People's Republic of Bangladesh
Ministry of Irrigation, Water Development and Flood Control

Flood Plan Coordination Organisation

Southwest Area Water Resources Management Project

United Nations Development Programme
(BGD/88/038)

Asian Development Bank
(TA No 1498-BAN)

FAP 4

FINAL REPORT

Volume 6

Land Resources, Agriculture and Fisheries

August 1993

Sir William Halcrow & Partners Ltd.

in association with
Danish Hydraulic Institute
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Land Resources and Agriculture

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SOUTHWEST AREA WATER RESOURCES MANAGEMENT PROJECT (FAP-4)

FINAL REPORT

LAND RESOURCES AND AGRICULTURE

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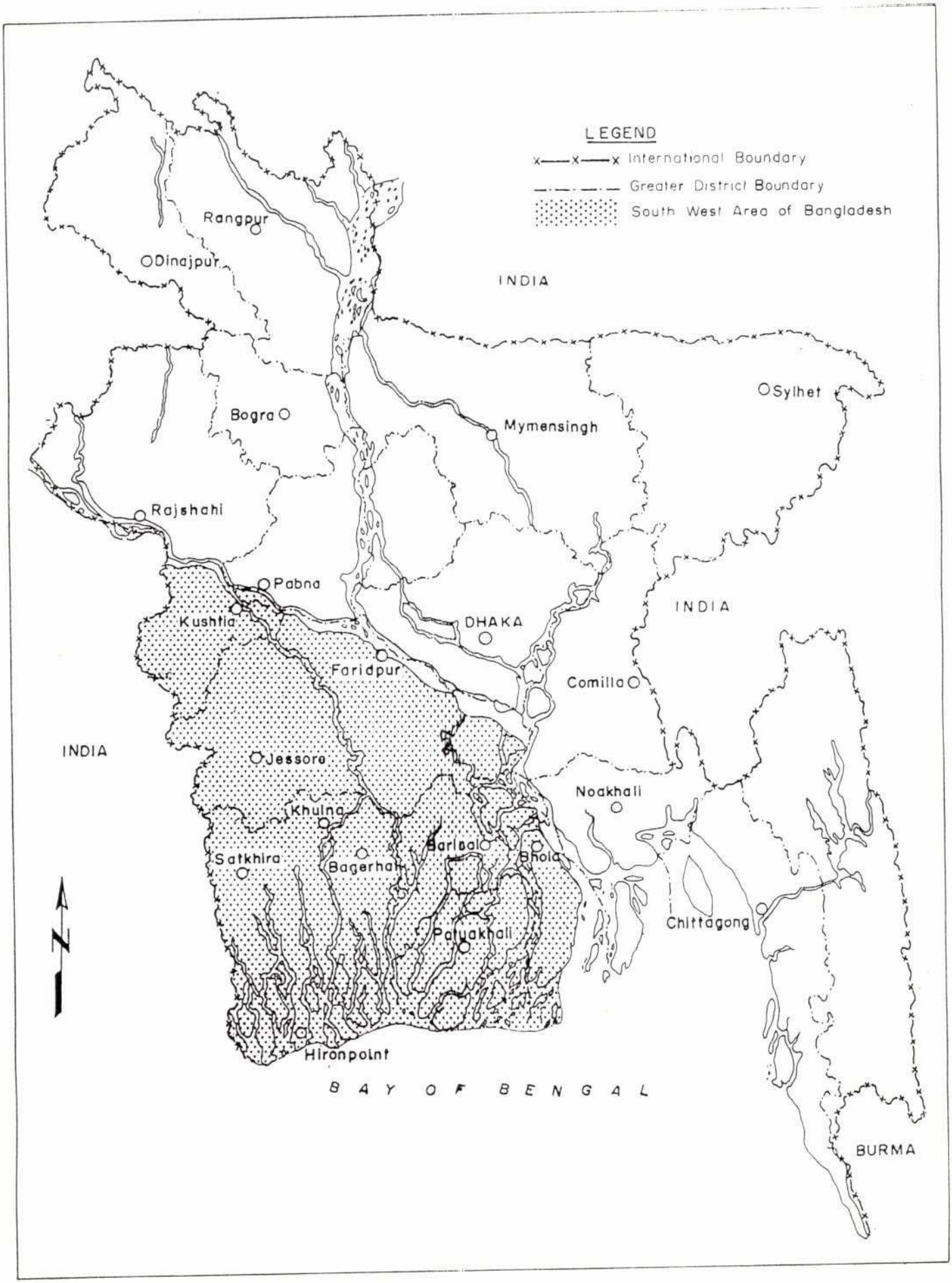
ACRONYMS AND ABBREVIATIONS

AEZ	Agro-Ecological Zone
ASR	Agriculture Sector Review
AST	Agriculture Sector Team
AWC	Available Water Capacity
BADC	Bangladesh Agricultural Development Corporation
B.Aman	Broadcast Aman
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BEPP	Bangladesh Energy Planning Project
BJRI	Bangladesh Jute Research Institute
BKB	Bangladesh Krishi Bank
Boro (L)	Winter Season Paddy (Local Variety)
Bovine	Cattle and Buffalo
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BS	Block Supervisor
BSB	Bangladesh Samabaya Bank
BWDB	Bangladesh Water Development Board
CDP	Crop Diversification Programme
CI	Cropping Intensity
CIDA	Canadian International Development Agency
CPP	Cyclone Protection Project
DAE	Department of Agricultural Extension
D.Aus	Dibbled Aus
DTW	Deep Tube-well
DW.T.Aman	Deep Water Transplanted Aman
EEC	European Economic Community
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/Irrigation
FFYP	Fourth Five Year Plan
GIS	Geological Information System
G-K Project	Ganges - Kobadak Project
GOB	Government of Bangladesh
HYV	High Yielding Variety
IDA	International Development Agency
IFDC	International Fertilizer Development Centre
Kharif	Summer monsoon cropping season
LLP	Low Lift Pump
L.T. Aman	Local Transplanted Aman
LV	Local Variety

MDIP	Meghna Dhonagoda Irrigation Project
MP	Muriate of Potash
MPO	Master Plan Organization
NCA	Net Cultivated Area
NGO	Non Governmental Organization
NSB	National Seed Board
ODA	Overseas Development Administration (U.K.)
P AND K	Phosphorus and Potassium
PET	Potential Evapotranspiration
PIE	Project Impact Evaluation
PU	Planning Unit
Rabi	Winter Cropping Season
RRA	Rapid Rural Appraisal
SC	South Central
SCR	South Central Region
SODAPS	Soil Survey Data Processing System
SRDI	Soil Research Development Institute
SRTI	Sugercane Research and Training Institute
STW	Sallow Tube-well
SW	South West
SWA	South West Area
SWR	South West Region
TCCA	Thana Central Co-operation Association
T.Aman	Transplanted Aman (main monsoon paddy)
T.S.P	Triple Super Phosphate
UNDP	United Nations Development Programme
WARPO	Water Resources Planning Organisation
WB	World Bank

Figure 1.1



South West Area Location Map

1 INTRODUCTION

This volume describes the physical background and agriculture of the Southwest Area (SWA). The objective is to provide sufficient detail for regional planning and pre-feasibility study purposes.

Section 2 of the volume provides the description and quantification of the physical resources of the SWA. The emphasis is on providing information in the context of the agro-ecological regions of Bangladesh which provides a framework in which to interpret the data. To this end, a summary of the more important agroclimatic parameters is given as are the major soil characteristics. An exhaustive description of the soils of the SWA has not been attempted. The approach has been to concentrate on those characteristics of the soil that have the greatest influence on crop production. The regional pattern of inundation is given which, at the level of regional planning, has been derived from secondary sources.

Section 3, Crop production describes the present situation and attempts to assess the changes that have occurred in the SWA over the past ten years as a guide to future trends. The section provides the information on crop production inputs and outputs to allow calculation of benefits for the present as well as the future 'without' and future 'with' situations. The details of the calculations for these situations are given in Volume 10, Economics.

Section 4 provides an overview of livestock conditions in the area and draws attention to the changes that have occurred. In Section 5, the impact of FCD/I has been assessed as a guide to identifying both the positive and negative benefits that have occurred. There are several negative impacts to FCD/I which have an important bearing on the future agricultural production and need to be taken into account in designing future interventions.

Section 6 provides a short description of current institutional arrangements for supporting agriculture in the SWA.

The purpose of Section 7 is to summarise the major constraints to agriculture in the SWA which are by no means all concerned with flood control and drainage. Other, non-engineering interventions have the potential to improve agricultural productivity significantly.

In Section 8 an outline of some of the more important agricultural programmes that are being undertaken in the SWA is given.

Section 9 provides a description of the development potential of the areas identified as a result of the project.

The data used in this volume has come from both secondary and primary sources. Secondary sources include MPO (WARPO) and the Bangladesh Bureau of Statistics.

At the regional planning level the emphasis has been very much on the use of secondary data with field visits and limited surveys to verify the data. Details of the surveys undertaken are given in Volumes 9 and 10.

The majority of the data on crop production has been from MPO who have provided this on the basis of land types and mode of irrigation. Information on soils has been taken from the SODAP database held by BARC and from the district level reconnaissance soil surveys. This data has been incorporated into the project GIS.

All data has been transferred to planning units and has been input to the Resource Allocation and Optimisation Model for regional planning purposes. The same data form the basis of that used for pre-feasibility study but checked against and modified by primary field data.

2 LAND RESOURCES

2.1 Agroclimatology

This section describes the agro-climatic factors that affect crop production in the SWA.

The Land Resources Appraisal for Agricultural Development, FAO 1988 (AEZ project) has identified agro-climatic zones based on:

(i) average length of the pre-kharif period

(ii) average length of the rainfed kharif and rabi growing periods

(iii) average number of days in a year with temperature below a defined limit of importance for cropping (15°c)

(iv) average number of days in a year with maximum summer temperatures higher than 40°c.

The methodology followed in determining these units are described fully in the AEZ Project Report Volume 7, FAO 1988. The implication of these units on agricultural planning for the SWA are described below and the AE regions and sub-regions are shown in Figure 2.1.

2.1.1 Pre-kharif Transition Period

This is the period when rainfall is intermittently above and below 0.5 of potential evapotranspiration (PET). It starts when rainfall first exceeds 0.5 PET after the end of February and ends when rainfall continuously exceeds 0.5 PET.

There are six zones recognised, three of which occur in the SWA. The mean duration, start and end dates of the reference pre-kharif growing period are given in Table 2.1.

TABLE 2.1

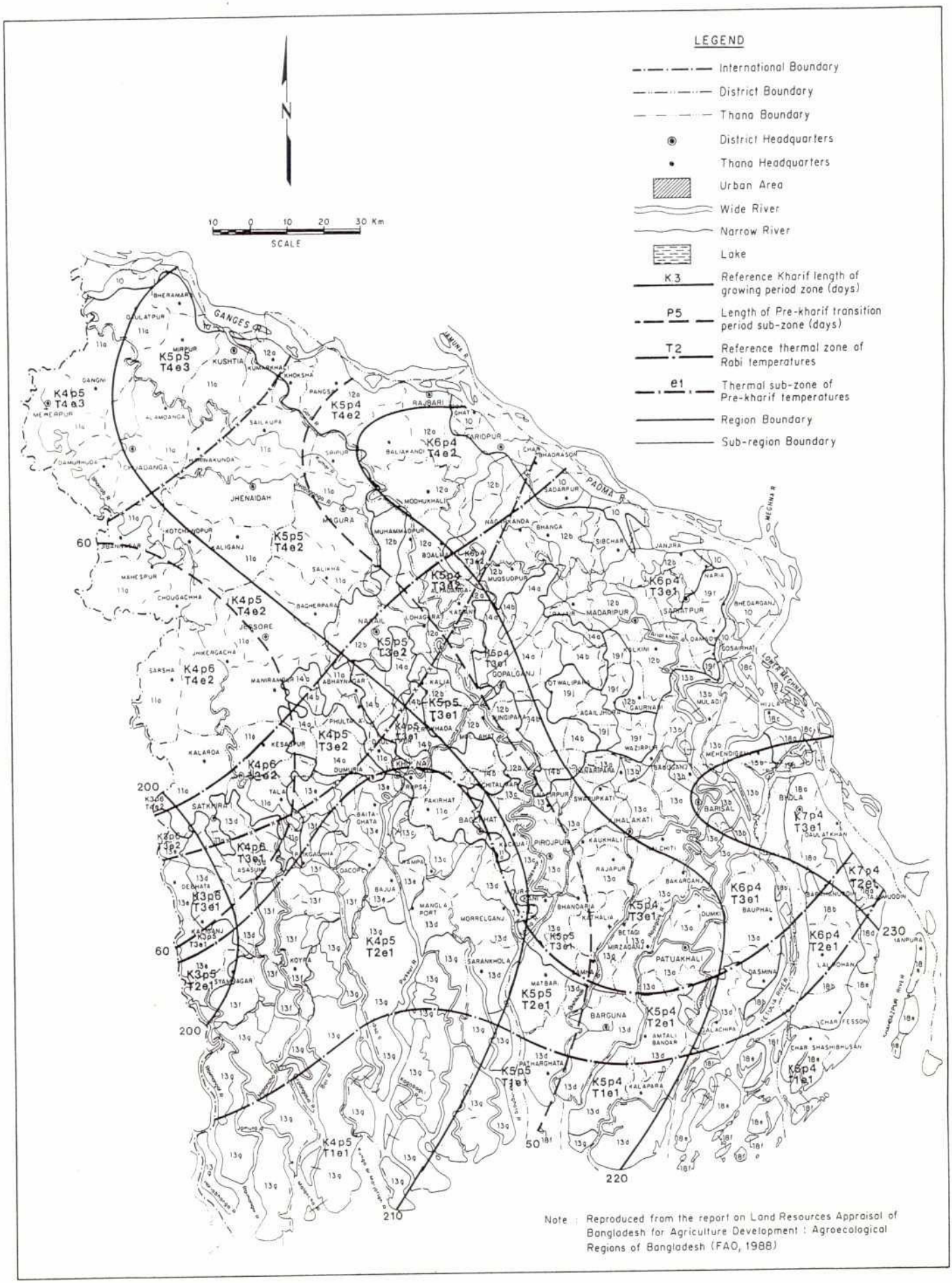
Mean Duration, Start and End Dates of the Reference Pre-Kharif Growing Period in the SWA

Zone	Duration (days)		Start Date		End Date	
	Mean	S D[1]	Mean	S D	Mean	S D
P4	40-50	20-30	24/3	5-25	8/5	10-30
P5	50-60	20-30	24/3	5-25	18/5	10-30
P6	60-70	20-30	17/3	5-25	21/5	10-30

(1) Standard Deviation
Source: Agroecological Regions of Bangladesh, Report 2 (FAO,1988)

Within the pre-kharif period the number of days that rainfall is below 0.5 PET (dry days) is important to crop growth. In all three areas (P4-6) the mean number of dry days is more than half the total length of the period. This means that there is a considerable drought hazard to rainfed crops grown during this period and this is greatest where the period is longest.

Figure. 2.1



Note : Reproduced from the report on Land Resources Appraisal of Bangladesh for Agriculture Development : Agroecological Regions of Bangladesh (FAO, 1988)

Agroecological Regions and Sub-regions

The duration of the pre-kharif period increases from north east to south west within the region, with the area around Satkhira and south west of Jessore (zone P6) being the longest.

2.1.2 Kharif Growing Period

This period is defined as the period when rainfall plus soil storage supplies sufficient moisture to support rainfed crops. It begins when rainfall continuously exceeds 0.5 PET and ends when the amount of rainfall plus 100 mm of soil storage fall below 0.5 PET.

Using isolines at 10 day intervals twelve zones have been recognised, four of which are found in the SWA.

The mean duration, start and end date for the kharif growing period zones K4-K7 found in the SWA area are shown in Table 2.2 below:

TABLE 2.2

Mean Duration, Start and End Dates of the Kharif Growing Period in the SWA

Zone	Duration (days)		Start Date		End Date	
	Mean	S D[1]	Mean	S D	Mean	S D
K4	200-210	20-40	16/5	10-30	9/12	20-35
K5	210-220	20-40	9/5	10-30	10/12	20-35
K6	220-230	20-40	3/5	10-30	14/13	20-35
K7	230-240	20-40	27/4	10-30	18/12	20-35

(1) Standard Deviation
Source: Agro-ecological Regions of Bangladesh, Report - 2 (FAO, 1988)

The high standard deviations attached to these dates indicates the year to year variability in the start and end of the Kharif period that occurs in the SWA.

The likelihood of dry periods occurring during the kharif period in the SWA is calculated as generally less than 10% of the decades. The period of July - August is critical for the transplanting and early growth of T. Aman and about once in 3-10 years there is a risk that two to three consecutive decads may be dry at this period.

The spatial variation in the onset and duration of the kharif growing period shows that it occurs earliest and lasts longest in the extreme south east of the area and begins later and decreases in duration in the north and west.

The implications for crop production are:

(i) delay in the planting of T. Aman with a consequential delay in harvest and planting of rabi crops

(ii) if the kharif period ends early then the T. aman crop may suffer from drought and there will be reduced recharge of soil moisture to support rabi crops

(iii) if the kharif period ends late, the sowing of rabi crops will be delayed.

The possible measures to over-come these problems involves the provision of formal supplementary irrigation such as in the G-K project, subject to excess accumulation of water being prevented. Other, informal modes of irrigation may also be used such as lowlift pumps and tubewells.

2.1.3 Rabi Growing Period

This period is defined as the period between the end of the humid period and the time when 250 mm of stored soil moisture is used. The mean duration, start and end dates are shown in Table 2.3 below:

TABLE 2.3

Mean Duration, Start and End Dates of Rabi Growing Period in the SWA

Zone	Duration (days)		Start Date		End Date	
	Mean	S D[1]	Mean	S D	Mean	S D
K4	115-135	10-30	15/10	20-30	17/2	20-35
K5	120-145	10-30	15/10	20-30	22/2	20-35
K6	120-145	10-30	21/10	15-30	2/3	20-35
K7	120-145	10-30	24/10	15-30	5/3	20-30

(1) Standard Deviation
Source: Agro-ecological Regions of Bangladesh, Report-2 (FAO, 1988)

The usefulness of this data is somewhat limited as two factors must be taken into account. One is that kharif crops frequently extend into the early rabi season thus reducing the amount of soil water available for succeeding dry land crops. Secondly, soil variability (texture, depth to impenetrable layer) means that the total soil water held or available to plants is frequently less than 250 mm. For these reasons, irrigation will normally be required during this period if crops are to come close to achieving their yield potential.

Nevertheless, the data does show that the rabi period is shortest in zone K4 to the south west of Satkhira and gradually increases to the northeast.

2.1.4 Rabi Temperature Zones

The rabi temperature zones are based on the number of days when the minimum temperature is below 15°c.

The classes identified are:

Class	No of days below 15°c
T1	30-40
T2	40-50
T3	50-70
T4	70-90
T5	90-110

Source: Agroecological Regions of Bangladesh, Report 2 (FAO,1988)

In the SWA the number of days when the minimum temperature falls below 15°c increase from south east to north west with the area north west of a line from Satkhira -Jessore - Faridpur falling in zone T4 indicating conditions more suitable for temperate crops such as wheat and lentil.

2.2 Agro-ecological Regions

Within the project area 7 agroecological regions have been differentiated in the Land Resources Appraisal for Agricultural Development, FAO, 1988 (AEZ report). These are based on a combination of physiography, soils, land level in relation to flooding and agroclimatology (described above).

The seven agroecological regions identified are the Active Ganges River Floodplain, High Ganges River Floodplain, Low Ganges River Floodplain, Ganges Tidal Floodplain, Young Meghna Estuarine Floodplain, Old Meghna Estuarine Floodplain and Gopalganj - Khulna beels (peat basins). The geomorphological characteristics along with physical constraints for agricultural development in each of these agroecological regions are described below.

The Active Ganges River Floodplain comprises the char lands, either isolated or attached to the mainland along the Ganges and other large rivers. The area has an irregular relief of broad and narrow ridges and depressions, interrupted by cut-off and active channels. Both the outline and relief of char formations are liable to change each flood season due to bank erosion and deposition of sediments.

The total land area including beels and ponds in this region is about 1208 sq km.

The major physical constraints to agricultural development include:

- shifting of river channels causing river bank erosion;
- burial of new sediments over agricultural land; and
- severe flooding and rapid flow over the land during the peak flooding period.

The High Ganges River Floodplain occurs in the north-western part of the project area. This area is often termed the moribund gangetic delta area where the flow of the rivers is practically cut-off from their parent river, the Ganges. The area has a complex relief of broad and narrow ridges and inter-ridge depressions, separated by areas of smooth broad ridges and basins. The upper part of the high ridges which constitute about 45 percent of the area stands above normal flood level (F0 land). Lower parts of the ridges and basin margins which constitutes about 35 percent of the area are seasonally shallowly flooded (F1 land). The rest of the area (about 20%), mostly basin centres are moderately deeply or, in a few places, deeply flooded. In general, the depth of flooding in this agroecological region increases towards the south-east.

This part of the project stands on the "dry zone" where the annual rainfall is lowest and most variable, and where summer temperature generally is highest. Mean annual rainfall increases eastward and southward across the region, from about 1500 mm in the west to slightly more than 1600 mm in the east.

Total land area including beels and ponds in this region is about 8700 km^2.

The major physical constraints to agricultural development in the region include:

- the project's driest zone, characterised by rainfall variability, especially in the pre-monsoon season (pre-kharif period);

- permeable loamy soils of the highlands and medium highlands

- cracking, heavy basin clays which stay wet early in the dry season and then quickly become dry, limiting their suitability for rainfed rabi crops and

- uncertain flood levels at some time during the monsoon season because of variability of intensity of local rainfall that accumulates as run-off in the depressions.

The Low Ganges River Floodplain area has a typical meander landscape of broad ridges and basins. Differences in elevation between ridge tops and basin centres are generally in the range of 3-5 meters. In this region about 15 percent of the area remains above normal flood level, about 30 percent of the area is shallowly flooded (about 90 cm deep) and the rest, about 55 percent of the area is predominantly moderately deeply flooded (about 120 cm). The major differences between the High Ganges River Floodplain and Low Ganges River floodplain is in the proportion of land classes relating to flooding, permeability of soils and climate. Most of this unit is moderately deep to deeply flooded; permeability of the soils is generally less and rainfall is greater.

This region is not as dry as the High Ganges River Floodplain region. Mean annual rainfall increases from about 1600 mm to the west to about 2000 mm in the east.

Total land area including beels and ponds in this region is about 7240 km^2.

The major physical constraints for agricultural development in the region include:

- widespread deep flooding;

- droughtiness on ridge soils; and

- heavy clays in basins which stay wet early in the dry season, then quickly becoming dry limiting rabi crop cultivation.

The Ganges Tidal Floodplain area occupies most of the lower half of the region. The landscape is criss-crossed by innumerable tidal rivers and creeks. The areas between channels appear almost level but are, in fact, slightly basin shaped. Except where bounded by polders, the area is tidally inundated twice a day. In the west, the tidal water in the channels is saline throughout the year, although less saline in the rainy season than in the dry season.

There is a considerable difference in climatic conditions between the east and west of this region. Mean annual rainfall increases from 1700 mm in the extreme west to more than 3300 mm in the extreme south-east.

Total land area including beels and ponds in this region, excluding the Sundarbans, is about 10,400 km^2.

The major physical limitations for agricultural development include:

- Heavy clay basin soils which are difficult to plough because they are sticky and plastic when wet, and hard and compact when dry. Most of the soils in these area is only suitable for transplanted aman paddy and poorly suitable or unsuitable for rabi crops;

- Dry season salinity of soils limiting crop production;

- Local patches of extremely acid soils (acid sulphate soils) which are unsuitable for growing crops. There are also areas of potential acid sulphate soil which if dried could become actual acid sulphate soils;

- Flooding in basins which is usually too deep for growing existing HYV T. Aman paddy varieties;

- River bank erosion along major rivers; and

- Siltation on agricultural land within the empoldered areas.

The Young Meghna Estuarine Floodplain includes Bhola island and some small adjacent islands. The relief is mainly very flat and there are few or no creeks except in the fringe of the region. Almost all the deposits are young with little sign of soil development, and consist mainly of finely stratified silts. Saline soils are common but the intensity of dry season salinity is less than the Ganges Tidal Floodplain area.

This is the area of highest rainfall within the SWA, it is also exposed to cyclones and storm surges. Mean annual rainfall increases from slightly less than 2500 mm in the north-west to more than 3000 mm in the south-east.

The total land area including beels, ponds, Manpura and other small outer islands is about 2490 km^2.

The major physical constraints to agricultural development include:

- very silty soils which provides little structural stability;
- constant bank erosion and new char formation; and
- dry season soil salinity.

The Old Meghna Estuarine Floodplain occupies a small area within the project. The landscape is almost level with predominantly moderately deeply to deeply flooded basins. The sediments are mostly stratified silt with clays in some basin bottoms.

Because of its small extent the area has a uniform climate. The mean annual rainfall is about 2000 mm throughout the region.

Total land area including beels and ponds is about 740 km^2.

The major physical constraints to agricultural development include:

- moderately deep or deep seasonal flooding together with risk of early floods; and
- slow drainage.

The Gopalganj - Khulna Beels (Peat basins) occupy a number of low lying areas between the Ganges Floodplain and the Ganges Tidal Floodplain. The area stands only 30 - 60 cm above sea level. On basin margins heavy clay overlies peat or muck at 25 - 100 cm and soft peat and muck occupy perennially wet basin centres. These basins are mainly deeply flooded by fresh water in the monsoon season but by saline water in some basins near Khulna.

The total land area including beels and ponds is about 2247 km^2.

The major physical constraints for agricultural development include:

- peat soils which have low bearing capacity when wet. If allowed to dry they will shrink irreversibly. Muck soils when dried harden irreversibly into coal-like lumps. These soils are potentially strongly acid and are low in essential nutrients;
- slow draining and wet throughout the dry season;
- heavy clays on basin margins; and
- deep flooding.

2.3 Land Types

2.3.1 Land Types defined by MPO

For the purpose of this study, the system as devised by the MPO has been used. This is because the MPO is the only organisation to produce data on crop production and land use related to land types and which forms part of the analysis used in this study.

The definition of land types used by MPO is given in Table 2.4 below.

TABLE 2.4

Land Types Defined by MPO on the Basis of Flood Depth

Land Type	Description	Flood depth	Nature of Flooding	Remarks
F0	High Land	0 - 30 cm	Intermittent	Land suited to HYV rice in wet season
F1	Medium Highland	30 - 90 cm	Seasonal	Land suited to local varieties of Aus and T. Aman
F2	Medium Lowland	90 - 180 cm	Seasonal	Land suited to B. Aman in wet season
F3	Low Land	Greater than 180 cm	Seasonal	Land on which B. Aman can be grown in wet season
F4	Low to very Low land	Greater than 180 cm	Seasonal/ perennial	Land on which either the depth or rate or timing of flooding do not permit growing of B. Aman

Source: MPO, based on SODAPS (computerized version of the soil survey reports of SRDI) - National Water Plan, Vol-I (1986).

TABLE 3.1

Distribution of Land Type by Planning Units in SWA

PU CODE	F0 km²	F1 km²	F2 km²	F3 km²	F4 km²	Total km²
SW1	621	599	232	27	0	1479
SW2	597	658	227	33	0	1515
SW3	224	458	237	55	0	974
SW4	756	543	191	51	0	1541
SW5	126	212	120	31	0	489
SW6	57	116	59	16	4	252
SW7	172	452	582	337	131	1674
SW8	719	555	152	34	0	1460
SW9	455	341	196	60	0	1052
SW10	200	251	450	137	0	1038
SW11	354	1881	89	9	0	2333
SW12	88	334	41	11	0	474
SW13	146	693	358	171	46	1414
SW14	159	877	53	8	0	1097
SW15	1	7	0	0	0	8
SC1	147	410	406	67	5	1035
SC2	78	300	148	30	0	556
SC3	49	209	161	52	18	489
SC4	53	220	202	103	43	621
SC5	148	376	91	32	13	660
SC6	69	242	89	21	2	423
SC7	171	421	3	0	0	595
SC8	293	1070	57	1	0	1421
SC9	104	430	16	0	0	550
SC10	72	369	3	0	0	444
SC11	154	614	0	0	0	768
SC12	67	281	8	0	0	356
SC13	77	281	14	0	0	372
Total	6157	13200	4185	1286	262	25090

Source: Consultant's calculations from MPO (1986) data base.

2.3.2 Land Types as Defined by FAO

The above system of classification is not the only one in use in Bangladesh. A modification which is used in the agroecological regions of Bangladesh reports (FAO, 1988) is as follows:

Highland (H) : Land which is above normal flood-level

Medium Highland (MH) : Land which normally is flooded up to 90 cm deep during the flood season.

Medium Lowland (MLL) : Land which normally is flooded up to between 90 and 180 cm deep during the flood season.

Lowland (L)	:	Land which normally is flooded up to between 180 and 300 cm deep during the flood season.
Very Lowland (VL)	:	Land which normally is flooded deeper than 300 cm during the flood season.

An additional class, Bottom land, is recognised for depression sites in any land type class which remains wet throughout the year. The Medium Highland, land type has been divided into two subclasses: MH-1, normally flooded up to about 30 cm deep; and MH-2, normally flooded up to between 30-90 cm deep.

It is important to realise that the depth limits separating the classes are not rigid as the definitions might suggest. Flood levels in an area may vary by as much as half a metre or so between different years. They may also reach their peak levels for only a few days at a time during a particular year. What these classes indicate is the level of flooding which the farmer expects when they decide which crops to grow in the kharif season on their different kinds of land, based on their long experience of cultivation on particular sites. The relation between flooding and land use is described below and shown schematically in Figures 2.2 to 2.8.

- Highland may be suitable for kharif or perennial dry land crops if the soils are permeable. Impermeable soils or soils which can be made impermeable by puddling the top soil may be suitable for transplanted aus and/or aman if bunds are made to retain water.

- Medium Highland is suitable for crops which can tolerate shallow flooding, such as broadcast or transplanted aus, jute and transplanted aman. Rabi crops are widely grown if drained by the end of November.

- Medium Lowland is flooded too deeply for transplanted aus or transplanted aman paddy to be grown reliably. Mixed broadcast aus and deep water aman is a common practice. Local varieties of transplanted aman may be grown in areas where flood water recedes by late September. Rabi crops are widely grown on soils which drain by November.

- Lowland is flooded too deeply for broadcast aus or transplanted aman to be grown. Deep water aman is typically grown on such land (although the cultivation of irrigated boro paddy on such land in the dry season now preclude the cultivation of deep water aman over considerable areas of lowland). Rabi crops can only be grown if the flood water recedes by December.

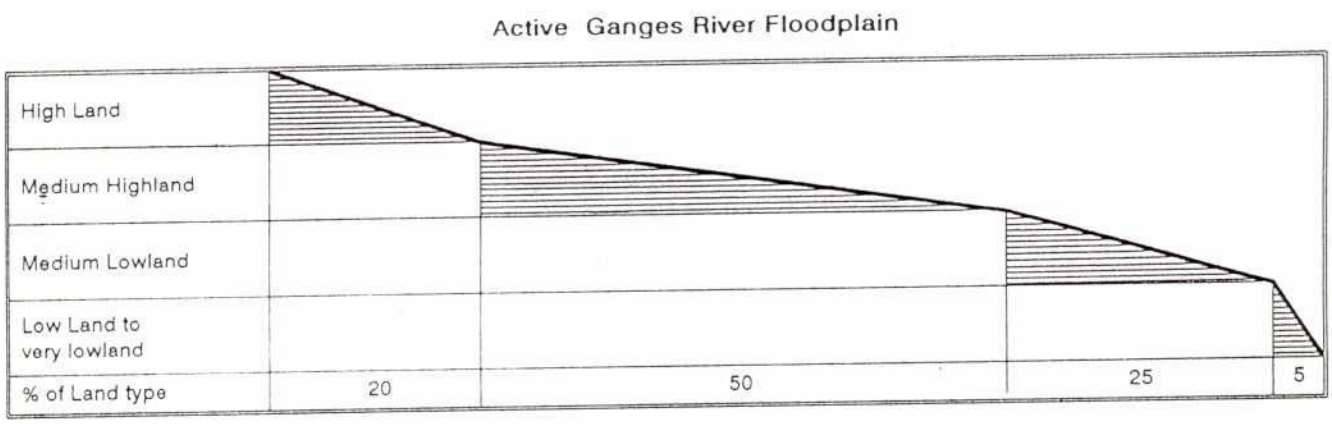
- Very Lowland is generally too deeply flooded for even deep water aman to be grown; (this is not necessarily because of the depth of flooding but because of such associated characteristics as early flooding, rapid flooding or wave action on large open bodies of water. Where cultivated, Very Lowland is generally used for boro paddy, either HYV or local varieties.

- Bottom land stays too wet for paddy to be sown broadcast. The traditional crop on such land is local boro paddy, either rainfed or irrigated by traditional low-lift irrigation devices.

The depth of water has an influence on the varieties of rice grown but so also does the timing and duration of flooding and the three factors cannot be considered in isolation. The depth of flooding has most impact on the aus and aman rice varieties. Traditional, tall varieties of t.aman can be grown in areas where flood waters reach a depth of 90-100 cm. The maximum depth of flooding tolerated by the short strawed, HYV t.aman is about

Figure 2.2

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	Rainfed	Irrigated
High Land	20	B. Aus, Jute T. Aman, Millet	T. Aman	Wheat, Pulses, Millet Oilseeds, Spices	------
Medium Highland	50	B. Aus, Jute, T. Aman	-------	Wheat, Pulses, Oilseeds Spices, Groundnut Sweet potato, Millet	Boro
Medium Lowland	25	Mixed Aus & B. Aman B. Aman, D.W.T. Aman	-------	Oilseeds, Kheshari	Boro
Lowland to Very Lowland	5	B. Aman	-------	-------	Boro

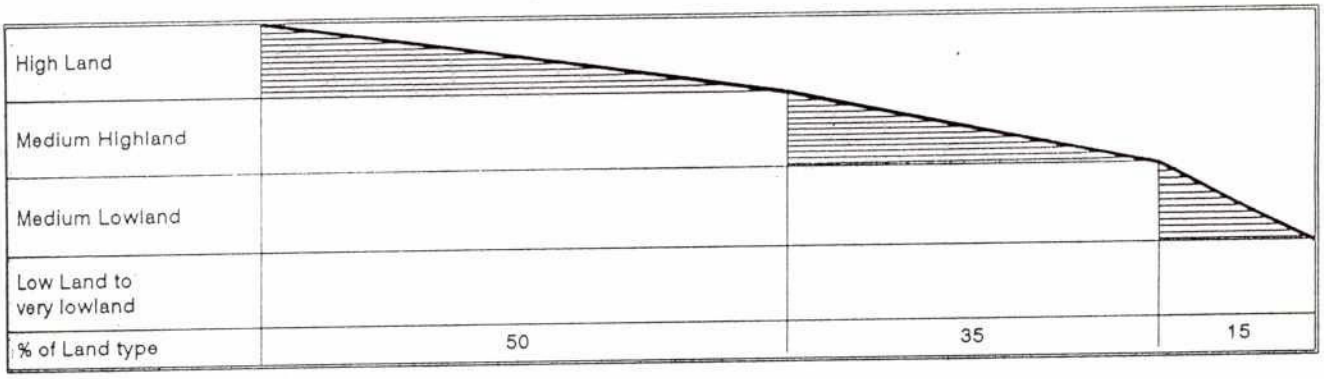
mrr\tab4

Source Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

Figure 2.3

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping

High Ganges River Floodplain



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	Rainfed	Irrigated
High Land	50	B. Aus, Sugercane Cotton, T. Aman, Jute	T. Aman, T. Aus	Wheat, Pulses, Vegetables, Oilseeds, Tobacco	Wheat, Spices, Banana, Tobacco, Vegetables
Medium Highland	35	B. Aus, T. Aman, Jute	T. Aus, T. Aman	Wheat, Pulses, Spices, Pulses	Wheat, Boro
Medium Lowland	15	Mixed Aus & B. Aman Jute, B. Aman	--------	Kheshari	Boro
Lowland to Very Lowland	---	B. Aman	--------	--------	Boro

mrr\tab3

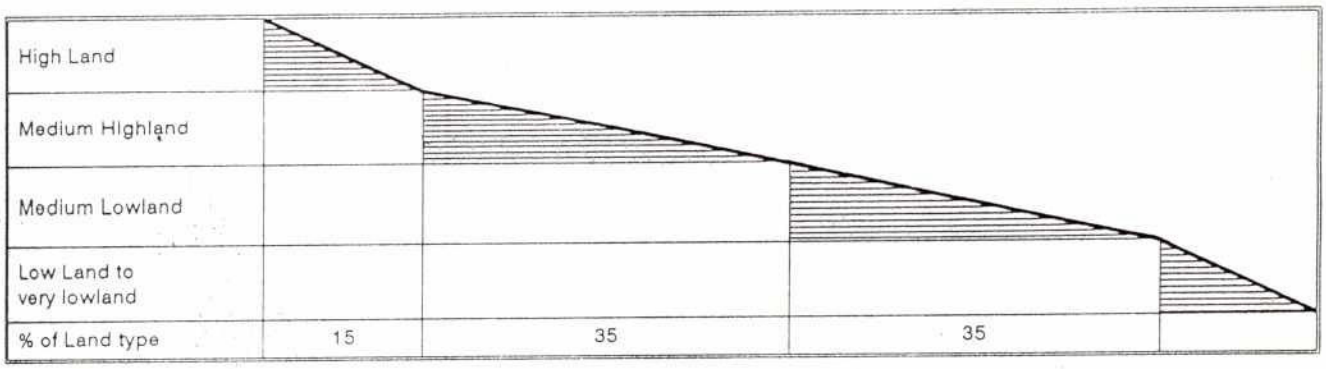
Note : Proportion of Lowland to Very Lowland is insignificant.

Source : Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

Figure 2.4

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping

Low Ganges River Floodplain



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	Rainfed	Irrigated
High Land	15	B. Aus, Jute, T. Aman	T. Aman	Wheat Pulses, Oilseeds Vegetable, Sugarcane	Wheat, Boro Banana
Medium Highland	35	B. Aus, Jute, T. Aman	T. Aus	Wheat Pulses, Spices Oilseeds	Wheat, Boro
Medium Lowland	35	Mixed B. Aus & B. Aman Jute, B. Aman	--------	Kheshari	Boro
Lowland to Very Lowland	15	B. Aman	--------	--------	Boro

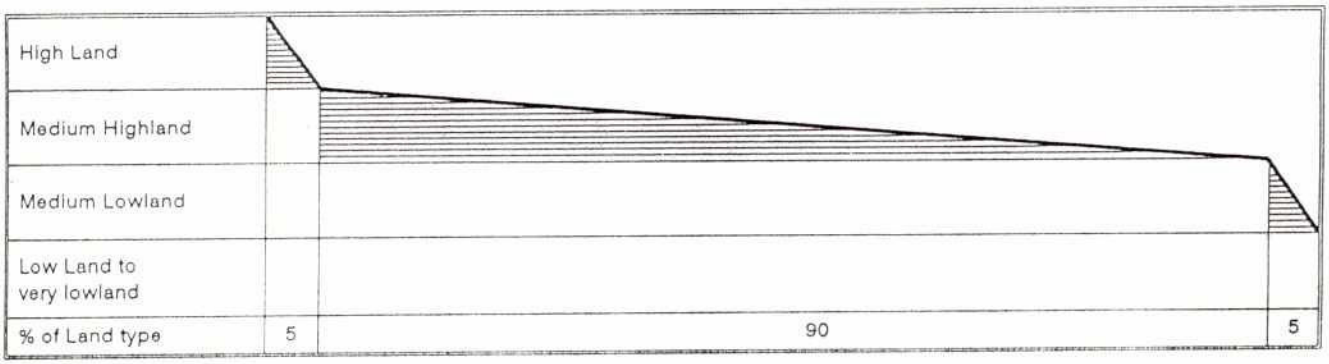
mrr\tab2

Source : Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

Figure 2.5

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping

Ganges Tidal Floodplain.



