
Total		114837	199

XXI. Adjusted for Homesteads

Deduct = GCA - NCA = 8470 (ha)

Crop		Area(ha)	Percentage
Boro		23650	48
HYV T Aman	(late)	27844	57
	(early)	13906	28
Local T Aman	(late)	1037	2
	(early)	0	0
TDW Aman	(< 3m)	544	1
	(> 3m)	0	0
B Aus		24665	50
Jute		509	1
B Aman	(< 3m)	102	0
	(> 3m)	0	0
Rabi		5640	11
Total		97897	199

XXII. Future-With-Project Cropping Pattern Including Other Crops

Crop		Area(ha)	Percentage
Boro		23650	48
HYV T Aman	(late)	27184	55
	(early)	13906	28
Local T Aman	(late)	1037	2
	(early)	0	0
Deep water rice		1484	3
B Aus		14014	29
Jute		509	1
Oilseeds/pulses		2000	4
Wheat		2500	5
Potato		460	1
Veg/Spices		640	1
Tobacco		450	1
Sugarcane		200	0
Orchards		20	0
Total		88054	179

XXIII. Cropping Pattern for "Future-Without-Project"

Crop	Area(ha)	Percentage
Boro	23650	48
HYV T Aman	23000	47
Local T Aman	20500	42
Deep water rice	250	1
B Aus	4400	9
Jute	8400	17
Oilseeds/pulses	2400	5
Wheat	4000	8
Potato	460	1
Veg/Spices	640	1
Tobacco	450	1
Sugarcane	200	0
Orchards	20	0
Total	88370	180

XXIV. Cropping Pattern for "Future-With-Project"

Crop	Area(ha)	Percentage
Boro	23650	48
HYV T Aman	26400	54
Local T Aman	21000	43
Deep water rice	70	0
B Aus	4500	9
Jute	7000	14
Oilseeds/pulses	2000	4
Wheat	2500	5
Potato	460	1
Veg/Spices	640	1
Tobacco	450	1
Sugarcane	200	0
Orchards	20	0
Total	88890	181

PART 2
FISHERIES

FISHERIES

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FISHERIES

1. Introduction

The North West Region of Bangladesh (NWR) is bounded by the international border with India to the North and West, by the Brahmaputra-Jamuna River to the East and the Ganges-Padma River to the South. The region is well endowed with a network of internal rivers in addition to the two major boundary rivers, and notably the Teesta, the Karatoya, the Atrai and Mohananda rivers. There is also a complex of depressions known as beels, which are flooded either seasonally or permanently. The best available representation of the distribution of these water bodies in NWR, all of which are important for fisheries is in Figure 1 which is based on SPARRSO interpretation of February 1980 Landsat satellite imagery. However, it is known that many of these beels will have been drained since then.

NWR fisheries comprise open water capture fisheries for a wide variety of fish species in rivers, beels and floodlands and culture fisheries, mainly for various species of carp, in farmed ponds and other closed water bodies.

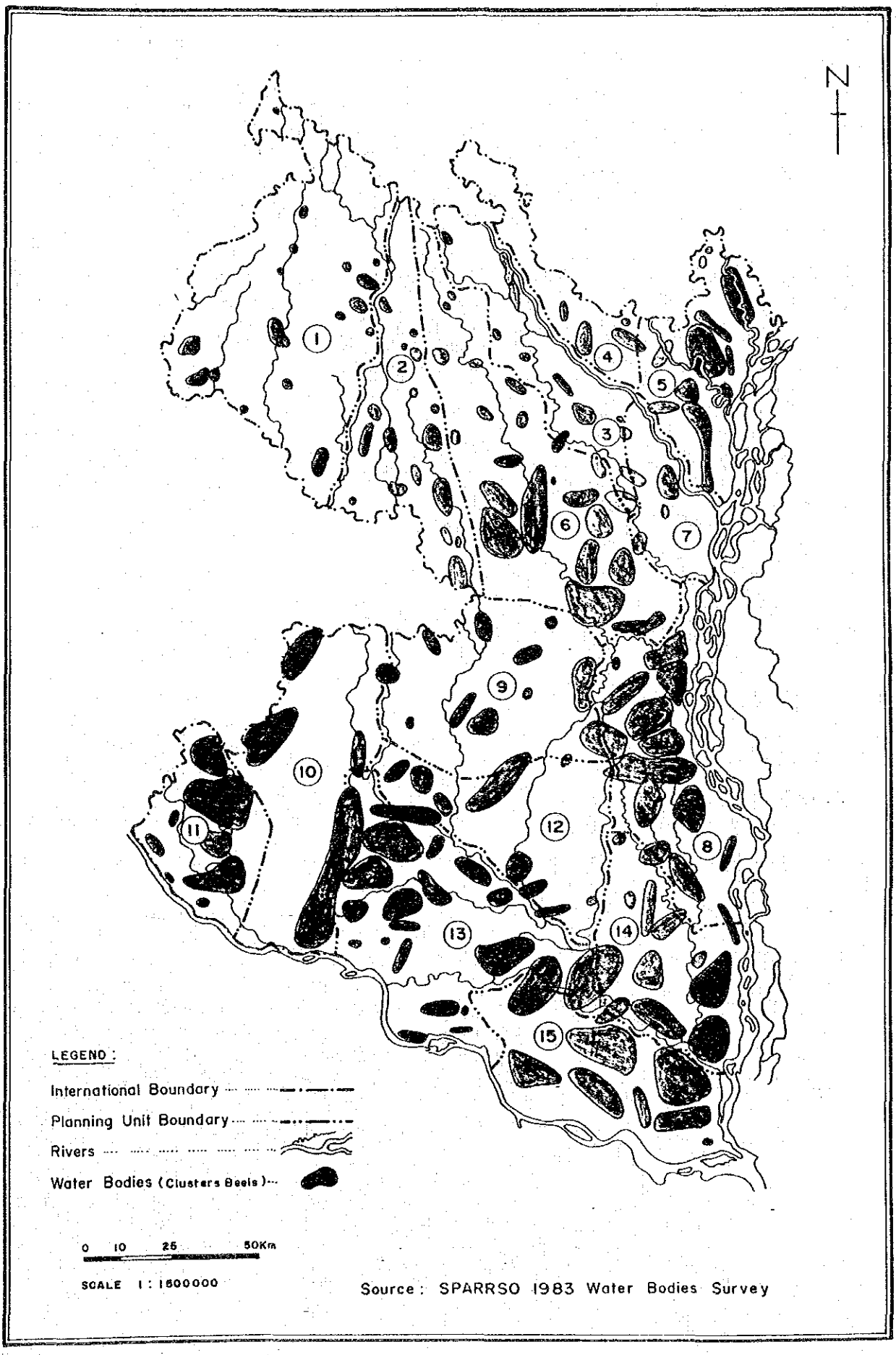
In line with the findings of earlier studies, such as MPO Technical Report No. 17 of 1985, and the FAP 12 Agricultural Impact Evaluation Study, FAP 2 field studies have confirmed that inland capture fisheries in the North West Region, as in most parts of Bangladesh, have been and are continuing to suffer from the cumulative impact of a succession of FCD/FCDI river embankment and polder type projects. Developments such as the Brahmaputra Right Embankment (BRE) and the Chalan Beel, Bogra polder complex have blocked access routes for fish between beels, floodplains and the river system, large areas of former floodland have been rendered flood free and many erstwhile perennial beels have been drained or made only seasonal to the detriment of the fish stocks which they once contained. These changes, coupled with the impact of a fish disease epidemic and ever increasing fishing effort and demand for fish have reduced fishable areas, caused fish stocks to decline and impeded reproduction.

Beneficial impacts on culture fisheries which were anticipated, have been slow to materialise because of the Department of Fisheries (DOF) inability to field the necessary aquaculture field extension effort, a general lack of low cost, formal credit and the Bangladesh Water Board's (BWDB) inability to maintain its flood protection infrastructure intact or to prevent public cutting of many of the embankments. The resultant sudden overtopping of ponds and other damage in areas which are supposed to have been made free of such catastrophes, acts as a strong disincentive to fish farming development.

Table 1(a) summarises the pattern of fish production in NWR since 1983/84 as far as the availability of data from DOF permits. 1989/90 statistics are not yet complete but it is apparent that whereas total production declined by 21% over the six year period, the fall was much more dramatic in the case of beel fisheries, down by 43% and river fisheries which have virtually collapsed by no less than 84%. Fish farming on the other hand did show a 41% increase, which offers some hope for the future.