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	* Rainfed	Irrigated
High Land	5	T. Aman Vegetables	T. Aus	Pulses, Chilli Mustard, Sesame Mungbean, Lentil	Boro
Medium Highland	90	T. Aman	T. Aus	Pulses, Chilli Sesame, Mungbean	Boro
Medium Lowland	5	B. Aus Mixed B. Aus & B. Aman	--------	Kheshari	Boro
Lowland to Very Lowland	--	--------	--------	--------	--------

mrr\tab1

Note : Proportion of Lowland to Very Lowland is insignificant.

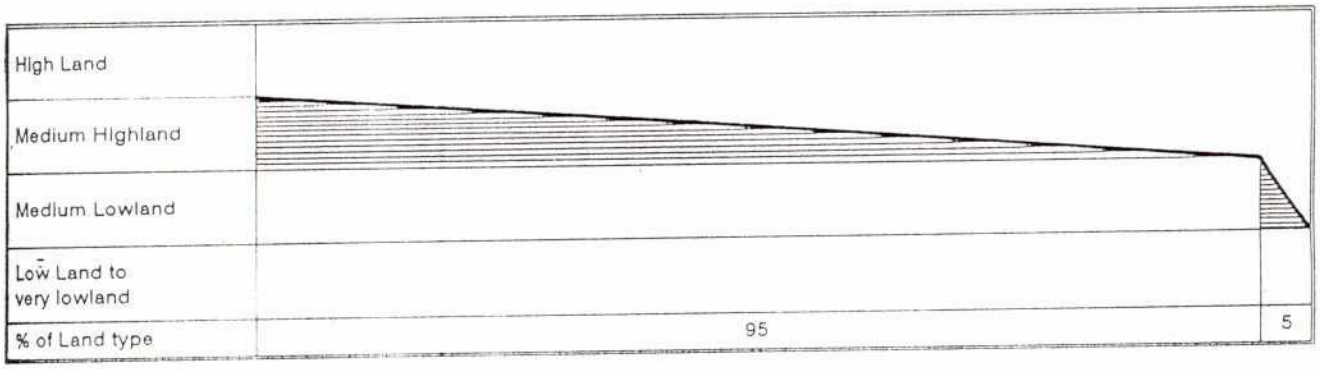
* Mostly in non saline to slightly saline areas (dry season salinity).

Source : Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

Figure 2.6

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping

Young Meghna Estuarine Floodplain



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	Rainfed	Irrigated
High Land	---	B. Aus, Dibble Aus, T. Aman	-------	Vegetables, Pulses	Boro
Medium Highland	95	B. Aus, Dibble Aus, T. Aman	-------	Pulses / Kheshari Spices	Boro
Medium Lowland	5	T. Aus, T. Aman	-------	-------	Boro
Lowland to Very Lowland	---	-------	-------	-------	-------

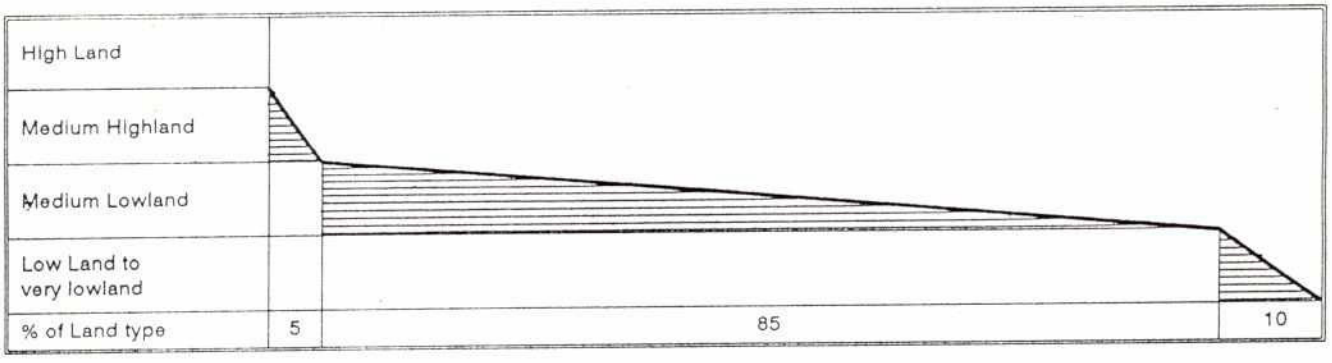
mrr\tab6

Note : Proportion of Highland and Lowland to very Lowland is significant.
* Mostly in non-saline to slightly saline area (dry season salinity)
Source : Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

Figure 2.7

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping

Old Meghna Estuarine Floodplain



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	Rainfed	Irrigated
High Land	---	Aus, Jute, Banana, Vegetables, Betel vines	-------	Vegetables	Boro
Medium Highland	5	Aus, Jute, T. Aman	-------	Chillies, Oilseeds Pulses, Wheat, Mustard	Boro
Medium Lowland	85	Mixed Aus. & B. Aman Jute	-------	Chillies, Kheshari	Boro
Lowland to Very Lowland	10	Mixed Aus. & B. Aman B. Aman	-------	Kheshari	-------

mrr\tab7

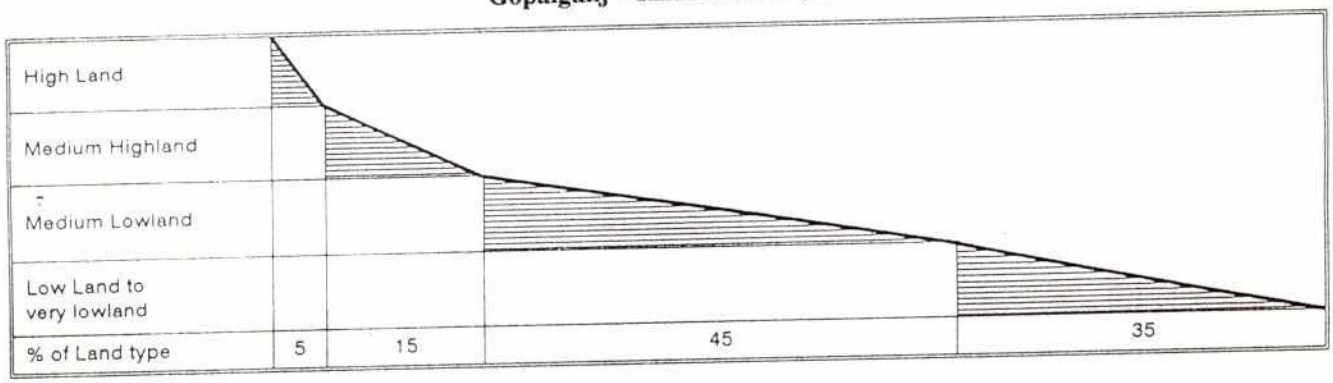
Note : Proportion of Highland is significant.

Source : Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

Figure 2.8

Schematic Diagram Showing the Proportion of Land Type (Agricultural Land) and the Relationship between Landtypes and Cropping

Gopalganj - Khulna beels (Peat basins)



Major Crops grown

Land type	%	Kharif		Rabi	
		Rainfed	Irrigated	Rainfed	Irrigated
High Land	5	Summer Vegetables, Perennial crops	--------	Vegetables	-------
Medium Highland	15	Mixed B. Aus & Seasame, D.W.T. Aman	--------	Kheshari	-------
Medium Lowland	45	Mixed B. Aus & B. Aman, B. Aman	--------	Kheshari, Boro	Boro
Lowland to Very Lowland	35	B. Aman	--------	Boro	Boro

mrr\tab5

Source : Computed from Land Resources Appraisal of Bangladesh for Agricultural Development - Report 2 and B.B.S report.

75 cm at full height. In this context, the depth classes as defined by MPO and others should be modified to take this into account. Specifically, the boundary of F1 should be fixed at around 70-75 cm. For the purposes of regional planning, the standard MPO definitions of land type are used whilst acknowledging their limitations. The revised definitions should be taken into account though, for feasibility studies.

The timing of flooding and its duration is clearly important to the growth of rice. Aman can be transplanted into 30 cm of water and the water depth can increase upto the maximum of 75 or 100 cm before falling before harvest. The timing of transplanting is from the beginning of July until September, although early transplanting is preferred. Flood levels should recede before harvest in November-December.

The aus rice which is transplanted in March-April can be transplanted into 30 cm of water, the depth can increase upto 75-100 cm depending on variety before receding before harvest in July.

The boro crop is transplanted in the period December-February, local varieties transplanted earlier than HYV's. With HYV boro, water depth can increase to 75 cm by May before receding in June for harvesting.

Clearly, the depth, timing and duration of flooding will vary widely over an area as large as the SWA.

The distribution of land type by planning units as defined by MPO is shown in Figures 2.9 to 2.13. Figures 2.12 and 2.13 show the proportion of F3 & F4 land respectively as a percentage of NCA. The only significant areas (>10% NCA) are found in the central and north east of the region. The planning unit with the greatest proportion of F4 land is SW7.

The extent of F2 land type, Figure 2.11, is again most extensive in the north east and central area. The area adjacent to Padma and Arial Khan rivers being the most extensive. The area of F1 land is most extensive in the south of the SW and SC regions (Figure 2.10). F0 land dominates (30-50% of NCA) in the north and east of the region, Figure 2.9.

2.4 General characteristics of the soils

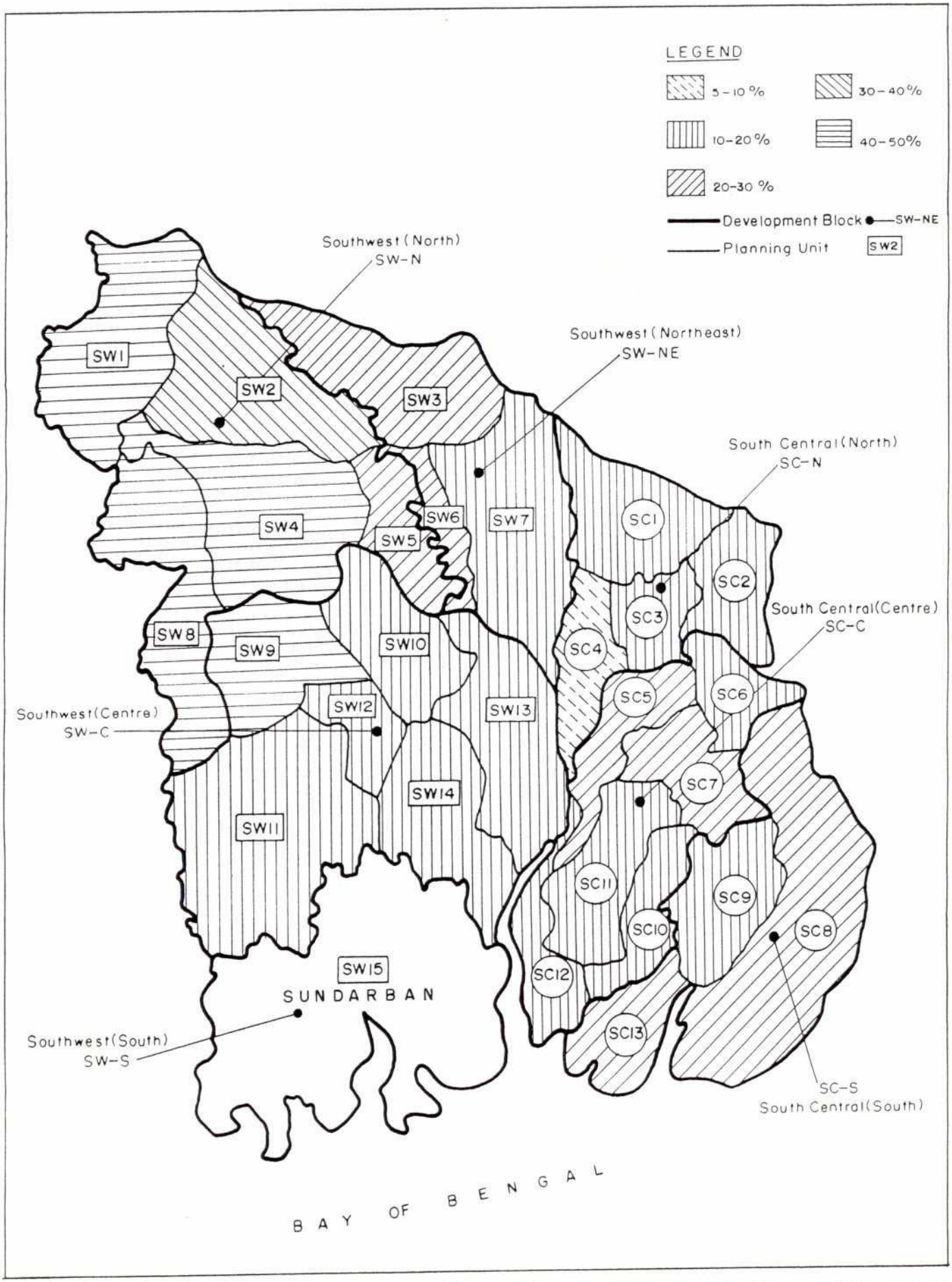
2.4.1 Introduction

With the exception of the peat basins and the Meghna estuary, all soils in the SWA are developed in the calcareous Ganges alluvial sediments of recent geological age. These soils show different degrees of development due mainly to the different age, drainage condition and texture of the sediments.

2.4.2 Active and Young Ganges Meander Floodplains

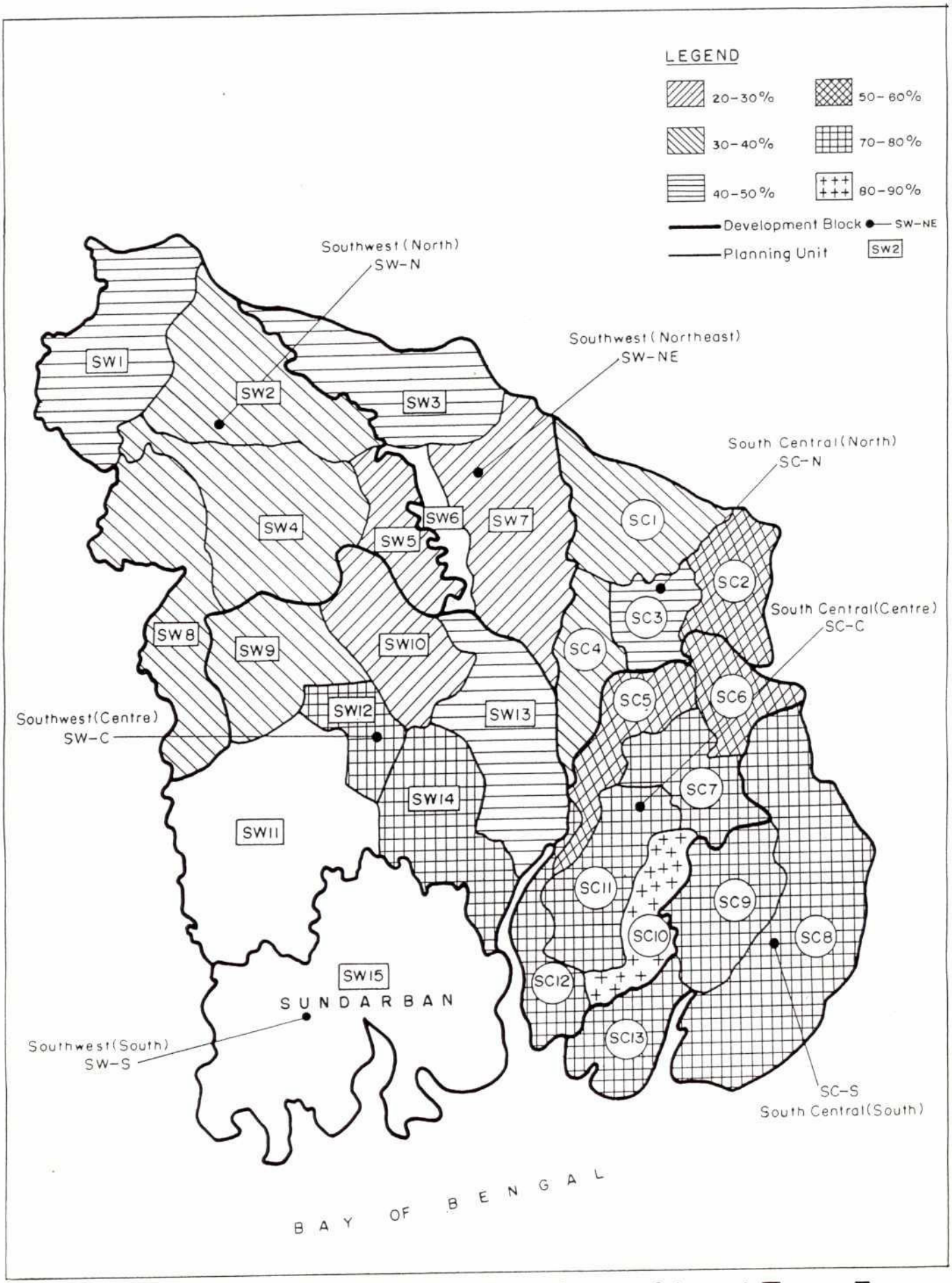
In the Active and Young Ganges Meander floodplains, the major soils are usually thick layers of newly deposited sand or silt to moderately developed silt loam to silty clay which overlie stratified alluvium at less than 25 cm from the surface. They are mainly olive or olive grey in colour; developed soils have fine yellow - brown mottles and silty clay and clay soils may have grey or dark grey clay coating (gleyans) along subsoil cracks. Raw silt or silty clay layers are unripened. Virtually all the soils are moderately alkaline and calcareous throughout. Organic matter content ranges from about 0.5 percent in sandy soils to 1.5 percent in clay top-soils. There is no developed ploughpan. Moisture holding capacity is moderate in silty soils but low in sandy and raw silty and clayey soils.

Figure 2.9



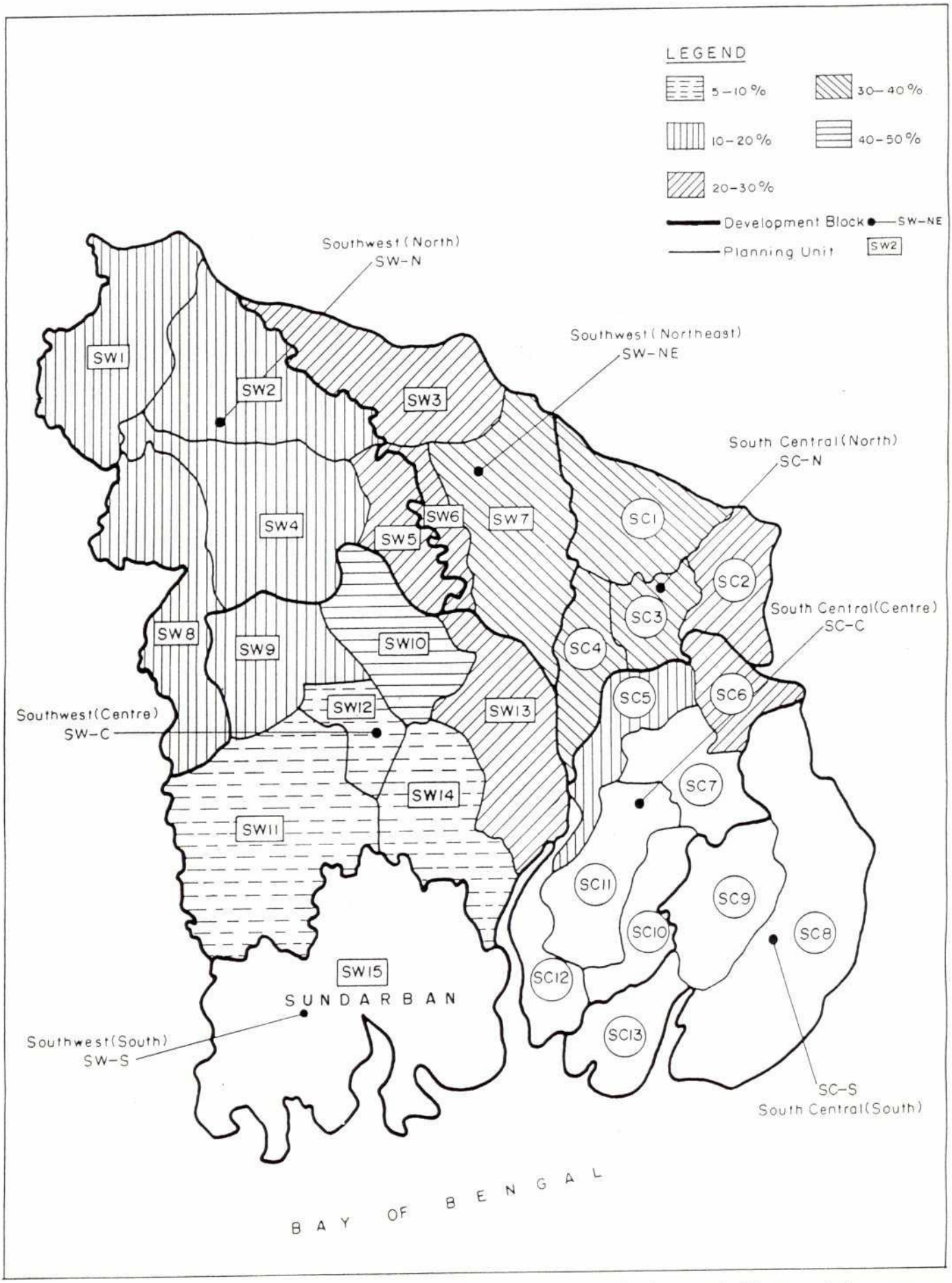
The Area of Land Type F0 as a percentage of Net Cropped Area

Figure 2.10



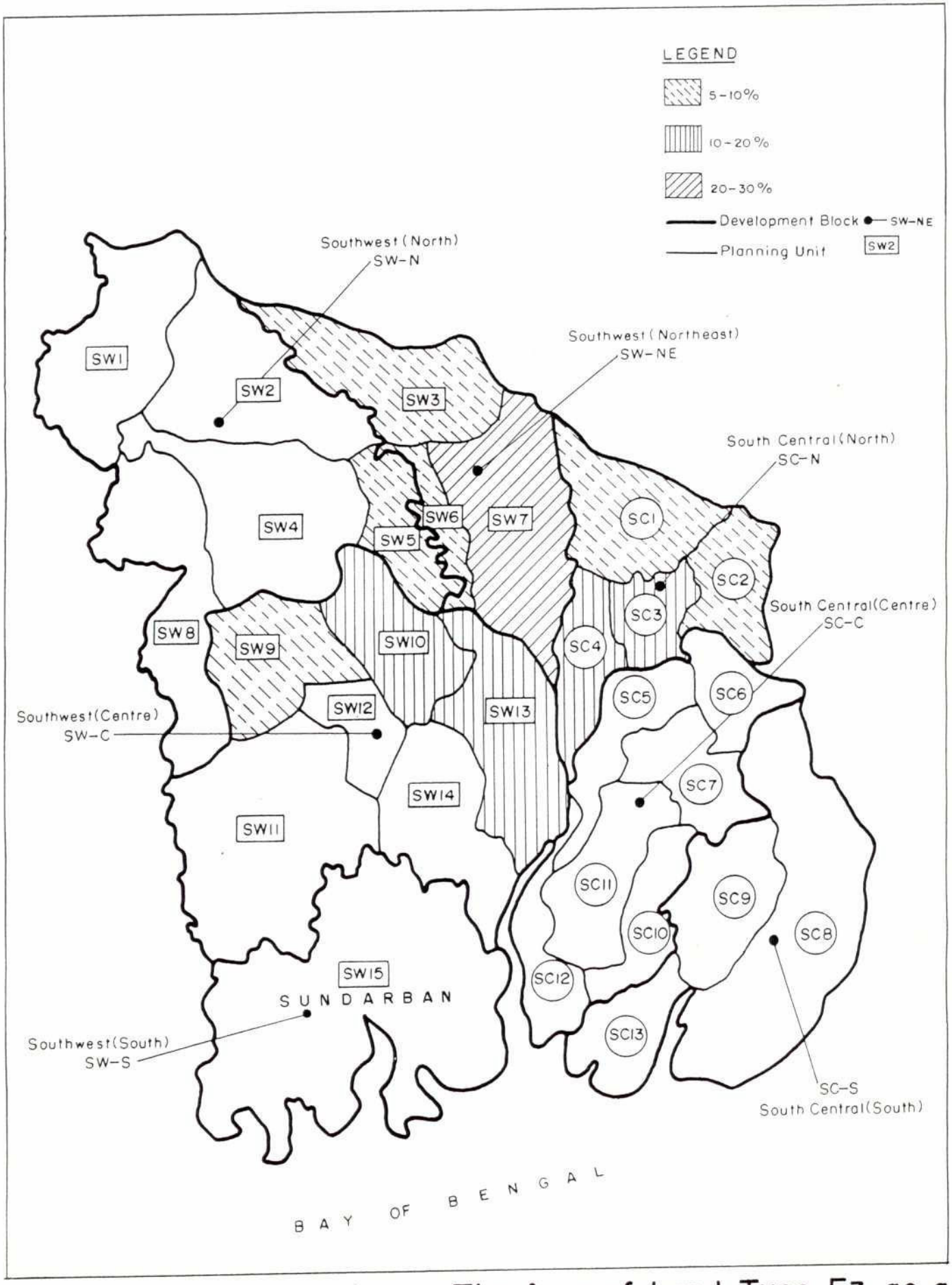
The Area of Land Type F1 as a percentage of Net Cropped Area

Figure 2.11



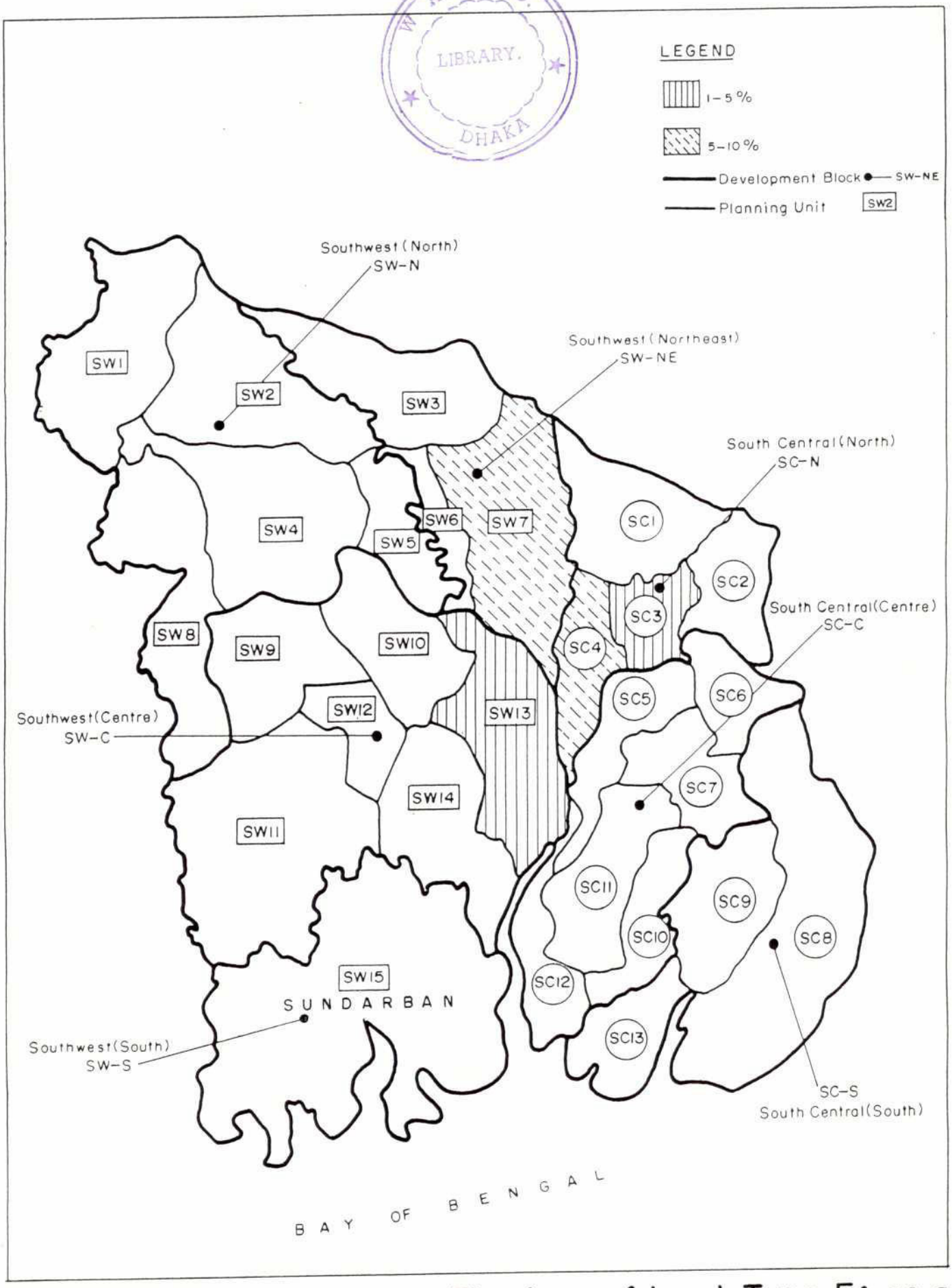
The Area of Land Type F2 as a percentage of Net Cropped Area

Figure 2.12



The Area of Land Type F3 as a percentage of Net Cropped Area

Figure 2.13



The Area of Land Type F4 as a percentage of Net Cropped Area

2.4.3 Old Ganges Meander Floodplain

Old Ganges Meander Floodplain includes areas of High Ganges Floodplain and Low Ganges Floodplain. In the old Ganges Meander Floodplain the soil pattern is one of olive -brown, silt loams and silty clay loams on the upper parts of ridges and dark grey, mottled brown, mainly clay soils on lower ridge sites and in basins. Most ridge soils are calcareous throughout. Some soils on higher sites have non-calcareous upper layers, but these overlie calcareous material below 30 - 60 cm. Basin clays are non-calcareous in the upper layers but overlie calcareous material at about 40 - 60 cm or in some places deeper. Non-calcareous top soils generally are slightly acid to neutral, but on basin clays they are sometime strongly to very strongly acid. Except on sandy ridges, a strong ploughpan has developed in most of the topsoils.

The organic matter content of brown ridge soils is generally low (< 1.5%). Permeability in most ridge soils is rapid but it is only moderate in top soils puddled for transplanted aman and where a ploughpan has developed. Moisture holding capacity generally is moderate, but it is low in soils which overlie sand at 25 - 50 cm. The basins have dark grey silty clays and clays. These soils crack widely when dry. Most soils are non-calcareous in the cultivated layer and the acidity ranges from slightly to very strongly acid (pH 4.7-6.9). The subsoil is generally slightly acidic to slightly alkaline (pH 6.0 - 7.5). Permeability is variable; rapid when cracked in the dry condition but moderate when wet. The top soil has relatively higher organic matter content than the ridge soils (1.5 - 2.5%).

2.4.4 Ganges Tidal Floodplain

Ganges Tidal Floodplain soils have developed from the tidal deposits of mainly fine alluvium. The most extensive soils have a grey or olive - grey silty clay or clay topsoil which is strongly puddled and has a strong ploughpan at the base.

This overlies a silty clay or clay subsoil. The higher ridge soils have a silty clay loam topsoil and subsoil texture. Below the subsoil, generally at about 90 cm, there is commonly a dark coloured buried top soil.

The soils of this region are both calcareous and non-calcareous. Some soils, are saline during the dry season, particularly in the southern part of the region. The degree of salinity varies. Most of the polders lie within this region to protect tidal saline water intrusion. In areas not completely protected from saline water tidal flooding, the soils are mostly moderately saline, occasionally strongly saline in the dry season.

Top soils of the non-calcareous soils are strongly or very strongly acid (pH 4.5 - 5.4) in basin clays but less acid (pH 5.5 - 6.5) in higher soils. Calcareous soils are alkaline throughout. Organic matter content in the top soils of both calcareous and non-calcareous soils is in the range 1-2 percent in ridge soils and 2-5 percent or more in basin clays; amounts decrease slowly with depth.

Permeability is slow in puddled top soils but moderate in lower layers. Soils in basin centres commonly stay wet long into the dry season due to the high water table. Basin clays which dry out in the dry season become very hard and crack widely at that time.

Within the Gangetic Tidal Floodplain region, particularly in the central-western part there are patches of acid sulphate soil which are extremely acid (pH less than 4.0) from the surface; others are acid in the subsoil only.

2.4.5 Young Meghna Estuarine Floodplain

In the Young Meghna Estuarine Floodplain the main soils are grey to olive, deep silt loams and silty clay loams which are finely stratified either throughout or at a shallow depth.

Young soils are mostly calcareous raw alluvium and saline in the dry season. They occur in the southern part of the area, mostly in the fringe of Bhola island and in southern off-shore islands. Organic matter content in these soils is very low (<1.0 percent). Permeability is moderate to rapid.

Older soils in the northern half of the area are mostly non-calcareous and are only very slightly or non-saline, organic matter content in the top soils range between 1.0 - 1.5 percent. These soils have a compact ploughpan. Permeability in the topsoil is slow because of existing ploughpan but in the sub-soil it is moderate.

2.4.6 Old Meghna Estuarine Floodplain

In the Old Meghna Estuarine Floodplain soils are relatively uniform. Silty soils predominate, but there are significant proportion of silty clay and clay soils in the basins.

Most soils have a dark grey top soil. Reaction in the top soil generally is strongly acid, but in some soils it is slightly acid or neutral. Subsoil reaction is generally neutral to slightly alkaline.

Organic matter content in the cultivated layer range from 1-2.5 percent in most ridge soil and from 2-5 percent in soils of the depressions.

Permeability is mainly moderate in the ridge soils and slow in depressions. Soils of the highland and some medium highland used for Aus and transplanted Aman cultivation have puddled top soils and have strong ploughpans which makes permeability slow. Moisture holding capacity is generally high. Depression soils generally stay wet early in the dry season, and in some areas stay wet for longer periods of the dry season.

2.4.7 Gopalganj - Khulna Beels

In the Gopalganj - Khulna beels peat or muck soils predominate. On the basin margins soils are grey and dark grey, acidic, heavy clay overlying peat or muck at 25 - 100 cm. In the basin centres which remain perennially wet, peat and muck predominate, usually covered by a shallow clayey surface layer.

2.5 Soil Associations, Soil Series and Soil Classification

2.5.1 Soil Association

The landscape of the project area is characterised by 4 physiographic units subdivided into 13 sub-units. Each physiographic subunit is again subdivided by soil associations.

Soil Mapping has been undertaken by SRDI for the entire SWA at reconnaissance level. Maps have been produced at 1:125,000 scale showing soil, land use and land capability. The mapping unit used is the soil association. Soil associations are therefore mapping units containing two or more soils occuring side by side in a distinctive pattern which repeats itself over a particular landscape. As such, the mapping units are not homogeneous in terms of soil characteristics.

Information on each of the soil associations has been computerised by BARC. This data has been obtained by the Consultants and forms the basis of the soil component of the GIS.

2.5.2 Soil Series and Soil Classification

Within the project area, 65 soil series have been identified in the Reconnaissance Soil Survey reports published by SRDI. In those reports the physical and chemical properties of each soil series have been described. The chemical properties described include cation exchange capacity, exchangeable bases, base saturation percentage, pH, electrical conductivity, total salt content, organic carbon and total nitrogen content. In addition, the proportion of sand, salt and clay has been measured to assess the soil texture.

In the same reports all soil series have been classified under USDA soil classification system (Soil Taxonomy). Of the total 65 soil series identified about 75 percent of the soils are Inceptisols and the rest 25 percent are Entisols, Mollisols and Histosols. Within Inceptisols 42 soil series are Aquepts and 7 soil series are Ochrepts. The remaining 16 soil series are Aquents, Aquolls and Histosols distributed almost in equal proportions.

Table 2.6 indicates the name of the physiographic subunits, number of soil associations in each physiographic subunits and number of soil series association in the subunits.

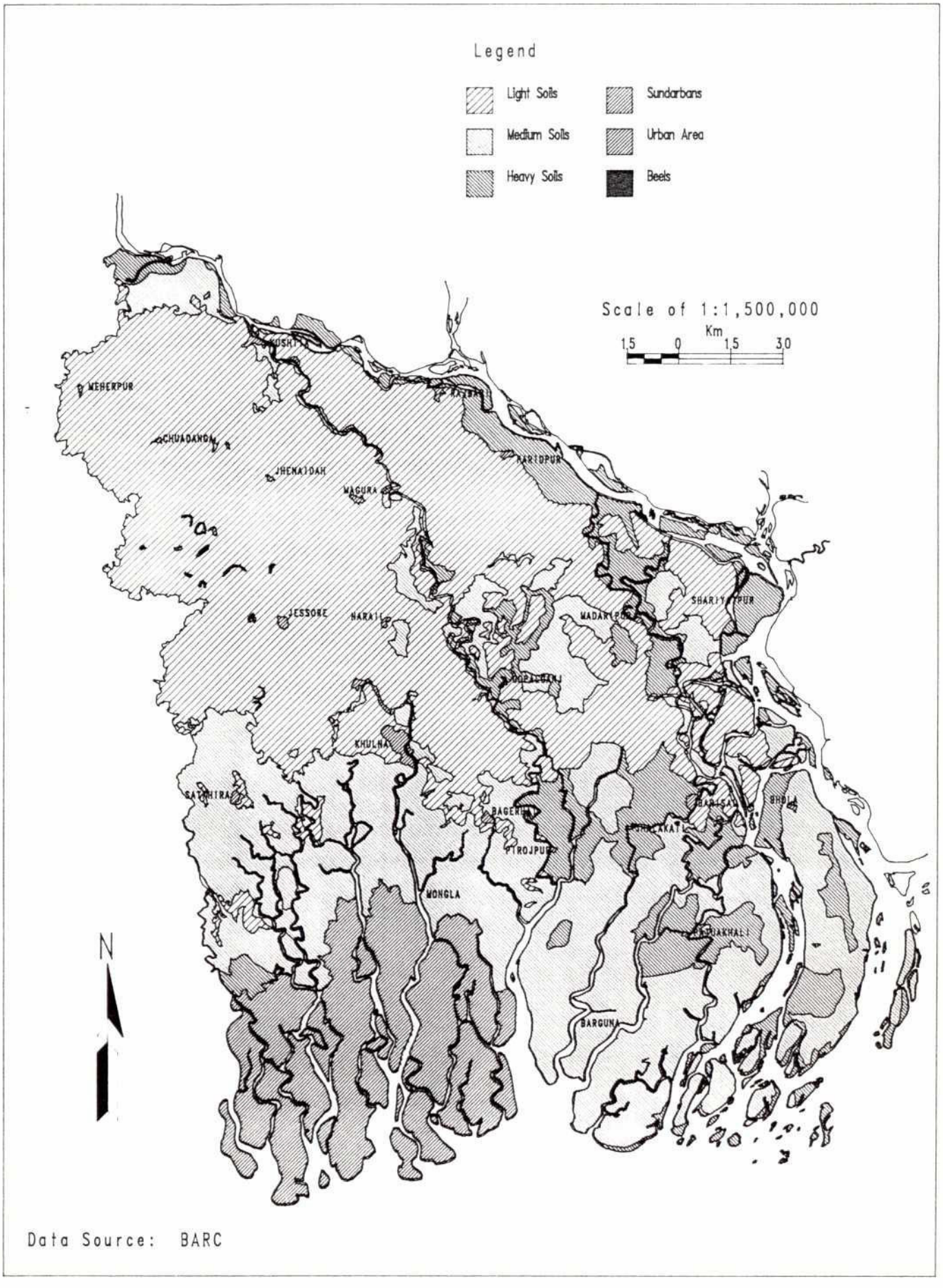
TABLE 2.6

Physiographic Units in the SWA

Sl No	Name	Soil Types	Total Number of Soil Series	Total Number of Soil Association
1	Active and very young Ganges meander floodplain	60% Siltation 40% Silty Clay	9	4
2	Young Ganges meander floodplain	30% Silt loam 35% Silty clay loam 35% Silty clay	13	16
3	Old Ganges meander floodplain	25% Silt loam 25% Silty clay loam 50% Clay	12	25
4	Mixed young and old Ganges meander floodplain	20% Silt loam 40% Silty clay 40% Clay	15	10
5	Mixed Ganges meander floodplain and tidal floodplain	25% Silt loam 40% Silty clay, 35% Clay	15	5
6	Mixed Old Ganges meander floodplain and peat basin	80% Silty clay, 20% Peat	15	3
7	Ganges Tidal floodplain	20% Silty clay loam, 50% Silty clay, 30% Clay	17	19
8	Young lower Meghna Estuarine	50% Silt loam, 50% Silty clay loam	6	3
9	Old lower Meghna Estuarine floodplain	50% Silty clay loam 50% Clay	10	7
10	Mixed lower Meghna Estuarine floodplain and Ganges meander floodplain	20% Silt loam 80% Clay	8	1
11	Mixed lower Meghna Estuarine floodplain and peat basin	40% Silty clay, 20% Clay, 20% Peat	21	3
12	Old lower Meghna tidal floodplain	15% Silt loam, 40% Silty clay, 45% Clay	15	8
13	Peat basin	60% Clay 40% Peat	15	4

Source: MPO Technical Report No. 10 (1986) and Consultants' estimate.

Figure 2.14



Data Source: BARC

Topsoil Texture

2.6 Soil Physical Characteristics

2.6.1 Soil Texture

Soil texture, particularly topsoil texture is important to tillage, distribution and the availability of soil moisture and nutrients.

The 16 soil textural classes for mineral soils used by SODAPS have been generalised into three broad classes namely light, medium and heavy. Light soils ranges from sand to sandy loam, medium soil ranges from sandy clay loam to silty clay loam and heavy soils ranges from clay loam to clay. Figure 2.14 shows distribution and extent of these soils within the project area.

About 58 percent of the project area is covered by light soils mostly occurring in the High Ganges Floodplain area and in the higher parts of the Low Ganges Floodplain area. These soils are easy to till, root growth is largely unhindered and they have high aeration and moisture availability. About 32 percent of the project area is covered by medium textured soils, mostly occupying the Ganges Tidal Floodplain and Meghna Estuarine Floodplain. Though in both of these agroecological regions the topsoil is silty in nature. The Ganges Tidal Floodplain soils being saline become very hard and cloddy when dry and cannot be easily ploughed unlike the soils of the Meghna Estuarine Floodplain which can be cultivated over a wider range of moisture conditions and to a greater depth.

About 10 percent of the project area is covered by heavy soils, mostly occurring in the depressions except in the peat basins where top soil texture is fibrous peat or muck. They are sticky and plastic, even at relatively low moisture condition and become very hard on drying. These soils are very difficult to plough. The range of moisture condition within which these soils can be successfully prepared for rabi dryland crops is very narrow. Moreover, the country plough is unable to penetrate below the upper 4-6 cm. Germination of seeds of rabi crops is hindered in heavy textured soils. They are suitable for transplanted boro cultivation.

2.6.2 Permeability and Drainage

The following classes of permeability and drainage have been defined in the SODAPS database:

Permeability

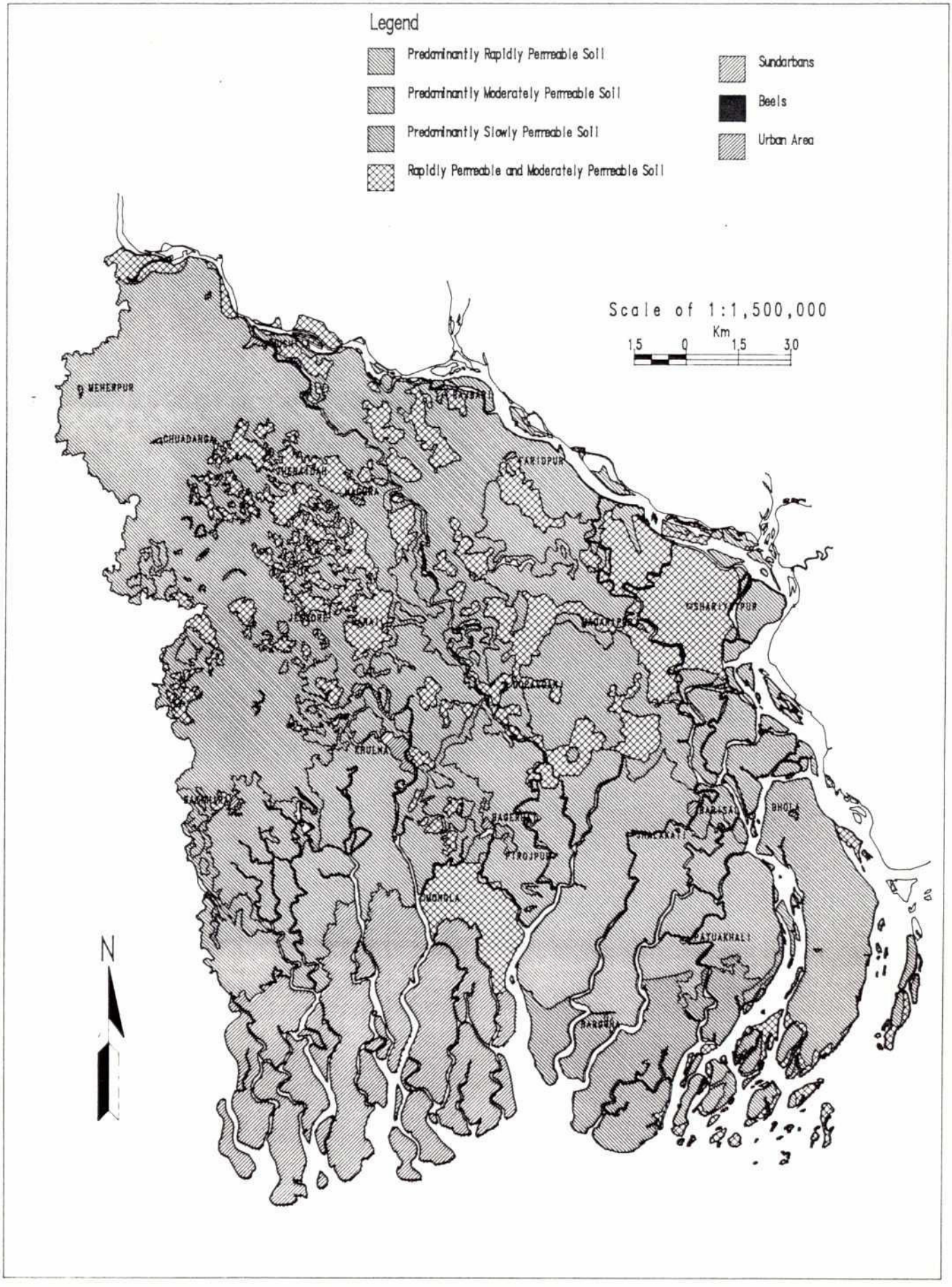
1. Rapid, >305cm/day
2. Moderate, 12-305cm/day
3. Slow, <12cm/day

Drainage

1. Well to excessively drained
2. Moderately well drained
3. Imperfectly drained
4. Poorly drained, but surface drains before mid-November
5. Poorly drained, but surface drains after mid-November
6. Very poorly drained

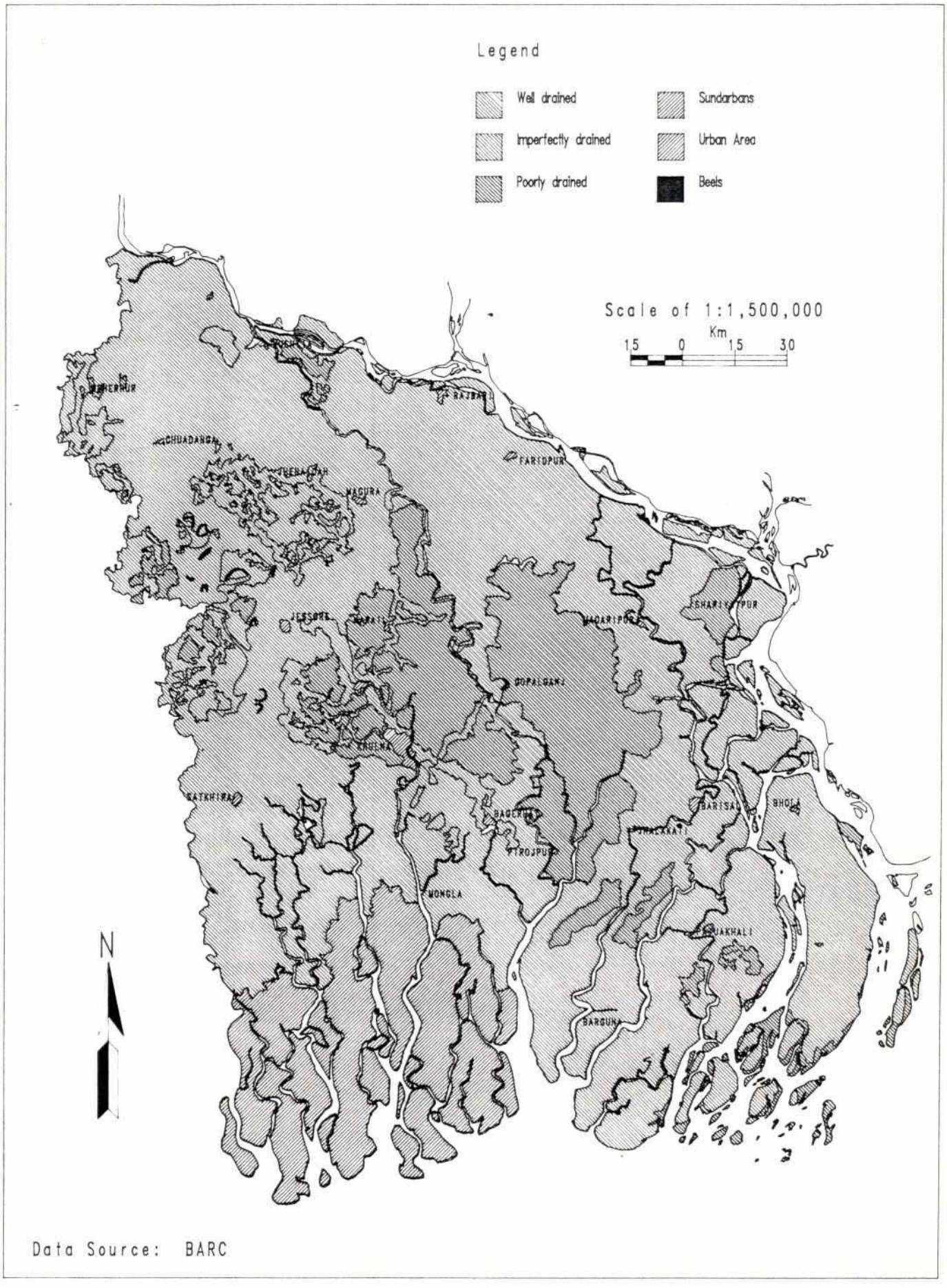
The distribution of permeability and drainage classes across the region is shown in Figures 2.15 and 2.16 respectively. The permeability classes have been combined into two groups, greater and less than 305cm/day. The area of NCA in each soil permeability class by planning unit is shown in Table 2.7.

Figure 2.15



Soil Permeability

Figure 2.16



Data Source: BARC

Soil Drainage

TABLE 2.7

The Area of NCA in each Soil Permeability Class by Planning Unit, SWA

PU CODE	High (km^2)	Low + Medium (km^2)	Total (km^2)
SW1	192.0	1282.1	1474.1
SW2	242.0	1274.8	1516.8
SW3	280.8	979.8	1260.6
SW4	238.8	1305.1	1543.9
SW5	226.4	342.6	569.0
SW6	72.2	254.5	326.7
SW7	683.2	802.3	1485.5
SW8	232.3	1138.1	1370.4
SW9	169.6	698.0	867.6
SW10	446.3	376.7	823.0
SW11	1753.2	358.4	2111.6
SW12	293.3	53.3	346.6
SW13	921.0	290.5	1211.5
SW14	661.2	423.6	1084.8
SW15	0.0	0.0	0.0
Sub-Total	6412.3	9579.8	15992.1
SC1	458.2	551.7	1009.9
SC2	262.8	348.0	610.8
SC3	135.7	309.0	444.7
SC4	239.9	321.7	561.6
SC5	310.5	273.6	584.2
SC6	15.0	479.8	494.9
SC7	348.3	218.5	566.7
SC8	200.3	1697.1	1897.4
SC9	367.9	292.3	660.3
SC10	289.1	251.5	540.6
SC11	644.8	162.1	806.9
SC12	191.6	230.6	422.2
SC13	115.6	382.3	497.8
Sub-Total	3579.7	5518.2	9097.9
Total	9992.0	15098.0	25090.0

Source: Consultant's estimation from BARC data (1984).

Although large areas of the SWA are covered by soils of high permeability, this does not necessarily reduce the suitability of the soil for rice or increase water requirements. The soils are usually silt loams or silty caly loams sometimes interstratified with layers of heavier texture and can be successfully puddled. Water movement is further reduced by ploughpans. In the unpuddled condition, these soils are suitable for a wide range of crops including pulses, oilseeds and wheat.

2.6.3 Organic Soils

Peat deposits are derived from partly decomposed aquatic grasses and reeds and overly or are interstrtified with Ganges sediments at variable depth.

They are termed "Organic soils" in which organic material occupies more than half of the upper 80 cm of the profile. The organic matter may occur at the surface, be buried under up to 40 cm of mineral soil, or occupy one or more layers separated by layers of mineral matter. The mineral soil material generally is grey or dark grey clay. The organic deposits are very dark brown to very dark greyish brown or black, calcareous (sometimes non-calcarious) mucky peat of varying thickness ranging from about 30 cm to more than 1 meter.

The area of organic soils by planning units is shown below in Table 2.8:

TABLE 2.8

Area of Organic Soils by Planning Units

Planning Unit	Area of Organic Soils (km^2)
SW4	24.6
SW5	22.0
SW7	389.9
SW8	22.3
SW9	171.8
SW10	211.6
SW12	107.0
SW13	236.1
SC3	4.6
SC4	228.1
Total	1418.0

Note: Planning Units with zero percent not shown
Source: Consultant's estimation from BARC data (1984)

The organic soils are found mainly in the Gopalganj-Khulna beels. The nature of the organic soils varies from area to area in terms of the thickness of peat and mineral layers and as such it is difficult to generalise regarding their management. Options for their use which have been mentioned range from no intervention to full FCD/I.

The organic soils may currently support crops of local boro followed by fallow or if the area dries out late, only a crop of mixed aus-b.aman. The areas may benefit from irrigation for the boro crop which would allow HYV to be grown; this would be possible especially if measures could be taken to prevent early floods to protect boro harvest. The improvement to the kharif cropping in such areas depends on controlling the depth, timing and duration of flooding together with the provision of drainage. The danger in this approach is that it would allow the soils to dry out with the possible irreversible shrinkage of the organic layers and their oxidation if they are exposed. This has been identified as a limitation to their exploitation for many years and leads the consultants to conclude that the decision to use such areas can only be taken after detailed study. For the purposes of the Regional Plan they have been excluded from development although small areas of organic soils may occur in the areas selected for pre-feasibility study.

2.6.4 Other Soil Physical Characteristics

The physical characteristics of the soil such as infiltration, hydraulic conductivity, water holding capacity and bulk density are of importance if the soil is to be managed correctly. This is particularly true for irrigation. As irrigation is likely to feature as a development

option for the SWA, the soil physical characteristics must be known and the implications explained.

A study of the physical properties of soils in the Ganges River Floodplain (FAO/UNDP, 1983) gives results of the measurement of the properties mentioned above. The study does not cover the entire SWA but does describe the soils of Faridpur, Kushtia and Jessore.

The soils of the area are predominantly silts and clays. The main physical characteristics are shown in Table 2.9. The base infiltration rate varies from 0.44 cm/hr in a silty clay loam to 5 cm/hr in a clay. This is the reverse of what might be expected but is most likely due to the stronger top soil structure in the clay and weak structure plus surface slaking in the silty clay loam.

The hydraulic conductivity ranges from 0.35 to 5.54 cm/hr and is again highest in the clay. This result is most likely due to stable cracks and pores remaining open in the clay soil during the test.

The available water capacity of the soils range from 42% in the silty loam to 16% in the clay. This is in line with expectations as, although clay soils may hold more water in total than a silt loam, less of the water in a clay is held at tensions available to plants. The value for field capacity in the table is assumed to be 0.1 bar for all soils. This is not strictly true but examination of the moisture retention curves shows very little change in moisture content at tensions between 0.1 and 0.5 bar.

For the calculation of crop water requirements in this study it has been decided to use the values of available water capacity (AWC) representing sandy and medium - fine textured soils. The AWC for sandy soils is set at 100 mm water per metre of soil and for medium fine soils it is set at 180 mm/m.

TABLE 2.9

Summary of Physical Characteristics of Soil

Soil Series	Texture	Base Infiltration rate (cm/hr)	Hydraulic conductivity (1) (cm/hr)	Field capacity (0.1 bar)	Permanent wilting point (15 bar)	Available moisture (% vol)	Bulk density (g/cm^3)
Sara topsoil	Silt loam	3	-	-	-	-	-
- subsoil	Silt loam	-	1.87	52	10	42	1.4
Mirpur top soil	Silt loam	-	-	-	-	-	-
- subsoil	Silt loam	-	-	44	12	32	1.4
Gopalpur topsoil	silty clay loam	0.4	-		-	-	-
- subsoil	silty clay loam	-	1.24	47	26	21	1.46
Amjupi top soil	silty clay	8	-	-	-	-	-
- subsoil	silty clay	-	2.13	53	22	31	1.45
Ishurdi topsoil	silty clay	0.8	-	-	-	-	-
- subsoil	silty clay	-	0.35	50	17	33	1.45
Gangri top soil	clay	5	-	-	-	-	-
- subsoil	clay	-	2.22	47	27	20	1.47
Pakuria topsoil	clay	4	-	-	-	-	-
- subsoil	clay	-	5.54	448	32	16	1.47

Notes (1) pump-in method

Source: Physical properties of Soils in the Ganges River Floodplain, FAO/UNDP, 1983.

2.7 Soil Chemistry and Fertility

2.7.1 Soil Salinity

The area of salt affected soils (defined as soils with ECe >4mmhos/cm) in the SWA is about 32.9 sq km. The area of saline soils in each planning unit is shown in table 2.10.

TABLE 2.10

Area of Saline Soils, SWA

PU CODE	Saline Soils
	Saline (km²)
SW1	0.0
SW2	0.0
SW3	0.0
SW4	0.0
SW5	0.0
SW6	0.0
SW7	0.0
SW8	22.6
SW9	4.5
SW10	1.6
SW11	1,597.5
SW12	196.0
SW13	120.2
SW14	635.0
SW15	0.0
Sub-total	2,577.4
SC1	0.0
SC2	0.0
SC3	0.0
SC4	0.0
SC5	0.0
SC6	0.0
SC7	0.0
SC8	512.3
SC9	26.4
SC10	22.8
SC11	17.7
SC12	38.7
SC13	91.7
Sub-total	709.6
Total	3,287.0

Source: Consultant's estimates from SODAPS

The data on salinity has been taken from the BARC database. The salinity classes used are as shown in the Table 2.11 below:

TABLE 2.11

Salinity Classes

Class	Salinity (mmhos/cm)
S1	< 2
S2	2 - 4
S3	4 - 8
S4	8 - 16
S5	> 16

About 90 percent of the saline areas are moderately saline (4-8mmhos/cm). They occur mostly in Bagerhat, Barguna, Patuakhali, Bhola and Pirojpur districts. The remaining 10 percent are highly saline occurring in Khulna and Satkhira districts in a mix with moderately saline soils. In these areas salinity prevents cultivation of rabi crops and reduces transplanted aman yield, especially in years of low rainfall. Soil texture in Khulna and Satkhira varies from silty clay to clay. Land preparation becomes very difficult as the soil dries out; deep and wide cracks develop and surface soils becomes very hard. In these areas dry season salinity has not decreased considerably within the poldered areas but tidal flooding has. Polder management is not as adequate as it is required to be for cultivation of HYV rice. This has severely constrained the adoption of HYV aman and HYV aus in these areas (BARC, 1990).

The accumulation of salt has come about as a result of regular flooding by saline tidal water during the monsoon season. During the dry season, salt water gradually penetrates inland and capillary movement of moisture to the soil surface concentrate salts in a thin layer until there has been sufficient monsoon rainfall to dilute or leach the salt.

The relationship between crop yield and soil and water salinity is shown in Table 2.12.

TABLE 2.12

Expected Percentage of Yield Decrease due to Different Degrees of Salinity on Crops

Sl No	Crops	0%		10%		25%		50%		Maximum ECe
		ECe	ECw	ECe	ECw	ECe	ECw	ECe	ECw	
1	Rice	3.0	2.0	3.8	2.6	5.1	3.4	7.2	4.8	11.5
2	Wheat	6.0	4.0	7.4	4.9	9.5	6.4	13.0	8.7	20.5
3	Cotton	7.7	5.1	9.6	6.4	13.0	8.4	17.0	12.0	27.0
4	Barley	8.0	5.3	10.0	6.7	13.0	8.7	18.0	12.0	28.0
5	Corn	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10.0
6	Cowpea	1.3	0.9	2.0	1.3	3.1	2.1	4.9	3.2	8.5
7	Cabbage	1.8	1.2	2.8	1.9	4.4	2.9	7.0	4.6	12.0
8	Potato	1.7	1.1	2.5	1.7	3.8	2.5	5.9	3.9	10.0
9	Sweet Potato	1.5	1.0	2.4	1.6	3.8	2.5	6.0	4.0	10.5
10	Tomato	2.5	1.7	3.5	2.3	5.0	3.4	7.6	5.0	12.5
11	Cucumber	2.5	1.7	3.3	2.2	4.4	2.9	6.3	4.2	10.0
12	Spinach	2.0	1.3	3.3	2.2	5.3	3.5	8.6	5.7	15.0
13	Lettuce	1.3	0.9	2.1	1.4	3.2	2.1	5.2	3.4	9.0
14	Carrot	1.0	0.7	1.7	1.1	2.8	1.9	4.6	3.1	8.0

Note: a. ECe = Mean electrical conductivity of the saturation extract of soil reported in millimhos/cm at 25°c.
b. ECw = Mean electrical conductivity of the irrigation water in micromhos/cm at 25°c.

Source: Saline Soils of Bangladesh, BARC

The dominant crop grown is rice and so a limit of 4 mmhos/cm has been taken as the boundary between saline and non saline soils in this study. The conductivity of water affecting rice yield has been set at 2 mmhos/cm.

The Cyclone Protection Project II (CPP II) (FAP-7) has studied the salinity situation in the polder areas. Their study area comprises of the entire coastal area whereas this study is only concerned with the SW and SC regions.

The CPP II, has categorised the polders according to a combination of soil and water salinity and land use. In the SW & SC regions they have identified four categories of polder as follows:

Category - I: Polder Nos -5, 7/1, 7/2, 10-12, 14/1, 14/2, 15, 31, 32, 35/1 -high to moderate dry season soil salinity, high dry season water salinity, low cropping intensity, shrimp culture.

Category - II: Polder Nos 40/1, 40/2, 45, 48 - moderate to low dry season soil salinity, high dry season water salinity, low cropping intensity.

Category - III: 56/57 (northern and central part) and 72-Moderate to low dry season soil salinity (Northern Bhola has non-saline soil), high dry season water salinity, high cropping intensity.

Category - IV: 56/57 (Southern part) and 73/2B - High dry season soil salinity, high dry season water salinity, polders complete with severe damage or polder incomplete, low cropping intensity.

2.7.2 Acid Sulphate Soils

Acid Sulphate Soils are grey or dark grey soils in tidal alluvium which are actually or potentially extremely acid (pH 4.0 or less) in some layer within 125 cm of the surface.

Two kinds of Acid Sulphate soils occur in the project area. Soils that are tidally flooded with saline water throughout the year and are finely stratified, soft, muddy sediments which contain partially decomposed tree roots and sometimes buried organic layers. They are generally under mangrove forest or scrub and mainly occur in the Sundarbans. Such soils are neutral in reaction but would turn extremely acid on oxidation which would occur if drained.

The other type of acid sulphate soil occurs on land which has been cleared from mangrove forest and brought under cultivation. Some areas have been empoldered to prevent intrusion of tidal saline water. In many areas before empoldering the area of former mangrove forest soils has been buried by a layer of river sediments, consequently, the extremely acid layer is buried at a variable depth.

These soils are potential acid sulphate soils as the horizons containing sulphides have not yet been exposed to oxidation. The area of potential acid sulphate soils is about 11,180 ha excluding Sundarbans. Table 2.13 shows areas of acid sulphate soils in planning units.

TABLE 2.13

Area of Acid Sulphate Soils, SWA

PU CODE	Acid Sulphate (km^2)
SW11	81.9
SW12	1.2
SW13	17.5
SW14	11.2
Total	111.8

Source: Consultant's estimation from BARC data (1984)

The potential acid sulphate soils should not be drained otherwise oxidation and a sharp reduction in pH will occur, this will decrease their productivity sharply. Any FCD/I project in these areas must be managed carefully to prevent this happening.

2.7.3 Soil Fertility

The natural fertility of the Ganges floodplain soils is relatively high and well sustained. Since the soils have developed in calcareous parent material they are rich in such elements as calcium, magnesium and potassium even when they are decalcified.

The soils of the active and young floodplains are rich in weatherable minerals such as feldspar and biotite. Conditions suitable for rapid weathering ensures the continuous availability of these nutrients. Soils of the old floodplain area have high base saturation usually above 80 percent and seldom below 70 percent.

Most of the ridge soils both in young and old floodplains particularly those on highland areas, have a low nitrogen content, usually ranging from 0.03 to 0.08 percent. Presently, farmers apply considerable amounts of urea to overcome the deficiency. In addition, farmers use manure and cow dung for the cultivation of sugarcane, jute, betel leaf, tobacco and vegetables. Recent research work has demonstrated the general deficiency of sulphur and zinc.

Potash deficiency has not been reported although the possibility of fixation cannot be discounted since some of the illites in the clay fraction could have a strong fixation capacity.

Phosphate fixation is likely to occur in the calcareous soils.

Soil reaction has a marked effect on the availability and uptake of nutrients. A notable seasonal change in reaction on the topsoils of the seasonally flooded soils has been reported. When flooded the reaction is near-neutral. In the soils that have been decalcified in the surface, pH values fall to around 5.0 within a period of a few weeks of drying out of the soil. Calcareous top soils fluctuate in reaction between pH 7.0 when flooded and about pH 8.0 when dry.

Most soils have favourable cation exchange capacity. Dominant clay minerals are montmorillonite.

Soils of the Meghna Estuarine floodplain are predominantly silty and rich in weatherable minerals. They have relatively moderate to high content of nitrogen usually ranging between 0.08 to 0.2 percent.

2.8 Land Suitability for Irrigation

A land suitability assessment has not been carried out as part of the regional plan. Detailed information can be found on crop suitability in the SODAPS database and the MPO Planning Analysis Reports. The Consultants have collected this information and intend to use it during the feasibility study phase.

The approach adopted at this stage of the study is to assume that no new crops or croping patterns will be introduced as a result of any intervention. Future cropping patterns will involve changes in those that already exist in a given area and are, therefore assumed to be suitable for that locality. However, an upper limit must be placed on the amount of land suitable for irrigation.

The area suitable for irrigation in each planning unit is shown in Table 2.14.

TABLE 2.14

Area of Land Suitable for Irrigation, SWA (km²)

PU CODE	Potentially Irrigable Area (1)	Existing Irrigation (2)	Land suitable for Irrigattion and still to be developed
SW1	1309	451	858
SW2	1517	1292	225
SW3	1090	208	882
SW4	1703	439	1264
SW5	539	90	449
SW6	280	54	226
SW7	1486	275	1211
SW8	1173	672	501
SW9	812	347	465
SW10	905	107	798
SW11	451	282	169
SW12	150	40	110
SW13	1143	93	1050
SW14	240	20	220
SW15	-	-	-
Sub-Total	12798	4370	8428
SC1	1010	175	835
SC2	536	93	443
SC3	391	137	254
SC4	494	92	402
SC5	546	414	132
SC6	394	66	328
SC7	489	396	93
SC8	618	211	407
SC9	281	28	253
SC10	314	36	278
SC11	611	327	284
SC12	202	43	159
SC13	160	21	139
Sub-Total	6046	2039	4007
Total	18844	6409	12435

Note: (1) National Water Plan, Draft Final Report (1991)
(2) BWDB updated from the Census of Lift Irrigation, CIDA (1991)

From this table it can be seen that about 34% of the potentially irrigable land has been developed in the SWA and that the proportions for the SW and SC regions are about the same.

In the SWR, the planning units with the largest areas of land suitable for irrigation development are SW4, SW7 and SW13. Planning unit SW7 has the largest extent of F3 and F4 land in the SWR and as such requires extensive flood control and drainage for the Kharif season irrigation potential to be exploited where it does not already exist.

The provision of irrigation for the boro crop would not require such extensive FCD works. Planning unit SW13 has rather less area of F3 land but still above the regional average; Planning Unit SW4 is predominantly F0 and F1 land. Other extensive areas of potentially irrigable land are found in PU SW1,3,10 and 8.

In the SCR, large areas of potentially irrigable land can be found in SC1 which is mainly F2 land with some F3. Other areas of land remain to be exploited throughout the SCR particularly in SC4, SC8, SC2 and SC6.

3 CROP PRODUCTION

3.1 Crops

A large number of crops are grown in the SWA but only a few account for the major proportion by area. The crops used in the study are those identified by the MPO and given in its Report 14, Agricultural Production Systems. The list is shown in Table 3.1. Rice is the dominant crop accounting for 72% of the total annual cropped area followed by pulses, 9%, oilseeds, 6% and wheat, 4%. The remaining area is planted to a wide range of crops including jute, sugarcane and spices. Minor crops includes cotton, millets, vegetables etc.

TABLE 3.1

Major Crops Grown in the SWA, 1990-91

Season	Crops	Area (ha) ('000's)	% of NCA
Kharif	Broadcast Aus	636	25
	HYV Aus	122	5
	Broadcast Aman	359	14
	Local Transplanted Aman	919	37
	HYV Aman	422	17
	Jute	119	5
Rabi	Local Boro	35	1
	HYV Boro	407	16
	HYV Wheat	154	6
	Potato	30	1
	Pulses (1)	355	14
	Oilseeds (2)	239	10
	Spices (3)	47	2
	Minor crops (4)	76	3
	Orchards (4)	30	1
Perennial	Sugarcane	52	2
	Total Cropped Area	4002	159
	Total Rice Area	2900	

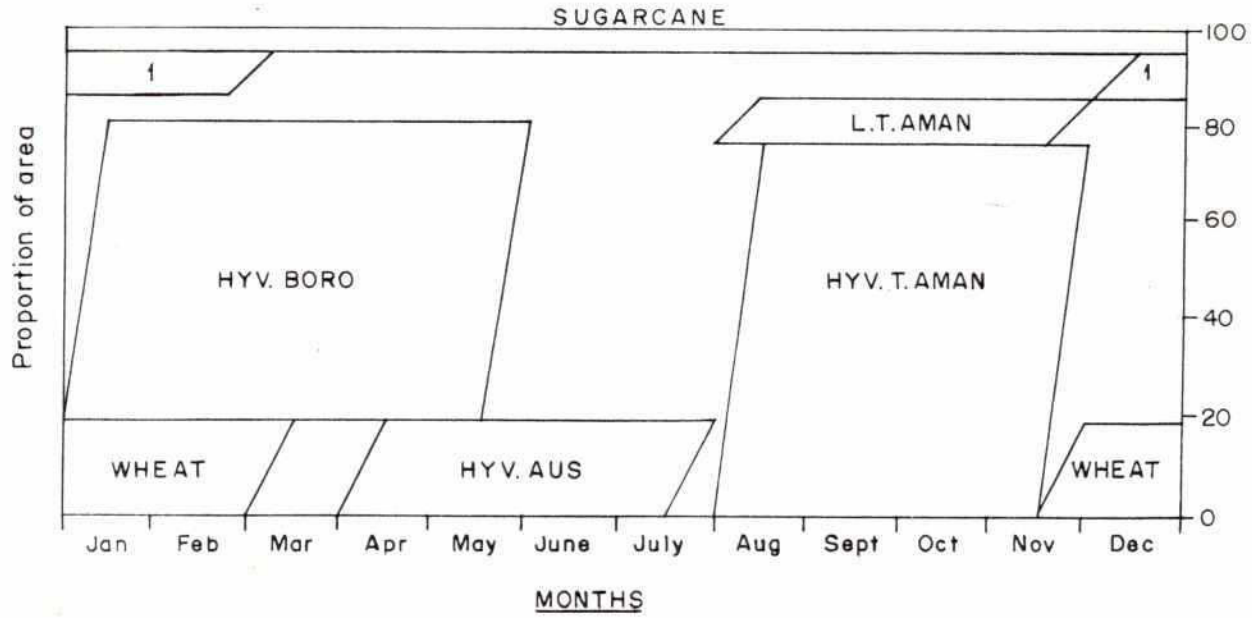
Source: MPO (1989/90) and BBS unpublished data for 1990-91

Notes: (1) Lathyrus, lentil & chickpea
(2) Mustard and rape
(3) Onion, garlic, chilli
(4) MPO estimate

Of the total cropped area 73% is under rice.

3.2 Present Cropping Patterns and Crop Calendars

Cropping patterns are the spatial and temporal arrangement of crops grown on a given area of land over a year. They are the farmers response to the environmental and socio-economic conditions affecting him and his land. The farmer grows particular crops to suit the prevailing conditions and to minimise risk.

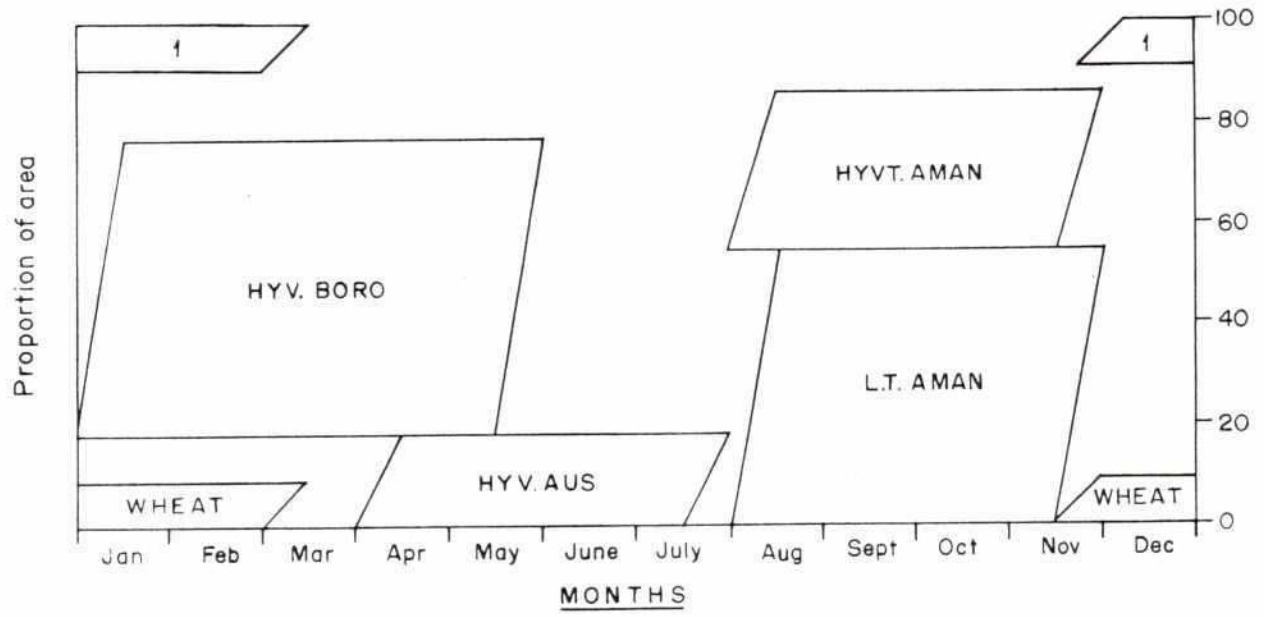


1. Minor Crops: Pulses, Oilseeds, Spices, Vegetable

Source: Calculated from MPO data (1989-90)

Illustrative Irrigated Cropping Pattern, Fo Land

Figure3.2

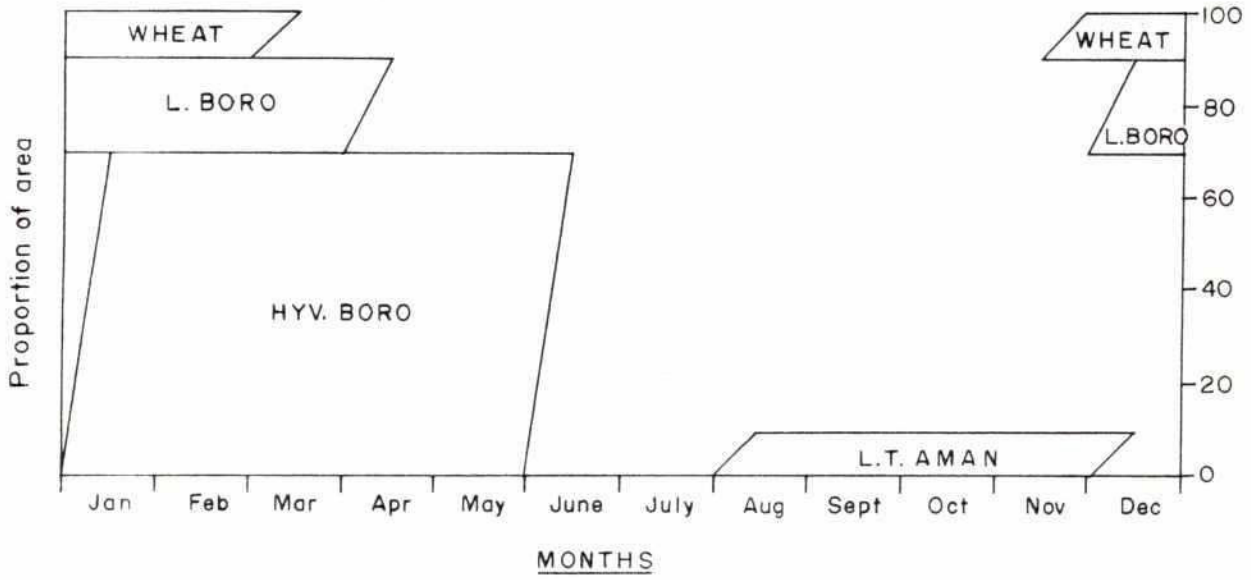


1. Minor crops: Pulses, Oilseeds, Spices, Vegetable.

Source: Calculated from MPO data(1989-90)

Illustrative Irrigated Cropping Pattern, F1 Land

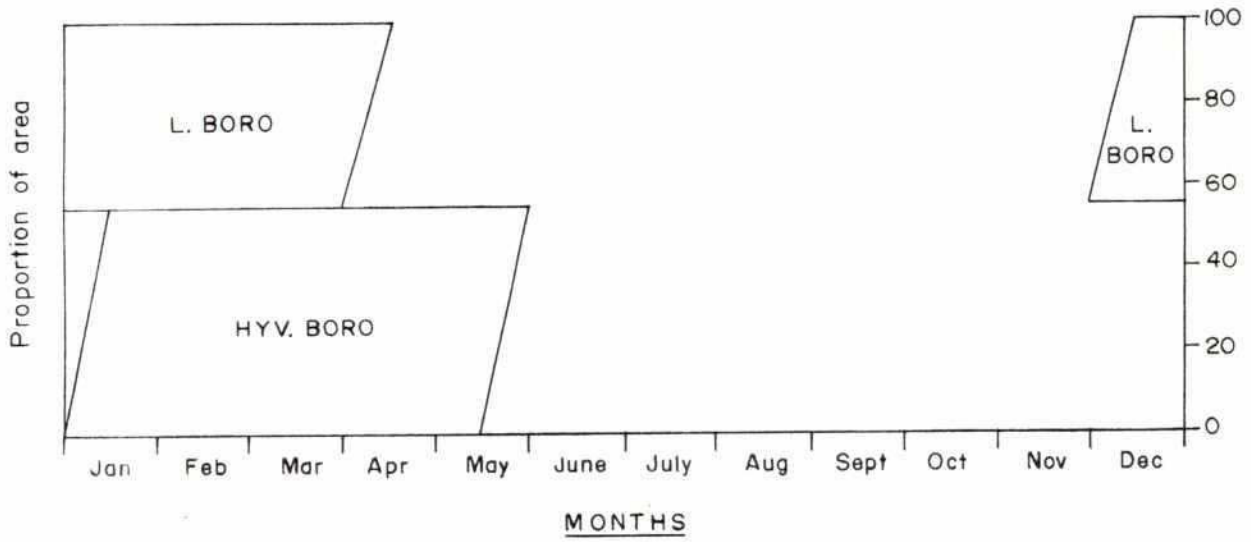
Figure 3.3



Source: Calculated from MPO data (1989-90)

Illustrative Irrigated Cropping Pattern, F2 Land

Figure 3.4



Source: Calculated from MPO data (1989–90)

Illustrative Irrigated Cropping Pattern, F3 Land

In Bangladesh, cropping patterns have been developed largely in response to the seasonal pattern of rainfall and inundation. Cropping patterns are dominated by rice and under rainfed conditions, they are a reflection of inundation during the kharif season. Rabi cropping is determined, in the absence of irrigation by the amount of residual moisture remaining after the aman rice crop and this varies with soil type and topography.