Figure: I

Water Bodies Rivers and Planning Units in N.W. Region



Source : SPARRSO 1983 Water Bodies Survey

Table 1(a) Fish Production in N.W. Region (Metric Tons)

	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Rivers	24507	22840	11883	7824	7865	3937	n/a
Beels	15141	12000	10638	8379	9466	8555	8663
Floodplain	42344	45343	52033	43237	44452	42183	42329
Total Capture	81992	80183	74554	59440	61783	54675	n/a
Fish Ponds	25232	23257	26190	25493	26712	30135	35703
NWR Total	107224	103434	100744	84933	88495	84810	n/a

Source: DOF; Annual Fish Catch Statistical Bulletins

In addition to many interviews with fishermen, pond owners, fish traders, upazila officials and other people during the field visits, close contact has been maintained throughout the study with DOF headquarters, regional, district and thana fisheries staff, with members of the IDA 3rd Fisheries Project (TFP) and ADB 2nd Aquaculture Project (SAP) implementation teams, the ODA Parbatipur Fisheries Project, and with many of the other FAP components, including FAPs 2, 12, 13, 16 and 17, to take account of developments in the fisheries sector which might bear on the N.W. Regional Plan.

2 Fisheries of the N.W.Region

2.1 Capture Fisheries

The open water capture fisheries in NWR comprise the major rivers, Upper Padma, Jamuna, Brahmaputra and Teesta, plus a network of lesser rivers and tributaries and totalling overall a water area of about 131,500 hectares. In addition the region possesses 33,650 hectares of perennially flooded small lakes or beels(SPARRSO, Feb. 1983) and a seasonally inundated floodplain (water depth 0.3 m or more) extending from 17,500 to nearly 23,200 km^2 depending on the severity of flooding which varies from year to year during the monsoon season.

The fish stocks in these waters consist of a complex of species groups of differing behaviourial characteristics. The more important of these groups include anadromous fish such as the shad, Hilsa ilisha, which migrate up the main rivers from the brackish water estuarine zone to spawn in freshwater before returning to the sea; and Indian major carp species which as fry are swept involuntarily by mid-monsoon floods onto the floodplains to grow and overwinter in the beels for two or more seasons until, on attaining maturity the survivors return to the rivers and migrate upstream during the very early monsoon in order to spawn. Other lesser riverine species move from river to floodplain in order to feed or reproduce, whilst others again are resident floodplain/beel species, including some catfish (Clarias and Heteropneustes spp), snake-heads (Channa spp) and in some areas Tilapia. A group of commercially important freshwater prawns, (Macrobrachium spp) have to migrate downstream to the brackish inter-tidal zone in order to spawn, after which the juveniles return up-river and into the freshwater khals and floodplain areas to feed and grow.

The freshwater fish fauna of NW Bangladesh includes at least 134 species grouped into 30 families. Species which currently predominate in capture fishery landings in NWR include the minor carps Chela and Puti (Oxygaster, Salmostoma and Puntius spp), the catfishes Boal (Wallago attu), Magur (Claries batrachus), Aaer and Tengra (Mystus spp), Singi (Heteropneustes fossilis), the snakeheads Shol, Taki and Gajar (Channa spp) and the perch Koi (Anabas testudineus), but even some of these appear to be in decline. The major carp species such as Labeo rohita, L. calbasu, Catla and Cirrhinus mrigala which formed a large part of the catch in the past are now increasingly scarce in the wild but are being produced by the growing fish farming industry. Hilsa supports an important seasonal fishery in the inland rivers during its May to October spawning run. A list of NWR fish species, with local names is provided in Appendix 1.

The crucial importance of the flood season for successful spawning by a wide range of riverine and floodplain species can be seen from Appendix 2; in most cases the breeding period coincides with th early flood or throughout the monsoon flood season. Appendix 3 lists capture fisheries species which are now increasingly scarce in NWR waters according to reports from fishermen and fish traders.

The fishing gears used to harvest such a wide range of fish also vary widely in shape, type and size with an almost bewildering list of local names. They broadly fall into seven main categories, namely:

Seine nets, gill nets, stake nets, lift-nets, cast nets, hand nets and traps.

Fishing methods, such as trawling, which require high powered vessels are not used on the rivers or other inland waters of NWR. Further details of NWR fishing methods with local names for the gear concerned are provided in Appendix 4. It has also been noted that whereas most of the methods detailed above can be used with netting of several different mesh sizes, the progressive reductions in fish stocks and consequent reduced catch rates are causing fishermen to use smaller and smaller mesh sized netting, to the stage in some areas where even mosquito larvae can hardly escape. This is despite the existence of minimum mesh regulations and other rules intended to prevent overfishing which are clearly not being enforced.

According to published DOF fish catch statistics, the overall annual production of fish in NWR decreased by 21% between 1983/84 and 1988/89, from about 107,200 metric tons to 84,800 mt, as shown in Table 1(b). This is in contrast to the national trend which showed an 11% increase over the same period. 1988/89 is the most recent year for which full data are available. In consequence NWR's share of national fish supply fell from 14% to 10% and in particular, riverine fish production (Table 2) has collapsed by 84% from 24,500 mt in 1983/84 to only 3940 mt in 1988/89. Tables 3(a) to 3(c) demonstrate that the decline in riverine fish stocks and catches has occurred in all the rivers concurrently and this has also been confirmed by FAP 12 findings in NWR and other parts of the country which show falls of up to 75% in riverine production. Mean catch rates have fallen during this period, from 186 kg/ha to 30 kg/ha and the decline shows no sign of stopping, so it is clear that the diminished fish stocks are now being badly over fished.

Table 1(b) Overall Total Production of Fish in N.W. Region (m.t)

(Old) District	1983/84 (mt)	1984/85 (mt)	1985/86 (mt)	1986/87 (mt)	1987/88 (mt)	1988/89 (mt)	1989/90
Bogra	11903	18403	16533	12553	13791	14370	na
Dinajpur	12456	12865	15402	9484	8803	10346	na
Pabna	30936	27257	21404	14378	15856	12885	na
Rajshahi	31069	25831	27554	26577	26379	24881	na
Rangpur	20860	19081	20851	21941	23666	22328	na
Total	107.224	103434	101744	84933	88495	84810	na

Source: DOF: Annual Fish Catch Statistical Bulletins.

Table 2 N.W. Region Riverine Fish Production (m.t.)

(Old) District	River Area(ha)	1983/84 (mt)	1984/85 (mt)	1985/86 (mt)	1986/87 (mt)	1987/88 (mt)	1988/89 (mt)	1989/90
Bogra	13736	2191	2856	877	691	616	379	na
Dinajpur	9104	358	1278	174	107	219	76	na
Pabna	41378	3767	10568	6783	3653	4246	1808	na
Rajshahi	20991	10594	1991	365	616	592	426	na
Rangpur	46309	7597	6147	3684	2757	2192	1248	na
Total	131518	24507	22840	11883	7824	7865	3937	na
Mean catch (kg\ha)		186	174	90	59	60	30	na

Source: SPARRSO Inland Water Studies, February 1983
DOF: Annual Fish Catch Statistical Bulletins

Note: na = data not yet available.

Table 3(a) N.W. Region-1984/85 Riverine Catches, by River

(Old) District	Upper Padma	Jamuna	Brahmaputra	Other Rivers	Total
Bogra	-	1255	-	1601	2856
Dinajpur	-	-	-	1278	1278
Pabna	2084	5770	-	2714	10568
Rajshahi	331	-	-	1660	1991
Rangpur	-	-	3317	2830	6147
	2415	7025	3317	10083	22840

Table 3(b) N.W. Region 1986/87 Riverine Catches by River

(Old) District	Upper Padma	Jamuna	Brahmaputra	Other Rivers	Total
Bogra	-	224	-	467	691
Dinajpur	-	-	-	107	107
Pabna	1187	959	-	1507	3653
Rajshahi	191	-	-	425	616
Rangpur		241	1185	1331	2757
	1378	1424	1185	3837	7824

Table 3(c) N.W. Region 1988/89 Riverine Catches by River

(Old) District	Upper Padma	Jamuna	Brahmaputra	Other Rivers	Total
Bogra	-	158	-	221	379
Dinajpur	-	-	-	76	76
Pabna	282	565	-	961	1808
Rajshahi	126	-	-	300	426
Rangpur	-	217	523	508	1248
	408	940	523	2066	3937

Source: Annual Fish Catch Statistical Bulletins(DOF).

Production from the beel fisheries has also shown a similar, although not quite so dramatic decline (see Table 4), by 43% from 15,140 mt in 1983/84 to 8550 mt in 1988/89. The NWR beel catch in 1988/89 was only 18% of national beel production, although the region has nearly 30% of the total beel area in Bangladesh, namely 33,650 ha out of 114,160 ha of perennial water according to SPARRSO, 1983. These water body area figures have not been updated since 1983 whereas it is known that because of FCD/I, a number of beels have been drained so that they now hold water for only part of the year or are greatly reduced in area. Thus, the apparent drop in productivity rate from 449 kg/ha in 1983/84 to only 254 kg/ha in 1988/89 may not be quite so severe in reality. Nevertheless the loss of more than 6000 tons per annum to local fish supply has to be viewed as a matter of serious concern.