The provision of irrigation during the rabi season allows great flexibility in crop production. However, boro rice and wheat are the main crops grown usually resulting in a reduction of the area under pulses, oilseeds and vegetables.

The major cropping patterns are shown in Table 3.2. They are shown by land type and whether irrigated or rainfed for the major agro-ecological regions. Simplified crop calendars for the major patterns are shown in Figures 3.1 to 3.8.

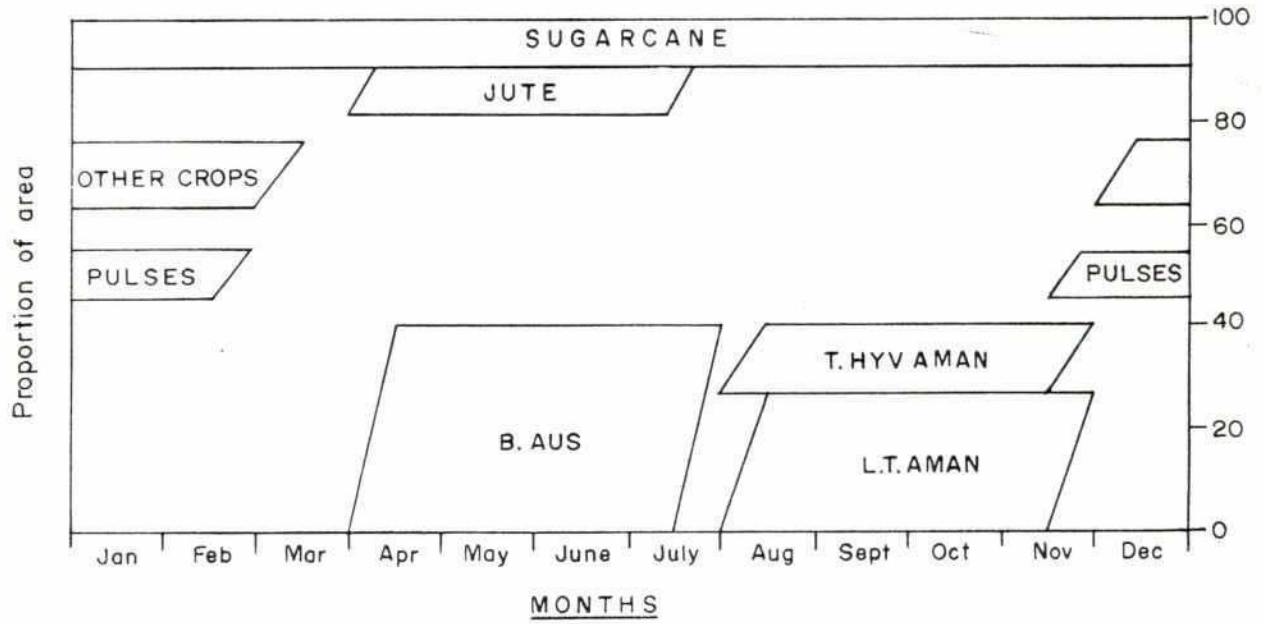
In Table 3.2, two columns are shown one for rainfed and one for irrigated cropping. The crops listed under the irrigated pattern are not all irrigated, those that are, are marked with an asterisk.

Figures 3.1 to 3.4 show illustrative cropping patterns for irrigated land by land type. Not all of the crops shown will be irrigated and those that are may receive full or supplementary irrigation as shown below:

Crop	Irrigation Status
HYV Boro, HYV Wheat	Fully Irrigated
HYV T.Aman, Sugarcane	Supplementary
HYV Aus	May or may not be fully irrigated depending on season
L.T.Aman, Minor crops	Not irrigated

The crops shown in Figures 3.5 - 3.8 are entirely rainfed.

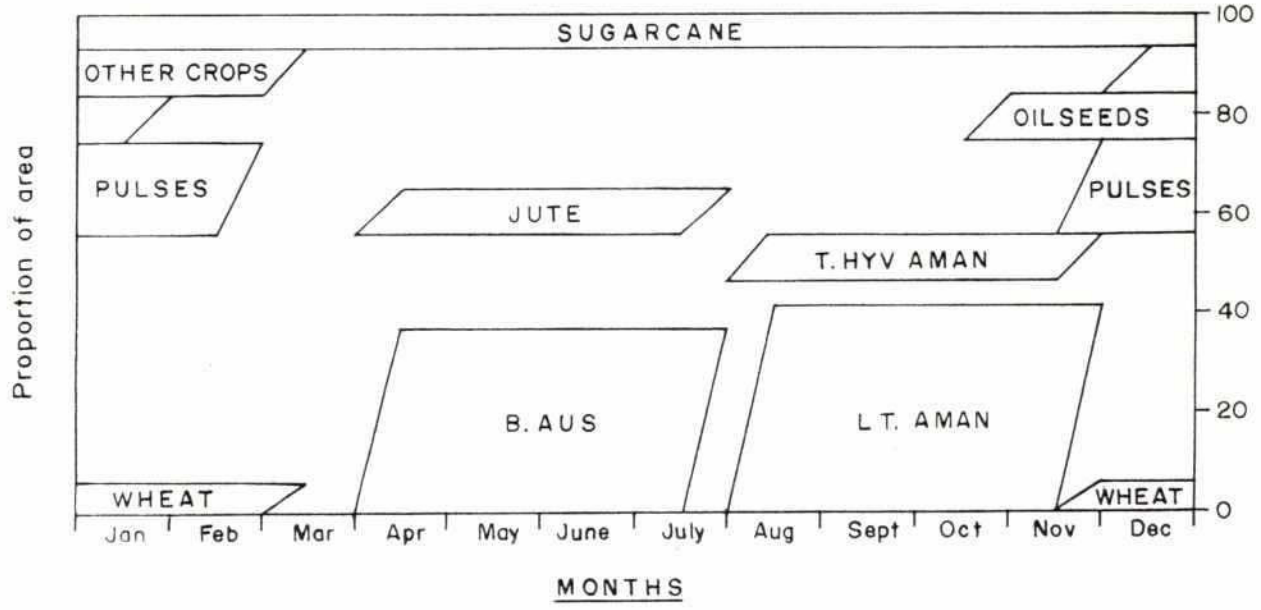
Figure 3.5



Source : Calculated from MPO data (1989-90)

Illustrative Rainfed Cropping Pattern, FO Land

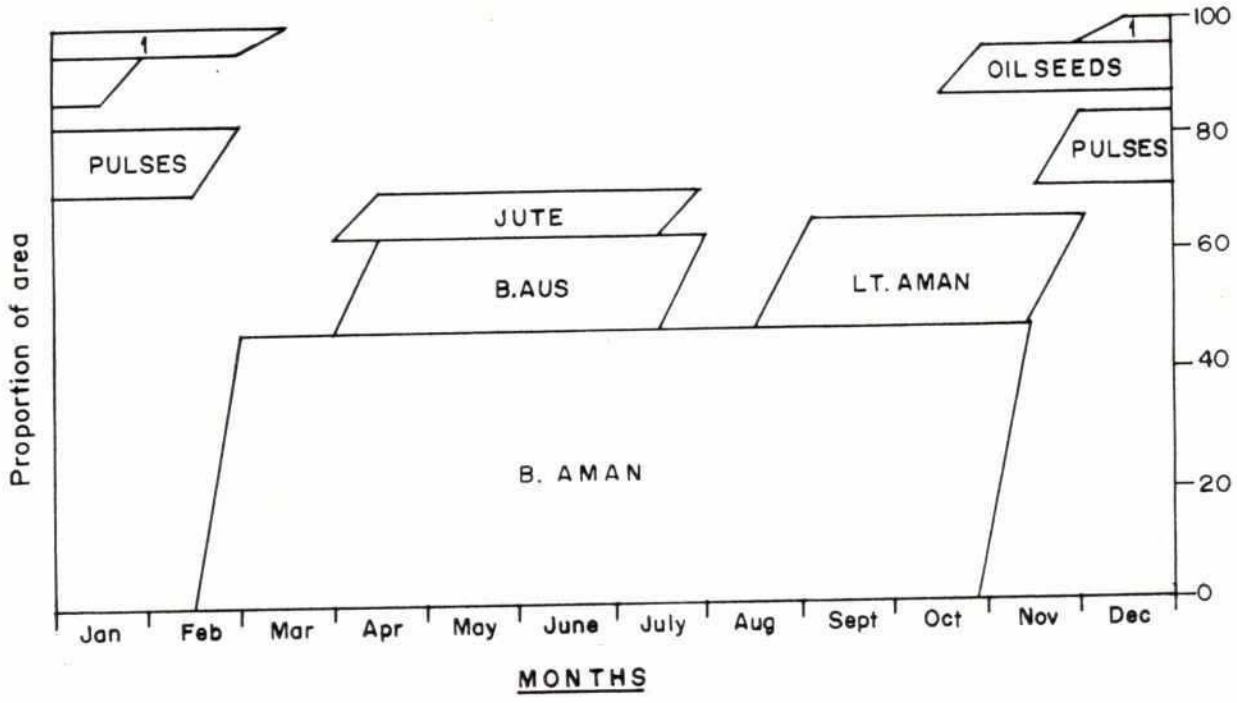
Figure 3.6



Source : Calculated from MPO data (1989–90)

Illustrative Rainfed Cropping Pattern, F1 Land

Figure 3.7

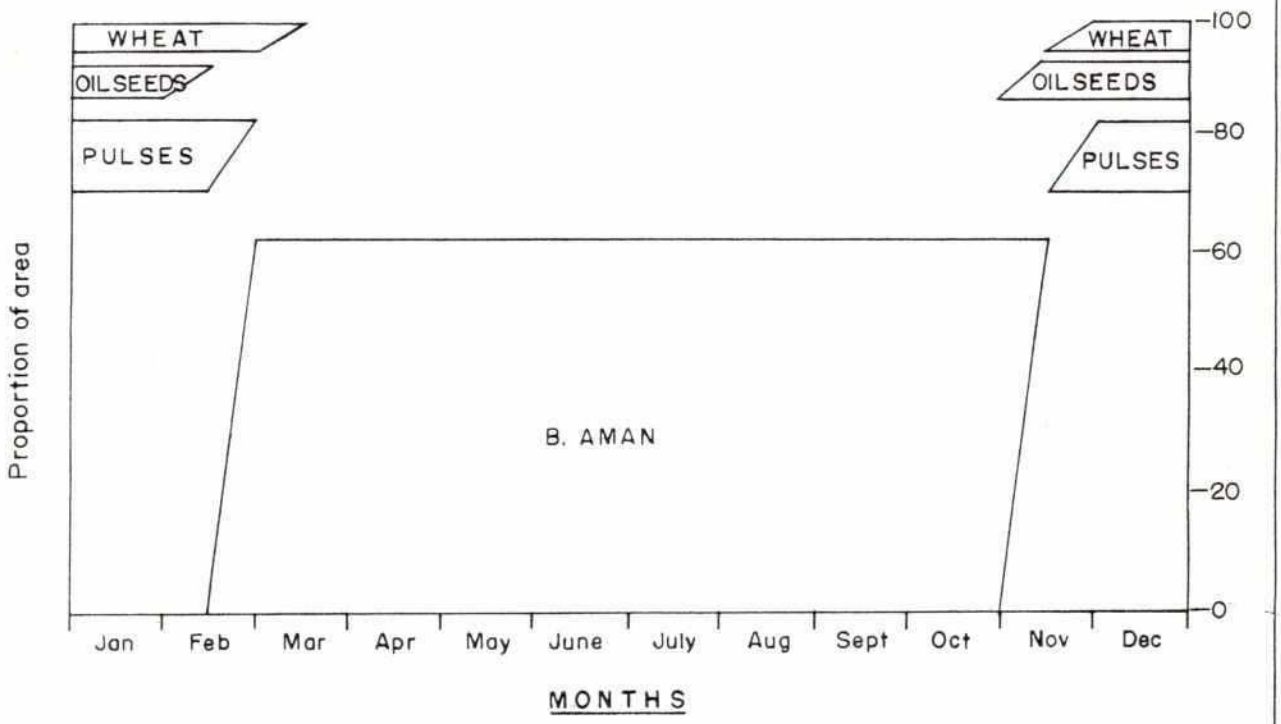


1. Minor Crops: Pulses, Oilseeds, Spices, Vegetables.

Source: Calculated from MPO data (1989–90)

Illustrative Rainfed Cropping Pattern, F2 Land

Figure 3.8



Source: Calculated from MPO data (1989–90)

Illstrative Rainfed Cropping Pattern, F3 Land

TABLE 3.2

Major Cropping Patterns in the Southwest Area

AEZ	Predominant Textures	Land Type	Rainfed	Irrigated
Active Ganges Floodplain	Sands, loamy Sands and Sandy loam	F0	1. B.Aus/Jute-W/P/V/O/S 2. B.Aus/Jute-LT Aman(1)	-
		F1	1. B.Aus/Jute-L.T. Aman 2. B.Aus/Jute-W/P/V/O/S	1.T.Aman (L/HYV)(2)-HYV Boro*
		F2	1. Mixed B.Aus and B.Aman-rabi crops	1.DWT T.Aman-HYV* Boro
High Ganges River Floodplain	Loams to clay	F0	1. B.Aus - W/P/V/O/S 2. B.Aus - T.Aman(L/HYV) 3. Sugarcane 4. B.Aus - Cotton	1.HYV T.Aus-HYV T.Aman-rabi crops 2.Sugarcane*
		F1	1. B.Aus - T.Aman(L/HYV) 2. B.Aus-T.Aman(L/HYV)-rabi 3. B.Aus-Tobacco/W/P/V/O/S	1.HYV* T.Aman-HYV Boro* 2.Hyv* TAus-HYV T.Aman*
		F2 + F3	1. Mixed B.Aus and B.Aman-Kheshari 2. B.Aman-Kheshari/fallow	1.Mixed B.Aus and B.Aman-HYV Boro* 2.HYV Boro*- Fallow
Low Ganges River Floodplain	Silty clay loam to clay	F0	1. B.Aus/Jute-T.Aman(L/HYV) 2. B.Aus-T.Aman-rabi	1.HYV T.Aman - HYV Boro*
		F1	1. B.Aus/Jute-T.Aman(L/HYV) 2. B.Aus/Jute-T.Aman-rabi	1.HYV T.Aman - HYV Boro*
		F2 + F3	1. Mixed B.Aus and B.Aman-kheshari 2. B.Aman-kheshari/Fallow	1.HYV*Boro-Fallow 2.DWT Aman-HYV Boro*
Ganges Tidal Floodplain	Silty clay loam to silty clay(3)	F0	1. T.Aman (L/HYV)-Fallow 2. Hyv Aus- T.Aman	1.HYV T.Aman - HYV Boro*
		F1	1. T.Aman(L/HYV)-Fallow 2. T.Aus(L) - T.Aman(L/HYV) 3. B.Aus - T.Aman (L/HYV) 4. Shrimp - T.Aman (L)	1.HYV T.Aman - HYV Boro*
Young Meghna Estuarine Floodplain	Silt loam to silty clay loam(3)	F0	1. B.Aus - T.Aman(L/HYV) 2. B.Aus - P/S/V 3. D.Aus - T.Aman (L)	1.HYV T.Aman - HYV Boro*
		F1	1. T.Aman(L/HYV) - Fallow 2. B.Aus/Jute-T.Aman(L) 3. T.Aus(L)-T.Aman(L/HYV) 4. T.Aman(L/HYV)-P/V/S	1.HYV T.Aman - HYV Boro*
Old Meghna Estuarine Floodplain	Silt loam to silty clay	F0	1. B.Aus/Jute-T.Aman(L/HYV) 2. B.Aus/Jute-W/P/V/O/S	1.HYV T.Aman - HYV Boro
		F1	1. B.Aus/Jute-T.Aman(L/HYV) 2. B.Aus/Jute-W/P/V/O/S 3. B.Aus/Jute-T.Aman(L/HYV)-rabi	1.HYV T.Aman - HYV Boro
		F2	1. Mixed B.Aus and B.Aman-pulses/oilseeds 2. B.Aman-Pulses/Oilseeds/Wheat 3. B.Aus/Jute - T.Aman(L)	1.Mixed B.Aus and B.Aman - HYV Boro* 2.HYV* Boro-Fallow
Peat Basin	Peat + clay + muck	F2 & F3	1. B.Aman - Fallow 2. Mixed B.Aus and B.Aman rabi/fallow 3. Boro(L) - Fallow	

Sources: Compiled from AEZ Reports (FAO, 1988), MPO (1989-90) and DAE (1992)

Notes: (1) L.T. Aman refers to Local varieties of transplanted Aman
(2) (L/M) refers to local and HYV respectively
(3) D. Aus refers to dibbled Aus
(4) W = Wheat; P = Pulses; V = Vegetables; O = Oilseeds; S = Spices
* Irrigated or partially irrigated

The cropping patterns shown in Table 3.2 are qualitative, for planning purposes these must be quantified. The MPO has produced data showing the areas of land type for each MPO Planning Area and the area of each crop by irrigation mode within each land type. This information was produced on the basis of cropping data for 1986-87 from BBS and transferred by MPO to give areas of land types. The MPO then used this to forecast the cropping patterns for 1989-90. The Consultants have obtained this data from MPO and transferred it to the planning units as used in this study. The cropping patterns have been further modified in line with the increase in minor irrigation since the mid 1980's based on data collected by the Agriculture Sector Team of CIDA. This was necessary as irrigation has increased significantly since the liberalization of laws on the importation of pumps and other irrigation equipment.

The area and proportion of each crop by land type and whether irrigated or rainfed for the South West and South Central Regions are shown in Tables 3.3 and 3.4 respectively and for the SWA in Table 3.5. The same comments on which crops receive irrigation made above applies to these tables. Tables showing the same information for each planning unit are given in Appendix A.

TABLE 3.3

Cropped Areas, Southwest Region

(Area in hectare)

SW Total Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	149170	153818	75952	0	0	378940	378940
HYV Aus	27611	55816	0	0	1681	2913	0	0	83427	4594	88021
B Aman	0	0	0	0	0	25155	152543	70233	0	247931	247931
LT Aman	18638	123714	5483	0	59991	270462	7400	59	147835	337912	485747
HYV Aman	109087	70885	0	0	47065	50204	0	24	179972	97293	277265
Jute	0	0	0	0	35506	48008	10989	0	0	94503	94503
Sugarcane	13622	2856	0	0	15540	6999	0	0	16478	22539	39017
Rabi											
L Boro	0	1	350	5416	0	0	1003	8192	5767	9195	14962
HYV Boro	79101	121145	45086	10027	1350	0	0	0	255359	1350	256709
HYV Wheat	34153	43382	8197	0	4245	21980	9227	6996	85732	42448	128180
Potato	755	2694	302	0	3067	4924	4018	54	3751	12063	15814
Pulses	5293	16896	2847	4	49396	87513	42896	11717	25040	191522	216562
Oilseeds	8543	21444	2092	24	27051	66044	27809	8161	32103	129065	161168
Spices	3893	3434	0	0	4312	8438	1207	0	7327	13957	21284
Minor crops	9165	17415	440	0	4218	22914	1719	0	27020	28851	55871
Orchards	950	0	0	0	18335	0	0	0	950	18335	19285
Totals	310811	479682	64797	15471	420927	769372	334763	105436	870761	1630498	2501259
Total NCA	148577	216672	54829	16809	303602	547221	222750	88750	436887	1162323	1599210
Average CI	209%	221%	118%	92%	139%	141%	150%	119%	199%	140%	156%

Source: MPO (1989-90)

TABLE 3.4

Cropped Areas, South Central Region

(Area in hectare)

SW Total Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	51007	177773	28143	0	0	256923	256923
HYV Aus	11323	12541	0	0	3000	7283	0	0	23864	10283	34147
B Aman	0	0	0	0	0	16920	68858	25499	0	111277	111277
LT Aman	7543	47716	3183	0	62778	304254	7814	1	58442	374847	433289
HYV Aman	68631	29621	0	0	13706	32975	0	0	98252	46681	144933
Jute	0	0	0	0	4022	16425	4332	0	0	24779	24779
Sugarcane	341	0	0	0	7464	5006	0	0	341	12470	12811
Rabi											
L Boro	0	10617	1164	3668	0	0	0	4941	15449	4941	20390
HYV Boro	63770	54075	30632	1857	0	0	0	0	150334	0	150334
HYV Wheat	5012	1552	0	0	1626	11592	5015	1083	6564	19316	25880
Potato	6085	3958	0	0	1185	2149	649	0	10043	3983	14026
Pulses	964	2661	643	0	14201	94694	21907	3213	4268	134015	138283
Oilseeds	9944	16631	630	37	5974	28145	14772	1460	27242	50351	77593
Spices	7034	1689	0	0	3492	11902	1430	0	8723	16824	25547
Minor crops	1370	2778	74	0	1951	13159	853	0	4222	15963	20185
Orchards	0	0	0	0	10367	0	0	0	0	10367	10367
Totals	182017	183839	36326	5562	180773	722277	153773	36197	407744	1093020	1500764
Total NCA	84943	81038	31852	6153	125446	462329	87932	30096	203987	705803	909790
Average CI	214%	227%	114%	90%	144%	156%	175%	120%	200%	155%	165%

Source: MPO (1989-90)

TABLE 3.5

Cropped Areas, Southwest Area

(Area in hectare)

SW Total Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
B Aus	0	0	0	0	200177	331591	104095	0	0	635863	635863
HYV Aus	38934	68357	0	0	4681	10196	0	0	107291	14877	122168
B Aman	0	0	0	0	0	42075	221401	95732	0	359208	359208
LT Aman	26181	171430	8666	0	122769	574716	15214	60	206277	712759	919036
HYV Aman	177718	100506	0	0	60771	83179	0	24	278224	143974	422198
Jute	0	0	0	0	39528	64433	15321	0	0	119282	119282
Sugarcane	13963	2856	0	0	23004	12005	0	0	16819	35009	51829
Rabi											
L Boro	0	10618	1514	9084	0	0	1003	13133	21216	14136	35352
HYV Boro	142871	175220	75718	11884	1350	0	0	0	405693	1350	407043
HYV Wheat	39165	44934	8197	0	5871	33572	14242	8079	92296	61764	154060
Potato	6840	6652	302	0	4252	7073	4667	54	13794	16046	29840
Pulses	6257	19557	3490	4	63597	182207	64803	14930	29308	325537	354845
Oilseeds	18487	38075	2722	61	33025	94189	42581	9621	59345	179416	238761
Spices	10927	5123	0	0	7804	20340	2637	0	16050	30781	46831
Minor crops	10535	20193	514	0	6169	36073	2572	0	31242	44814	76056
Orchards	950	0	0	0	28702	0	0	0	950	28702	29652
Totals	492828	663521	101123	21033	601700	1491649	488536	141633	1278505	2723518	4002023
Total NCA	266521	297710	86681	22962	429048	1009550	310682	118845	640874	1868126	2509000
Average CI	211%	223%	117%	92%	140%	148%	157%	119%	199%	146%	160%

Source: MPO (1989-90)

3.3 Future Cropping Patterns

In the calculation of the future, with project situation no new cropping patterns are proposed. Rather, the future situation will reflect shifts in the proportion of land types and, therefore, a change in the cropping patterns associated with them. This is thought to reflect more accurately the actual situation and is the outcome that has been observed to occur following FCD/I.

In Table 3.3, for example, engineering interventions in the form of FCD will result in increases in land types Fo and F1 and a decrease in F2 and F3. The result is an increase in the cropping patterns associated with these land types.

3.4 Cropping Intensities

The overall cropping intensity in the SWA is 160.5%. The intensity of use on irrigated land averages 199.5% and for non-irrigated land 147.5%. The overall cropping intensity for the SW and SC region is shown below, Table 3.6:

TABLE 3.6

Summary of Cropping Intensity, SW & SC Regions

Region	Irrigated	Non-irrigated	Overall
SW	199	140	156
SC	200	155	165

Source : Consultant's calculation from MPO data (1989/90)

An indication of the potential to increase agricultural production can be gained from the intensity of use of land in the rabi season. This is shown in Table 3.7.

TABLE 3.7

Overall and Rabi Season Cropping Intensity %

Region	Irrigated	Non-irrigated	Total	Irrigation % of total	Overall C.I.
SW1	25	25	50	50	164
SW2	85	5	90	95	196
SW3	17	37	54	31	149
SW4	28	31	59	47	164
SW5	16	36	52	30	149
SW6	16	36	52	30	149
SW7	20	45	65	31	163
SW8	53	22	75	71	179
SW9	46	23	69	67	183
SW10	14	34	48	29	148
SW11	13	22	35	37	127
SW12	12	23	35	34	132
SW13	8	40	48	17	149
SW14	2	23	25	7	117
SWR	28	28	56	50	156
SC1	19	52	71	27	165
SC2	21	42	63	33	169
SC3	38	27	65	58	171
SC4	19	33	52	37	169
SC5	83	10	93	89	188
SC6	18	38	56	32	169
SC7	76	10	86	88	198
SC8	12	24	36	33	154
SC9	4	26	30	13	150
SC10	6	27	33	18	152
SC11	39	18	57	68	176
SC12	10	25	35	29	154
SC13	4	26	30	13	150
SC	25	28	53	47	165

Source: Consultant's calculation from MPO data (1989/90)

From this table it can be seen that in only 4 planning units in the SWR and 5 in the SCR is there a rabi cropping intensity greater than 60%. Also of interest is the fact that on average only 28% of the land in the SWR is irrigated in the rabi season, in the SCR it is 25%.

The rabi season cropping intensity is also low in those Planning Units where dry season soil saliniy is found. This is particularly noticeable for PU SW11 where 75 percent of the soil is classed as saline and the Rabi season cropping intensity is 35 percent. PU SW14 has 60 percent saline soils and a rabi cropping intensity of 25 percent.

The proportion of area irrigated in the rabi season is also shown in the table as a percentage of the total area cropped in the rabi season. Although the average area irrigated in the rabi season is about 50% of the area cultivated at that time, the figure hides some large regional variations. The Planning Unit with the greatest proportion of cultivated land irrigated in the rabi season is SW2 with 95%. This is due to the G-K project. The lowest proportion is found in PU SW14, the saline area around Satkhira. In the SC region the highest figures are in PU SC5 and SC7.

These figures indicate a generally low usage of land in the rabi season that could benefit from irrigation.

The overall cropping intensities in the SWR vary from 117% in SW14 in the coastal region to the north and east of Mongla to 183% in SW9 to the south of Jessore. There is less of a range in cropping intensity in the SCR where they range from 150% in SC9 and SC13 to 198% in SC7.

3.5 Agricultural Practices

Agriculture in the SWA, as in the rest of the country is traditional and entirely rice based. This section describes the principal agricultural practices for the major crops in the SWA pointing out the differences that occur over such a large region. The purpose is to show how agricultural practices have developed in response to prevailing conditions.

Rice.

The aus rice crop may be broadcast or transplanted and is grown mainly on higher ground (F0 and F1 land). Aus rice is photo non-sensitive, but thermosensitive.

Land preparation for broadcast aus starts after the harvest of aman crops and is then left fallow until the first rains allow sowing. Where soil moisture is insufficient to allow land preparation, this is delayed until after sufficient rain has fallen. Usually, five or six ploughings or ladderings are needed. Sowing generally starts during the first week of April and continues until May depending on rainfall. Weed control is usually undertaken at least twice and is normally done by hand.

All broadcast aus varieties are local with a duration of 85-110 days. Bangladesh Rice Research Institute (BRRI) has developed broadcast, high-yielding varieties such as BR-20 and 21 for high rainfall areas (rainfall in excess of 2000 mm). There is a very early local variety, 'Shaita' which matures in 70-75 days. Harvesting is by hand and threshing either by bullocks walking on the rice, by beating the rice on wooden planks or metallic drums or, less commonly by manually operated paddle threshers.

In the coastal regions a variation of aus cultivation is practised. In those areas where salinity is a hazard, the seed is dibbled to avoid surface salt accumulations and to take advantage of moister sub-surface conditions.

Aus rice may also be transplanted where water and soil conditions permit. Seedlings are raised in nurseries and transplanted after 3-4 weeks. Fertiliser and manure are applied before the final land preparation. Normally, high yielding varieties are transplanted such as BR-8, BR-9, Chandina, Purbachi, IR-50, BR-12, 14 and 15. In Kushtia and Jessore areas IR-50, a fine grained variety is widely grown.

Weeding may be either by hand or by a hand drawn weeder. The major pests are Hispa and stem borer which are controlled either by spraying or granular insecticide.

Aman rice is either broadcast or transplanted. In low lying areas (F2 and F3) where B.aman is cultivated, land preparation starts immediately after harvesting of the preceding crop. Sowing is done either into residual soil moisture or after the first rains and continues from the latter part of February through March. Harvesting is done throughout November. Broadcast aman is grown without inputs and yields are low due to low stand density, diseases such as Ufra and unimproved, though locally well adapted, varieties.

Broadcast aman is sometimes sown with b.aus in the proportion of 1:3. The aus crop is harvested in standing water along with the tops of the aman rice from which new tillers emerge. Early floods may lead to the loss of the whole or part of the aus crop. A new development is the transplanting of deepwater rice following boro harvest.

In the SWA, parts of Faridpur, Jessore and the area to the north of Barisal are important b.aman production areas.

The principal rice crop of the SWA, as indeed of the rest of Bangladesh, is transplanted aman. There are both local and HYV, high yielding varieties of t.aman. Among the local varieties Nizersail, Latisail and Rajasail have been improved to give high yields. There are a large number of local varieties all with characteristics best suited to local conditions. Among the high yielding varieties, Pajam, BR-10, BR-11, BR-4 and BR-22 are widely grown. BR-11 is weakly photo-sensitive and has become, along with Pajam the leading modern variety. More recently developed are BR-22 and BR-23 which are photo-sensitive.

The transplanting of aman begins in July and continues until September although it is best transplanted before August 15th as yields decline after this date. To offset this effect, farmers increase the seeding rate.

High yielding varieties are usually grown on F0 land whilst local varieties can be grown on both F0 and F1 land. The depth of water in the field determines the height of seedling needed for transplanting. In areas around Barisal which are tidally submerged, transplanting is done in upto 50 cm of water with locally adapted varieties.

In areas where drought may occur, supplementary irrigation may be applied. This can take the form of formal irrigation such as in the G-K Project or shallow tubewells and lowlift pumps elsewhere.

Boro rice is widely grown in Faridpur, Jessore, Barisal and Khulna. The local varieties are long stemmed and grown in and around water bodies and very low lying areas which flood early. High yielding varieties are cultivated in F0-F3 land depending on water availability and soil permeability.

All boro is transplanted. Local varieties are transplanted from December to mid-January and harvested in April. High yielding varieties are transplanted in January and February. Recently, farmers are extending transplanting time of boro upto March 15 to reduce its field duration. This allows it to be transplanted after the harvest of other rabi crops, this crop is called braus.

Forty percent of local boro varieties are grown under rainfed conditions in the deeper flooding areas (F2 - F3). In contrast HYV Boro is almost entirely irrigated and its success depends entirely on the correct management of water and the control of weeds and other pests. High yielding varieties are harvested in May and June and it produces higher yields than the other rice crops.

All varieties of boro rice are photo non-sensitive but highly thermo- sensitive with local varieties more cold tolerant than modern varieties. There are many high yielding varieties

including IR 8, Pajam, Purbachi, Chandina and BR varieties 3,6,7,8,9,12,14,15,16,17,18, and 19. Methods of weeding, harvesting and post-harvest operations are similar to the other rice crops.

Wheat

The principal wheat growing areas in the SWA are in Kushtia, Jessore and Faridpur. Wheat is grown under both rainfed (60% by area) and irrigated (40%) conditions. It is best cultivated on light, permeable soils. The optimum time of sowing is from mid to the end of November although planting continues throughout December with a consequent reduction in yield. Wheat can be sown on time after aus or jute but will be delayed if it follows aman. The delay in planting may mean that soil moisture is insufficient for land preparation and germination, in these circumstances irrigation is necessary. Fertiliser is used and, although adequate rates of urea are used amounts of TSP and MP are rarely sufficient.

The varieties grown have a duration of 100-110 days. The leading variety is Sonalika but this is gradually being replaced by Balaka, Ananda and other varieties due to its susceptibility to rust. In order to overcome the problem of yield decline with late planting, the variety Agrahayani has been bred for late planting under rainfed conditions for the southern most districts of the SWA. The irrigation of wheat has been demonstrated to increase yield by upto 100%.

A variation on the normal wheat production practice is found in some areas of Kushtia where it is broadcast into aman rice 15-20 days before harvest. This ensures that the soil is moist enough to allow for the germination before the surface soil becomes too dry.

Jute

Jute is grown in all areas of the SWA but is of particular importance in Faridpur, Jessore and Kushtia. There are two types of jute, Corchorus capsularis and C. olitorius. The capsularis varieties are grown on medium lowland while the olitorius varieties are grown on high to medium high land. Jute is sown broadcast in March to May and harvested in June to August. After harvesting, the stems are placed under water for retting, slow moving water is preferred. Retting facilities are poor in some parts of the SWA and quality of jute produced is low. An improved system of retting and stripping has been developed but has not been widely adopted by farmers.

Although jute is rainfed, on highland it benefits from a pre-sowing irrigation.

Sugarcane

Sugarcane is the second most important cash crop in Bangladesh and the SWA. Four sugar mills are located in the area at Darshana, Mubarakganj, Kushtia and Faridpur. Sugarcane is grown in high to medium high land (F0 and F1) under both rainfed and irrigated conditions. Planting begins in November and continues until February. Sugarcane is planted either in furrows or trenches along with fertiliser. Irrigation may be supplied to aid germination. The crop is subsequently earthed up. Harvesting is from November to May and the crop is either sold to the mill or used locally to produce ***gur***. Sugarcane suffers from a number of pests and diseases and pesticides are used, mainly by the farmers supplying the mills.

Intercropping is usually practised in cane fields with onion, garlic, wheat, sesame and potato etc.

Pulses

Pulses are widely grown in Faridpur, Jessore, Kushtia, Barisal and some areas of Khulna. The most important pulses are lathyrus, lentil, chickpea, blackgram, mungbean, pea and pigeonpea. Lathyrus is normally cultivated in lowlands as relay crops in the b.aman and T.aman fields. After grazing, the remaining plants are harvested for grain. Lathyrus contains a neurotoxin and if taken continuously for a long period as a staple food may cause limb paralysis. The neurotoxin is water soluble and can be removed by careful preparation.

Next to lathyrus, the most important pulses are lentil and chickpea. Lentil is normally sown in November and harvested in February. Local varieties are small grained and no high yielding varieties are currently available. Chickpea is sown in December and harvested in March. An improved variety, Nabin has been developed by BARI.

Blackgram and mungbean are grown in both the rabi and early kharif seasons. For rabi cultivation, October sowing is optimal but it can be continued upto the beginning of November. Harvesting is in January and February. In Barisal and Patuakhali, mungbean is grown in the early kharif season.

Attempts are being made to develop new varieties of blackgram and mungbean as the present varieties are usually susceptible to yellow mosaic virus.

Soybean has been introduced under the Crop Diversification Programme and is now grown in some areas with encouraging results. However, there are difficulties in marketing the crop.

Oilseeds

Mustard is the most widely grown oilseed in the SWA, sesame and linseed are the next most important. Two species of mustard are grown, Brassica campestris and B. juncea. The juncea group are more popular and the variety Rai-5 is most widely grown. The duration of the crop is about 95-100 days and the yield is higher than Tori-7 which is the most popular of the campestris varieties.

The BARI has developed a new variety in the campestris group called SS-75, which under irrigated conditions can yield upto 2t/ha of seed.

Mustard is sown in October/November and harvested in January/February. It is grown either singly or as a mixed crop with pulses, especially Lathyrus. Intercropping with sugarcane is also not uncommon.

Sesame is grown in both the rabi and kharif-1 seasons either as a sole crop or mixed with aus, spices, millets etc. BARI has released two varieties Til-6 and Til-58077, but the yield is comparatively poor. Both the stalks of mustard and sesame are important for fuel.

Linseed is grown on the heavier soils in the rabi season mainly in the Jessore region. The main use for the oil is for paints and varnishes.

Groundnut is grown on char lands in the rabi season. In the coastal areas of Patuakhali and Barguna, groundnut is becoming more popular but, because of a lack of crushing facilities, very little is grown for oil.

Spices

A large number of spices are grown. Onion, chilli, coriander, turmeric and ginger are the most widely grown spices. Onion, garlic, chilli and coriander are field crops grown in the

rabi season. Sometimes they are grown mixed with other crops or as an intercrop with sugarcane. The seedlings of onion and chilli are raised in seed beds and transplanted in November and December. Coriander is broadcast into the fields. Onion, garlic and coriander are harvested in March/April, whilst harvesting of chilli continues upto May.

Turmeric and ginger are grown primarily as homestead crops.

Tobacco

This is an important cash crop in the SWA and is grown on light soils on high and medium highland. Seedlings are transplanted in November and December. The two varieties of tobacco grown are Nicotiana rustica and N. tobaccum (cigarette tobacco). The cigarette tobacco is grown in the regions of Kushtia and Jessore; there are buying and curing facilities at Meherpur. N. rustica is grown throughout the SWA for local consumption.

Cotton

In recent years, attempts have been made to expand cotton cultivation in Jessore, Kushtia and Khulna regions. The cotton (Americam Upland cotton, G. hirsutum) is cultivated in highlands following aus rice. Seeds are sown in July/August and the crop harvested in January. The crop is rainfed. The success of cotton cultivation depends almost entirely on the amount of rainfall in July and August, too much can cause complete crop failure.

Other Crops

In addition to the crops mentioned above, banana, potato, sweet potato, millets and maize are also grown. Jessore, Khulna and Faridpur are important centres of vegetable production, both summer and winter. Potato and maize are high input crops, milletts and sweet potato are normally grown in sandy soils especially charlands.

3.6 Input use

In this section the inputs used in the calculation of gross margins are described as is the regional trend in the use of fertilisers and pesticides. The inputs and yields are shown in Table 3.8.

TABLE 3.8
Crop physical Inputs and yields

Name of Crop	Human Labour (Manday)	Bullock-Pair-day	Seed Kg	Pesticides Kg	Manures (Ton) Cowdung	Fertilizers (kg)					Production (Ton)	
						Urea	T.S.P	M.P	Gypsum +	Zinc +	Main Product	by Product
B. Aus (R)	130	35	90	-	1.00	15	-	-	-	-	1.2	2.4
Aus (M) (IR)	180	42	30	0.50	1.00	70	40	10	-	-	2.9	2.9
T. Aman (L) (R)	125	35	30	0.50	-	30	10	-	-	-	1.9	3.8
B. Aman (R)	102	35	90	-	-	-	-	-	-	-	1.2	2.4
T. Aman (M) (IR)	160	35	30	1.00	-	80	40	15	30	-	3.2	3.2
Boro (L) (IR)	167	42	30	0.25	-	25	-	-	-	-	1.9	3.8
Boro (M) (IR)	188	42	30	1.00	-	160	80	30	60	4	4.4	4.4
Wheat (R)	107	35	130	0.50	1.50	80	25	10	-	-	1.7	1.7
Wheat (IR)	121	35	130	0.50	1.50	120	60	30	60	4	2.4	2.4
Jute (R)	180	42	10	0.50	1.50	30	10	8	-	-	1.7	3.4
Sugarcane (R)	243	42	5000	1.00	2.00	120	90	30	-	-	41.0	-
Sugarcane (IR)	283	42	5000	1.00	2.00	140	100	40	60	5	50.0	-
Potato (R)	195	45	1000	0.50	1.00	80	40	20	-	-	8.0	-
Potato (IR)	231	45	1000	1.00	2.00	120	65	60	60	4	12.0	-
Lentil (R)	70	25	30	-	-	-	-	-	-	-	0.7	0.7
Kheshari (R)	47	*	40	-	-	-	-	-	-	-	0.7	0.7
Chickpea (R)	82	25	35	-	-	-	-	-	-	-	0.8	0.8
Mungbean (R)	61	14	20	-	-	-	-	-	-	-	0.5	0.5
Blackgram (R)	61	14	25	-	-	-	-	-	-	-	0.7	0.7
Mustard (R)	82	25	8	0.50	-	20	30	10	-	-	0.7	0.7
Groundnut (R)	150	28	90	-	-	-	-	-	-	-	1.2	1.2
Sesame (R)	66	21	10	-	-	-	-	-	-	-	0.6	1.0
Onion (R)	195	45	6	-	1.00	20	-	-	-	-	4.0	-
Garlic (R)	195	45	90	-	1.00	20	-	-	-	-	3.2	-
Chilli (R)	180	42	0.5	0.50	1.00	25	-	-	-	-	0.6	1.0
Tomato (R)	151	42	0.1	0.50	1.50	80	40	-	-	-	6.2	-
Cabbage (IR)	185	42	0.1	0.50	1.50	100	40	20	-	-	9.7	-
Cauliflower (IR)	185	42	0.1	0.50	1.50	100	40	20	-	-	8.5	-
Sweetpotato (R)	155	30	1.5	0.50	-	-	-	-	-	-	9.0	-

cland\tab3.8

(R) Rainfed * Relay crop.

(IR) Irrigated ** Seed cotton + Usually farmers use only Urea, TSP & MP. But in Sulphur and Zinc deficient soils, some farmers use Gypsum and Zinc.

(L) Local *** Ash (M) Modern HYV

Note : Rice yield denotes unhusked rice Sources : Compiled from MPO, BRRI, BARI, BARC, and BJRI data.

Input Delivery

The distribution of fertilisers, pesticides and seeds is handled by different mechanisms.

The distribution of fertiliser has been deregulated by GOB under the new marketing system, introduced since the late eighties. The former BADC monopoly has been reduced and they now control 75 wholesale outlets or Primary Distribution Points. Competition has eased bottlenecks and lowered marketing margins and prices. Temporary shortages may still occur locally but as private distributors can now purchase directly from the urea factory on equal terms with BADC such shortages/bottlenecks should be overcome.

The GOB privatised the pesticide trade in 1979 and further reduced restriction on pesticide usage in 1989. Pesticides are now distributed through private marketing channels.

The supply of seed to farmers is rather different. The majority of cereal seeds (rice and wheat) is supplied through BADC. There are about 90 private sector seed companies which account for 85% of vegetable and jute seed commercial sales. The price of seeds is subsidised by GOB and this inhibits the development of a private sector seed industry and competitive seed markets.

Labour and animal power

The labour requirement for the major crops are shown in Appendix B. The results are summarised here in Table 3.9. The data for these table has been obtained from a number of sources including MPO, BARC, BARI, BADC and DAE.

TABLE : 3.9
LABOUR CALENDAR SOUTH WEST AREA

Crop	Rainfed/ Irrigated	Month												Mandays Per Hactare
		Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	
B. Aus	Rainfed			15	52	30		22	11					130
T. Aus (M)	Irrigated				75	30	20		55					180
B. Aman (LV)	Rainfed			20	22	15	5					30	10	102
T. Aman (LV)	Rainfed							15	55	10		25	20	125
T. Aman (M)	Irrigated							40	30	20	15	40	15	160
Boro (LV)	Irrigated	16	16	18	30	25						16	46	167
Boro (M)	Irrigated	42	12	17	16	15	30						36	188
Wheat	Rainfed	15	5	30	15							21	21	107
Wheat	Irrigated	16	6	35	20							22	22	121
Jute	Rainfed			26	31	30	15	30	45	3				180
Sugarcane	Rainfed	47	33	13	15	15			10	10	20	38	42	243
	Irrigated	56	42	20	17	15			10	10	20	42	51	283
Potato	Rainfed	20	20	50	15						10	45	35	195
	Irrigated	22	27	70	20						10	45	37	231
Lentil	Rainfed			30	10						10	20		70
Kheshari	Rainfed			25	20					1	1			47
Chickpea	Rainfed			25	25							13	19	82
Mungbean	Rainfed		25	15							5	11		61
Blackgram	Rainfed	27								5	11		18	61
Mustard	Rainfed	2	20	25							19	14	2	82
Sesame	Rainfed	5	5	15	15							13	13	66
Groundnut	Rainfed	20	20	15	35	15						15	30	150
Onion/Garlic	Rainfed	35	25	25	40						5	30	35	195
Chilli	Rainfed	30	20	17	30	18					5	20	40	180
Tomato	Rainfed	15	24	17	12						5	40	35	151
Cabbage/Cauliflower	Rainfed	44	12	7						5	30	50	37	185
Sweetpotato	Rainfed	10		35	35						30	40	5	155

Source : Compiled from BARC, DAE, MPO, BRRI, BARI, BJRI data.

hussain\tab3.9

The yield level assumed for each crop is also given in the tables in Appendix B as labour requirement varies with yield. Labour requirements are highest at land preparation and planting of rice. The labour requirement for harvest is higher with HYV, because of the higher yield but not in direct proportion because the higher grain yield is offset by the lower quantity of straw in HYV's compared to local varieties.

The animal power requirements expressed as bullock-pair per day are shown in the same Tables. The requirement for draught power is at its maximum in July-August for the preparation of land for the aman rice crop.

Fertiliser

The rates of fertiliser used for the major crops is shown in Table 3.8. The principal fertilisers used are urea, triple super phosphate and muriate of potash. Smaller amounts of diammonium phosphate, gypsum and zinc are also used.

The principal use of fertiliser is on the rice crops with irrigated rice accounting for the greatest proportion. The fertiliser used on irrigated and rainfed aus rice (HYV) for 1990 has been estimated from sample surveys undertaken by the International Fertiliser Development Corporation and is shown in Table 3.10.

TABLE 3.10

Fertiliser Use and Irrigation, Aus HYV Rice 1990

	Area fertilized (% of land)		Average use of area fertilized (kg/ha)	
	Irrigated	Unirrigated	Irrigated	Unirrigated
Urea	99	95	177	133
TSP	91	63	96	90
MP	85	22	47	39
Gypsum	0.9	5	58	47
Zinc	5.1	1	10	13

Source: IFDC, 1991. Report on 1990 Aus season. P. 42; Results of sample survey.

The use of urea is widespread regardless of whether the crop is irrigated or rainfed. However, the rate used per unit area of irrigated aus is higher than for rainfed. The use of P and K fertilisers is much more widespread on irrigated HYV aus than rainfed although the rates used are similar.

HYV aus received more fertiliser than local varieties, with 95% of the area of HYV aus receiving urea compared to 69% for local varieties. The corresponding figures for TSP were 67% and 13% respectively and for MP 33% and 2%.

The aman rice crop shows a similar pattern, as shown in Table 3.11.

TABLE 3.11

Average Fertiliser use by Variety for Irrigated and Unirrigated Aman rice, 1989 (kg/ha)

	Average of all area				Average of area fertilized			
	LV		HYV		LV		HYV	
	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated
Urea	40	107	123	195	70	111	127	196
TSP	22	46	58	100	67	75	90	103
MP	4	4	18	44	38	42	46	54
Gypsum	0.47	0	3	3	56	0	63	34
Zinc	0.02	0.20	0.15	0.54	9	8	10	8

Source: IFDC . 1991. Report on 1989 Aman season. P. 32

The rate of fertilizer use is greater on HYV aman than local aman and on the irrigated compared to the unirrigated crop.

The pattern for boro is similar with more fertiliser applied on HYV's, than local varieties and on irrigated compared to rainfed land (Table 3.12).

TABLE 3.12

Average Fertiliser use by Variety for Irrigated and Unirrigated Boro Rice, 1989/90 (Kg/Ha)

	Average of all crop area				Average of area fertilized			
	HYV		LV		HYV		LV	
	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated	Irrigated	Unirrigated
Urea	198	53	124	7	200	119	140	85
TSP	98	17	57	0.7	108	100	72	102
MP	31	5	20	0.05	48	38	31	24
Gypsum	7	2	0.6	0	71	28	33	0
Zinc	0.86	0.27	0	0	15	9	0	0

Source: IFDC, 1991. Report on 1989/90 Rabi/Boro Season. P.54

The sample surveys found that about 85 percent of plots growing Boro used more than 200 kg per hectare of chemical fertiliser whereas in 1989-90 the corresponding figure was 35 percent.

The fertiliser rate recommended by BARC for boro, aman and aus rice is shown below:

Recommended Fertiliser rates, HYV Boro, Aman and Aus (Kg/Ha)

Crop	Urea	TSP	MP	GYPSUM	ZNS
Boro (1)	174	133	67	56	3
Aus/Aman (2)	110	89	33	-	-

Notes: (1) assuming moderate soil fertility, yield 4.0 t/ha
(2) assuming moderate soil fertility, yield 3.0 t/ha

Source: BARC, Fertiliser Recommendation Guide, 1989.

A simple comparison between the recommended fertiliser rates for HYV boro, aus and aman and the actual amounts used on the areas receiving fertiliser found by the survey under irrigated conditions shows that, for the assumptions noted above, the actual rates exceed those recommended. For HYV aus and aman the average rates for the whole cropped area is less than for the area receiving fertiliser unlike HYV Boro where nearly the entire area receives fertiliser.

The application of fertiliser is found to increase with both the provision of irrigation and FCD in response to the increased security of cultivation. Results from FAP-12 studies shows that an increase in fertiliser use is usually found following interventions (see Table 5.2).

The regional pattern of fertiliser use, Table 3.13. shows an increase in all types of fertiliser in all districts from 1986-87 to 1988-89. The greatest absolute increase is in the use of urea with the largest total amount used in Kushtia and Khulna.

The regional variation in fertiliser usage is wide. The usage is highest in Kushtia at 328 kg nutrients (all types) per hectare of cultivable area. This is most likely due to the presence of the G-K scheme. The per hectare use of nutrients declines to the east and south with low figures in Barisal (88 kg/ha) and Faridpur (78 kg/ha) and very low usage in Patuakhali.

TABLE 3.13
Distribution of Chemical Fertilizer by Type

Region (former district)	Year	Urea	TSP	MP	DAP HP Other	Gypsum	Zinc	Total
Faridpur	1986-87	20287	9276	1465	83	25	58	31194
	1987-88	25164	8848	2669	59	59	-	36799
	1988-89	27615	8994	2750	237	128	109	39833
					-	-		
Barisal	1986-87	24585	7628	1237	39	9	30	33528
	1987-88	28200	9968	684	92	28	64	39036
	1988-89	31137	10518	991	447	199	248	43540
						-		
Jessore	1986-87	45547	18421	4420	371	207	164	69130
	1987-88	51908	22546	4977	348	99	249	80127
	1988-89	39454	18920	4821	843	382	405	64825
						-		
Khulna	1986-87	22365	5831	1122	128	36	92	29574
	1987-88	38748	11082	975	178	18	160	51161
	1988-89	79088	25293	3843	917	382	535	110058
					-	-	-	
Kushtia	1986-87	39255	16154	4391	368	302	66	60536
	1987-88	51942	20533	5779	369	295	74	78992
	1988-89	56255	24321	7043	1208	923	285	90035
					-	-		
Patuakhali	1986-87	6812	1258	225	3	1	2	8301
	1987-88	8446	1899	38	6	5	1	10395
	1988-89	8240	1019	55	18	17	1	9350

[sh\tab3-13]

Source : BADC, BBS

Pesticides, Pests and Diseases

The regional use of pesticides is shown in Table 3.14. Table 3.15 shows the major pests and diseases by crop and chemicals used to control them.

TABLE 3.14

Use of Pesticide per ha of Net Cultivated Area, SWA

Region (former District)	Year	Pesticides used (Ton)	Net Cultivated Area (000 ha)	Kg/Ha
Faridpur	1984-85	34.30	483	0.07
	1985-86	55.80	504	0.11
	1986-87	71.50	504	0.14
	1987-88	106.50	505	0.21
	1988-89	148.25	504	0.29
Barisal	1984-85	175.30	476	0.37
	1985-86	214.80	482	0.45
	1986-87	223.50	481	0.46
	1987-88	244.00	482	0.51
	1988-89	280.50	483	0.58
Jessore	1984-85	186.50	490	0.38
	1985-86	209.00	506	0.41
	1986-87	268.00	504	0.53
	1987-88	243.50	505	0.48
	1988-89	299.85	506	0.59
Khulna	1984-85	119.20	434	0.27
	1985-86	143.70	438	0.33
	1986-87	102.50	438	0.23
	1987-88	113.00	440	0.26
	1988-89	138.00	439	0.31
Kushtia	1984-85	73.10	216	0.34
	1985-86	98.50	265	0.37
	1986-87	133.00	266	0.50
	1987-88	131.50	266	0.49
	1988-89	138.75	267	0.52
Patuakhali	1984-85	94.10	300	0.31
	1985-86	94.10	304	0.31
	1986-87	166.50	317	0.53
	1987-88	198.00	318	0.62
	1988-89	207.50	319	0.65
Bangladesh	1984-85	3014	8645	0.35
	1985-86	3701.9	8770	0.42
	1986-87	3928	8857	0.44
	1987-88	4199	8890	0.47
	1988-89	5040.76	8890	0.57

Source: BBS, Statistical yearbook of Bangladesh, 1991

The average use of pesticides has increased in all areas with by far the largest use being on HYV rice.

TABLE 3.15

Major Pests and Diseases by Crop and Chemicals Used for their Control

Name of Crop	Major Pests		Chemicals used for control
	English Name	Technical Name	
Rice	Hispa	Diclodispa armigera	Dimethoate, Malathion
	Yelow stemborer Pink stemborer Dark headed border	Tryporyza incertulas Sesamia inferens Chilotrea polychrysa	Carbafuran, Diazinon, Dicrotophos, Malathion Phosphamidon
	Brown Plant hopper	Nilaparvata lugens	Diazinon, Carbafuran, Fenthion, Fenitrothion
	Swarming Caterpillar Earcutting Caterpillar	Spodoptera mauritia Mythema separata	Dichlovos, Carbaryl
	Leaf roller	Cnaphalocrocis medinalis	Carbaryl, Diazinon, Malathion
	Rice bug	Leptocorisa acuta	Malathion, Dimecron
	Green leaf hopper	Nephotettix nigropictus	Diazinon, Carbafuran etc
	Rice gall midge	Orseolia orygae	Carbafuran, Diazinon
	Thrips	Baliothrips biformis	Malathion, Diazinon, Fenitrothion
	Major diseases		
	Blast	Pyricularia Orygae	Agrosan (seed treatment)
	Brown spot Sheath blight Bacterial leaf blight Bacterial leaf streak Ufra Tongro	Cochliobolus miyabeanus Thanalephorus Cocumeris Xanthomonus Campestris Xanthomonus Ditylanchus angustus Virus	Vector control by Malathion
Major pests			
Jute	Jute hairy Caterpillar Jute semilooper Indigo Caterpillar Mole Cricket Jute stem Weevil	Diacrisa obliqua Anomis sabolifera Spodoptera exiqua Bachytruypis portentosus Apion Corchori	Diazinon, Carbaryl
	White mite	Hemitrasonemus latus	Dicofal, sulphur
	Diseases		
	Stem rot Black band Chlorosis Anthracnose	Macrophomina phaseolina Botryodiplodia theobromae Virus Colletotrichum corchoruna	Seed treatment by Agrosan GN
Major pests			
Sugarcane	Top shoot borer Stem borer Root borer White grub Wooly aphis Leaf hopper Termite	Schirpophaga excerptalis Chilo tumidieostalis C. auricilius C. indicus Sesamia inferens Emmalocera depressela Pyrella perpusillavar pusana Odontotermis obesus Rhopalosiphum padi Holotrichia, Sp. Brahminasp	Carbafuran, Carbaryl, Diazinon, Malathion Heptachor
	Diseases		
	Red rot White leaf disease Wilt disease	Colletotrichum falcatum Mycoplasma Cephato sporium Sacchari	Agrosan GN

TABLE 3.15 (CONTINUED)

Major Pests and diseases by crop and chemicals used for their control

Name of Crop	Major Pests		Chemicals used for control
	English Name	Technical Name	
Fruits	Fruit borer Fruit fly Hopper Leaf defoliator Mango leaf gall Psyllid Orange fruit Fly Beettles Red pulmkin betel	Sternochetus frigidus Dacus dorsalis Idioscopus Cricula trifenes trata Apsylla cistellata Chaetodacus sp Nodostoma viridipennis Phynochophorus ferrugienus	Carbaryl Malathion Rogor, Dimethoate DDUP
Cotton	Cotton Jassid Pink bokworm Spotted boll worm American boll worm	Amra biguttala Pectinophora gossgpiella Earias vittella Heliothis armigera	Dimecron, Dimethoate
Vegetables	Cut worm	Agrotis ypsilon	Heptachlor, carbaryl
Potato Potato Blight (Early and late)	Tuber worm Red ant Cut worm Disease	Gnorimos chema opercubella Dorylus orientalis Agrotis spp	 Heptachore Dithane, Copper Oxycholide, Baurdeux mixture
Brinjal	Epilachna betel	Epilachna 28 - Puntata	Dimethoate
Tomato	Aphis Mealy bug	Aphis craceivora Pseudococcus virgatus	Malathion
Cucurbit	Pumpkin betel Fruit fly Dimond back moth Prodenia caterpillar	Anlacophora foveicollis Dacus Candatus Plutella maculipennis Prudenia litura	Dichlorovos
Beans	Aphis	Aphis medicagensis	Malathion
	Major Rodents		
All crops	Field rat	Bandicola bengolensis	Zinc Phosphide

Source : Department of Agricultural Extension (DAE), 1992

Losses due to pests and diseases specifically for the SWA have not been quantified. For Bangladesh as a whole some 2 millions tons or 14 percent of foodgrains is lost annually (MPO Technical Report No. 1). It was also estimated that this loss was 6 times larger than the damage due to flood and abnormal drought. These losses are doubly damaging as some 50 percent of the annual benefit of irrigation and fertiliser are lost due to pests and diseases.

The correct application of pesticides is also difficult for most farmers with the result that they are not used successfully. The potential for accidental poisoning and environmental damage is high.

Seed

The distribution of improved seeds in the region are shown in Tables 3.16 and 3.17 for 1982-83 and 1988-89 respectively.

TABLE 3.16

Distribution of Improved Seed by District, 1982-83 (tonnes)

Region	Aus		Aman		Boro		Wheat	Potato	Mustard	Winter Vegetable
	LIV	HYV	LIV	HYV	LIV	HYV				
Faridpur	0.13	0.4	0.03	1.03	-	1.0	14.3	1.70	0.34	0.2
Barisal	0.08	0.44	-	0.80	-	2.2	1.50	0.80	0.24	0.02
Jessore	0.30	1.59	-	5.62	-	5.93	44.53	5.90	0.40	0.13
Khulna	0.14	0.40	0.08	0.99	-	1.02	8.38	4.91	0.23	0.03
Kushtia	0.71	1.15	0.03	1.39	-	0.87	29.75	2.37	0.38	0.24
Patuakhali	-	0.15	-	0.17	-	0.35	0.20	0.10	0.19	0.02
Total	1.36	4.13	0.14	10.00	-	11.37	98.66	15.78	1.78	0.64

Source: BBS Statistical Year Book, 1991

TABLE 3.17

Distribution of Improved Seed by District, 1988-89 (tonnes)

Region	Aus		Aman		Boro		Wheat	Potato	Mustard	Winter Vegetable
	LIV	HYV	LIV	HYV	LIV	HYV				
Faridpur	1.0	15.58	-	31.79	2.0	51.83	1072.66	19.30	1.89	0.17
Barisal	0.22	3.14	-	24.75	-	66.69	299.92	56.64	0.51	0.16
Jessore	2.87	20.39	-	293.78	-	133.31	2243.96	707.56	3.28	0.38
Khulna	0.24	12.76	-	78.10	-	25.47	430.24	204.07	0.51	0.16
Kushtia	8.70	2.85	-	57.23	-	44.66	1022.00	204.00	0.63	0.09
Patuakhali	-		-	5.30	-	1.00	6.40	8.00	0.25	0.07
Total	13.03	72.4	-	466.20	-	256.27	5075.16	1199.57	7.07	1.03

Source: BBS Statistical Year Book 1991

The Tables show the rise in distribution of improved seeds. The most dramatic increase has been in wheat and potato of 159% and over 700% respectively.

The distribution of improved rice seed has also increased particularly for HYV aman and boro and slightly less so for HYV aus.

The regional pattern shows that the distribution of HYV aman, boro and Wheat seed increased most in Jessore. The region that seems to have benefitted least from improved seeds is Patuakhali.

3.7 Irrigation

Data on the area irrigated by different mode was obtained from the Agriculture Sector Team (CIDA). The AST undertook a census of lift irrigation during 1991 the results of which are shown in Table 3.18 for each planning unit together with the area of surface irrigation.

TABLE 3.18

Area under Existing Irrigation, SWA (km2) 1991.

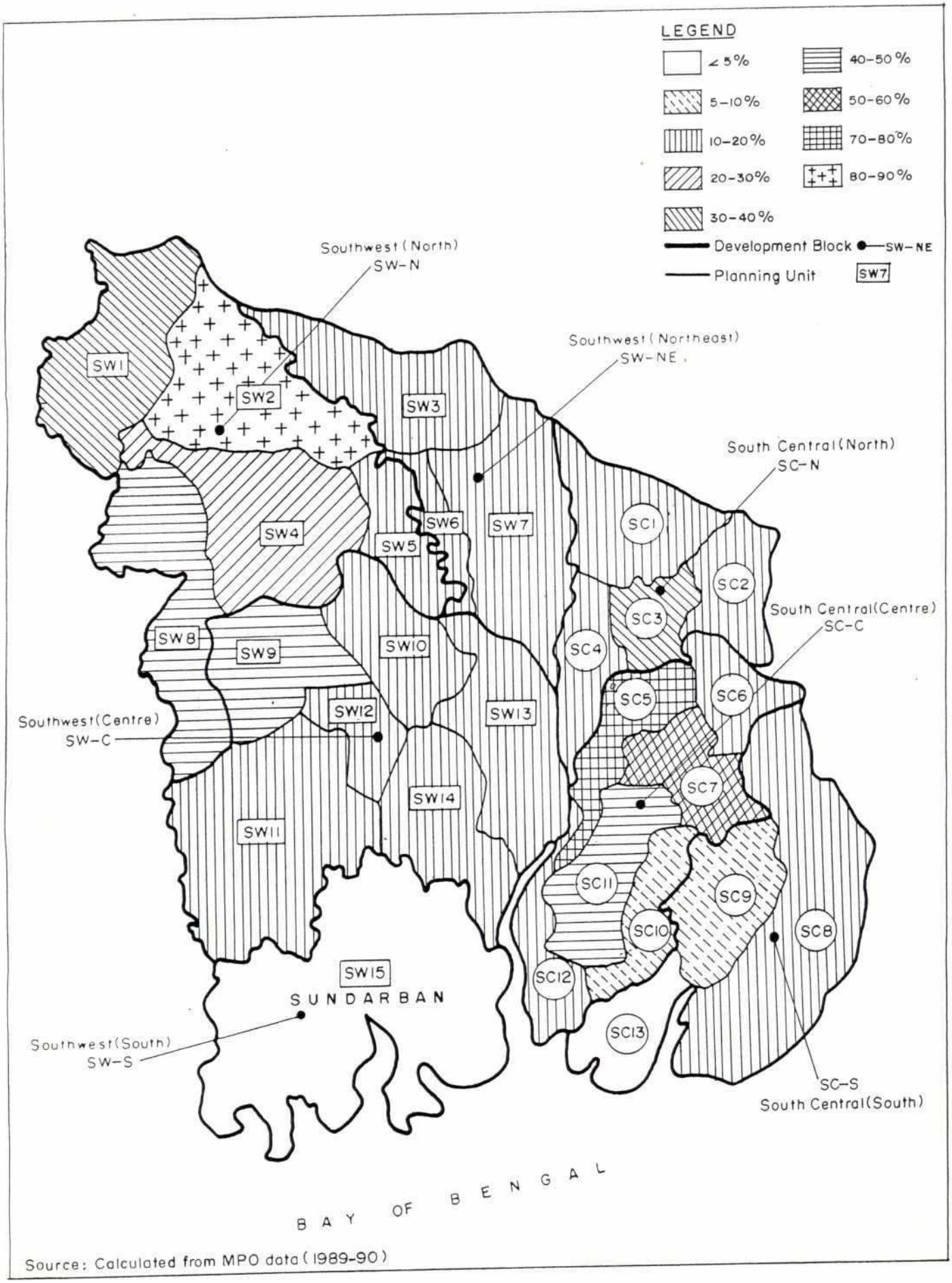
Planning Unit	Major Surface	STW	DSSTW	DTW	LLP	Other	Total
SW1	119.6	173.6	0.0	92.2	11.6	33.5	430.5
SW2	1119.7	126.2	0.4	18.1	11.9	15.3	1291.6
SW3	0.0	140.5	0.8	45.7	6.9	14.2	208.1
SW4	0.0	306.6	0.2	100.4	16.5	14.9	438.6
SW5	2.4	65.3	0.0	2.1	12.3	7.8	89.9
SW6	0.0	34.7	0.0	4.5	10.7	3.8	53.7
SW7	0.0	138.5	0.0	20.7	102.2	13.2	274.6
SW8	0.0	473.6	1.2	157.9	24.5	15.1	672.3
SW9	0.0	257.1	0.3	52.9	22.2	14.7	347.2
SW10	4.4	44.5	0.1	1.9	29.5	26.5	106.9
SW11	0.0	174.4	2.5	14.2	60.3	31.0	282.4
SW12	0.0	25.6	0.0	0.2	7.3	6.8	39.9
SW13	0.0	4.5	0.0	0.0	45.1	43.4	93.0
SW14	0.0	0.5	0.0	0.0	3.8	16.0	20.3
SW15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub Total	1246.1	1965.6	5.5	510.8	364.8	256.2	4349.0
SC1	0.0	82.0	0.2	10.6	78.0	4.0	174.8
SC2	0.0	5.0	0.2	0.0	80.0	9.0	94.2
SC3	0.0	7.0	0.0	1.0	119.0	10.0	137.0
SC4	0.0	7.0	0.0	1.1	72.0	12.0	92.1
SC5	336.3	0.0	0.0	0.0	63.0	16.0	415.3
SC6	10.1	0.0	0.0	0.0	48.0	8.1	66.2
SC7	346.0	0.0	0.0	0.0	36.0	14.0	396.0
SC8	0.0	0.0	0.0	0.0	168.0	43.0	211.0
SC9	0.0	0.0	0.0	0.0	12.8	14.9	27.7
SC10	14.6	0.0	0.0	0.0	12.9	9.0	36.5
SC11	267.4	0.0	0.0	0.0	44.6	15.2	327.2
SC12	14.2	0.0	0.0	0.0	19.6	9.2	43.0
SC13	0.0	0.0	0.0	0.0	9.3	11.3	20.6
Sub Total	988.6	101.0	0.4	12.7	763.2	175.7	2041.6
Total	2234.7	2066.6	5.9	523.5	1128.0	431.9	6390.6

Source: AST CIDA, 1991. BWDB, 1992.

The distribution of irrigation in the region is shown on Figure 3.9. The figure shows the Planning Unit wise irrigated area as a percentage of the net cultivated area. Irrigation is concentrated in the north west of the SW region and the north and west of the SC region. The highest proportion, 80-90% occurs in planning unit SW2 where the G-K project is situated and the next highest areas in planning unit SC5 and SC7 around the Barisal Irrigation Project. In about 50% of the region, the proportion of NCA irrigated is between 10 and 20%. The area of groundwater irrigation as a percentage of total irrigated area is shown in Figure 3.10.

The area of minor irrigation has increased rapidly since 1988-89 with the removal of duties and standardisation restrictions on imports of small diesel engines. This has resulted in lower prices and a rapid expansion of private sales of STW's and LLP's. The increase in area from 1987-88 to 1989-90 was 300,000 hectares per year for Bangladesh and this rate of increase is forecast to continue. This will have implication for the agricultural production in the SWA independent of formal, government sponsored schemes.

Figure 3.9



Source: Calculated from MPO data (1989-90)

Irrigated Area as a percentage of Net Cropped Area

The yield of the major crops based on the average yield for each district over the last five years are given in Table 3.19

TABLE 3.19

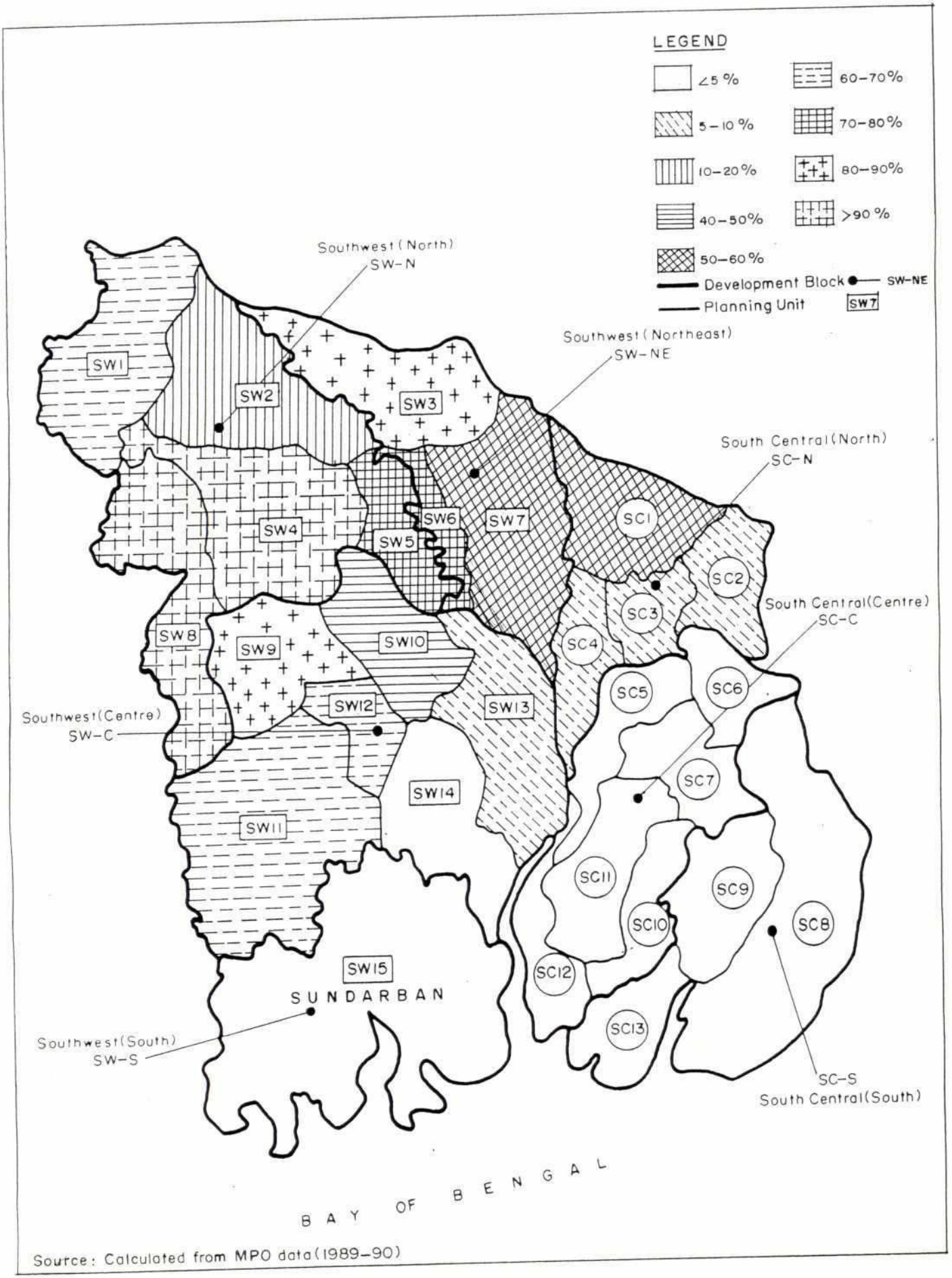
Average Crop yield by District, SWA (t/ha)

Crops	District						SWA	Bangladesh
	Kushtia	Jessore	Khulna	Barisal	Patuakhali	Faridpur		
aus (L)	0.88	0.78	0.89	0.76	0.64	0.66	0.80	0.76
aus (HYV)	2.08	1.97	1.87	1.86	1.58	2.27	1.93	1.79
B.Aman(L)	1.01	1.03	0.94	1.12	0.00	0.80	0.83	0.99
T.Aman(L)	1.39	1.43	1.29	1.32	1.14	1.02	1.26	1.32
T.Aman(HYV)	2.12	2.14	2.31	2.06	1.97	1.90	2.14	2.16
Boro(L)	1.69	1.73	1.29	1.31	0.87	1.23	1.25	1.36
Boro(HYV)	2.78	3.05	2.56	2.50	1.65	3.26	2.96	2.52
Wheat	1.81	1.91	1.93	1.40	1.25	1.46	1.71	1.72
Jute	1.82	1.78	1.80	1.14	0.70	1.49	1.66	1.59
Sugarcane	42.17	39.28	53.79	29.55	29.51	41.94	41.35	41.89
Kheshari	0.74	0.69	0.62	0.77	0.58	0.77	0.71	0.73
Lentil	0.69	0.72	0.47	0.72	0.43	0.86	0.71	0.73
Chickpea	0.94	0.66	0.75	0.65	0.56	0.73	0.76	0.75
Mungbean	0.69	0.81	0.42	0.41	0.51	0.67	0.52	0.54
Blackgram	0.68	0.71	0.56	0.58	-	0.64	0.67	0.72
Mustard	0.66	0.64	0.52	0.43	0.37	0.77	0.69	0.66
Groundnut	1.09	1.17	0.64	1.31	0.89	1.31	1.23	1.15
Sesame(HYV)	0.58	0.60	0.59	0.65	0.56	0.50	0.57	0.55
Potato (L) Potato (HYV)	7.02 11.08	7.5 12.78	6.86 11.51	9.60 6.19	5.63 6.08	7.62 12.75	8.22 11.24	7.26 11.95
Sweet Potato	7.36	9.63	10.94	9.22	7.87	10.92	9.02	10.42
Onion	4.91	3.56	3.73	2.45	2.20	4.07	4.10	4.09
Garlic	3.80	3.28	1.97	2.57	1.98	3.11	3.24	3.01
Chilli	0.60	1.07	0.67	0.66	0.57	0.59	0.61	0.70
Cabbage	10.44	9.72	12.00	6.47	5.96	5.16	9.67	8.54
Cauliflower	8.36	7.56	11.88	3.31	2.93	5.24	8.50	7.76
Tomato	6.54	7.56	7.56	4.27	2.53	4.13	6.18	7.35
Brinjal	7.22	6.68	9.39	3.58	1.89	3.82	6.19	6.62
Tobacco	0.79	0.74	0.46	0.57	0.43	0.73	0.77	0.88
Cotton	0.53	0.59	0.67	-	-	-	0.57	0.46
Banana	18.29	15.86	14.58	16.28	15.06	18.34	15.52	16.85

Source: Calculated from BBS data.

Note : Rice yield denotes clean rice

Figure 3.10



Source: Calculated from MPO data (1989–90)

Groundwater Irrigation as a percentage of Total Irrigated Area

The notable point with regard to the yields shown in the above table is the extent to which yields in Patuakhali are lower than in the other districts in the SWA. The reasons for this situation include:

- dry season salinity which is found extensively in Planning Units SC9.10,11 12 and 13 which cover Patuakhali district. This directly limits the scope for dry season cropping.

- poor groundwater quality, salinity does not permit the installation of tubewells to irrigate rabi crops.

- exposure to catastrophic events such as cyclones and tidal surges associated with them.

- a land tenure system with large numbers of absentee landlords.

- poor communications which limits access to markets and increases the price of inputs.

The situation of Patuakhali has improved somewhat with the construction of the coastal embankment but the area still faces severe problems which need to be adressed.

3.8 Crop Production Trends

The crop production statistics used to develop the present situation have been taken from the MPO data mentioned previously as this is the only data to relate production to land type and irrigation. However, in order to see the change in production over time a longer time series is required. Data has been taken from BBS for the years 1983-84 to 1990-91 and is summarised in Table 3.20, the complete set of production data is given in Appendix C.