Table 4 N.W. Region Annual Catches of Beel Fisheries

(Old) District	Beel Area(ha)	1983/84 (mt)	1984/85 (mt)	1985/86 (mt)	1986/87 (mt)	1987/88 (mt)	1988/89 (mt)	1989/90
Bogra	3801	1710	845	1013	1108	1930	1863	1507
Dinajpur	1252	563	288	292	278	257	253	265
Pabna	3255	1465	1351	1134	965	938	908	1212
Rajshahi	19849	8932	8240	6916	4807	4081	3865	3929
Rangpur	5492	2471	1276	1283	1221	2260	1666	1750
	33649	15141	12000	10638	8379	9466	8555	8663

Note: (i) Beel areas were measured by SPARRSO in 1983 but have not been updated since them.

(ii) Mean catch per hectare in 1983/1985 was 403 kg.
1986/1989 was 261 kg (range 145-508)
1989/90 was 275 Kg

Riverine and beel fish production is assessed on the basis of periodic frame surveys and collection of sample catch data for estimating monthly total catches by the mainly full-time professional fishing community. Estimation of subsistence fish catches by the widely dispersed population of the floodplain is more difficult and to a large extent has been based on rural household surveys rather than catch sampling. The flooded area varies quite widely from year to year in extent, depth and duration, all of which must have a greater influence on catch rates than is suggested in Tables 5(a) and 5(b). The fishable area in NWR, i.e. F2, F3 and F4 according to the MPO system of floodland classification, varies in extent from 11,446 square km to 19,038 sq.km for 2.33 year and 20 year return periods respectively, on the basis of which the 1988/89 estimated catch of 42,183 mt corresponds to a mean catch rate of 22 to 36 kg/ha. This is lower than the national floodland mean catch rate of 66 kg/ha but, along with the lower than average catch rates for river and beel fisheries, it is indicative of the cumulative adverse impact of a progression of FCD and FCD/I developments in the N.W. Region during recent years.

Table 5(a) N.W. Region - Floodlands Fish production by Subsistence Households

(Old) District	1983/84 (mt)	1984/85 (mt)	1985/86 (mt)	1986/87 (mt)	1987/88 (mt)	1988/89 (mt)	1989/90
Bogra	3823	10780	10924	6723	6728	7557	7108
Dinajpur	4476	4982	5396	3299	2477	2981	5741
Pabna	21686	11568	9897	5560	5568	4972	4805
Rajshahi	3512	8172	12374	13222	13504	10344	11163
Rangpur	8847	9841	13442	14433	16175	16329	13512
	42344	45343	52033	43237	44452	42183	42329

Table 5(b) N.W. Region - Subsistence Fishing Households ('000)

(Old) District	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Bogra	369	342	404	436	438	449	449
Dinajpur	432	408	491	540	552	552	552
Pabna	367	367	366	226	281	227	232
Rajshahi	711	747	719	787	787	819	819
Rangpur	854	806	854	936	955	939	939
Total NW Region	2733	2670	2834	2925	3013	2986	2997
Est. Flood-land catch	42344	45343	52033	43237	44452	42183	42329
Av. catch/ h'hold (kg)	15.5	17.0	18.4	14.8	14.7	14.1	14.1

Source: DOF: Annual Fish Catch Statistical Bulletins
Subsistence Fisheries Catch Assessment Programme.

There appear to be no published data on the numbers of full-time and part-time professional fishermen in NWR or on their distribution. FAP 2 field investigations yielded some information, almost certainly not comprehensive, from the district and thana fishery offices. The story in most of the thanas visited was similar to FAP 12 findings, namely that the very sharp decline in capture fishery stocks and catch rates has forced up to 50% of the former full-time fishermen to seek other employment, eg as unskilled daily labour. Many have had to migrate elsewhere in search of work whilst some still fish but only on a part-time basis. All those interviewed have blamed FCD as being the principal cause of the destruction of their means of livelihood and in no case was there any prior consultation about the FCD scheme or suggestion of compensation. Based on the details that were

collected it is now estimated that there have been about 108,000 full time fishermen and up to 590,000 part time fishermen in NWR, but numbers are containing to decline and it is impossible to judge how many still remain. Flood season subsistence fishing has involved the majority of the rural population in the flood affected areas. FAP2 findings concerning numbers of fishermen and fleet size, as an indication of fishing effort level is shown in Appendix 5.

2.2 Culture Fisheries

The pattern of pond fish production in NWR since 1983/84 is shown in Table 6(a) and indicates a virtually static level of production around a mean of 25,400 mt per year but with the first signs of an increase appearing in 1987/88 and 1988/89. The distribution of ponds by district, area, culturable status and number, is detailed in Table 6(b). This is the only data set so far that can be allocated to all sixteen new districts in NWR instead of the five original districts and is based on the results of a SPARRSO survey in 1983 coupled with ground level verification. Unfortunately DOF has not been able to update this information, either by means of a repeat survey or by routine reporting from thana fishery staff. Changes such as new pond construction, rehabilitation of previously derelict ponds or formerly productive ponds falling into disuse, must have occurred during the eight years since the SPARRSO survey was undertaken. In consequence, any extrapolations made from the pond area data to estimate total production or productivity rates, especially for the more recent years, must be viewed with caution. The benefits to fish farming which can flow from FCD and FCD/I developments, cannot be reliably quantified and monitored unless the data base is routinely revised at reasonable intervals and all that can be said now is that there were about 41,400 ponds in NWR in 1983/84 of which only 38% were being regularly restocked and cultured. The balance of potentially culturable or derelict ponds depend entirely on wild fish stocks being retained in the pond when the monsoon flood recedes.

Table 6(a) N.W. Region - Pond Fish Production by Districts

(Old) District	1983/84 (mt)	1984/85 (mt)	1985/86 (mt)	1986/87 (mt)	1987/88 (mt)	1988/89 (mt)	1989/90
Bogra	4179	3922	3719	4031	4517	4571	5399
Dinajpur	7059	6317	8540	5800	5850	7036	4713
Pabna	4018	3767	3590	4200	5104	5197	6695
Rajshahi	8031	7428	7899	7932	8202	10246	15687
Rangpur	1945	1817	2442	3530	3039	3085	3209
	25232	23251	26190	25493	26712	30135	35703

Source: Catch Assessment Survey of Ponds, Fisheries Resources Survey System.

Table 6(b) N.W. Region- Fish Ponds- Area and Status by Districts:

New Districts /a	Area of Ponds (ha)				Total Number	Average Size (ha)
	Cultured	Culturable	Derelict	Total		
Bogra	2206	1437	624	4267	19001	
Joypurhat	730	475	206	1411	6283	
Total	2936	1912	830	5678	25284	0.22
Dinajpur	2603	1696	736	5035	22421	
Thakurgaon	1373	894	388	2655	11825	
Panchagarh	982	639	278	1899	8456	
Total	4958	3229	1402	9589	42702	0.22
Pabna	1113	1636	898	3647	17902	
Sirajganj	1146	1685	926	3757	18439	
Total	2259	3321	1824	7404	36341	0.20
Rajshahi	1175	1727	949	3851	18897	
Naogaon	1652	2428	1334	5414	26574	
Natore	889	1307	718	2914	14302	
Nawabganj	799	1174	645	2618	12850	
Total	4515	6636	3646	14797	72623	0.20
Rangpur	285	213	454	952	11195	
Kurigram	279	208	444	931	10945	
Lalmonirhat	149	111	237	497	5841	
Nilphamari	200	149	319	668	7862	
Gaibandha	265	197	422	884	10396	
Total	1178	878	1876	3932	46239	0.08
Region Total	15846	15976	9578	41400	223189	0.18

/a: Old district names are as underlined.
Source: 1983 SPARRSO Satellite imagery studies & DOF ground truthing Surveys.

Indian major carp species dominate pond fish culture production in NWR because of their fast growth rate, ability to withstand high stocking densities and high market value. In particular demand are, Labeo rohita (Rui), Catla catla (Katla) and Cirrhinus mrigala (Mrigal), together with the introduced European and Chinese carps, Cyprinus carpio (Common carp), Hypophthalmichthys molitrix (Silver carp), Ctenopharyngodon idellus (Grass carp) and the Bighead carp, Aristichthys noblis. Pond culture was originally based on carp fry and juveniles collected from the rivers but hatchery technologies for all of these species have now been fully adapted to conditions in Bangladesh and are being widely practised in both the public and private sectors. Wild spawn collection from the rivers nevertheless continues as a diminishing specialised component fishery still supplying about 60% of the market.

Fish farming is being conducted throughout much of NWR, as in most of Bangladesh, at a comparatively low level of technology and very few cultured ponds are producing more than about 1400 kg/ha per annum (Tables 6(c),6(d) & 6(e)). It has been demonstrated by DOF that by stocking with the right combinations of fish species and numbers and with more systematic feeding and

fertilisation of the pond water, yields can be increased three or four-fold to at least 4200 kg/ha. By definition, culturable ponds receive no inputs beyond what nature provides and derelict ponds are mostly overgrown with weeds and silted up. It follows that culturable ponds cannot be expected to yield more than the average for beel fisheries, ie about 400 kg/ha, whilst derelict ponds are unlikely to produce more than the surrounding floodplain, or up to 70 kg/ha.

Table 6(c) NW Region- Fish Pond Status & Productivity (1984/85)

District	Production (m.t)			
	Cultured	Culturable	Derelict	Total
Bogra	3272	496	154	3922
Dinajpur	5219	838	260	6317
Pabna	2517	862	388	3767
Rajshahi	5031	1722	675	7428
Rangpur	1241	228	348	1817
Total	17280	4146	1825	23251

Productivity: Cultured Ponds - 17280 m.t. @ 441 kg/acre or 1090 kg/ha
Cultivable Ponds - 4146 m.t. @ 105 kg/acre or 259 kg/ha
Derelict Ponds - 1825 m.t. @ 77 kg/acre or 190 kg/ha

Table 6(d) NW Region- Fish Pond Status & Productivity (1988/89)

District	Production (m.t)			
	Cultured	Culturable	Derelict	Total
Bogra	3914	473	184	4571
Dinajpur	4371	1820	845	7036
Pabna	3137	1315	945	5197
Rajshahi	5703	3115	1428	10246
Rangpur	1595	466	1024	3085
Total	18720	7189	4226	30135

Productivity: Cultured Ponds - 18720 m.t. @ 478 kg/acre or 1181 kg/ha
Cultivable Ponds - 7189 m.t. @ 182 kg/acre or 450 kg/ha
Derelict Ponds - 4226 m.t. @ 178 kg/acre or 441 kg/ha

Source: DOF Annual Fish Catch Statistical Bulletins.

Table 6(e) Bangladesh National Inland Fisheries Productivity, 1988/89

(a)	Culture Fisheries			
	Ponds -	Cultured	573 kg/acre;	1417 kg/ha
	Ponds -	Culturable	284 kg/acre;	703 kg/ha
	Ponds -	Derelict	237 kg/acre;	586 kg/ha
	Baors			241 kg\ha
(b)	Capture Fisheries			
	Rivers and Estuaries			176 kg/ha
	Beels			412 kg/ha
	Floodlands			66 kg/ha

Source: DOF Annual Fish Catch Statistical Bulletins.

The financial inducement to expand fish farming should be substantial in that a number of studies have shown the net return per hectare from well managed carp ponds to be considerably more than from the equivalent area of paddy. The World Bank 1990 Fisheries Sector Review, using DOF findings anticipated a net return of Tk 43,000 per ha from a yield of only 2500 kg of fish compared to Tk 9000 per ha for a crop of HYV T.Aman rice. FAP 12 findings have provided independent confirmation of this comparison and of a growing awareness amongst some pond owners. In a recent IFPRI-BIDS Agriculture Diversification study (MK. Bhuiyan March 1992) fish pond budgets based on sample surveys, indicated a net profit after all costs including leasing, of Tk. 43,700 per hectare for ponds producing 2000 kg/ha. However, only in a few places was there any significant interest in digging new ponds because of difficulty in obtaining the necessary technical advice and credit to cover the costs of pond construction or rehabilitation, estimated to be up to Tk 275,000 per ha. The continuing high risk of ponds being over-flooded, even in many parts of existing FCD project areas and thereby of wasting the extra investment, was also viewed as a major disincentive. District fisheries staff confirmed that there was an acute shortage of credit for fish farmers and that DOF aquaculture extension efforts were severely constrained by a lack of equipment and operating funds.

2.3 Fish Hatcheries, Nurseries and Spawn Collection

Carp hatcheries have been found to be quite evenly scattered throughout NWR as is shown in Table 7. The technology was initiated by DOF under programmes which resulted in the establishment of more than 82 public sector hatcheries and fish seed multiplication farms nationwide, of which 30 are located in NWR. The rapid expansion of private sector involvement has been a notable feature of the last few years, to the extent that in NWR there are now at least 60 private hatcheries producing carp fry. A recent survey by 3rd Fisheries Project (TFP) of 20 of the NWR private hatcheries noted current fry production as about 2250 kg (1 kg contains approximately 400,000 tiny fish), or about 36% of their theoretical capacity. In contrast, 19 public sector hatcheries operated by DOF produced only 265 kg in 1989 at a much lower level of capacity utilisation. A major new hatchery and aquaculture training school is under construction at Parbatipur in Dinajpur District with ODA assistance which should help to improve the public sector hatchery performance. In most cases the hatchery produced fry are taken by nursery pond owners who rear them to the fingerling stage at which they are sold to production pond farmers who then grow them on to market size.Based on current experience, 1 kg of fry will produce 100,000 fingerlings, 50% of which should survive to marketable size. More work needs to be due to reduce this very high mortality rate.

Table 7 Distribution of Hatcheries and Nursaries in NWR

Planning Unit		Hatcheries		Nurseries		Wild Spawn Collection centre
No.	Name	Govt.	Private	Govt.	Private	
1	Thakurgaon	1	-	-	20	-
2	Upper Atrai	2	2	-	20+	-
3	Teesta Right Bank	-	7	-	22	-
4	Teesta Left Bank	-	-	2	6	-
5	Kurigram	2	1	-	24	4
6	Upper Karatoya	2	7	-	39	2
7	Gaibandha	-	5	2	20	2
8	Middle Bangali	6	2	-	75	35
9	Joypurhat	4	15	3	230	-
10	Barind Tract	2	1	-	63	2
11	Mohananda Basin	2	-	-	4	1
12	Atrai Left Bank	2	14	2	276	-
13	Atrai Right Bank	4	6	-	156	-
14	Lower Bangali	1	-	-	14	1
15	Pabna	2	2	-	120	3
	Totals:	30	62	9	1089	50

Source: FAP2 distinct and upazilas Investigations.

During the course of both FAP 2 and FAP 12 field surveys it was noted that an unknown but substantial quantity of carp fingerlings are imported into NWR each year from the Jessore area of S.W.Bangladesh, indicating that internal production is still insufficient to meet the demand. As TFP is just starting its programme of restocking annually some 10,000 ha of depleted beel and floodplain waters in NWR, at the rate of about 2700 fingerlings per ha, the very large additional demand which it is creating for fingerlings could pose some supply problems, particularly at a stage where it seems that the supplies of wild caught spawn are also declining. This is making it more difficult, and more expensive for pond owners to obtain their requirements, although TFP is taking every care to try to ease the supply problem.

Prior to the introduction of carp hatchery technology, the specialised wild spawn fishery was the traditional source of fry for stocking ponds throughout Bangladesh. As indicated in Table 8, in NWR there are about 50 main centres and a number of lesser sites for spawn collection and distribution. These are mainly located at intervals along the right bank of the Brahmaputra/Jamuna and along the left bank of the Ganges/Padma. Up to 4000 people engage in this fishery which has produced over 17,000 kg/p.a. of hatching fry in the past, down to between 8000 and 10,000 kg during 1988 and

1989. The fishery is highly seasonal during May to July each year and is still of great importance to the fish farming industry. However, given the diminished state of riverine fish stocks, consideration will have to be given to imposing some limitation, such as a close season, on wild spawn harvesting in the interest of conservation.

Table 8 Wild Carp Spawn Collection in N.W. Region

Year	Collection Centres (Nos.)	People Employed (Nos.)	Nets Used (Nos.)	Quantity of Spawn (kg)	Catch Per Net (kg)	Prices Range (Tk/kg)
1984	64	2799	11648	17023	1.46	na
1985	41	2216	7589	12282	1.62	na
1986	57	2816	7495	6497	0.87	500/ 6500
1987	62	3895	16622	14420	0.87	2000/ 3750
1988	50	3672	11956	7667	0.64	1500/ 4750
1989	47	3102	7152	9788	1.37	300/ 4000

Source: DOF Annual Fisheries Statistical Bulletins

2.4 Fisheries Management

2.4.1 DOF Support Services & Extension

The fisheries administration in NWR is headed by a Deputy Director based in Rajshahi who is directly responsible to DOF head office in Dhaka. The sixteen districts each have a District Fishery Officer, Fishery Survey Officer and supporting clerical staff. In theory each of the 124 thanas should be staffed by a fishery officer, an assistant fishery officer and a field assistant but in reality a number of these posts are vacant. The districts each have at least one of the 30 DOF managed public sector carp hatcheries or fish seed multiplication farms, each of which is staffed by a hatchery superintendent and a number of trained junior staff. In most cases it was stated that the offices lacked transport and, even where a serviceable vehicle or motorcycle was available, there was an acute shortage of operating and maintenance funds so that duty travel was severely restricted. This situation is particularly damaging to fish farming extension and, as pointed out in section 2.2 above, is one of the reasons why pond owners have failed to benefit from the opportunities offered by FCD. Under TFP number of new motor cycles and other equipment are now being distributed to various fishery offices in NWR and these will greatly improve the mobility of fisheries staff in the future.