TABLE 3.20

Area, Production and percent change of Major Crops, SWA 1983-84, 1990-91

Area in '000 hectares; Production in '000 tons

Crop	Faridpur				Jessore				Kushtia			
	1983 - 84		1990 - 91		1983 - 84		1990 - 91		1983 - 84		1990 - 91	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Aus (L)	218	158	199	133	183	124	113	113	101	83	100	125
Aus (HYV)	2	5	3	6	15	24	19	38	24	56	20	42
B. Aman	242	176	183	164	119	124	57	57	26	23	22	22
T. Aman (L)	27	25	77	84	113	143	42	61	8	9	2	3
T. Aman (HYV)	3	4	10	20	30	76	190	410	24	50	71	160
Boro (L)	7	10	30	38	1	2	1	1	1	1	1	1
Boro (HYV)	32	81	90	311	29	61	111	355	3	6	22	60
Total Rice	531	459	592	756	490	554	533	1035	187	228	238	413
Wheat	41	100	46	68	25	59	43	74	53	132	45	72
Jute	74	106	69	105	94	103	54	104	33	53	36	72
Sugarcane	19	813	23	904	11	479	12	506	18	887	12	506
Lathyrus	42	22	33	30	13	8	14	11	5	3	5	4
Lentil	55	38	50	38	49	30	34	31	29	24	31	26
Chickpea	31	27	27	17	35	21	30	24	12	13	7	8
Total Pulses	128	87	110	85	97	59	78	66	46	40	43	38
Mustard	32	18	81	60	35	20	71	55	12	9	14	12
Tobacco	3	2	2	2	2	2	2	1	8	8	6	4
Onion	7	25	7	30	2	13	3	15	1	6	2	8
Garlic	3	6	3	9	1	3	1	3	1	2	1	2
Chilli	6	3	6	3	2	1	2	2	1	0.4	1	0.4
Banana	2	32	2	35	2	30	1	22	1	12	1	14

TABLE 3.20 (Continued)

Area, Production and percent change of Major Crops, SWA 1983-84, 1990-91

Area in '000 hectares; Production in '000 tons

Crop	Khulna				Barisal				Patuakhali			
	1983 - 84		1990 - 91		1983 - 84		1990 - 91		1983 - 84		1990 - 91	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Aus (L)	20	42	46	100	148	125	168	163	67	66	66	58
Aus (HYV)	5	9	6	14	29	50	10	19	3	4	13	23
B. Aman	40	47	35	30	89	78	35	30	0	0	0	0
T. Aman (L)	321	394	288	397	274	317	315	439	270	345	303 -	321
T. Aman (HYV)	30	62	72	176	33	65	22	41	12	26	72	108
Boro (L)	6	8	11	15	4	4	4	6	6	5	0.4	1
Boro (HYV)	14	34	35	85	28	71	59	240	4	8	2	3
Total Rice	436	596	493	817	605	710	613	938	362	454	456	514
Wheat	2	5	3	5	2	2	4	5	0.0	0.0	0.22	0.2
Jute	13	22	11	22	3	2	2	3	0.4	0.3	0.4	0.3
Sugarcane	4	152	4	245	3	119	4	117	1	16	0.4	13
Lathyrus	5	3	2	1	42	34	50	36	19	10	33	20
Lentil	6	4	6	26	9	5	6	4	2	1	1	0.2
Chickpea	14	19	29	21	5	3	4	2	1	1	2	1
Total Pulses	25	26	37	48	56	42	60	42	22	12	36	21
Mustard	0.8	5	11	15	4	3	39	14	0.3	0.1		6
Tobacco	0.3	0.2	0.1	0.04	1	1	0.4	0.2	1	0.3	7	0.05
Onion	1	4	1	2	1	2	1	1	0.1	0.4	0.3	1
Garlic	0.3	2	0.3	1	1	2	0.4	1	0.2	0.3	0.3	0.4
Chilli	1	1	1	1	7	4	7	5	6	3	7	4
Banana	3	43	0.2	17	7	127	6	95	2	32	2	36

Source : BBS. Statistical year book 1990-91 and unpublished reports, 1992.

cland/tab-20

Note : These comparative data are from BBS and differ from the MPO data for 1990/91 which were forecast from 1986/87 BBS data.

The annual percentage change in area, yield and production of the major crops has been calculated from BBS data for ten years by linear regression. The results are shown in Tables 3.21, 3.22.

TABLE 3.21

Annual Trends in National Crop Production (%) (Year 1979-80 to 1987-88)

Crop	Yield Trend	Area Trend	Production Trend
Rice	1.97	0.20	2.17
Wheat		Recently	Negative
Pulses	1.86	-4.53	-2.67
Sugarcane	-0.21	1.40	1.19
Vegetables	-0.79	1.50	0.71
Fruits	-0.76	1.41	0.65
Oilseeds	1.67	-0.07	1.60
Jute	1.93	0.23	2.16

Source: Crop Agriculture Development Programme for the Fourth Five Year Plan, Ministry of Agriculture, 1991.

TABLE 3.22

Annual Trends in Crop Production SWA 1980-81 to 1990-91

Crop	Yield Trend	Area Trend	Production Trend
L. aus	3.81	1.86	5.67
HYV aus	-1.46	-2.85	-4.31
B. aman	1.42	-2.57	-1.15
L.T. aman	2.28	0.91	3.19
HYV aman	0.25	11.87	12.12
L. boro	0.56	5.71	6.27
HYV boro	1.70	11.12	12.82
Wheat	-6.48	1.21	-5.27
Jute	4.51	-6.62	-2.10
Lathyrus	0.73	0.80	1.53
Lentil	0.6	-0.80	-0.2
Mustard & Rape	0.02	0.01	0.04

Source: Calculated from BBS data

The results show some interesting changes in area over the past ten years. The area of HYV aus, b.aman, jute and lentil have decreased, the area of the other crops have increased at the regional level. The largest percentage decrease in area is in jute. The area of b.aman has decreased but HYV aman has also decreased. The reduction in area of b.aman is a reflection of improved flood control and that of HYV aus due to an increase in boro.

The largest average annual increase in area has been in HYV aman and HYV boro. Smaller increases in l.boro. l.aus and wheat have occurred.

A comparison of regional with national trends shows that they are broadly similar but that areas of l.aus, l.boro and l.t.aman have not decreased in the SWA as they have nationally. The national decrease in mustard and rape is not reflected in the SWA although the increase in the SWA is only marginal. The national increase in lentil production is not found in the SWA.

The regional pattern of changes in area are complex (Table 3.23). In general, the area of HYV aman has increased in the north and centre of the region. The area of HYV boro has decreased in the south of the area and increassed elsewhere. Jute has decreased in all regions whereas the area of lentil has increased in Patuakhali and Faridpur. Mustard and rape continues to increase in the south of the region but the changes are only slight in the north.

The annual percentage change in yield is shown in Table 3.24. In the SWA the yield of all crops except HYV aus and wheat have increased. The increases (Table 3.22) are greatest for jute (4.51 percent), l.aus (3.81 percent),l.t.aman (2.28 percent) and HYV boro (1.7 percent). The differences in the changes between SWA and the national figures are most marked in mustard and jute. Whereas the yield of mustard has increased significantly nationally, it has hardly changed in the SWA. The yield of jute has increased significantly in the SWA but has hardly changed for Bangladesh.

TABLE 3.23

Annual Percentage Change in Area of Selected Crops by District, 1980-81 to 1989-90

Crop	Kushtia	Jessore	Khulna	Barisal	Patuakhali	Faridpur	Bangladesh
L. Aus	0.57	-2.15	-2.56	3.54	5.89	3.88	-3.24
HYV Aus	1.85	-1.4	-13.7	-4.16	-2.8	-7.71	-2.53
B. Aman	-1.74	-8.26	0	-2.21	0	-10.53	-1.75
L.T. Aman	-3.54	-3.75	0.23	3.24	1.83	-10.53	-1.75
HYV Aman	15.62	23	4.57	0.2	0.23	6.92	10.41
L. Boro	-0.17	-0.15	-0.01	-0.03	-0.05	0.19	-0.04
HYV Boro	26.29	14.35	9.66	-1.34	-14.17	15.49	14.6
Wheat	-3.08	6.29	3.29	10.42	17.25	0.28	0.33
Jute	-0.05	-0.1	-0.09	-0.03	0.01	-0.04	-0.06
Lathyrus	0.28	1.49	-12.48	1.13	6.44	-2.99	0.14
Lentil	0.32	0.47	-0.8	-5.42	10.72	6.14	1.62
Mustard & Rape	-5.39	1.87	-5.64	10.72	6.14	1.62	-7.93

TABLE 3.24

Annual Percentage Change in Yield of Selected Crops by District, 1980-81 to 1989-90

Crop	Kushtia	Jessore	Khulna	Barisal	Patuakhali	Faridpur	Bangladesh
L. Aus	5.95	4.08	2.36	6.09	-0.93	3.57	2.49
HYV Aus	1.24	-3.35	-1.42	-1.78	-3.08	1.24	-2.2
B. Aman	2.48	2.39	-1.72	0.11	n/s	2.45	-0.91
L.T. Aman	403	3.61	5.96	-0.41	-0.32	-1.15	1.67
HYV Aman	-0.42	0.77	1.24	0.4	-1.63	1.02	0.02
L. Boro	-0.17	-0.15	0.01	0.03	-0.04	-0.01	-0.02
HYV Boro	1.33	2.11	0.11	0.17	-4.87	2.04	-0.13
Wheat	-5.72	-5.32	-5.01	1.38	-0.12	-8.74	-5.15
Jute	0.05	0.07	0.03	0.1	-0.02	0.02	0.02
Lathyrus	0.32	0.71	-3.1	-3.46	-0.26	8.62	1.16
Lentil	-2.88	-0.32	-7.1	3.14	-0.27	3.35	1.36
Mustard & Rape	-2.45	3.13	-7.1	-8.91	-8.74	5.41	10.24

TABLE 3.25

Annual Percentage Change in Production of Selected Crops by District, 1980-81 to 1989-90

Crop	Kushtia	Jessore	Khulna	Barisal	Patuakhali	Faridpur	Bangladesh
L. Aus	6.52	1.93	-0.2	9.63	4.96	7.45	-0.75
HYV Aus	3.09	-4.75	-15.12	-5.88	-5.88	-6.47	-4.73
B. Aman	0.74	-5.87	-1.72	0	0	-8.08	-2.56
L.T. Aman	0.49	-0.14	6.19	1.51	1.51	-11.68	-0.08
HYV Aman	15.62	23.77	5.81	-1.4	-1.4	7.94	10.43
L. Boro	-0.34	-0.3	0	-0.09	-0.09	0.18	-0.06
HYV Boro	27.62	16.46	9.77	-19.04	-19.04	17.53	14.47
Wheat	-8.8	0.97	-1.72	17.13	17.13	-8.46	-4.82
Jute	0	-0.03	-0.06	-0.01	-0.01	-0.02	-0.04
Lathyrus	0.6	2.2	-15.58	6.18	6.18	5.63	1.3
Lentil	-2.56	0.15	-7.9	10.45	10.45	9.49	2.98
Mustard & Rape	-7.84	5	-12.74	-2.6	-2.6	7.03	2.31

The average annual change in production is positive for all crops except HYV aus, b.aman, wheat, jute and, to a lesser extent lentil (Table 3.25). The largest increase has been in the production of HYV aman and HYV boro. Geographically, the northern districts of Kushtia,Jessore and Faridpur have seen the largest increase in production of HYV boro whilst in Patuakhali and Barisal there has been a decline. Likewise, production of HYV aman has increased significantly in Kushtia and Jessore and rather less in Khulna and Faridpur. In Patuakhali the production of wheat has increased by 17 percent and lentil by 10 percent. Faridpur has also seen an increase of 9 percent in the annual production of lentil. The production of mustard and rape has increased by 7 percent and 5 percent in Faridpur and Jessore respectively.

The pattern of crop production across the area is of interest to regional planning. Maps showing the distribution of four crops as a percentage of net cropped area are given as Figures 3.11 to 3.14. Figure 3.11 shows the distribution of Broadcast Aman. The planning units with the highest proportion of B. Aman as a percentage of NCA are SW7 and SC4 with between 40 - 50%; planning units SC2,SC3, SC6 and SW10 have 30 - 40% of the NCA devoted to B. Aman and Planning Units SW5, SW6 and SC1 between 20 and 30%.

The planning units where HYV T Aman is most widely grown are shown in Figure 3.12. Other than HYV T Aman being grown less widely in the areas of F3 land, the distribution shows that the crop is least widely grown in areas of Barisal, Patuakhali and Khulna.

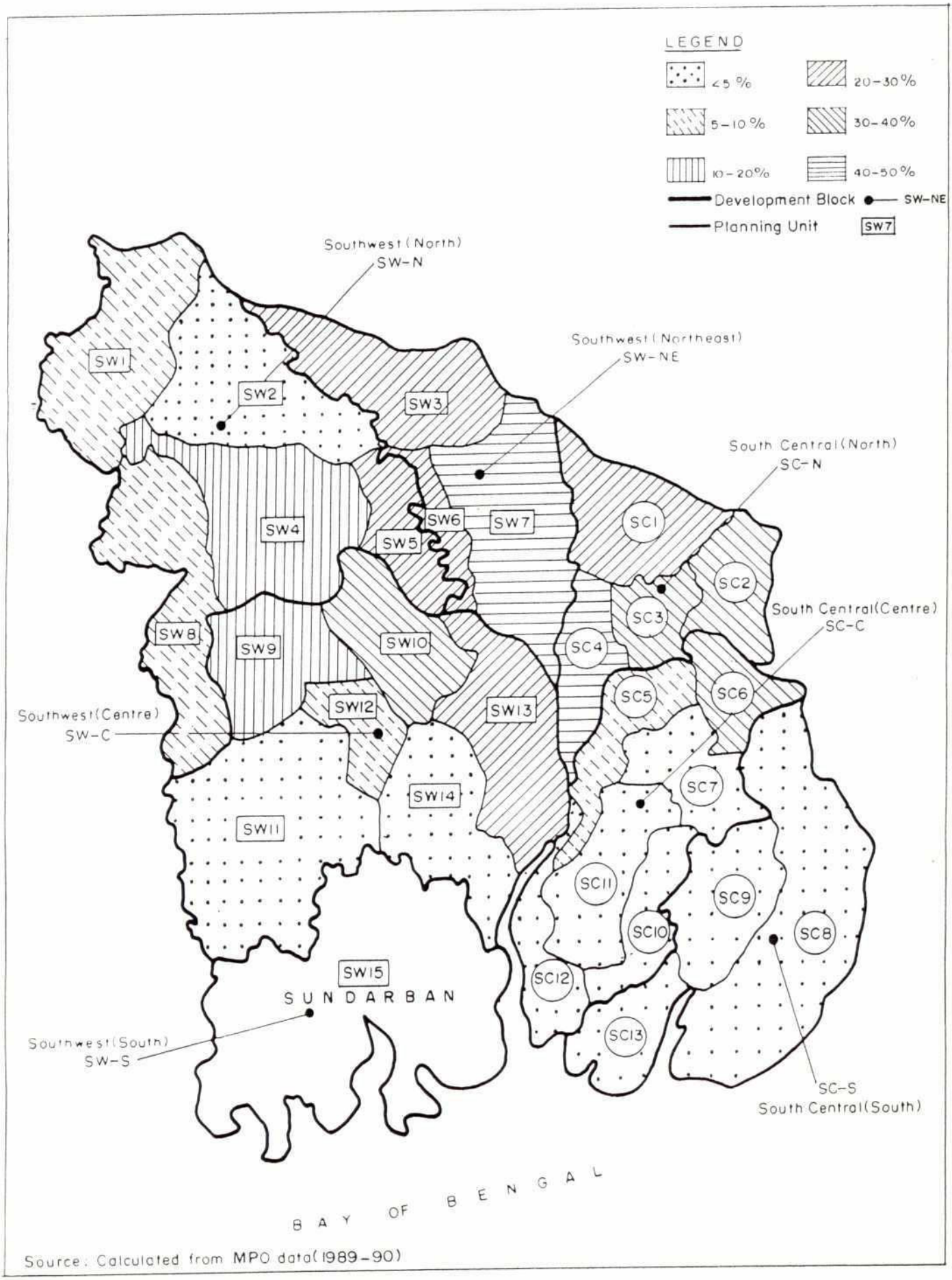
The pattern shown for HYV Boro and Pulses shows a rather mixed pattern but areas of high pulse production tend to be areas where HYV Boro is least grown (Figures 3.13 and 3.14).

3.9 Shrimp-Rice Production

In parts of the SWA, the surface and ground water quality is saline and this may give rise to saline surface soils due to capillary rise. Under such conditions, cropping in the dry season is not possible. Irrigation water with a salinity above 2,000 micromhos/cm will decrease the yield of rice as shown in Table 2.12. When the conductivity of irrigation water reaches 3,400 micromhos, the yield of rice may decrease by 25 percent. There is a degree of salinity tolerance in rice which varies with variety but, in general, rice is best not cultivated using such quality water. There are some crops for which the yield is relatively little affected by irrigation water of 6,000 micromhos such as cotton and barley but, in practice, land is left fallow when water salinity reaches such levels.

The response to this situation has been for some areas to be used for the production of shrimp. The area of shrimp farms in the SWA is shown in Table 3.26.

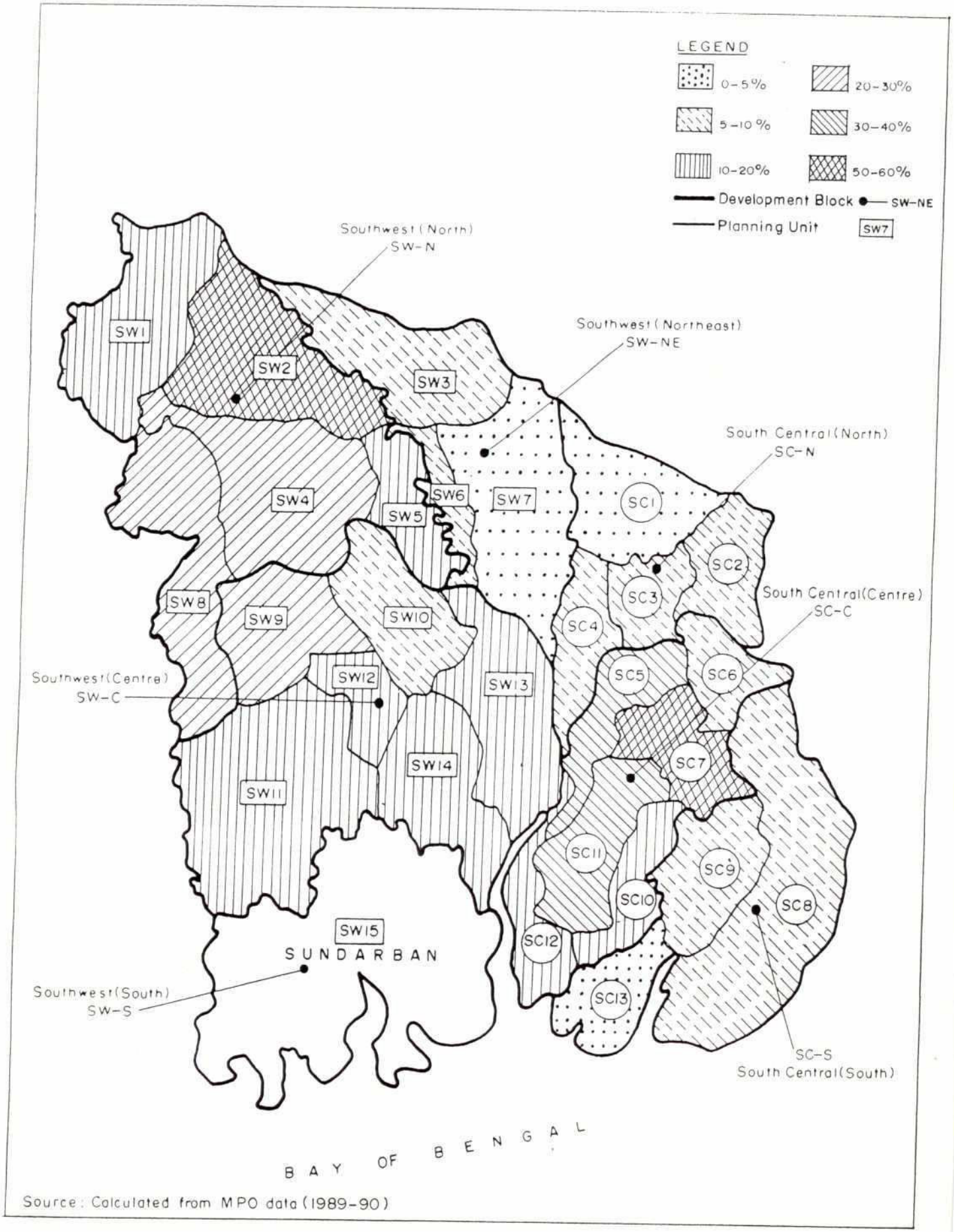
Figure 3.11



Source: Calculated from MPO data(1989-90)

Area of B.Aman as a percentage of Net Cropped Area

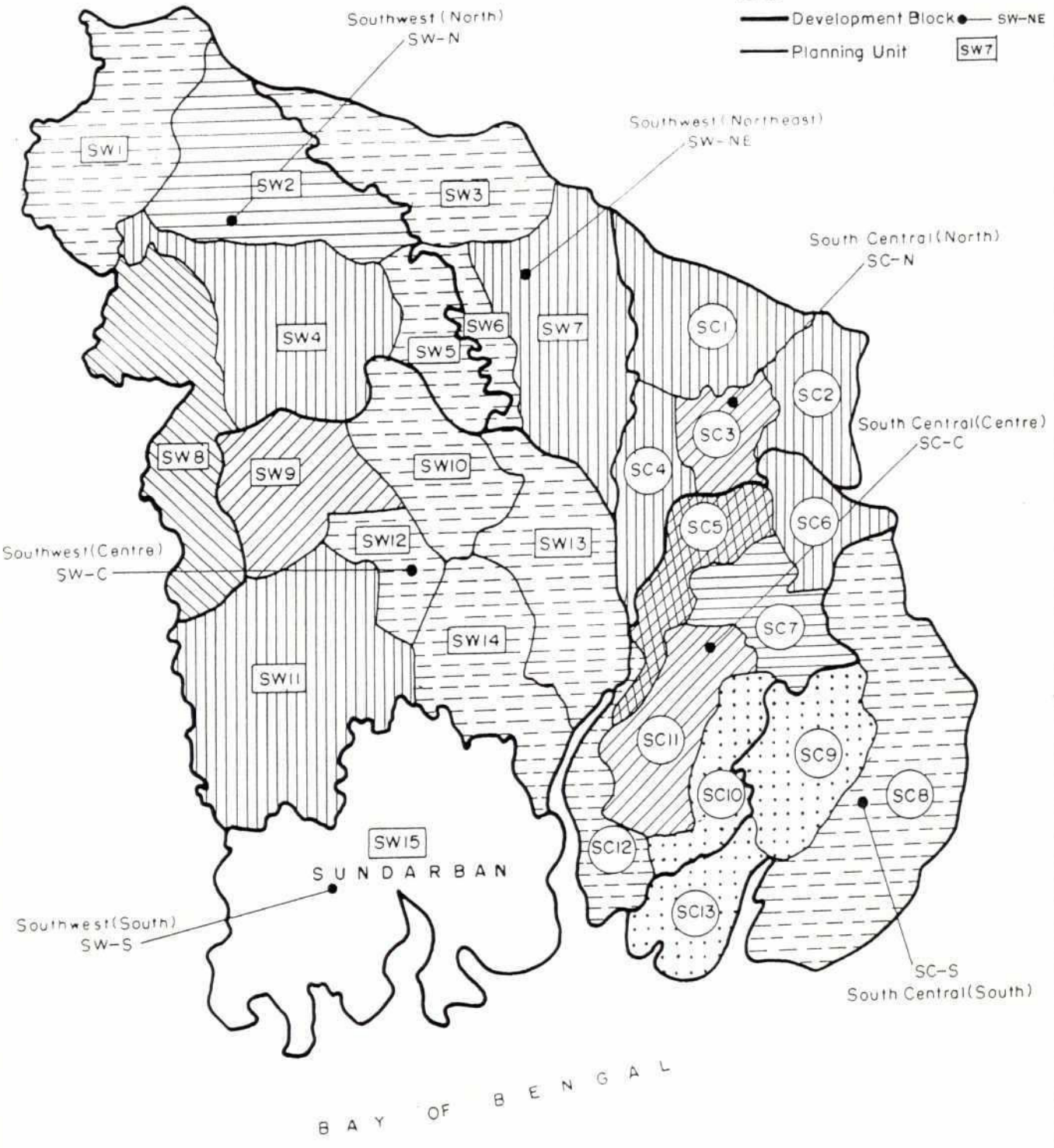
Figure 3.12



Source: Calculated from MPO data (1989-90)

Area of HYV T. Aman as a percentage of Net Cropped Area

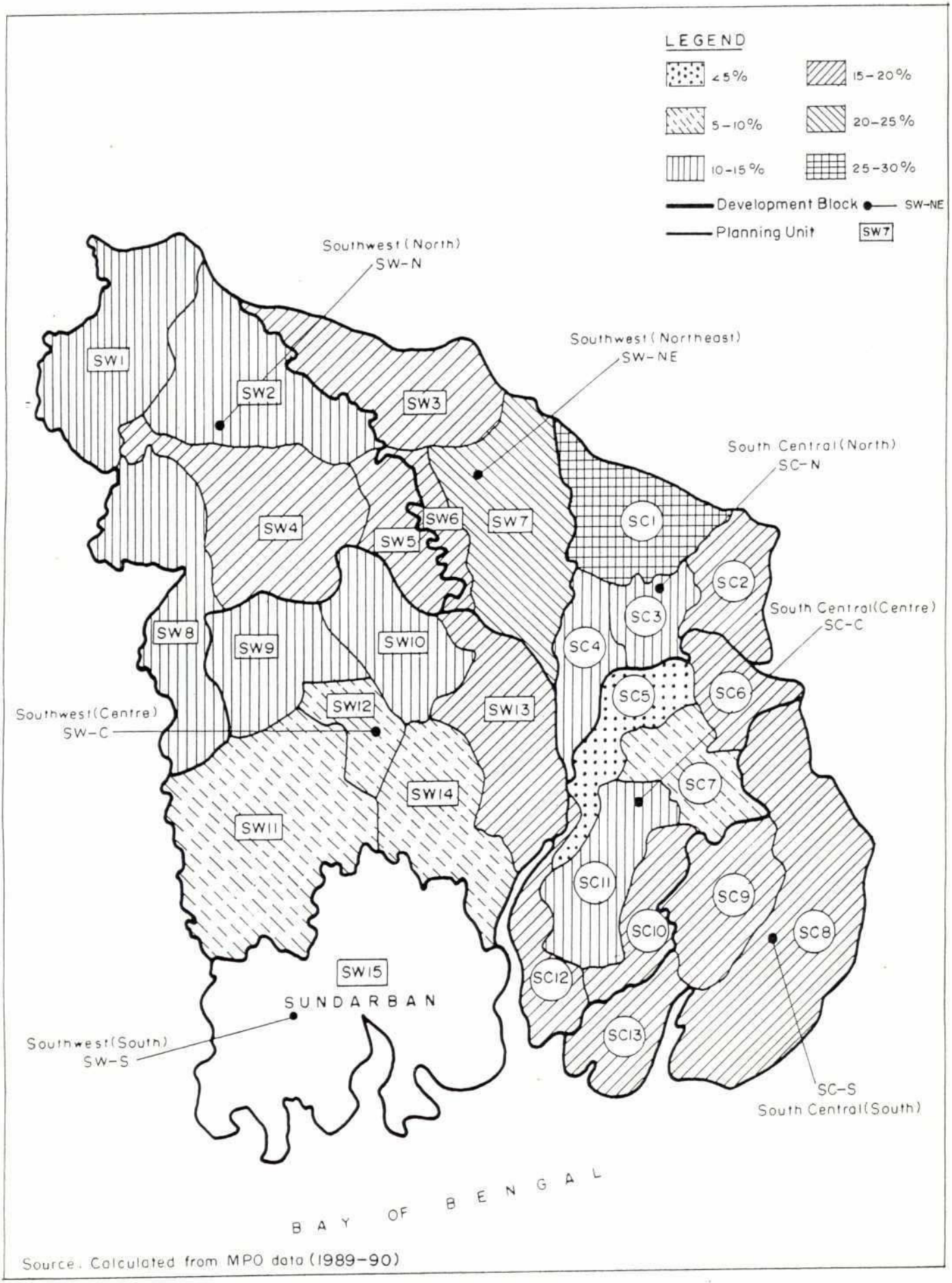
Figure 3.13



Source: Calculated from MPO data (1989-90)

Area of HYV Boro as a percentage of Net Cropped Area

Figure 3.14



Source. Calculated from MPO data (1989-90)

Area of Pulses as a percentage of Net Cropped Area

TABLE 3.26

The Area of Shrimp Farms in the SWA

Planning Unit	Area Km²
SW2	0.5
SW4	1.0
SW5	0.3
SW8	83.2
SW9	35.9
SW10	70.7
SW11	191.7
SW12	94.9
SW13	108.8
SW14	37.5
SC5	0.1
SC7	0.1
SC8	0.2
SC9	0.1
SC11	0.1
SC13	0.1
TOTAL	625.2

The area under shrimp farms totals some 625.2 square kilometres, of which only 0.7 km² is in the South Central Region. The cultivation of shrimp is found within the area bounded by the 1 ppt dry season isohaline (see Volume 4, Coastal Studies for maps of surface water salinity).

Although shrimp farming occupies land that would otherwise be fallow in the dry season, it does present problems. These include social issues which are discussed in Volume 9, Impact Studies. The land use issues are concerned with salinity and access to the land for the cultivation of the aman rice crop. They are summarised below:

- in theory, the shrimp areas should be drained by June-July to allow rainfall to leach the residual soil salinity before transplanting rice in August. In practice, the land is not released on time which delays transplanting thereby reducing the rice yield considerably.

- there is a tendency for soil salinity to gradually increase from year to year. The result is a decline in rice yields and, in some areas land has gone out of agricultural production completely. The influence of salinity is not confined to the flooded area, salinity also occurs in the areas adjacent to the ponds

- the shrimp ponds occupy land that might otherwise be used for grazing cattle. This has resulted in a steep decline in the availability of animal feed

- in some areas the production of vegetables has declined considerably due to the presence of shrimp ponds.

4 LIVESTOCK

4.1 Introduction

The importance of livestock in Bangladesh agriculture and its subsistence economy cannot be over emphasized and the picture is no different in the SWA. The most important livestock are cattle which provide the necessary draught power for ploughing, road and farm transport, threshing and oilseed and sugarcane crushing. In addition, cattle and other livestock provide animal protein through milk, meat and eggs, and a cash income through the sale of live animals, hides and skins, meat, milk and eggs as well as through the hiring out of draught animals. Livestock also provide fuel in the form of dry cow dung for rural households and manures in the form of cow dung and urine as well as poultry droppings for fields and homestead plots. Hides, skin and leather goods are important items of export.

4.2 Livestock Population

There has been a long and serious lack of reliable statistics on livestock resources, production and utilization in the country. The livestock component of the Agricultural Census 1960, 1977 and 1983-84 and the livestock survey of 1983-84 are the main sources of information. The report on the latest census of Agriculture and Livestock conducted in 1989 by BBS is not yet published. The following discussion is based largely on the data from 1983-84. Table 4.1 shows the regional distribution and density of livestock in the Southwest Area.

TABLE 4.1

Regional Distribution and Density of Livestock

Region (Greater district)	Total cultivated land ('000 ha)	Bovine animal No ('000)	Per Ha of cultivated land	Goat and Sheep No. ('000)	Per Ha of cultivated land	Poultry No. ('000)	Per Ha of cultivated land
Faridpur	483	1138	2.36	726	1.50	3222	6.67
Barisal	476	1131	2.38	510	1.07	4973	10.45
Jessore	490	1169	2.39	998	2.04	3369	6.88
Khulna	434	1198	2.76	645	1.42	2681	6.12
Kushtia	256	539	2.11	597	2.33	2060	8.05
Patuakhali	300	638	2.13	2147	7.16	2612	8.71
SW Area	2439	5814	2.38	3690	1.51	18917	7.76
Bangladesh	8645	22498	2.60	14476	1.67	76446	8.84

Source: BBS, 1987-88. Agriculture and Livestock Survey 1983-84.

On an average SWA has 2.38 units of cattle, 1.51 units of goat and sheep and 7.76 units of poultry per hectare of cultivated land. However, there are some regional variations. Khulna has the highest density of cattle and buffalo (2.76), while Patuakhali has the highest number of sheep and goat (7.16). Barisal has the highest density of poultry (10.45) per hectare of cultivable land.

In Table 4.2 per capita availability of bovine animals, sheep and goat, and poultry are presented.

TABLE 4.2

Per Capita Availability of Bovine Animals, Sheep and Goat and Poultry in Farm Households.

Region (Greater district)	Per capita Bovine animal			Per Capita Sheep and goat			Per Capita Poultry	
	1960	1977	1983-84	1960	1977	1983-84	1977	1983-84
Faridpur	0.28	0.23	0.22	0.05	0.09	0.15	0.48	0.66
Barisal	0.29	0.25	0.23	0.05	0.06	0.11	0.79	1.06
Jessore	0.52	0.30	0.28	0.19	0.19	0.25	0.86	0.83
Khulna	0.42	0.34	0.31	0.08	0.11	0.17	0.50	0.68
Kushtia	0.41	0.25	0.22	0.23	0.19	0.26	0.53	0.89
Patuakhali	0.38	0.36	0.33	0.07	0.07	0.12	1.00	1.40
Bangladesh	0.38	0.28	0.26	0.12	0.12	0.18	0.65	0.91

Source: BBS. The Bangladesh Census of Agriculture and Livestock: 1983-84, Vol. I

It is seen that per capita bovine animals is gradually decreasing in all the regions of the study area, while that of sheep and goat and poultry are increasing. This is in conformity with the national trend.

4.3 Management practices

Most livestock are kept by farm households in small numbers as opposed to commercial or more specialised operations with large number of animals. According to the 1983-84 Agricultural Census, 95 percent of all cattle are on farms - a farm being statistically defined as having 0.20 ha or more of land. Lately it appears that livestock keeping has become increasingly an activity of its own. The rural landless, sometimes supported by NGOs and Grameen Bank have taken up cattle fattening and milk production. Entrepreneurs are also becoming involved in commercial poultry, dairy and seasonal animal fattening.

The important feature of livestock production is that, in the farm context animals are fed on residues of crop cultivation. Cattle are fed on fodder from embankments, fallow land, road sides, river levees and crop residues such as straw from rice and pulses, sugarcane tops, and crop by-products like rice and wheat bran, pulse husks etc. There are no commercial goat farms and most goats subsist by scavenging the farmer pays very little attention to their management. Sheep are kept predominantly in larger flocks by families who have established special land-use rights in char areas. Poultry birds are widely distributed among rural households and nearly all are kept as scavenging birds. The flock size is generally very small in order to provide enough feed from crop residues, homestead picking and household waste. Ducks are reared by rural households in small flocks under condition of scavenging in those regions which are seasonally inundated and households having ponds or some sort of water body nearby.

4.4 Livestock Breeds

Virtually all cattle in Bangladesh are Bos indicus (Zebu). There are two main varieties found in the Southwest Area the small deshi and the large deshi. These animals are genetically

small in size, slow growers and poor milk producers. Deshi bulls are normally castrated and trained for work. Milk yields under existing rural farm conditions are very low, between 200 and 300 kg in a lactation period of 180 - 200 days. Cattle on the higher ground around the Ganges, especially in the districts of Faridpur, Barisal are heavier and yield more milk. In these areas indigenous cattle have been crossed with Hariana and Sahiwal bulls.

Buffaloes like cattle are used mainly as draught animals. They are better than cattle in the cultivation of muddy land and for transportation. A local buffalo cow produces on an average 600 - 900 kg of milk per lactation and buffalo milk is richer in protein and fat. Buffaloes subsist essentially on a greater volume of the same diet as cattle but are able to better utilize low grade roughage. In the coastal areas buffaloes are kept in large numbers (up to several hundreds) by a single family on the newly emerging lands.

There are two main types of goats in Bangladesh - the Black Bengal and the somewhat larger Jamunapuri, the former accounting the bulk of the population. The rural households accounts for 98% of the goats and there are no commercial goat farms in the study area. Goats subsist on scavenging. Black Bengal goats are highly prized for their quality meat and their skins fetch higher prices in the leather market.

Sheep in Bangladesh are primarily reared for production of meat, though about 500 gm of coarse wool may be produced per adult per year. Sheep in large flocks are seen in char areas.

Indigenous chicken are small and poor layers. About 70 - 80 eggs are lain by a local hen with an average weight of 30 gm per year. The exotic varieties of chicken like RIR, White Leghorn and Black Minarca have been introduced into the country. A hen of these improved varieties on an average produces about 200 eggs per year. Several poultry farms, both in the public and private sector, have been established in the city areas of the Southwest region.

Local ducks, with improved feeding, can increase their egg production from 90 - 110 to 150 - 160 per year. Some imported duck breeds like Khaki Kambal are better producers.

4.5 Feeds and Fodder

The single most important constraint to livestock development is the acute shortage of feeds and fodder. This shortage of feeds and nutrients has been intensified over the past decade mainly for the following reasons:

- the traditional grazing lands have been converted to cereal crop lands
- introduction and large scale cultivation of HYV, the short stemmed rice causes serious reduction in the quality of rice straw
- increased use of straw for domestic fuel and housing material reduces availability of straw and,
- with introduction of modern irrigation facilities for cultivation of modern wheat & rice varieties leguminous crops like lathyrus, chickpea, blackgram previously grown exclusively for fodder has been practically eliminated.

The main feed supplies for cattle, goats and sheep come from the by-products of food and cash crops e.g. rice straw, weeds from crop fields, rice bran, oil cakes, pulse husks etc. These animals scavenge for grass or any other feed that may be available on the non cultivated areas along roadsides, embankments and bunds. Poultry usually subsist on food

scraps, insects and fallen grain scavenging around village housing. Sometimes cattle, also, graze after harvesting of the Aman crop in single cropped lands, especially in the coastal areas. Due to priority of grain production for human consumption most of the fallow and waste lands that were used for forage production and grazing have now been converted into crop land. Regional area and production of kharif and rabi season fodder in the study area is presented in Table 4.3.

TABLE 4.3

Area and Production of Fodder
(Area in hectare and production in ton)

Region (Greater district)	Kharif				Rabi			
	1986 - 87		1987 - 88		1986 - 87		1987 - 88	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Faridpur	407	4650	425	4845	789	1735	806	1830
Barisal	83	920	75	840	20	210	16	165
Jessore	138	855	136	745	109	490	310	1290
Khulna	53	110	61	90	65	600	73	360
Kushtia	59	330	63	355	-	-	-	-
Patuakhali	97	555	115	630	-	-	-	-
SW Area	837	7420	875	7505	983	3035	1205	3645
Bangladesh	1650	13810	1723	13805	4823	33435	5478	31760

Source: Yearbook of Agricultural Statistics of Bangladesh 1987-88.

4.6 Draught Power

The most important function of cattle and buffalo is that of providing draught power for ploughing, road and farm transport, threshing, sugarcane and oilseed crushing. Because, Bangladesh has a predominantly rainfed agriculture, the available time for land preparation is very short and a delay in sowing/planting will have adverse effect on crop yield. It is now a growing concern that animal draught power supply is increasingly becoming a constraint to agricultural development. This shortage is and will be more pronounced in areas where the cropping intensity is high due to development of irrigation and introduction of HYVs. According to the livestock survey of 1983-84, the regional distribution of draught cattle and buffaloes are shown in Table 4.4. It can be seen that there are some variations in the density of draught cattle and buffaloes in the Southwest Area.

TABLE 4.4

Regional Distribution of Draught Animals (Figures in '000)

Region (Greater district)	Total cultivable land ('000 ha)	Working cattle	Cattle used in cultivation	Working Buffaloes	Working Buffaloes used in cultivation	Total working bovine (3+5)	Bovine used in cultivation (4+6)	No of draught bovine per acre of cultivated land
1	2	3	4	5	6	7	8	9
Faridpur	483	579	523	8	8	587	531	1.10
Barisal	476	572	550	18	18	590	568	1.19
Jessore	490	570	517	8	8	578	525	1.07
Khulna	434	563	549	32	32	595	581	1.34
Kushtia	256	264	251	18	16	282	267	1.04
Patuakhali	300	373	263	53	50	426	313	1.04
Total	2439	2921	2653	137	132	3058	2785	1.14
	8645	11064	10489	364	343	11428	10065	1.16

Source: Adapted from Livestock survey 1983-84 and ASR 1989.

The main scarcity of draught power in Bangladesh is due to the pronounced seasonal requirements of ploughing. The mean peak for ploughing falls in March and April depending on the time of rainfall during sowing/transplanting of B. Aman and Jute. The other peak periods are between July and August when Aman is transplanted, and again in late November to mid December for cultivation of rabi crops. These three peak ploughing seasons are essentially determined by climatic conditions and the cropping patterns which have evolved to fit into these three seasons. The period during which soil moisture is optimal for ploughing and sowing is short, late ploughing and sowing invite severe risk of total crop loss.

Though regional figures are not available, 1983-84 Agricultural Census shows that Bangladesh is deficient in its animal draught power requirement by about 33 percent. Only a small part of this deficit is made up by the use of tractors, and results in excessive over working of the available animals, use of labourers and family members pulling ploughs. Because of the draught shortage,most of the land is not cultivated properly resulting in decreased yields.