In several areas, eg in Kurigram , Rangpur, Gaibandha and Pabna Districts, DOF is actively implementing the New Fisheries Management Policy, under which water bodies which were previously leased out by the Ministry of Land to individuals are being transferred to the Ministry of

Fisheries & Livestock for allocation to recognised groups of bona fide fishermen on long term leases. NGOs are also cooperating in this programme by providing assistance to the groups in setting up their organisation and management systems.

DOF staff in the region are also actively engaged with 3rd Fisheries Project staff in implementing TFP's restocking programme in NWR, initially in the Halti Beel area of Chalan Beel Polder-C, and in progressing the Integrated Fisheries Development Project NWR components. These include 3 new hatcheries in Panchagarh, Rangpur and Sirajganj districts, 2 small fish reserves on the Padma River in Rajshahi and Gur River in Natore District, and fisheries development in the Gohala River Irrigation Project in Sirajganj and Pabna districts. Thus, such resources as DOF has in NWR are committed and the Dept. would have difficulty in taking on additional activities without reinforcement.

2.4.2 Fisheries Statistics

Prior to 1983, estimates of annual fish production were derived by extrapolation based mainly on periodic national nutrition surveys. A new Fisheries Resources Survey System (FRSS) was initiated along more systematic lines in 1983, with FAO assistance and despite problems of sample size and a possible underestimation of the subsistence fish catch, the system of frame surveys and sample catch data collection is basically sound. It should yield reasonably reliable information provided that the resources needed to maintain the data collection schedules can be guaranteed. One weakness is DOF's inability, because of cost constraints, to update the areas of beels, other water bodies and ponds. These areas were last surveyed in 1983 by the Bangladesh Space Research and Remote Sensing Organisation (SPARRSO) and many changes will have occurred since then which have a bearing on production rates from both the capture and culture sectors. The principal beel areas in NWR are indicated in Figures 1. A further weakness is the shortage of trained staff and resources for data analysis, which is centralised in DOF HQ in Dhaka. As a result it is taking more than 2½ years to process and publish the annual statistics. For effective fisheries management, this must be speeded up.

2.4.3 Fisheries Regulation & Enforcement

Attention has already been drawn to the urgent need for action to prevent any further damage to remaining open-water fish stocks, from illegal and harmful fishing methods which are widespread and being used quite openly. Legislation such as the Protection and Conservation of Fish Act and the Tanks Improvement Act already exist and should be adequate for the immediate needs of fish protection and conservation provided that there is the will to enforce them. Unfortunately, this does not appear to be the case. Fishery officers are not taking the necessary action for a variety of reasons, including lack of transport, lack of support from the police and possible fear of repercussions.

Whatever the cause it seems pointless to engage in restocking waters if the existing stocks cannot be effectively protected, as part of the management process. Such action constitutes the most basic responsibility of any fisheries administration and without firm but fair enforcement of essential controls there can be no hope of sustainable development.

Existing rules should be reviewed and amended it necessary, to ensure their relevance and to deal with possible loopholes. DOF must be given the directives and resources to fulfil these responsibilities and consideration given to reinforcing the staff units who will be engaged in enforcement duties.

2.5 Fish Marketing

2.5.1 Fish Supply & Demand

In the country as a whole, demand for fish is increasing faster than supply, whilst in NWR fish production has fallen by 21% during the six year period 1984 to 1989 and additional supplies have to be transported from surplus producing areas, such as Chittagong and Barisal. During a visit to Sirajganj fish market on 16th July,1991 it was observed that of the 3 to 4 tons sold daily, more than 75% was trucked in from outside the District, much of it being Hilsa from Barisal. A further visit to Gaibandha Town Market in late August 1992 showed a similar situation, in that more than 50% of the 1½ to 2 tons of fish on offer was iced sea-caught Hilsa from Barisal. Supplies also show marked seasonal variation, being most abundant during November to January when the floods drain away leaving concentrations of fish in all the remaining pools and depressions. Greatest scarcity is during the peak flood time, July/August, when fish are still small and widely dispersed and when fishermen are reluctant to risk losing gear whilst the rivers are in spate.

Fish prices also fluctuate with the seasonal changes in abundance but the growing level of unsatisfied demand is making fish ever more costly even during peak supply periods when prices might have been expected to fall more steeply. Published data relating to demand per capita are rather confusing, in that there appears to have been an increase in fish consumption during the 12 years 1974 to 1986, from 9.84 kg to 13.18 kg/capita according to official Household Expenditure Surveys, at a time when DOF catch records showed per capita availability remaining stable at around 7.7 kg and to have declined since 1987 to about 7.5 kg. As things stand, the prospects for a reversal of this trend and for an increase in consumption to 9.5 kg/capita by the end of the 4th Five Year Plan in 1994/95, do not seem very good. Fish market price studies indicate that beel species, such as Koi, Magur & Shingi are increasing more rapidly than the major carps in cost.

There are no separate statistics on fish consumption and demand for fish in NWR, but given that the present population of the region is about 25.43 million, fish supply would have to be of the order of 191,000 tons to provide 7.5 kg/capita whereas total production in the region is less than half that amount. Even taking into account some fish imports from other parts of Bangladesh, it seems certain that NWR consumption is now very much less than the national average.

2.5.2 Market Organisation

Fish marketing is almost entirely a function of the private sector and operates through a complex system of village markets (hat), township markets (bazar), assembly centres and major urban wholesale and retail markets. There is a corresponding network of personnel, from buyers who may be hat traders or agents of bigger bazar fish merchants (Bepari) up to wholesale market commission agents (Arotdar) who effectively control the whole system. It is claimed that competition between buyers at the fish landing centres is deliberately restricted and exploitive of the fishermen who have very little bargaining power and are largely dependant on particular buyers who are their only source of credit. Despite these problems the fish marketing system is quite efficient and enables fish to be moved as and when needed between market centres without excessive loss of quality. For example, Barisal fish arrived in Sirajganj packed in 200 kg baskets, with ice, and having taken 2 to 3 days en route, in reasonably fresh condition. The main problems are the lack of ice, or at best inadequate and costly ice supplies at most centres and the almost indescribably bad state of most of the fish market structures. Unfortunately, with fish being an increasingly scarce commodity in very high demand, there is little inducement to traders or others to invest in better quality products and facilities, but urban authorities responsible for public health should take action to improve market conditions.

Virtually all fish produced in NWR is marketed and consumed fresh and is handled through the private sector marketing system as described above. The Bangladesh Fisheries Development Corporation (BFDC) does however operate a fish marketing depot in Rajshahi town which is equipped with a 10 ton capacity cold store and a small block ice plant. BFDC imports about 700 tons of Barisal and coastal Hilsa each year for sale in NWR, but otherwise has only a minor role in the North West. BFDC premises are quite well maintained but from the public health aspect there is urgent need to rebuild most of the township fish markets where drains are clogged, floors are cracked and filthy, there are no facilities for washing down and inadequate provision of market stalls such that much fish has to be sold on the ground amid all the dirt.

3. Fisheries Development and the Flood Action Plan

3.1 Impact of FCD/FCDI on Fisheries

The main impacts of FCD and FCDI projects on the fisheries of NWR have been identified in the course of case studies by FAP 12 and during FAP 2 field surveys and can be summarised as follows:

(a) There is a potentially positive impact by effective flood control on culture fisheries in closed water bodies, such as ponds, borrow pits and canals, whereby the protection against over-flooding encourages regular restocking, improved culture methods and where necessary, pond rehabilitation. Unfortunately these benefits have not always materialised because of ineffective flood control caused by poor maintenance and in some cases faulty design of FCD infrastructure, coupled with inadequate fisheries extension back-up and lack of credit.

(b) Negative impacts on capture fisheries arise from FCDI works which reduce the areas of perennial beels and floodplain for fish breeding, feeding and nursery grounds; which block essential fish migration routes from beels to and from the rivers and which thereby alter and diminish the fish stock size and species composition of the faunas both within and outside the FCD project boundaries and with detrimental effects on fishermen's catch rates and earnings.

(c) Reduction of the areas of open water remaining within FCD developments has severely restricted access for subsistence fishing, especially by the poorer sections of the rural community who have relied on their former traditionally free fishing rights to provide the bulk of their animal protein food. This has adverse consequences for nutrition in the population groups concerned who mostly lack the financial means to purchase fish which previously they were able to catch for themselves.

(d) Reduced fish stocks and lower catch rates endanger the livelihood of fishermen, many of whom have been forced to emigrate from the areas concerned in search of alternative employment. Reduced catches also encourage the use of harmful fishing methods in the absence of any effective means of enforcing controls, as a response by fishermen in an effort to maintain their production and income levels. This is part of a vicious circle which only contributes even further to the collapse of the capture fisheries.

(e) Expansion of the areas of irrigated HYV crops within FCD developments has led to increased use of chemical fertilisers and pesticides and thereby to contamination of the residual water bodies. This may lead to higher mortality rates especially of the juvenile stages of resident species and other fish which are able to breed in the beels or adjacent flooded areas.

In the light of these findings, analyses were carried out to determine the effects on fisheries of a range of possible FCD projects and options which were being considered for inclusion in the NW Regional Plan. The results, which were described in more detail in Interim Report No. 1, showed that in virtually all cases the "With Project" condition predicted a large drop in capture fish quantity and value only partly offset by an increase in culture fish production. In the meantime, and as outlined in Volume 1, the range of possible projects and options for inclusion in the Plan was refined to include:

- resealing and training the Teesta Right and Left banks,
- resealing BRE from TRE to the Manas/Ghagot outfall,
- Gaibandha Project works,
- the Bangali Floodway,
- the Lower Atrai project, involving changes to the Chalan Beel and Bogra polder complex,
- the Hurasagar and SIRDP projects, and
- the Mohananda project.

Further analyses carried out on these projects showed, as expected, that without any mitigatory provision all would produce substantial net losses from fisheries in the "Future With" condition, compared with "Future Without". Partial protection yielded smaller capture fish losses than full FCD but also smaller benefits to fish farming.

In all cases the risks of further damage to fisheries is outweighed by the benefits accruing to other sectors, but it is therefore reasonable to expect that the projects concerned will include specific provision for fisheries mitigation. As far as is feasible, the measures to be taken should address the physical, biological and social impacts of the projects concerned, both within and in the vicinity of the project areas and, inter alia should aim at restoring at least part of the lost production and preserving the livelihoods of as many of the affected fishermen as possible.

3.2 Development Strategy

A concerted effort is needed to minimise the risk of further FCD related damage to fish stocks and the fishing community and to promote measures designed to restore at least some of the past fishery losses. The principal components of a strategy and action programme for achieving a reversal of the present downward trend in fish production in NWR is as follows:

(1) Prevention of any further avoidable harm to fish stocks arising from illegal or other damaging methods of fishing, by rigorous enforcement of existing legislation. Top level and unequivocal political support for such action is considered essential.

(2) Introduction of additional conservation measures to encourage a revival of natural fish stocks, by imposing close periods during the carp spawn collection season; by creating breeding reserve areas in which fishing should be prohibited, and if necessary by imposing limitations on numbers of fishermen or nets, in order to restrict the exploitation of particular fisheries to safe sustainable limits.

(3) Reduction of the causes of FCD related damage to fish stocks, by further research into the design of sluices and other protective structures, concerning which the FAP 3/1 Draft Final and FAP 13 Final Report contain design proposals for pilot trials. FAP 17 is currently evaluating possible designs for such trials.

(4) Reduction of the continuing loss of fishing grounds and catches from perennial beels, by restricting the extent to which areas and water levels may be reduced for irrigation water extraction or by drainage. Where possible residual silted beels should be excavated and bunded to increase water storage and fish productive capacity.

(5) Expansion of the private sector hatchery programmes, eg as under TFP, for annual restocking of public open water fisheries with carp fingerlings and their extension to include stocking all perennial waters capable of supporting year-round breeding stocks, with suitable fish species such as tilapia (Oreochromis niloticus), which will thereby sustain greater catches of cheaper fish for consumption by the lower income population groups.

(6) Revival of research and development efforts at DOF establishments to develop hatchery technologies for a range of minor carp and other riverine & floodplain species, to facilitate eventual fish stock regeneration in the capture fishery areas. As this is an R & D rather than a commercially viable undertaking, it is correctly a function for the public rather than the private sector.

(7) Reinforcement of DOF's aquaculture extension service in the project areas, by providing the necessary equipment, transport, operating finance and services of a project extension coordinator, to ensure that pond owners gain the necessary know-how to benefit from FCD's potentially positive impact on pond culture fisheries.

(8) Provision of a source of credit for disbursement via established rural credit agencies, such as the Grameen Bank, for pond rehabilitation and to enable newly formed fishermen's groups to acquire necessary boats and fishing gear. A crucial factor in this aspect will be the willingness and availability of NGOs to take on the task of guiding and overseeing the establishment of such fishing groups, most of whose members will be barely, if at all literate.

3.3 Beneficiaries and Role of NGOs

Virtually the only fisheries sector beneficiaries of FCD hitherto have been land owners whose property included ponds which were made less vulnerable to over-flooding. Such owners should have been encouraged to culture their ponds rather than depend solely on nature, as was previously the case. In reality the potential benefit has accrued to only relatively few pond owners because of a general lack of know-how and DOF's inability to field effective extension support.

Capture fishermen have invariably been the victims of FCD who have received scant attention and no recompense from the designers, managers and financial sponsors of FCD projects. Even the relatively few cases where fishermen have formed groups and taken over the management of particular fisheries (Jalmohals), with DOF and NGO assistance, the action has been a response to the fishermen's plight rather than an FCD project related benefit.

For the first time therefore, it is proposed that FCD should take the initiative to promote and finance at least some of the activities intended to revive damaged fish stocks and assist the fishing communities to restore their traditional means of livelihood. The initiative should be taken in active cooperation with DOF and the NGOs concerned and aim to reinforce their efforts by providing the necessary additional resources. The beneficiaries would include a large proportion of the full-time and part time fishing force, numbering about 170,000 in all, plus their families and those of the 220,000 pond owners who would benefit from the strengthened extension service and easier access to rural credit.

A number of NGOs are already actively supporting groups of fishermen and fish farmers in various parts of NWR, including BRAC (Bangladesh Rural Advancement Committee), the Grameen Bank, TDH (Terredes Hommes), CARE, CARITAS, and the Production Employment Programme (PEP) and Rangpur & Dinajpur Rural Service (RDRS), both of which operate under the umbrella of BRDB (Bangladesh Rural Development Board. Typical projects include assisting small groups of displaced fishermen to restore and operate formerly derelict fish ponds on long term leases, assisting other groups to operate jalmohals by setting up their management systems and negotiating credit. However, their involvement is constrained by shortages of trained manpower and limited funds but given such resources their contribution will be invaluable because they can function in support of the business interests of infant groups in ways that would be inappropriate for a Government department.

3.4 Possible Mitigatory Measures

3.4.1 Preservation & Improvement of Beels

FAP 2 fisheries specialists were informed that BWDB, DOF and their respective Ministries have agreed that in all future plans for FCD development, any state owned "khas" beels or other water bodies in the areas concerned, which retain water all year round, will not be drained as in the past, but will be preserved and improved for fisheries development under the New Fisheries Management Policy.

In compliance with this very important agreement and to facilitate its implementation, an up-to-date national register of all perennial beels needs to be compiled and verified, showing name, location, minimum permanent area and depth and current fishery status. This could be done quite quickly by thana fisheries staff provided they have means of transport. After identification of the khas water bodies concerned in each project area, the improvements should take the form of excavating silted up areas around the edges of the beels and using the spoil to raise bunds within which the area and depth of water can be increased, clearing any excessive vegetation and restocking to supplement any remaining fish stocks. Restocking should involve an appropriate range of species, most of which should, preferably be able to establish resident permanent breeding populations within the beel.

It is not considered feasible to restore beel areas which have already been drained, converted for rice cultivation and allocated to the farmers concerned. Owners of beels which are private property cannot be prevented from draining them, but should be encouraged by all possible meas to develop and manage them as viable fisheries, rather than to destroy them.

Beels located in close proximity to a boundary river should, if possible be left outside the embanked, protected area so that the natural system of water flows and fish migrations can be maintained. In any case, all such khas beels, after improvement, should be leased to genuine fishermen's groups on a long term basis in accordance with NFMP arrangements and with NGO assistance in organising the fishermen.