Low fertility of the cows, the shortage of fodder, losses due to disease and natural calamities plus the increasing demand for meat have aggravated the draught power situation. The seasonal supply/demand analysis of draught power specific to location has been estimated by the Bangladesh Energy Planning Project (BEPP). According to their analysis the percentage shortage of draught power varies widely within the study area both in the dry and wet seasons (Table 4.5).

TABLE 4.5.

Estimated Shortage of Animal Draught Power in the Dry and Wet Seasons

Region (Greater district)	Percent shortage in the dry season				Percent shortage in the wet season			
	In week number				In week number			
	11	12	13	14	29	30	31	32
Faridpur	6.5	53.0	57.0	20.4	29.6	43.8	43.8	43.8
Barisal	-	29.6	30.7	20.0	33.4	39.8	39.8	39.8
Jessore	-	39.5	48.0	35.3	-	8.7	8.7	8.7
Khulna	-	-	-	-	28.3	36.7	36.7	36.7
Kushtia	-	43.6	48.1	45.5	-	-	-	-
Patuakhali	-	-	-	-	52.9	54.4	54.4	54.4

Source: Bangladesh Energy Planning Project (BEPP) (GOB 1985). As quoted in Bangladesh Agricultural Sector Review Compendium Vol. II. P. 65 & 66.

Notes: Week Nos

11 - 12th March	29 - 16th July
12 - 19th March	30 - 23rd July
13 - 26th March	31 - 30th July
14 - 2nd April	32 - 6th August

4.7 Livestock and Food Supply

(a) Meat

Cattle and chicken are the main sources of meat in Bangladesh. A considerable quantity of meat also comes from goats and a small amount from sheep and buffaloes. The national statistics on meat production and consumption are scanty and weak. In 1987, the World Bank undertook a review and showed that annual meat production in Bangladesh has increased by 1.87 percent in 1987 over 1977. But this increase was due mainly to an increased supply of chickens and goat meat. Meat production could not, however, keep pace with the population growth and actual meat consumption declined from 1.66 kg/per person per year in 1977 to 1.56 kg in 1987. (ASR, 1989, Compendium Vol. II). In the absence of regional data, these national figures may be accepted for the study area.

(b) Eggs

Eggs are an important source of animal protein in the human diet,but in Bangladesh, a very small percentage of animal protein comes from eggs. The data base of this sub-sector is very weak and different sources give different figures of total number of laying hens and ducks and their annual production as well as per capita consumption of eggs. In 1987, the World Bank estimated that only six to seven percent of animal protein consumption came from eggs of both hens and ducks. It was also stated that the per capita supply of egg protein had increased by only one percent during the last 10 years. According to the livestock survey of 1983 - 84, the annual production of eggs per laying hen and duck were 150 and 268 respectively and per capita annual availability of eggs were 7-8 only. Of late a large number poultry farms with improved poultry breeds have been established in and around big cities but no reliable data are available.

(c) Milk

The average milk production of local cows is very low and it varies between 200 and

300 kg per lactation of 180 to 200 days, but there is great variation among cows. The average milk production of cows in the milk pocket areas like Faridpur and Barisal is somewhat better and varies between 600 and 800 kg per lactation of 210 to 240 days. The majority of the cows in these milk pockets are cross breeds. There are wide variations in the estimates of milk production by different agencies. However, all such surveys reported wide regional variations in milk production and consumption. The livestock survey results of 1983-84 is given in Table 4.6. It may be seen that the average for the Southwest Area comes to about 28 gm/day/person which is more or less similar to the national average.

TABLE 4.6

Average Production and Per Capita Consumption of Milk

Region (Greater District)	Population 1985 ('000)	Annual Milk Production ('000 tons)	Per capita consumption (g/day)
1. Faridpur	5494	39	19
2. Barisal	5385	58	30
3. Jessore	4652	43	25
4. Khulna	4993	59	32
5. Kushtia	2642	18	19
6. Patuakhali	2120	43	56
Total	25286	260	28

Source: Livestock Survey 1983 - 84 and Statistical Yearbook 1986.

The nutritional situation of the poulation of the SWA as determined by survey is discussed in detail in Volume 9.

4.8 Non-Food Livestock Products

(a) Dung

Dung is one of the by-products of cattle and buffaloes having significant economic importance. Cow dung has several uses, namely compost as an organic manure for crop production, dry dung cakes as domestic fuel and a mixture of cow dung and clay as plaster for walls and floors of huts.

The World Bank (1981) made a theoretical calculation based on the assumption that cattle produce an average of 10 kg fresh dung and a buffalo 12 kg of fresh dung per day. About 50 percent of the total dung is used as manure, either left directly on the field or spread on after collection and composting. The remainder is mainly used as fuel. The energy value of dung cakes is about 8250 BTU per kg against 14500 BTU per kg of firewood (ASR Compendium Vol II, p 93).

(b) Hides, Skins & Leather

The main non-edible industrial raw materials generated in the livestock sector in Bangladesh are hides and skins. Cattle, buffaloes, goats and sheep all provide hides and skins for processing within the country or for direct export. Less then 20 percent of all hides and skins produced in the country are processed into low-grade finished leather for domestic consumption. The rest is chrome-tanned into "wet blue" - little more than basic preservation tanning - and exported as such. Government has imposed recently a ban on exporting wet blue leather to meet up the internal demand of local tanneries and promote export of finished leather goods. Regional figures of hides and skin production are not available.

5 IMPACT OF FCD/I ON AGRICULTURE

5.1 Introduction

The estimation of benefits arising from engineering interventions is required to allow calculation of the economic viability of any proposed project. The effect of flood control drainage and/or irrigation on agriculture must be predicted before this can be done. In particular, changes in crop production resulting from changes in crops grown, cropping patterns, cropping intensities, yields and output likely to come about as a result of FCD and FCD/I need to be described.

FAP12 - FCD/I Agricultural Study has undertaken a review of the agricultural, economic, social and environmental impacts of FCD and FCDI projects. Besides the FAP 12 studies, the Consultants have also compared the pre and post project polder situation in Bagherat district. The results on agriculture of relevance to the SWA are reviewed below.

The Agricultural study, conducted four investigations in the SWA as shown in Table 5.1.

TABLE 5.1.

Agricultural Studies Carried Out by FAP-12 in the SWA

Type of Appraisal	Project
Project Impact Evaluation	Kolabashukhali Project
Rapid Rural Appraisal	Polder 17/2 Sonamukhi-Benmander Beel Sakunia Beel.

Unfortunately, FAP-12 did not undertake to study an irrigation project in the SWA, but information on likely impacts can be taken from areas studied in the NW and SE of Bangladesh.

5.2 Crop Production

5.2.1 Cropped Area

The agricultural impacts are summarised in Table 5.2 for the four areas studied in the SWA and for projects that included irrigation as a component, Protappur and Meghna Dhanagoda.

TABLE 5.2.

Summary of Selected Project Agricultural Impacts, SWA

Project	Cropping Pattern	Cropping Intensity	Paddy yield (t/ha)	Change in paddy output	Change in Fertiliser use
Polder 17/2	From fallow or shrimp to boro, from T.Aman to HYV Aman	100% to 143%	1.95 to 2.97	+ 95%	N/A
Sakunia Beel	From B.Aman and /Aman to T.Aman and HYV Boro	No change	1.64 to 1.9 (all seasons)	+ 14%	N/A
Sonamukhi-Banmander	From to Boro, B.Aman to T.Aman LT Aman to HYV Aman	No change	1.54 to 3.92 (monsoon paddy)	positive	N/A
Kolabashukhali	From Jute to / Aman, B.Aman to LT Aman	No change	1 to 1.7	+ 144%	+50%
Protappur (1)	From LT Aman to HYV Aman, B.Aman to T.Aman	No change	2.5 - 4.5 (monsoon paddy)	+ 57%	N/A
Polder Areas of Bagherat District (2)	B.Aman to HYV T.Aman	131 to 138	1.58-1.82	+15	
Meghna - (1) Dhanagoda	From B. to T.HYV Aman, L.Boro wheat to HYV Boro	189 to 209	2.52-4.37 (all paddy)	+ 126%	+126%

Source: FAP-12 Final Report, Volume 3 (1992)

(1) Not in the SWA but included as examples of the impact of irrigation
(2) Feasibilty Study Report of the Rehabilitation and Improvement of BWDB Projects in Bagherat District, volume 1 (1988).

The Agricultural study (FAP-12) points out that there are two main ways in which FCD/I projects might change cropped areas : by increasing the net cultivated area by bringing in previously uncultivated land or by changing the seasons in which land is cultivated. As most potentially cultivable land is already used, FCD/I projects have more usually changed the incidence of seasonal cropping. The exception to this are when beels or semi-permanent beels are reclaimed as in Kolabashukhali project or where beel fringes are now cultivated eg Sakunia Beel and Sonamukhi - Banmander Projects.

The early monsoon season is usually the least benefitted season because of the development of boro irrigation, spontaneous or planned, that extends into the kharif season. There are exceptions to this, in the Kolabashukhali Project the jute area is

increasing as salinity levels fall. Whether boro irrigation will in turn lead to the displacement of jute if dry season salinity also decreases can only be speculated.

The Aman season is traditionally the major rice season whether an area is protected by FCD or not. The exception is when land cannot be cropped in the Aman season at all, or intensity is low usually because of saline water intrusion as in the case of the Kolabashukhali project. In the Kolabashukhali project, the provision of FCD has benefitted the Aman season as shown by the increase in cultivated land, 21% in the project compared to 4% in the control area.

The rabi season may benefit from FCD. FAP-12 identified three ways in which this may come about:

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

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

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

Given the rapid increase in irrigation that has occurred in the SWA in recent years it must be borne in mind that irrigation may increase regardless of future FCD/I projects. For this reason, benefits from boro production may be wrongly attributed to FCD/I.

5.2.2 Cropping Patterns

The FCD/I projects tend to strengthen the dominance of rice in cropping patterns and to support a change in varieties grown. The FCD projects mainly influence monsoon season cropping pattern with a shift from broadcast to transplanted production and from local to high yielding varieties where irrigation is also introduced. This strengthens further the dominance of HYVs. In poldered areas such as Bagherat, introducing shrimp culture has adversely affected agriculture thereby reducing areas under rabi crops. It has also limited the increase in the area under HYV boro.

The range of crops grown declines. The most disadvantaged are jute, sugarcane, wheat, potato, pulses and spices. In Kolabashukhali, the percent of gross cropped land under rice is 89% compared to 63% in the control area. The largest decline was in sugarcane, 5% in the project as against 29% in the control. The major changes are summarised in Table 5.3 and 5.4.

TABLE 5.3

Changes in Cropping Pattern: PIE Data (1)

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

(1) Expressed as a percentage of gross cropped area.

Source: FAP 12 Farm Household Survey, Final Report 1992

TABLE 5.4

Changes in Cropping Pattern, Bagerhat District

Crops	Percent of Gross Cropped Land	
	1987-88	1991-92
T. Aman (L)	57.87	53.69
T. Aman (HYV)	0.23	11.65
T. Aus (L)	2.22	0.52
T. Aus HYV	0.98	2.51
B. Aus	4.96	5.12
Mixed Aus + Aman	6.51	-
B. Aman	5.51	11.38
Boro (L)	3.65	4.25
Boro (HYV)	2.51	2.67
Pulses	7.24	3.80
Oilseeds	2.15	0.19
Winter Vegetables	2.94	1.37
Jute	0.65	0.16
Till	1.00	0.10
Wheat	1.03	0.06
Chillies	0.39	0.38
Sugarcane	0.16	1.51
Other (Banana)	-	0.64
Total (%)	100.0	100.0
Gross Cropped Area(ha)	149892	171808
% Paddy	84.45	91.79

Note: 1987-88 Data from Feasibility Report of Rehabilitation and Improvement of BWDB Project in Bagerhat District, Vol I (1988) and data of 1991-92 from Thana Agriculatural Offices DAE and Statistical Offices (BBS).

5.2.3 Cropping Intensities

Changes to cropping intensity as a result of FCD are usually low and in the case of the projects studied by FAP-12 in the SWA there was no change except in Polder 17/2 and this is due to the inclusion of shrimp-Aman as a cropping pattern. With irrigation as a component, the increases in boro rice may more than offset the decrease in other rabi crops as has happened in Meghna - Dhanagoda Project.

5.2.4 Crop yields and output

The increase in yields of rice crops at Kolabashukhali and the other PIE areas are shown in Table 5.5. The changes in the poldered areas of Bagherat are presented in Table 5.6.

TABLE 5.5.

Increase of Yields of HYV Rice: PIE Data (1)

Projects	Impacted Area				Control Area			
	HYV	Aman HYV	Boro HYV	All HYVs	HYV	Aman HYV	Boro HYV	All HYV
Chalan Beel	1.85	2.29	30.16	34.30	3.52	9.88	29.32	42.72
Kurigram South	2.97	5.81	19.33	28.11	1.33	2.47	16.62	20.42
Meghna-Dhonagoda	21.81	29.65	27.04	78.50	0.00	2.29	11.89	14.18
Zikar Haor	1.97	1.32	18.83	22.12	0.36	0.00	1.38	1.74
Kolabashukhali	1.04	3.66	3.11	7.81	0.00	0.78	2.04	2.825

(1) Expressed as a percentage of gross cropped area

Source: FAP 12 Farm Household Survey, 1992

TABLE 5.6

Increase of Yields of HYV Rice, Polder Areas, Bagerhat (1)

CROP	1987-88	1991-92
HYV Aman	0.23	11.7
HYV Aus	0.98	2.51
HYV Boro	2.51	2.67
All Varieties	3.72	16.83

Source: Feasibility Report of Rehabilitation and Improvement of BWDB Project in Bagerhat District, Vol 1 (1988) Thana Agricultural Offices and BBS (1992)

There is an increase in yields of rice crops in the project (impacted area) compared to the control areas. Thus, for a given land type the yields of the various and aman rice crops is higher as a result of the project.

The paddy output with and without project are summarised in Table 5.2. Output has increased in all the projects evaluated in the SWA by FAP-12.

It must be pointed out that this increase in output has largely come about because of the change in varieties grown (local to HYV) and cultural changes (broadcast to transplanted) rather than from increases in yields of the crops which were formally growing on the unprotected land.

5.3 Impact on Livestock

The projects studied by FAP-12 did not have a specific objective related to livestock development. However, changes in cultivated area and cropping intensity have had an effect on fallow and grazing land and the demand for draught power. Shrimp culture has affected livestock tremendously with a marked decrease in grazing land.

5.3.1 Draught Power

The summary of the rapid rural appraisal findings with regard to livestock in Table 5.7 indicate that the demand for draught power increased in all areas studied. Further, there was a decrease in the availability of draught animals to meet this demand.

The demand for draught power is greatest in the Aman season as the area of operated land has increased with project. There is a shortage of draught power at this time particularly for medium and large farms.

5.3.2 Grazing Land and Livestock Feed

The RRA results show that in nearly all the projects studied, the grazing area has been reduced due to conversion of fallow into crop land. The production of rice straw has increased but palatability has decreased due to the change from local to high yielding varieties. The conclusion of FAP-12 is that the increased production of straw and bran do not compensate for the loss in green feedstuff that has come about as a result of the project.

TABLE 5.7

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

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

Note: I - Increased; D - Decreased; NA - Not Available; ▲ - Deteriorated

Source: RRA Results from FAP-12; Final Report 1992.

6 AGRICULTURE EXTENSION AND OTHER SERVICES

6.1 Agriculture Extension Services

The Ministry of Agriculture through the Department of Agricultural Extension performs the vital task of training and motivating the farmers in adopting improved cultural practices and in replacing the traditional varieties by HYVs. It also trains farmers in the correct use of fertilisers, seeds, irrigation water management and in meeting the problems of pest control.

Under a reorganisation programme of the Ministry of Agriculture, an adequate number of staff have been placed at the union and village level for conducting extension through the training and visit system (T&V). Under this system a union is divided into three blocks - each block containing generally 600 - 700 farm families. A block is sub-divided into 8 sub-blocks, each of which contains 10 contact farmers. The contact farmers are normally literate and function as change agents among the farmers. Demonstration plots are established with the help of the contact farmers.

At the Thana (former Upazila) level there is the Thana Agriculture Officer (TAO) as head of administration, a Subject Matter Officer (SMO), Assistant Agricultural Extension Officer, Junior Agricultural Extension Officer, and at the union and village level, the Block Supervisors (BS). The Subject Matter Officer conducts training of the Block Supervisors and supervises their work. The Assistant Agricultural Extension Officer assists and advises the union level staff and conducts field supervision work. Normally each union is divided into 3 blocks and a Block Supervisor is appointed for each block who are agriculture diploma holders. They establish demonstration farms through selected farmers. Thus a wide net work of extension service is in operation. The functions of the TAOs are supervised by the Deputy Directors (DDA) from the district level. The DDAs are assisted by Subject Matter Specialists belonging to different disciplines.

In the SWA there are two Additional Directors of Agriculture (ADA) - posted at Jessore and Barisal who supervises and monitor the activities of the DDAs. The ADAs are responsible to the Director General of the Agricultural Extension Department (DAE).

DAE has three Agricultural Extension Training Institutes (AETI) at Daulatpur (Khulna), Faridpur and Rahmatpur (Barisal). These AETIs offer three years' Diploma course in Agriculture and also provide in-service training to the Block Supervisors.

6.2 Bangladesh Agriculture Development Corporation (BADC)

Bangladesh Agricultural Development Corporation (BADC) has been designated by the Government to meet the requirements of fertilisers, seeds, irrigation equipment, fuel and lubricants for the farmers. Up to 1989 BADC was responsible for procurement and distribution of fertilisers, pesticides and minor irrigation equipments. At present the private sector is handling procurement and distribution of fertilisers, pesticides and minor irrigation equipment. BADC is presently clearing their stock of LLPs and DTWs. But the seed sector is still with BADC which produces foundation seed in their own farms and certified seed through contact growers.

6.3 Other Agricultural Institutes

Bangladesh Agricultural Research Institute (BARI) has two Regional Research Stations (RARS) in the SWA at Khairatala (Jessore) and Rahmatpur (Barisal). The Jessore station

conducts research on all crops other than rice, jute and sugarcane, but concentrates mainly on wheat and pulses. The Rahmatpur Regional station researches on various aspects of coconut development. The On Farm Research Division (OFRD) of BARI has offices in all the old district headquarters from where they conduct research in the farmers field. In addition to undertaking research, the regional stations also, organise training programmes for the extension officers as well as farmers.

Bangladesh Rice Research Institute (BRRI) has two stations in the study area - one at Sagardi, Barisal and one at Bhanga, Faridpur. The Bhanga station is meant for conducting research on deep water rice.

The Cotton Development Board (CDB) maintains cotton ginning facilities at Kalaroa (Satkhira), Jhikargacha (Jessore) and Meherpur.

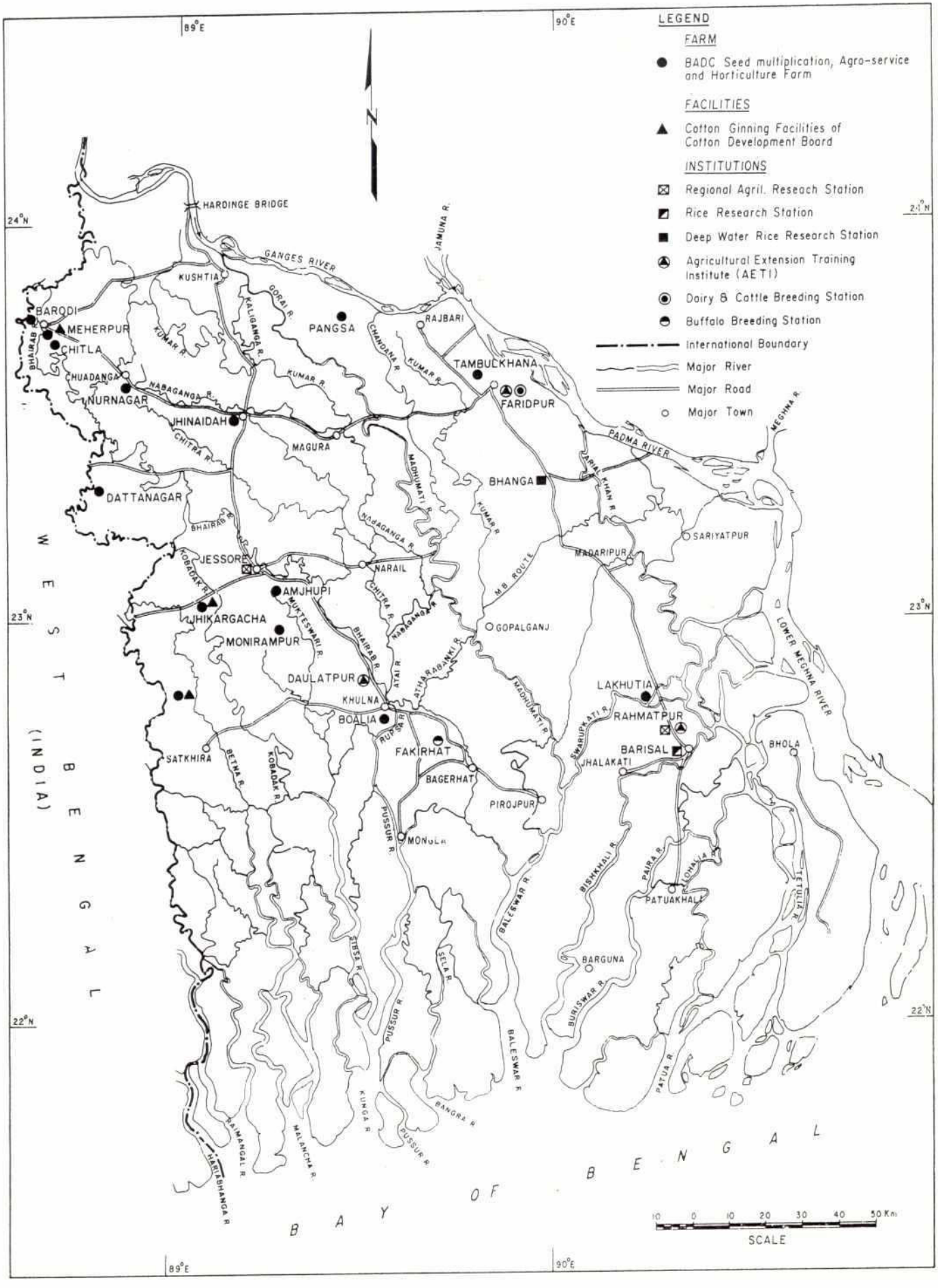
6.4 Directorate of Livestock Services (DLS)

Animal care and development of the livestock resources of the country are taken care of by the Directorate of Livestock services. This Directorate has their officers and staff up to thana level who are supervised by the District Livestock Officers. Government has taken up a programme to provide a veterinary hospital and artificial insemination facilities to each thana for the benefit of the farmers. But due to lack of resources, only a few thanas have been provided with these facilities uptil now.

In the SWA Livestock Directorate has one Dairy and Cattle Breeding Station at Faridpur and a Buffalo Breeding station at Fakirhat, Bagerhat.

The existing agricultural farms, facilities and institutions located in the SWA have been shown in Table 6.1 and Figure 6.1.

Figure 6.1



Existing Agricultural Farms, Facilities & Institutions

TABLE 6.1

Existing Agricultural Farms, Facilities & Institutions in SWA

N a m e	Location	District
FARMS		
	Dattanagar	Jhenaidah & Chuadanga
	Meherpur	Meherpur
	Barodi	Meherpur
	Chitla	Meherpur
	Nurnagar	Chuadanga
BADC Seed Multiplication, Agro-Service and Horticulture Farms	Sadhukati	Jhenaidah
	Tambulkhana	Faridpur
	Pangsha	Rajbari
	Amjhupi	Jessore
	Manirampur	Jessore
	Jhikargacha	Jessore
	Boalia	Khulna
	Lakhutia	Barisal
	Kalaroa	Satkhira
FACILITIES		
	Kalaroa	Satkhira
CDB Cotton Ginning Facilities	Jikargacha	Jessore
	Meherpur	Meherpur
INSTITUTIONS		
Regional Agric Research Station of BARI	Khairatala	Jessore
	Rahmatpur	Barisal
Rice Research Station	Sagardi	Barisal
Deep Water Rice Research Station	Bhanga	Faridpur
	Daulatpur	Khulna
Agric Extension Training Institute	Rahmatpur	Barisal
	Faridpur	Faridpur
Dairy & Cattle Breeding Station	Faridpur	Faridpur
Buffalo Breeding Station	Fakirhat	Bagerhat

7 CONSTRAINTS TO AGRICULTURAL DEVELOPMENT

7.1 Introduction

The review of the land resources and agriculture of the SWA together with field visits and the results of FAP 12, FCD/I Agricultural Study have lead to the identification of several constraints facing the further development of the region. The constraints identified are described below and the measures needed to alleviate them are described in section 9.

7.2 Physical Constraints

The climate of the region dictates that there are three distinct seasons each influencing crop production in a different way. The kharif period is divided into two seasons each with distinctive agroecological characteristics and cropping patterns.

The kharif 1 season is the pre-monsoon period when variable rainfall may lead either to an excess of water or a shortage both leading to crop losses. Early flash floods may lead to damage of the boro crop whilst late rains may delay the planting of aus.

The kharif II period, whilst it generally reflects an excess of rainfall over PET which can lead to accumulation of runoff and inundation, is also marked by dry periods which can delay transplanting, retard crop growth and reduce yields of the aman rice crop. As the aman crop is the main rice crop of Bangladesh the consequences may be serious.

The end of the kharif period is variable and this can lead to problems of water shortage during the grain filling period of Aman rice unless irrigation is provided.

In the rabi season crops are dependent on stored soil moisture for the major part of their growing period. Delays in harvesting the Aman crop or an early end to the kharif period can reduce the residual soil moisture and limit the opportunities for rabi cropping. Farmers will not invest in inputs for a low output crop unless irrigation is provided. Without irrigation, cropping is confined to low lying areas which dry out later than the ridge soils that is the F2 and some F3 land. The principal crops grown without irrigation are pulses and oilseeds.

Soil

The soil of the SWA presents a number of constraints to crop production. In the coastal districts, dry season soil salinity limits rabi cropping and delays kharif production until rainfall is sufficient to reduce salinity below a threshold which varies with the crop grown. A total of 0.829 million ha is estimated to be affected by dry season salinity in excess of 4 mmhos/cm. The result of this is that dry season cropping is limited to those areas where irrigation water of sufficient quality is available to leach the soil. This would be from groundwater in areas where surrounding rivers are saline in the dry seson.

Potential acid sulphate soils do not directly limit crop production other than through poor drainage and, perhaps seasonal flooding. However, they should not be drained as the acidity will increase dramatically and prevent crop growth. An area of 112 km^2 has been identified as being at risk in the SWA.

Peat and muck soils are cultivated but have limited potential. They are associated with areas of deep and also early flooding which limits the land use to either B.aman or fallow during the Kharif period. If irrigation is provided then HYV boro can be grown if not, then local boro, oilseeds or pulses might be grown on residual moisture.

Such soils should not be allowed to dry out as they will dry irreversibly and shrink thereby lowering the ground level again creating drainage problems.

Nutrient deficiencies occur in almost any soil. If high yields are to be obtained from improved varieties then fertilisers must be used at rates higher than at present.

Micronutrient deficiencies particularly of zinc and sulphur are common in the SWA. Zinc deficiency is associated with alkaline top-soils which are quite widespread in the SWA; sulphur deficiency also occurs and varies with organic matter status of the soil and crop grown. Fertilisers to correct this situation are not generally available.

Organic matter contents may be low particularly on higher lying ridge soils. The use of green manures such as sunhemp or Sesbania would be beneficial and although recommended will only be taken up after suitable on-farm research to see how the technique can be fitted into the existing farming system.

The texture and drainage of soils present problems. Low lying, fine textured soils of poor drainage status remain wet into the dry season. They are sticky and plastic when wet but very hard when dry which restricts the period when the soil is at a suitable moisture content for cultivation. Further, they dry quite rapidly, limiting rainfed rabi crop production. Soils on ridges are often of coarser texture with higher permeability. They are easier to cultivate but moisture retention also limits rainfed rabi production. Such soils are often in land type F0 which may be above normal flood/inundation levels and do not provide a receding water table for crop growth.

The depth of inundation/flooding is a limiting factor to crop production. Although cropping patterns have developed in response to the seasonal pattern of flooding, benefits accrue from the changes in land use that occurs when land types change.

The area of land flooding at some period to a depth greater than 90cm (F2 and above) is about 5450 km² or approximately 25% of the net cropped area. The area of lowland, F3 is about 6% of the net cropped area. Deep flooding is most widespread in the east central and northeast of the Area in P.U. SW7, 10 and 13 and SC3 and 4.

It must be remembered that flooding and inundation may have beneficial effects such as the addition of silt to the land which contains weatherable minerals which will release nutrients to crops.

The damage to crops due to flooding in the SWA has been calculated for a nineteen year period from data obtained from BBS and the Ministry of Relief. The results are shown in Table 7.1 below.

TABLE 7.1

Area of Crop Damage by Districts, SWA

Crop	19 Year Crop Damage (Percentage)						SWA Overall Average
	Kushtia	Jessore	Khulna	Faridpur	Barisal	Patuakhali	
Aus (L)	4.58 (9)	17.22 (3)	12.85 (4)	7.93 (8)	8.47 (5)	9.27 (3)	8.57
Aus (HYV)	10.45 (5)	18.68 (3)	37.52 (1)	43.03 (2)	3.69 (2)	45.87 (1)	13.88
Aman (B)	7.67 (9)	26.56 (4)	27.62 (4)	13.06 (10)	17.04 (5)	- -	14.82
Aman (T)	7.25 (5)	7.47 (3)	1.31 (3)	65.61 (6)	4.02 (4)	- -	4.72
Aman (HYV)	9.08 (3)	28.94 (2)	2.03 (2)	61.37 (3)	18.43 (3)	- -	18.71
Boro (L)	1.39 (1)	15.52 (1)	- -	- -	- -	- -	10.79
Boro (HYV)	1.86 (4)	9.22 (1)	5.37 (1)	11.81 (1)	1.30 (2)	11.39 (1)	6.45
Jute	1.44 (10)	18.37 (4)	15.85 (2)	5.70 (7)	12.29 (2)	- -	6.27
Sugarcane	1.29 (7)	1.39 (3)	- -	12.04 (5)	4.60 (1)	- -	4.17
Average	4.87	16.52	14.38	23.52	9.92	17.01	9.22

Notes: (1) Figures in parentheses indicate number of years damage occured.
(2) Districts mean greater districts.

In the table, the planning units have been grouped according to similar levels of crop losses. The average losses in crop area is usually less than 5 percent except for Planning Units SW 3,6,7 and SC 1,2,3. These are the Planning Units with the largest areas of deep flooding (F2 and F3) as shown in Figures 2.8-2.12. The crop losses for boro rice averaged over the period are less than one percent of the crop area.

The losses due to floods in the SWA are generally lower than in other floodplain regions of Bangladesh, for example the NW and NE and reflects the lower incidence of deep flooding.

The losses have been taken into account in calculating agricultural production in the present and the future without and with situations as explained in Volume 10, Economics.

7.3 Input Supply

Fertiliser distribution has been privatised but the availability of fertiliser to the farmer at the time it is needed and at a cost that they can afford is still limited. Fertilisers when purchased are applied to the rice crop and to sugarcane but rarely to pulses, oilseeds and other minor crops. The problem is particularly acute for the small farmer who faces difficulties in obtaining fertiliser at the right time and in the correct quantities.

Most farmers are not trained to use pesticides. Pesticides should only be used when pest attack attains a certain threshold value. Farmers are not sufficiently knowledgeable to scout their crops and apply pesticides at the correct time and rate. The quality of pesticides supplied by the dealers are often found to be adulterated. There is a need for proper labelling and packaging of dangerous chemicals.

The Consultants have undertaken several surveys during the course of the study and respondents have repeatedly emphahsised the problems that they face now that subsidies on inputs are being removed. This applies not only to fertilisers and pesticides but also to irrigation equipment and the construction of tubewells. Farmers in many areas consider the cost of inputs now that subsidies have been removed to be the principal constraint they face, in many cases greater than or at least equal to physical constraints such as inundation.

In the two peak seasons, that is in the transplanting of aman rice and harvesting of aus and jute and during transplanting of boro and other rabi crops, a temporary labour shortage is created. This is particularly the case in Barisal, Patuakhali and Kushtia. These shortages create an impediment to timely harvest and planting of crops.

Except for a few large farmers, most agricultural operations are carried out by bullock power. As mentioned earlier, FAP 12 has identified a draught power shortage and this has been confirmed during the course of this study. In June - July and December - January this shortage becomes acute resulting in inadequate land preparation affecting the yield of crops.

Agricultural extension and training need to be strengthened. Although the area and yield of rice has increased, further improvements are needed to build on this. The adoption of HYV's, the correct use of fertiliser and pesticides and improved water management are all needed. The diversification of cropping to encourage pulse production should be pursued otherwise there will be a continued deterioration in protein consumption.

The extension services have a crucial role to play in this if the farmers are to get the benefits from improvements in FCD/I. Further measures to strengthen this are needed.

7.4 Other Constraints

Cultivation of HYVs require substantial capital investment in the form of fertilisers, pesticides, improved seeds and irrigation. However, most farmers are unable to afford the investment required to obtain the desired return. Loans provided by BKB, Grameen Bank and other commercial banks are inadequate and the system is also very complex.

Farmers do not get a fair price for their produce due to instability in the market. In a year, when a bumper crop is harvested due to lack of market intervention the farm gate price goes down abnormally thereby discouraging the farmers. The harvest of aman crop of 1992, jute production of 1988, and potato production of 1991 are classic examples of such price fluctuations.

Few farmers can thresh and store their produce properly. For threshing of harvested crops either bullocks are used or they are beaten by bamboo sticks or on steel drums on wet earthen floors. This results in considerable wastage and deterioration in quality of the produce. Paddle threshers are becoming popular for threshing rice by the farmers. Measures should be taken to make available wheat and pulse threshers also.

Crops harvested in the rainy season, especially boro and aus are damaged to a large extent because of a lack of proper drying facilities. BRRI has evolved small scale drying equipments which can be easily operated by the farmers. This method should need proper extension.

Under improper storage a large percentage of stored grains are damaged by pest attack. The appropriate technology of storing and fumigation should be extended.

The road transport system in the rural areas is primitive and this acts as one of the main barriers for the farmers to market their produce properly. It is particularly true in case of perishable goods such as fruits and vegetables. Further development of the road and transport system will enable the farmer to market their produces at commercial centres instead of selling at the farmgate.

The decline in the area and production of fodder has consequences not only for livestock production but also for crop and fuel production. The increase in small ruminants and poultry may help offset the decline in protein intake but does little or nothing to help in draught power and fuel requirements.

8 OBJECTIVES AND POLICIES FOR AGRICULTURAL DEVELOPMENT

8.1 Introduction

The constraints identified above can be summarised as:

- insufficient provision of water for dry season and supplementary irrigation.
- inadequate supply of agricultural inputs including extension and training
- flooding and poor drainage

The GOB has taken these factors into account in preparing the agriculture programme of the Fourth Five Year Plan (FFYP). The stated objective is to :

1. Achieve food grain self-sufficiency
2. Increase substantially the production of minor crops
3. Continue the modest growth in other crops

Further the FFYP states that these objectives will be achieved through a strategy focusing on the following subject matter areas:

- crop diversification
- minor irrigation
- fertiliser
- seeds, plant protection and mechanisation
- extension
- research
- marketing
- area development and targeted programmes.

The following section will consider the first five of these subjects in relation to the SWA. A short summary of the more important projects not described below is given in Appendix D.

8.2 Crop Diversification

The north of the south west region is an important pulse producing region. In 1991 the SWA, produced 65% of the national output of lentil and 61% of the output of chickpea. Pulses are an important source of dietary protein and at a national level production declined, on average by 2.67% annually between 1979-80 to 1987-88. In the SWA production has in fact increased. The cultivation of pulses is extermely important in the coastal districts of Barisal, Patuakhali and Khulna.

The production of oilseeds is important throughout the SWA. The national increase in oilseed production averaged 1.6 percent per annum in the period 1979-80 to 1987-88. In the SWA, the increase has averaged 2.98 percent in the ten year period to 1990-91.

The FFYP aims to continue this increase by focusing the development effort in pulses, oilseeds and other minor crops through the crop diversification programme. In fact, the target for the increase of minor crops is set at 7.6% per annum (1989-90 to 1994-95), this includes an increase in cropped area of 2.4% for pulses, 3.1% for oilseeds and 5.7% for spices.

Given the overriding preference of farmers to produce rice, the crop diversification strategy will aim not to compete with cereal crops directly, but rather to demonstrate the profitability of these crops by offering 'high technology packages' and demonstration.

The GOB is implementing the policy of diversification through the Crop Diversification Programme. The programme is being implemented by the Ministry of Agriculture with the financial assistance of CIDA. Originally it was initiated in 90 Thanas of which 41 are in the SWA in the greater districts of Faridpur, Kushtia and Jessore which have the highest potential for crop diversification. From 1991-92, six more thanas within the same district have been added to the original list of 41. The crops includes:

Pulses : Blackgram, Mungbean, Lentil, Chickpea and Soybean
Oilseeds : Mustard, Groundnut and Sunflower
Rootcrops : Mainly potato

In addition to the above crops, maize is also included in the CDP from 1992-93.

To induce the farmers to adopt research based technology, DAE are setting up demonstration plots in selected farmers fields. Improved seeds, fertilisers and pesticides are made available to the participating farmers along with technical know how for correct management of the crop both in the field as well as for post harvest operations. Marketing facilities are also to be provided.

8.3 Minor Irrigation

The National Water Plan (MPO, 1991), identified 18,844 sq km of land as suitable for irrigation in the SW and SC regions. The climate of the region identified three periods when irrigation is required. The first period is the rabi season, the second season is the pre-kharif transition to benefit the latter half of the boro crops and/or the beginning of the aus crops and the third period(s) is during the kharif when dry periods can occur at almost any time but are particularly damaging at transplanting of aman rice and during the reproductive and grain filling stage.

The intensity of cropping during the rabi period is generally low with an overall intensity of about 50%. There is considerable need and scope to extend the area irrigated to increase crop production. There is scope for this as only about 33% of the land suitable for irrigation in the SWA is currently irrigated.

Minor irrigation has increased significantly, particularly in the second half of the 1980's. The FFYP proposes an increase of 300,000 ha in irrigated area per annum nationally. In the SWA this would mean an increase in irrigated area of about 70-80,00 ha per year mainly through STW, LLP and DTW.

The policy with regard to minor irrigation is being implemented through The National Minor Irrigation Project.

The GOB has initiated The National Minor Irrigation Development Project with the financial assistance of IDA/WB and EC with effect from 1993 to achieve this by:

(a) providing wider and more equitable access to minor irrigation through the introduction of more affordable and manageable irrigation technology

(b) institutionalising policy changes recently introduced by GOB to liberalise trade and siting of equipment

(c) upgrading BADC's capability to support the private sector through advice, market information and quality enhancement

(d) facilitating access to deep well (DTW) ownership to various forms of associations beside traditional co-operations

(e) assisting GOB in introducing and maintaining a nation-wide consistent approach to minor irrigation development.

To this end, the project will provide finance for

(i) procurement and installation of new DTW's,
(ii) rehabilitation of existing DTW's,
(iii) improvement of drainage canals,
(iv) installation of pontoon mounted pump schemes.

The project also finances demonstration irrigation systems; capacity building technical assistance in such areas as environment protection; information dissimination and private sector support; and technical assistance to support project implementation.

The project expects to create favourable conditions for a cost-effective approach to minor irrigation development and a reduction in the burden on the public sector through the elimination of subsidies on DTW.

Besides BADC, BRDB, DAE, NGOs and institutional credit agencies like BKB, BSB, TCCAS will also be involved in the project.