3.4.2 Development of Borrow-pit Fisheries

Throughout Bangladesh a very large area and number of borrow-pits have been dug in the course of constructing roads, embankments and other facilities. It is clear from the appearance of many of these areas in NWR, that very little thought has been given to the subsequent productive use of such areas, whereas it costs virtually no more plan the shape and depth of the borrow-pit and ensure that the contractors leave the area according to the plan rather than as an unusable derelict wasteland. In some parts of NWR the ground may be too porous to hold water, but it is believed that there must be many hundreds of hectares of potentially productive ground of this nature. It is therefore suggested that any such existing pits and any that may be dug in the course of the project, should be converted for fish. Fishing rights should be given, as first priority, to the capture fishermen whose livelihoods may have been affected by the project and who can be assisted by NGOs to establish themselves as viable groups.

3.4.3 Development of Modified FCD Structures

Designs for modifying or rebuilding sluices or regulators in order to allow fish passage in both directions, but without endangering the surrounding farmland, are still being studied by FAP 17. A number of proposals have been made, for example in reports by FAP 3/1 and FAP 13, for pilot trials to determine the effectiveness of the suggested designs. Incorporation of such designs into project constructional pans, to mitigate the biological impact on migratory fish stocks, will have to await the results of FAP 17's trials programme.

3.4.4 Enhancement of Capture Fish Resources

It is intended that the Third Fisheries Project will extend its beel restocking programme from Hilna and Halti Beels in Rajshahi and Natore Districts to other parts of NWR, but many beels and other capture fishery sources throughout the region will be left out because of funding limits. It will be necessary to review each project situation and the status of beels in the near vicinity, to determine which areas still need support. It is considered that private hatcheries and nurseries should be contracted, as they are with TFP, to produce and deliver carp fingerlings to the water bodies. The production of tilapia and Thai barb. fingerlings can be handled by DOF's existing public sector hatcheries in conjunction with an R&D programme to develop hatchery technologies for a range of minor carps and other less costly fish species.

The fish stock enhancement work should also include supplementing riverine fisheries but an effective technology for this purpose has not yet been developed and this is also a topic for further investigation by FAP 17. The proposed "green river" approach to redevelopment of FCD in the Lower Atrai area could provide a test-bed for methods of regenerating over-fished riverine stocks.

3.4.5 Fish Pond Development

Any reduction in the risk of ponds being over-flooded and of fish being swept away by river water or rainfall congestion, improves the prospects for fish farming and creates opportunities for restocking serviceable ponds or for rehabilitating others that have fallen into disuse and become derelict. Experience from other projects suggests that the response has often been disappointing, sometimes because of DOF's inability to provide the necessary extension advice and often because of the general non-availability of low-cost rural credit to assist with the costs of pond rehabilitation. In this situation

there is an opportunity for fishermen's groups, with NGO assistance, to negotiate long-term pond leases with owners of derelict ponds, whereby the group undertakes the task of excavation and stocking in return for use of the pond for long enough to make it worthwhile. Several of the NGOs already have experience of this approach, which can give displaced capture fishermen an alternative means of livelihood.

3.4.6 Implementation & Management Issues

Project implementation will be heavily dependant on DOF for most of the field staff who will be needed to implement the pond culture extension programme and to supervise the delivery and stocking of fish fingerlings in the various selected water bodies. DOF staff who can liaise with NGO personnel to oversee the activities of fishing groups will also be required. However, as noted earlier, DOF manpower is already substantially committed to ongoing projects and the extent to which they can take on additional work will have to be discussed and agreed with DOF senior management in each case.

A fisheries extension coordinator will definitely be required to determine where and when the limited manpower can be most usefully deployed, and to manage the allocation of equipment and funds for this purpose. In line with TFP experience, it seems likely that another coordinator will be needed to organise the procurement of fish fingerlings and ensure that the contracted private sector hatcheries/nurseries do supply the correct quantities at the specified times and places. Someone will also have to coordinate the respective roles of DOF district staff and NGO personnel in support of the fishing groups and to ensure that funds earmarked for rural credit are correctly administered, with appropriate arrangements for sub-loan appraisal, approval and recovery. DOF's senior manpower constraints are such that the three man project management team will almost certainly have to be provided from external sources.

4 Regional Plan Fisheries Components

4.1 Planning Units and Fisheries

Published fisheries data hitherto has been arranged on the basis of the former "greater district" boundaries, of which there were five in NWR. Some years ago they were divided into 16 "new" districts and those in turn each include a number of thanas (formerly upazilas). It has been the intention of DOF's data analysis unit to reorganise the system in accordance with the new district areas but so far this has not been accomplished. Thus the only way to obtain an idea as to the distribution of NWR fisheries down to thana level was to visit as many thanas as possible for on the spot data collection.

For regional water management planning purposes, NWR was divided into 15 planning units based on the principal river systems and catchments as described in detail elsewhere in this report, but whose boundaries frequently intersected rather than conformed to district and thana boundaries. It was therefore necessary to apportion the district and thana fisheries data to the respective planning units, using knowledge gained during the field studies as far as possible, but otherwise on a pro-rata basis, with the results shown in Table 9.

Table - 9 NW Region, Assessment of Fisheries - By Planning Units

(Area - ha; Production - M.T.)

Planning Unit	CULTURE FISHERIES-FISH PONDS						CAPTURE FISHERIES					
	Cultured		*Culturable*		*Derelict*		*Beel*		*Rivers*		*Floodplain*	
	Area	Prod'n	Area	Prod'n	Area	Prod'n	Area	Prod'n	Area	Prod'n	Area	Prod'n
PU - 1	3675	3490	2314	1040	1044	130	24	11	392	35	3000	207
PU - 2	1270	120	829	370	410	50	24	11	314	28	3000	207
PU - 3	205	190	130	60	269	30	294	132	4000	360	600	41
PU - 4	195	185	-	-	206	25	34	15	10900	370	1500	105
PU - 5	245	230	179	80	370	60	2950	530	5400	430	9500	650
PU - 6	2010	1910	600	270	680	80	2200	990	2050	143	8900	578
PU - 7	380	305	-	-	88	10	380	110	1800	70	3020	210
PU - 8	1105	1050	-	-	1547	170	1180	530	13250	530	10000	700
PU - 9	1545	1470	1308	590	654	70	930	205	1360	106	10000	690
PU - 10	1295	1230	1890	850	1038	125	10650	2340	3220	251	11300	780
PU - 11	635	600	929	420	555	90	4130	1115	2980	235	14000	966
PU - 12	1170	1115	1270	570	657	80	2885	635	3920	306	31000	2140
PU - 13	1450	1380	2137	960	1176	140	9920	2180	7600	590	50000	3450
PU - 14	1360	1290	-	-	768	90	1520	335	18100	1410	28000	1930
PU - 15	2090	2050	-	-	684	80	750	340	13220	1030	5170	360
TOTAL:	18630	16615	11586	5210	10146	1230	37871	9479	88506	5894	188990	13014

Source: FAP2 Upazila Survey; DOF District Fishery Offices

Note : Total Area of Fish Pond = 40362 ha; Pond Production Totals 23055 M.T.

Comparison of theses figures with DOF's published data, (Tables 1 to 6) , shows a mix of similarities and fairly substantial differences, but given the doubts expressed earlier about the accuracy of these statistics, it would be surprising if figures drawn from different sources were to agree more closely. The planning unit figures are therefore judged to be good enough for this stage of regional planning. The comparison is summarised in Table 10.

Table - 10 NW Region, Comparison of Planning Unit Fisheries Data with Published Figures

Sub-Sector	Planning Unit (Totals)	DOF Published (Totals)
Areas		
Fish Ponds		
Beels	40360	41400
Rivers	37870	33649
Floodplain	88505	131500
	188990	n.a
Productions		
Fish Ponds		
Beels	23055	35700
Rivers	9479	8660
Floodplain	5894	3900
	13014	42300

It must be stressed that when the time comes to consider the feasibility of each of the projects, much more detailed investigation of the status of the fisheries will be needed. It is also hoped that, by then, the thana fishery offices will be better organised as regards data collection than they have been hitherto.

4.2 Project Options and Fisheries Impacts

Projects selected for further analysis were:

- Teesta Left Bank, PU4;
- Bangali Floodway, PU6;
- Gaibandha Improvement, PU7; (dealt with separately in Annex 1);
- Mohananda River, PU11;
- Atrai Left Bank (Bogra Polders 2,3 & 4), PU12
- Atrai Right Bank (Ch. Beel Polders A,B,C and D), PU13;
- SIRDP Project, PU14; and
- Hurasagar Project, PU14.

Following the selection of projects for possible inclusion into the NW Regional Plan, and identification of a number of options in each case, it was thereafter necessary to undertake a further apportionment of beel, river and fish pond areas, pro-rata to the respective gross cultivable areas of planning units and the projects concerned. Fortunately, the areas of fishable flood plain, defined as the area of F1 to F4 land flooded to at least 0.3m deep for at least 3 months, were obtainable from the hydraulic model for each project option and condition.

The main variables for comparison of the "Future With" and "Future Without" situations, under different conditions of full FCD, controlled flooding, partial protection and free flow, were changes in the area of fishable floodplain and in fish yields from the beels, rivers and ponds, etc. The assumptions used are set out in Table 11, and it was also assumed that there were no mitigatory interventions.

Table - 11 Calculation of Fisheries Benefits

Assumptions Concerning Fish Yields

	Present	Future Without
Floodplain (Fishable)	70 kg/ha	60 kg/ha
Beels (*)	400 "	350 "
River and Canals	40 "	35 "
Cultured/Culturable Ponds	850 "	850 "
Derelict Ponds	180 "	150 "
Borrow Pits	180 "	150 "

Note : (*) Seasonal Beel Areas, if Quoted, Treat as Part of the Floodplain.

Future With	Full FCD	Partial Protection
Floodplain (Fishable) (**)	50 kg/ha	70 kg/ha
Beels	250 "	400 "
Rivers and Canals	20 "	40 "
Pond - C & C	1000 "	850 "
Pond - D	50 "	50 "
Borrow Pits	250 "	180 "

Note: (**) Fishable floodplain defined as that part of F1 - F4 land which floods at least 0.3m deep, for at least 3 months, data provided by the model.

The results of this analysis are set out in Table 12, which shows that in all full FCD/CFD cases the overall impact on fisheries was negative, by anything from minus 8% to minus 60%, whereas most, although not all of the "flow" portions of the Lower Atrai polders showed a positive impact, sufficient with Polders A, 3 and 4 and also with SIRDP, to produce an overall positive fisheries impact. More detailed analysis of the implications of these findings are provided in the NWR economics study, in Volume 10 of this report. The most significant impact on fisheries was the extent to which the floodplain area was either reduced, as with full FCD, or maintained as with the partial protection or "flow" case. The area available directly impacts on the volume of subsistence fish which can be caught, The other variables had much less effect on outcomes.

Table - 12 NWR Regional Plan: Project Options - Fisheries Impacts

	Future With	Future Without	% Change With Project
CHALAN BEEL:			
Polder A : 25 Year (Combined)	820	1102	- 25
Polder B : -Do-	816	1361	- 40
Polder C : -Do-	1751	2157	- 19
Polder D : -Do-	1654	3238	- 49
Polder A : 25 Year: CFD Part	571	646	- 11
Flow "	466	236	+ 97
Total :	1037	882	+ 18
Polder B : 25 Year: CFD "	591	987	- 40
Flow "	242	209	+ 16
Total :	833	1196	- 30
Polder C : 25 Year: CFD/I Part	53	64	- 17
CFD/2 "	631	777	- 19
Flow "	1336	1315	+ 2
Total :	2020	2156	- 6
Polder D : 25 Year: CFD/I "	338	788	- 57
CFD/2 "	736	1248	- 41
Flow "	700	1022	- 31
Total:	1774	3058	- 42

	Future With	Future Without	% Change With Project
BOGRA POLDERS :			
Polder 2 : 25 Year (Combined)	1519	1888	- 20
Polder 3 : -Do-	1516	1719	- 12
Polder 4 : -Do-	3320	3619	- 8
Polder 4 : Full FCD	2904	3523	- 17
Partial Protection	4040		+ 15
Polder 3 : 25 Year: CFD Part	1158	940	+ 23
Flow "	478	369	+ 30
Total :	1636	1309	+ 25
Polder 2 : 25 Year: CFD Part	974	1345	- 28
Flow "	613	491	+ 25
Total :	1587	1836	- 14
SIRDP : 25 Year (Combined)	3220	3259	- 1
-Do- CFD Part	503	702	- 28
-Do- Flow "	3634	3247	+ 12
Total :	4137	3949	+ 5
Hurasagar: 5 Year (Full FCD)	584	827	- 29
KARATOYA/BANGALI FLOODWAY:			
Route - 2	821	1196	- 31
Route - 22	826		- 31
MOHANANDA RIVER :	269	276	- 3
TEESTA LEFT BANK - Option - 1	274	716	- 62
Option - 2	308	690	- 55

4.3 Proposals for Mitigation

4.3.1 Preservation and Improvement of Khas Water Bodies

In furtherance of the agreement between BWDB, DOF and their ministries that any publicly owned (khas) water bodies capable of holding water all year round, should not be drained as in the past but rather should be preserved and improved for capture fishing, as part of the project. This development would be intended for the benefit of fishermen's groups and managed by DOF with NGO assistance, under the New Fisheries Management Policy. The improvement works would include excavation of parts of the beel, constructing low bunds around the beel perimeter to demarkate its extent and also increase its water holding capacity and restocking with an appropriate species mix to enhance fish yields.

4.3.2 Fish Breeding Sanctuaries

In conjunction with the beel improvement work, in some cases there may be need for breeding sanctuary areas to be set aside after restocking has been carried out. The means of establishing, demarkating and policing such areas requires further discussion, but the established local technique of using brushwood "katha" over a larger than normal area, may be one solution. Katha are places where bamboo stakes and cut brushwood are put into the water to encourage a concentration of fish under this over where they are relatively safe from predators and poachers.

4.3.3 Development of Borrowpit Fisheries

Many borrowpits have been dug throughout NWR and Bangladesh, in the course of embankment or road construction with little or no thought given to their being used afterwards for fish production, and as a result the workers leave the pit areas as worthless derelict waste land. It is proposed that whenever such work is to be done in future, in areas where water retention is possible, the contractors should be required to dig the pits to specified shape and depth, so that once the hole has filled with water after the construction work has been completed, it can be stocked and put into immediate operation as a fishery. These borrowpits would also be intended for use by bonafied groups of capture fishermen.

4.3.4 Enhancement of Capture Fish Resources

In the course of project planning attention must be paid to possible external or downstream impacts, in particular in beel and wetlands where the project may alter or block former drainage or fish migration routes. Projects should therefore follow the Third Fisheries Project example in supporting restocking programmes in such water bodies, in collaboration with DOF.

3.4.5 Modified FCD Structures

It is to be hoped that FAP17 studies into the design of fish-friendly regulators and other similar FCD structures, will have been completed and appropriate advice made available to the planners of new projects or old project rehabilitation. There seems little purpose in making other than token provision for such facilities in the meantime. In the meantime, however, it is recommended that gates be left fully open, especially during the early flood and for as long as it is safe to do so, to allow the maximum opportunity for fish to pass.

4.3.6 Fish Farming Opportunities

The main beneficiaries of FCD hitherto, in terms of fisheries development, have been the pond owners whose ponds cease to be at risk of over-flooding and therefore justify the investments needed to rehabilitate, restock and culture them. Unfortunately, and as recorded by FAP12, in many cases the response has been disappointing because of DOF's inability to field the extension effort needed to advise the pond owners and the general lack of low cost, institutional rural credit when needed. Project planners should examine ways of easing these constraints.

4.3.7 New Waterbody Area Survey

Existing data on pond status and perennial waterbody areas and locations derive from SPARRSO surveys based mainly on Landsat Imagery from February 1980, and are therefore well over 10 years old by now. There is urgent need for this information to be updated because many changes will have occurred in the meantime. The original work, for DOF, was carried out by SPARRSO under a UNDP contract and finance would be required for a repeat study. This need applies across the whole country and not just in NWR, so that the repeat survey should also be organised nationally.

It is therefore strongly recommended that funding for a national waterbody survey by SPARRSO be provided as part of the national Flood Action Plan follow-up programme.

4.3.8 Other Programmes in Support

If DOF is to fulfil its responsibilities in respect of effective fisheries management, research and extension, and the organisation of fishermen to benefit from FCD mitigatory measures, it stands in need of support and additional resources. In particular, and as noted earlier, the system for compilation and analysis of fisheries statistics is in need of a further injection of equipment, skilled advice and training for local staff.

There is need for an applied and well resourced research programmes by FRI, into the hatchery propagation of a range of minor carps and other species, to widen the species composition of restocking work in future, in the beels, rivers and other water bodies. Some of the existing DOF hatchery facilities could be used for this purpose, but finance and equipment is required.

DOF's inability to provide the necessary level of extension to support fish farming development in FCD areas necessitates the inclusion of provision in project estimates to enable DOF to play an effective role in this field.

The need for existing fisheries rules and regulations to be properly enforced, in the interests of protecting the remaining capture fish resources from over fishing, has been stressed. Continued failure to take the necessary action places all the remaining capture fish stocks at risk and DOF must give the most urgent attention to this issue.