As per preliminary estimate, six thanas of SWA would be selected for ground water development whilst the entire area would benefit from surface water development component of the project. The pontoon mounted pumps will primarily be located in the coastal zone where tidal freshwater is associated with saline ground water.

8.4 Input Supply

This is taken to include fertilisers, pesticides, seeds, mechanisation and extension. The strategy for promoting the increased use of fertiliser, seeds, pesticides and mechanisation relies on

- promoting competitive markets
- educating farmers about proper use
- deregulating imports
- removing subsidies

The strategy for improving extension, and to an extent inputs, includes the strengthening of DAE through the Agricultural Support Services Project initiated by GOB with financial support of WB/IDA and ODA. The project support and institutional reform process is aimed at:

(a) making technology transfer more responsive to farmer needs and improving outreach capabilities so that all sections of the rural community specially women, have access to improved technology;

(b) upgrading extension training;

(c) increasing the availability to farmers of improved seeds by ensuring participation of private seed companies in the supply of both food and cash crop seeds, and removing restrictive seed regulations;

(d) improving the cost effectiveness of public sector services through more efficient outreach services and reduction in staff; and

(e) promoting crop diversification and agro-business opportunities to increase the production options for farming enterprises.

The project has the following components:

(i) Technology transfer: through on-farm demonstration field days and extension meetings, media campaigns and extension pamphlets, creation of thana special initiative fund and extension service facilities.

(ii) Training : through inservice training of extension workers of all levels, career development training for Block Supervisor (BS), farmer and other client group training.

(iii) Seed Industry Development : through improvement and expansion of maintenance breeding and breeder seed multiplication; foundation and certified seed production; providing assistance to the private seed growers.

(iv) Homestead Production: through strengthening of women coordination programme in each thana.

(v) Agro-business Development : through support for development of horticultural exports.

(vi) Monitoring and evaluation.

Besides, DAE, BRRI, BARI, BADC, SRTI, BJRI, NSB and NGOs and private seed companies are involved in the project activities.

The project covers the whole of Bangladesh including SWA.

8.5 The Role of FCD and I

The FFYP for Agriculture, states that the objective of government policy must be to provide a more stable, less risk prone environment for farmers. The two ways to achieve this are to firstly increase rabi season production and secondly expand the area of FCD to reduce risks to kharif season cropping. The two strands of the strategy are seen as broadly complementary although acknowledging that FCD is not necessarily a pre-requisite for rabi season cropping except in those areas of early flash floods.

As outlined above, there are several ways to stimulate agricultural production which do not involve FCD. However, more benefit may accrue from FCD if it is pursued together with non-structural interventions such as input delivery, credit and marketing initiatives.

The Consultants are not proposing to include such initiatives as part of the future, with project situation. Yield prediction, for example do not include an increase due to increase in fertiliser use above that which farmers are already using. It would undoubtedly be beneficial if non FCD programmes can be included in any future FCD developments but benefits that will occur due to other initiatives, such as crop diversification or extension improvement cannot be included in the analysis of FCD.

It is strongly recommended that a policy of integration of FCD and non structural initiatives be pursued.

Irrigation has the potential to make significant contributions to crop production and agricultural development. Firstly it can extend cropping into the rabi season and secondly it can provide supplementary irrigation during the kharif I and kharif II seasons.

9 AGRICULTURAL DEVELOPMENT POTENTIAL

9.1 Development Area

As discussed in Chapter 3, the net cultivable areas in the Southwest (SWR) and South Central (SCR) regions are about 15,990 km² and 9,100 km² respectively. Approximately 32% (5152 km²) of the area in SWR and 52% (4735 km²) in SCR have been protected by existing FCD schemes. In addition, some of the FCD and non FCD areas totalling 4370 km² in SWR and 2040 km² in SCR are under irrigated agriculture, while rainfed agriculture is practiced in the remaining cultivable areas.

The water resources management analyses carried out as a component of the current studies relating to the Southwest Area (SWA) have identified several development options in the two regions. According to these options, additional areas totalling 8793 km² are proposed to be brought under improved water management, including controlled flooding, controlled drainage and irrigation. The development of the new areas in SWR (6468 km²) will depend on possible augmentation of the dry season river flows to SWR from the Ganges River, the level of augmentation being greatly increased by the incorporation of a Ganges Barrage.

According to the land resources study (Chapter 2), there are certain areas in SWA which have problem soils such as peat soil, acid sulphate soil and saline soil and these areas have been excluded from the proposed development.

9.2 Change in Land Type

Controlled flooding and drainage will bring major changes in the land type according to flood depth. The average flooding conditions in the pre-project (from MPO) and post-project condition (derived by Consultants) are shown below:

Land Type	Pre-Project Area (Percentage)	Post-Project Area (Percentage)
F0	26	55
F1	52	40
F2	16	5
F3 + F4	6	-

9.3 Cropping Patterns

The present cropping pattern and the crop calendar under rainfed conditions for the proposed additional irrigated area without augmentation have been presented in Table 9.1 and Figure 9.1.

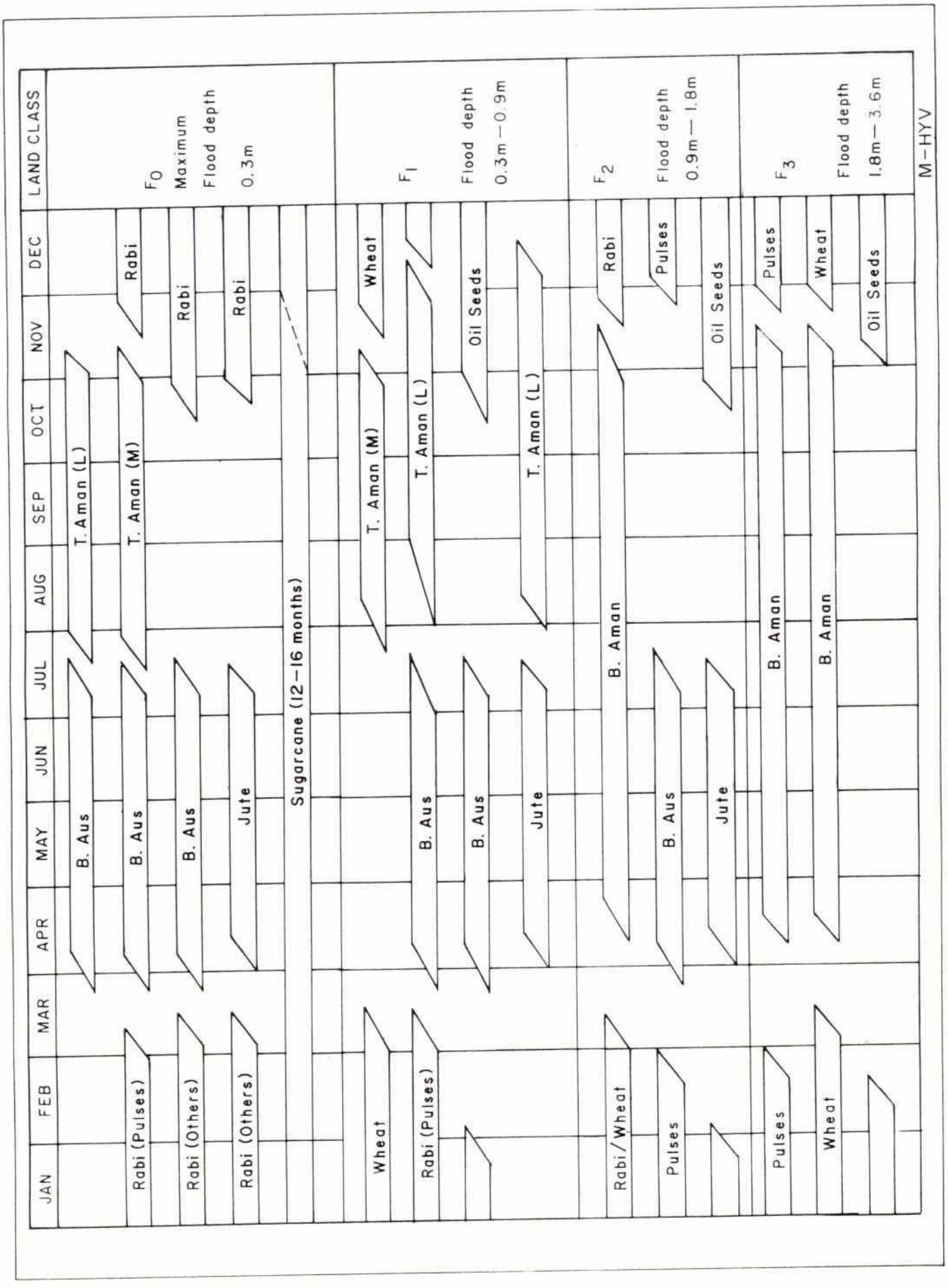
TABLE 9.1

Present Cropping Patterns Under Rainfed Conditions for the Proposed Additional Irrigated Area of 879,300 ha

Land Type	Patterns	Area (Ha)
F0 228600 (Ha)	B.Aus - T.Aman (L)	26700
	B.Aus - T.Aman (HYV)	26800
	Jute - T.Aman (L)	9200
	Jute - T.Aman (HYV)	7400
	T. Aman (L)	76100
	B.Aus - Pulse	14900
	- Oilseed	14800
	- Wheat	14000
	- Vegetables	4300
	- Spices	6000
	Jute - Pulse	1900
	- Oilseed	2200
	- Wheat	5400
	- Vegetables	3700
	- Spices	3700
	Sugarcane	11500
F1 457200 (Ha)	T.Aman (L)	172000
	B.Aus - T.Aman (L)	103300
	B.Aus - T.Aman (HYV)	49500
	Jute - T.Aman (L)	10400
	Jute - T.Aman (HYV)	10300
	T.Aman (L) - Wheat	11100
	- Pulse	34400
	- Oilseed	17100
	- Spices	16100
	- Veg.	8500
	B.Aus-T.Aman (L) - Pulse	9200
	- Spices	8500
	Sugarcane	6800
F2 140700 (Ha)	B.Aman - Pulse	35600
	- Oilseed	16000
	B.Aman - Fallow	89100
F3 & F4 52800 (Ha)	B.Aman - Fallow	52800
Single cropped Area		408300
Double cropped Area		906600
Tripple cropped Area		53100
Total cropped Area		1368000
Net Cropped Area		879300
Cropping Intensity		156%

Source: MPO, BBS and Consultants estimate

Figure 9.1



Present Crop Calendar

On the basis of the above changes in the land-type categories, future cropping patterns have been prepared assuming that full irrigation in the rabi season and supplementary irrigation in the wet season will be available. Soil properties have also been taken into consideration in preparing these patterns.

Proposed cropping patterns and crop calendars are shown in Table 9.2 and Figure 9.2

As usual with availability of irrigation water, the area under high yielding boro varieties will increase. Low yielding broadcast aus will be totally replaced by transplanted rice. Only modern varieties have been suggested for F0 land, but for t.aman in F1 land both local and modern varieties have been shown as flood depth after boro will not permit timely transplanting of modern varieties in all areas. In F2 land, transplanting of deep water rice varieties have been shown after harvest of boro as dry sowing will not be possible. This practice recommended by BRRI is gaining wide popularity in flood prone areas. BRRI has developed a number of high yielding rice varieties suitable for aus, aman and boro seasons having variable life cycles and seedling and plant heights. There will be no restrictions in selecting rice varieties to fit into the proposed cropping patterns.

TABLE 9.2

Proposed Cropping Patterns for Additional Irrigated Area of 879,300 ha

Land Type	Cropping Pattern		Area (ha)
F0 483600 ha	Boro (HYV)	- T. Aman (HYV)	233000
	T.Aus (HYV)	- T.Aman (HYV)	24400
	Jute	- Wheat	29600
		- Mustard	14400
	T. Aus(HYV)	- Mustard	36800
		- Vegetables	5500
		- Potato	7200
	T.Aus (HYV)-T.Aman (HYV)	-Pulse	33400
		- Vegetables	10600
		- Potato	7200
		- Spices	18400
	Sugarcane		35700
	Orchard (Banana, Papaya etc)		27400
F1 351700 ha	Boro (HYV)	- T. Aman (L)	203200
	Boro (HYV)	- T. Aman (HYV)	64900
	T. Aus (HYV)	- T. Aman (HYV)	19500
	T. Aus (HYV)	- Mustard	13000
		- Wheat	19500
		- Vegetable	5000
		- Potato	3000
	T.Aus (HYV)-T.Aman (HYV)	-Pulse	7600
		- Spices	8000
		- Vegetables	8000
F2 44000 ha	Boro (HYV)	- Fallow	20900
	Boro (HYV)	- DWT Aman	23100
Single cropped Area			84000
Double cropped Area			1404200
Tripple cropped Area			279600
Total cropped Area			1767800
Net cropped Area			879300
Cropping Intensity			201%

Source: Consultants estimate

Proposed Future Crop Calendar

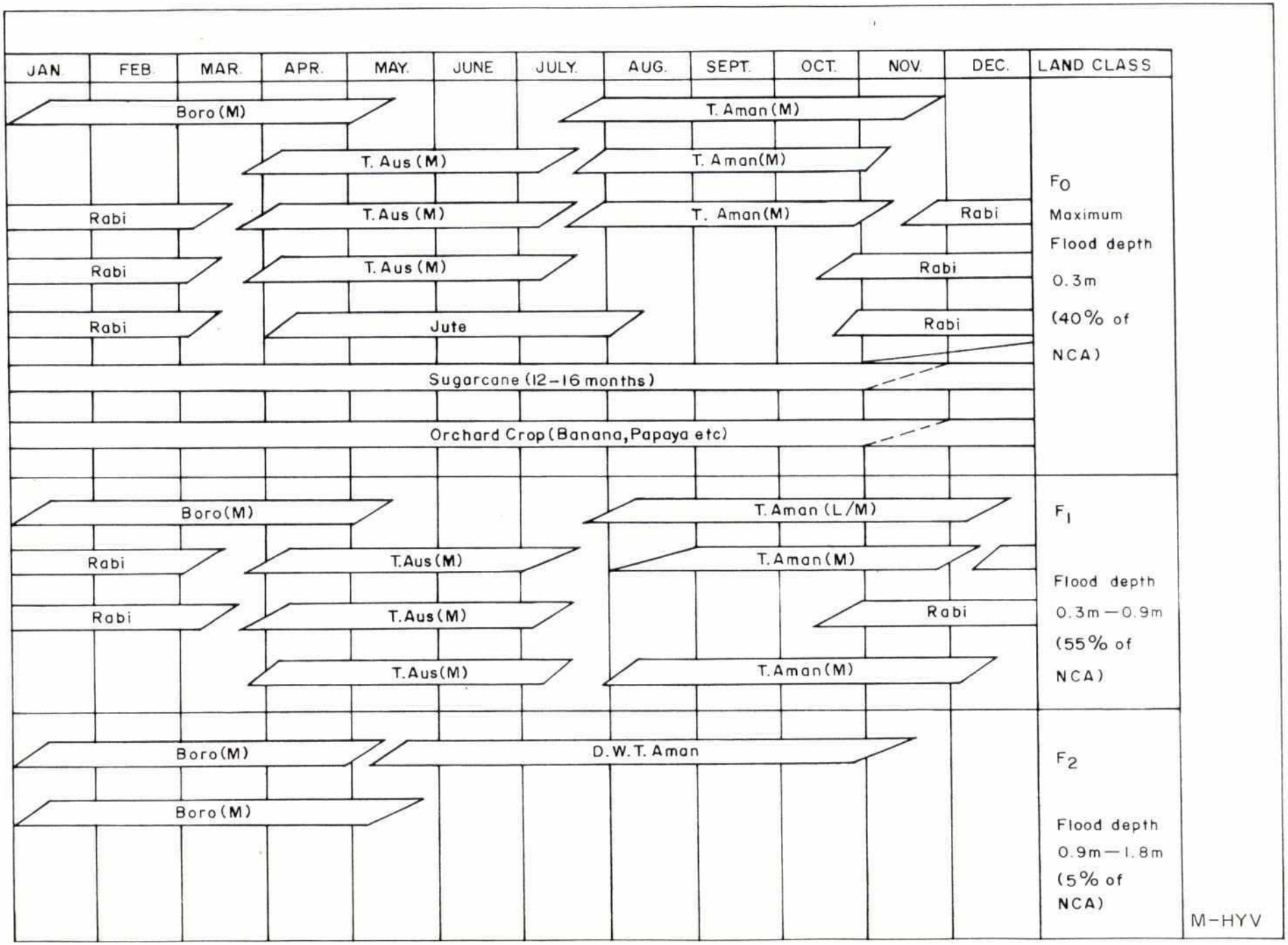


Figure 9.2

Jute is not an irrigated crop and the prices received by the farmer are low. As such, farmers are discouraged from growing jute. However, some areas of jute have been shown in the proposed pattern so that it may meet the farmers' individual and local demands.

Orchard crops like banana and papaya are highly profitable under irrigated conditions and these will be grown in flood free permeable light soils. Wheat requires much less water than boro and as such substantial increase in the wheat area has been proposed. Varieties specially developed like 'Agrahayani' for late planting in the southern districts will help the programme. Introduction of irrigation will considerably reduce the area under pulses because of their low yield and the non-availability of high yielding varieties.

At present the country has a defecit in sugar of about 150 - 200 thousand tons annually. With the rapid growth of population and increasing sugar demand the deficit will increase. GOB has plans to set up new sugarmills to meet the increased demand. Sugarcane responds well to irrigation and at least one ratoon crop can be raised from it. A Substantial increase in sugarcane area has been proposed.

Presently Potato is a minor crop in the area. Potato is very responsive to irrigation and under irrigated conditions its yield can easily be raised to 15 - 20 tons from the present level of 8/9 tons per hectare. So some areas under potato have been proposed.

In preparing the proposed cropping pattern the existing government policies like crop-diversification and minimization of nutritional imbalance have been taken into consideration.

9.4 Cropping Intensity

At present about 46% of the net cultivated area is single cropped, 52% double cropped and only 2% triple cropped. The average cropping intensity is 156%.

Under the proposed patterns the cropping intensity will increase from the present 156% to 201%. Net cultivated areas under single, double and triple cropping will be approximately 9.6%, 79.8% and 10.6% respectively.

In the G-K project area the cropping intensity of irrigated areas is 233% and the overall intensity 221% in 1989. (Review of options for the development of ground and surface water irrigation, 1992 by RDC & Mott McDonald). In Gumti Phase-I sub-project, this intensity is 201.6% (Gumti Phase I - sub-project. Final Report on Agro-Socio-Economic Aspect 1989, Sarm Associates Ltd). In the greater districts of Jessore and Kushtia the cropping intensity is around 200% (DAE), while in the whole of SWA it is 159%. The proposed area under development is very large compared to G-K and other on-going projects. The proposed cropping intensity of 201% for the whole of 879,300 hectares to be brought under FCDI is thought to be achievable over a realistic built up period and with sufficient supporting services.

9.5 Input use

In order to achieve the crop yields under irrigated agriculture, proper use of seeds, fertilisers, pesticide as well as appropriate management practices are needed.

At present, BADC through its seed multiplication farms and contact growers system produces quality seeds for distribution among farmers. But only a tiny fraction of the farmers need is met from this source. Most of the farmers use their own seed or procure it locally, this is often mixed or of sub-standard quality. It is expected that in future quality seeds will be available to them through strengthening of the seed sector.

Balanced use of fertilisers is a pre-requisite for obtaining more yield and maintaining soil productivity. At the moment very few farmers use recommended doses of fertilisers. They use mostly Urea and smaller quantities of phosphatic and potassium fertiliser in the form of T.S.P., S.S.P. or M.P. Of late, zinc and sulphur deficiency symptoms have appeared in soils particularly in the SWA which have high. Under continuous flooding, these deficiencies will increase. Research findings show that besides major elements (N, P, K, Zn and S) micronutrients like Copper, Manganese, Molybdenum application increases crop yield. The deficiency of these micronutrients can best be met by application of organic manures.

The practice of rhizobium fertiliser application is becoming popular in neighbouring countries. The Microbiology section of BARI and Soil Science Division of BAU, Mymensingh and Dhaka University have isolated several strains of rhizobium specific for different pulses which increase nodulation substantially thereby increasing pulse yield. BARI is equipped to produce rhizobium fertilizer commercially. It is expected that rhizobium inoculation will be commercially used in Bangladesh in the near future.

Indiscrimate use of insecticide due to lack of proper knowledge by farmers may do more harm than good. Farmers training in the use of pesticides will be needed. The cultural management aspect i.e. integrated pest management (IPM) should be emphasised.

Draught power shortage is a constraint for timely and adequate preparation of land which is most essential to realise maximum benefits from irrigated agriculture. With the introduction of modern rice varieties and increase in the cropping intensities this shortage will be intensified. Mechanisation of agriculture with small implements for land preparation, threshing and other operations should be encouraged.

9.6 Yield and Production

Crop yields under both irrigated and rainfed condition have been presented in Table 3.8 based on the average of five years BBS data. Present and future crops, yield and production from the additional area of 879,300 ha proposed to be brought under FCDI have been presented in Table 9.3 and 9.4. Table 9.5 summarises the present and future production of different crops. From this table it is seen that after implementation of the project there will be an additional cereal (rice and wheat) production of 3107280 tons (which will be equivalent to more than 2 million tons of rice). For understandable reasons Pulse, Spices and Jute production will decrease. There will be substantial increase in sugarcane, orchard fruits (banana, papaya), potato, vegetables and oilseeds production.

TABLE 9.3

Present Crops, Yield and Production from the Additional Area of 879,300 ha Proposed to be Brought Under FCDI

Crop	Area (Ha)	Yield (t/ha)	Production (ton)
B. Aus	278000 (20.3)	1.2	333600
T. Aman (L)	502600 (36.7)	1.9	954940
T. Aman (HYV)	94000 (6.9)	3.2	300800
B. Aman	193500 (14.2)	1.2	232200
Wheat	30500 (2.2)	1.7	51850
Sub-Total Cereal	1098600 (80.3)		1873390
Pulses	96000 (7.0)	0.75	72000
Oil Seeds	50100 (3.7)	0.75	37575
Vegetables	16500 (1.2)	8.0	132000
Spices	34300 (2.5)	3.0	102900
Jute	54200 (4.0)	1.7	92140
Sugarcane	18300 (1.3)	41.0	750300
Sub-Total Area (other crop)	269400 (19.7)		
Total Area	1368000 (100.0)		

Percentage of total cropped area shown in parenthesis

Source: MPO and Consultants' estimate.

TABLE 9.4

Future Crops, Yield and Production from the Proposed Additional Area of 879,300 ha to be Brought Under FCDI

Crop	Area (ha)	Yield (t/ha)	Production (ton)
Boro (HYV)	545100 (30.8)	4.4	2398440
T. Aman (HYV)	435000 (24.6)	3.2	1392000
T. Aus (HYV)	227100 (12.9)	2.9	658590
T. Aman (L)	203200 (11.5)	1.9	386080
DWT Aman	23100 (1.3)	1.2	27720
Wheat	49100 (2.8)	2.4	117840
Sub-Total (Cereals)	1482600 (83.9)		4980670
Pulses	41000 (2.3)	0.70	28700
Oilseeds	64200 (3.6)	0.70	44940
Vegetables	29100 (1.6)	8.0	232800
Potato	17400 (1.0)	12.0	208800
Spices	26400 (1.5)	3.0	79200
Sugarcane	35700 (2.0)	50.0	178500
Banana, Papaya etc	27400 (1.6)	12.5	342500
Jute	44000 (2.5)	1.7	74800
Sub-Total (other crop)	285200 (16.1)		
Total Cropped Area	1767800 (100.0)		
Percentage of total cropped area shown in parenthesis			

TABLE 9.5

Present and Future Production of Different Crops for the Proposed Additional Area of 879,300 ha to be Brought Under FCDI

Crop	Present Production (ton)	Future Production (ton)	Increase/ Decrease (ton)
B. Aus	333600	-	-333600
T. Aus (HYV)	-	658590	658590
B. Aman	232200	-	-232200
DWT Aman	-	27720	27720
T. Aman (L)	954940	386080	-568860
T. Aman (HYV)	300800	1392000	1091200
Boro (HYV)	-	2398440	2398440
Wheat	51850	117840	65990
Total Cereal	1873390	4980670	3107280
Pulses	72000	28700	-43300
Oilseeds	37575	44940	7365
Vegetables	132000	232800	100800
Potato	-	208800	208800
Spices	102900	79200	-23700
Jute	92140	74800	-17340
Sugarcane	750300	1785000	1034700
Banana, Papaya etc	-	342500	342500

APPENDICES

APPENDIX A

Cropped Areas According to Planning Unit

Cropped Areas According to Planning Unit (Ha)

SW1	Irrigated				Non-Irrigated				Totals		
Crop	**F0**	**F1**	**F2**	**F3**	**F0**	**F1**	**F2**	**F3**	**Irrigated**	**Rainfed**	**Overall**
Kharif											
Aus (B)	0	0	0	0	36,514	28,547	13,659	0	0	78,720	78,720
Aus (HYV)	4,746	8,771	0	0	0	0	0	0	13,517	0	13,517
Aman (B)	0	0	0	0	0	84	13,144	1,407	0	14,634	14,634
Aman (L T)	168	16,456	257	0	10	70	0	0	16,881	79	16,960
Aman (HYV)	12,932	7,571	0	0	4,588	1,152	0	0	20,503	5,740	26,243
Jute	0	0	0	0	6,004	6,174	47	0	0	12,226	12,226
Sugarcane	2,499	979	0	0	1,022	1,299	0	0	3,477	2,322	5,799
Rabi											
Boro (L)	0	0	0	338	0	0	0	817	338	817	1,155
Boro (HYV)	2,426	7,359	1,031	4	1,319	0	0	0	10,820	1,319	12,140
Wheat (HYV)	7,380	8,509	1,487	0	440	3,612	0	290	17,377	4,341	21,718
Potato	0	237	48	0	487	0	208	53	285	748	1,034
Pulses	1,672	323	145	4	4,884	8,265	3,512	416	2,145	17,077	19,222
Oilseeds	963	2,111	0	4	2,686	971	1,335	425	3,078	5,417	8,494
Spices	371	46	0	0	440	943	0	0	417	1,383	1,800
Minor crops	1,621	200	0	0	0	5,059	0	0	1,821	5,059	6,880
Orchards	912	0	0	0	937	0	0	0	912	937	1,849
Totals	35,690	52,564	2,969	350	59,330	56,175	31,906	3,407	91,572	150,819	242,391
Total NCA	16,882	25,237	2,567	398	44,924	32,835	21,772	2,797	45,083	102,328	147,411
Average CI	211%	208%	116%	88%	132%	171%	147%	122%	203%	147%	164%

SW2	Irrigated				Non-Irrigated				Totals		
Crop	**F0**	**F1**	**F2**	**F3**	**F0**	**F1**	**F2**	**F3**	**Irrigated**	**Rainfed**	**Overall**
Kharif											
Aus (B)	0	0	0	0	3,086	5,631	3,228	0	0	11,946	11,946
Aus (HYV)	7,122	18,459	0	0	5	29	0	0	25,581	34	25,615
Aman (B)	0	0	0	0	0	625	1,941	631	0	3,197	3,197
Aman (L T)	6,319	31,591	580	0	67	453	1	0	38,490	521	39,011
Aman (HYV)	46,309	17,805	0	0	1,177	1,269	0	0	64,113	2,446	66,559
Jute	0	0	0	0	1,005	1,967	316	0	0	3,289	3,289
Sugarcane	8,195	1,165	0	0	896	274	0	0	9,360	1,170	10,529
Rabi											
Boro (L)	0	0	0	393	0	0	0	8	393	8	401
Boro (HYV)	39,750	27,900	3,520	164	3	0	0	0	71,334	3	71,337
Wheat (HYV)	9,054	8,667	2,268	0	16	981	45	2	19,989	1,043	21,032
Potato	0	19	1	0	282	0	0	0	20	283	302
Pulses	37	12,128	4	0	370	2,639	1,158	131	12,169	4,299	16,467
Oilseeds	1,905	8,125	2	0	315	295	551	23	10,032	1,183	11,215
Spices	2,522	1,741	0	0	12	32	6	0	4,263	49	4,312
Minor crops	3,799	7,576	4	0	11	212	6	0	11,379	228	11,608
Orchards	13	0	0	0	365	0	0	0	13	365	378
Totals	125,024	135,176	6,378	556	7,610	14,405	7,252	796	267,135	30,063	297,198
Total NCA	63,375	59,343	5,799	640	6,155	9,122	6,130	1,111	129,156	22,519	151,675
Average CI	197%	228%	110%	87%	124%	158%	118%	72%	207%	134%	196%

cland\sw\sw1

Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SW3	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigatec	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	15,844	23,117	4,183	0	0	43,144	43,144
Aus (HYV)	1,312	4,404	0	0	244	1,321	0	0	5,716	1,565	7,281
Aman (B)	0	0	0	0	0	6,226	21,416	7,045	0	34,687	34,687
Aman (L T)	240	7,532	409	0	245	1,736	0	0	8,182	1,980	10,162
Aman (HYV)	2,891	3,723	0	0	2,585	2,660	0	0	6,613	5,245	11,859
Jute	0	0	0	0	2,339	4,684	1,957	0	0	8,980	8,980
Sugarcane	63	3	0	0	3,135	1,419	0	0	67	4,555	4,621
Rabi											
Boro (L)	0	0	0	580	0	0	0	460	580	460	1,040
Boro (HYV)	1,685	6,584	3,154	45	0	0	0	0	11,468	0	11,468
Wheat (HYV)	1,354	4,072	873	0	694	4,142	2,039	0	6,299	6,874	13,173
Potato	6	119	0	0	229	24	21	0	125	274	399
Pulses	102	488	37	0	3,285	13,498	5,328	428	627	22,540	23,166
Oilseeds	80	446	37	2	1,439	6,026	2,653	162	565	10,279	10,845
Spices	84	213	0	0	516	1,368	303	0	298	2,188	2,486
Minor crops	75	737	33	0	478	1,898	282	0	845	2,658	3,503
Orchards	0	0	0	0	1,421	0	0	0	0	1,421	1,421
Totals	7,891	28,322	4,544	628	32,454	68,118	38,183	8,095	41,385	146,850	188,235
Total NCA	3,426	12,574	4,093	713	23,521	45,728	28,287	7,716	20,807	105,252	126,059
Average CI	230%	225%	111%	88%	138%	149%	135%	105%	199%	140%	149%

SW4	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigatec	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	28,564	16,052	3,983	0	0	48,599	48,599
Aus (HYV)	3,357	4,583	0	0	317	0	0	0	7,940	317	8,257
Aman (B)	0	0	0	0	0	4,430	10,534	3,442	0	18,406	18,406
Aman (L T)	4,360	11,028	371	0	7,903	10,459	450	0	15,759	18,812	34,571
Aman (HYV)	12,177	7,168	0	0	9,765	1,986	0	0	19,345	11,751	31,096
Jute	0	0	0	0	7,807	6,458	1,039	0	0	15,305	15,305
Sugarcane	1,316	304	0	0	2,663	380	0	0	1,620	3,043	4,663
Rabi											
Boro (L)	0	0	0	468	0	0	0	206	468	206	674
Boro (HYV)	9,520	11,042	2,710	254	25	0	0	0	23,527	25	23,551
Wheat (HYV)	4,305	5,254	529	0	504	1,522	2,803	877	10,088	5,705	15,794
Potato	87	387	36	0	413	253	4	1	510	671	1,181
Pulses	1,268	998	490	0	13,534	6,484	3,470	501	2,757	23,989	26,746
Oilseeds	693	1,025	217	0	4,973	5,705	1,814	141	1,936	12,632	14,568
Spices	314	296	0	0	392	272	0	0	610	664	1,274
Minor crops	1,291	2,326	76	0	700	1,099	0	0	3,693	1,799	5,492
Orchards	21	0	0	0	2,403	0	0	0	21	2,403	2,424
Totals	38,710	44,412	4,429	723	79,963	55,099	24,097	5,168	88,274	164,326	252,600
Total NCA	18,531	20,783	3,708	831	55,020	34,309	16,266	4,942	43,852	110,537	154,390
Average CI	209%	214%	119%	87%	145%	161%	148%	105%	201%	149%	164%

Continued

Source : MPO (1989 - 1990)

Cropped Areas According to Planning Unit (Ha)

SW5	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	7,479	9,645	1,885	0	0	19,008	19,008
Aus (HYV)	640	1,643	0	0	96	505	0	0	2,283	601	2,884
Aman (B)	0	0	0	0	0	2,688	9,431	3,117	0	15,235	15,235
Aman (L T)	292	2,913	150	0	599	1,680	204	0	3,355	2,483	5,838
Aman (HYV)	1,559	1,550	0	0	1,630	1,240	0	0	3,109	2,869	5,978
Jute	0	0	0	0	1,266	2,091	828	0	0	4,184	4,184
Sugarcane	92	18	0	0	1,323	544	0	0	110	1,867	1,978
Rabi											
Boro (L)	0	0	0	269	0	0	0	228	269	228	498
Boro (HYV)	1,012	2,574	1,118	116	0	0	0	0	4,819	0	4,819
Wheat (HYV)	710	1,600	336	0	276	1,592	851	46	2,646	2,764	5,411
Potato	5	54	4	0	147	14	121	0	63	281	344
Pulses	68	190	15	0	1,892	5,327	2,314	230	274	9,763	10,037
Oilseeds	79	225	37	0	805	2,553	1,304	128	341	4,790	5,131
Spices	42	59	0	0	200	527	102	0	101	829	930
Minor crops	90	397	19	0	214	765	122	0	507	1,100	1,607
Orchards	0	0	0	0	720	0	0	0	0	720	720
Totals	4,589	11,224	1,680	385	16,646	29,169	17,160	3,749	17,879	66,723	84,602
Total NCA	2,045	5,009	1,504	436	11,864	19,437	13,009	3,600	8,993	47,910	56,903
Average CI	224%	224%	112%	88%	140%	150%	132%	104%	199%	139%	149%

SW6	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	4,125	5,873	1,028	0	0	11,026	11,026
Aus (HYV)	344	1,133	0	0	62	350	0	0	1,477	412	1,889
Aman (B)	0	0	0	0	0	1,621	5,516	2,121	0	9,259	9,259
Aman (L T)	62	1,960	99	0	60	463	0	0	2,121	524	2,645
Aman (HYV)	741	981	0	0	676	715	0	0	1,722	1,392	3,114
Jute	0	0	0	0	609	1,192	506	0	0	2,307	2,307
Sugarcane	11	0	0	0	793	353	0	0	11	1,145	1,156
Rabi											
Boro (L)	0	0	0	149	0	0	0	96	149	96	244
Boro (HYV)	423	1,712	741	60	0	0	0	0	2,936	0	2,936
Wheat (HYV)	362	1,098	235	0	182	1,068	488	45	1,695	1,784	3,479
Potato	0	32	0	0	63	3	4	0	32	70	103
Pulses	26	100	0	0	851	3,395	1,323	146	125	5,716	5,841
Oilseeds	19	108	0	0	368	1,509	670	80	127	2,628	2,754
Spices	18	33	0	0	123	352	72	0	50	548	598
Minor crops	18	195	9	0	123	477	74	0	222	675	897
Orchards	0	0	0	0	368	0	0	0	0	368	368
Total	2,022	7,352	1,085	209	8,405	17,372	9,682	2,488	10,668	37,948	48,616
Total NCA	874	3,267	994	232	6,083	11,713	7,203	2,307	5,367	27,306	32,673
Average CI	231%	225%	109%	90%	138%	148%	134%	108%	199%	139%	149%

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Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SW7 Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	7,975	20,023	24,571	0	0	52,570	52,570
Aus (HYV)	326	1,739	0	0	367	546	0	0	2,065	912	2,977
Aman (B)	0	0	0	0	0	1,885	32,489	28,691	0	63,065	63,065
Aman (L T)	51	4,381	1,337	0	165	186	0	0	5,769	352	6,120
Aman (HYV)	906	1,921	0	0	2,130	2,355	0	0	2,827	4,485	7,312
Jute	0	0	0	0	1,310	5,805	2,729	0	0	9,844	9,844
Sugarcane	52	0	0	0	2,603	1,480	0	0	52	4,083	4,135
Rabi											
Boro (L)	0	0	0	277	0	0	0	2,812	277	2,812	3,090
Boro (HYV)	688	5,282	13,278	5,431	0	0	0	0	24,678	0	24,678
Wheat (HYV)	137	418	90	0	365	4,479	1,790	4,006	645	10,640	11,285
Potato	43	12	0	0	276	406	553	0	56	1,235	1,291
Pulses	59	709	266	0	2,032	11,439	11,037	4,795	1,033	29,303	30,335
Oilseeds	175	1,293	266	17	1,385	3,945	6,227	3,824	1,751	15,381	17,132
Spices	104	649	0	0	794	1,128	544	0	753	2,466	3,219
Minor crops	7	74	3	0	512	2,684	581	0	84	3,777	3,861
Orchards	0	0	0	0	1,243	0	0	0	0	1,243	1,243
Totals	2,547	16,478	15,239	5,726	21,157	56,361	80,521	44,128	39,990	202,167	242,157
Total NCA	1,053	7,181	13,374	5,862	14,514	33,765	38,442	34,362	27,470	121,083	148,553
Average CI	242%	229%	114%	98%	146%	167%	209%	128%	146%	167%	163%

SW8 Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	19,163	6,241	1,543	0	0	26,947	26,947
Aus (HYV)	4,622	4,959	0	0	376	0	0	0	9,581	376	9,957
Aman (B)	0	0	0	0	0	928	5,433	1,843	0	8,204	8,204
Aman (L T)	4,176	18,207	805	0	10,003	11,958	130	0	23,188	22,092	45,280
Aman (HYV)	19,028	11,089	0	0	5,590	2,439	0	0	30,117	8,029	38,146
Jute	0	0	0	0	6,972	3,163	305	0	0	10,440	10,440
Sugarcane	1,128	279	0	0	688	106	0	0	1,407	794	2,200
Rabi											
Boro (L)	0	0	0	530	0	0	32	228	530	260	789
Boro (HYV)	14,660	21,720	7,074	536	3	0	0	0	43,991	3	43,994
Wheat (HYV)	5,487	5,021	808	0	1,046	1,678	642	133	11,316	3,497	14,814
Potato	345	794	81	0	23	129	1	0	1,220	153	1,373
Pulses	1,572	1,317	1,054	0	10,169	2,457	1,226	165	3,943	14,017	17,960
Oilseeds	2,277	4,304	550	0	4,842	3,743	958	75	7,131	9,618	16,749
Spices	315	274	0	0	360	162	0	0	589	521	1,111
Minor crops	1,275	2,648	84	0	734	723	0	0	4,007	1,457	5,464
Orchards	5	0	0	0	1,300	0	0	0	5	1,300	1,304
Totals	54,891	70,612	10,456	1,066	61,270	33,726	10,270	2,443	137,024	107,708	244,733
Total NCA	25,839	32,103	8,051	1,225	38,728	21,684	7,275	2,141	67,219	69,829	137,047
Average CI	212%	220%	130%	87%	158%	156%	141%	114%	204%	154%	179%

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Source : MPO (1989 - 1990)

Cropped Areas According to Planning Unit (Ha)

SW9	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	11,648	4,965	3,593	0	0	20,206	20,206
Aus (HYV)	2,861	4,135	0	0	23	0	0	0	6,996	23	7,019
Aman (B)	0	0	0	0	0	104	6,763	3,288	0	10,156	10,156
Aman (L T)	1,631	9,814	721	0	11,076	8,070	509	0	12,167	19,655	31,821
Aman (HYV)	7,525	5,443	0	0	5,646	2,199	0	0	12,968	7,845	20,813
Jute	0	0	0	0	4,979	2,431	733	0	0	8,143	8,143
Sugarcane	49	14	0	0	409	16	0	0	63	425	488
Rabi											
Boro (L)	0	0	0	93	0	0	7	86	93	93	186
Boro (HYV)	5,405	10,123	6,059	834	0	0	0	0	22,421	0	22,421
Wheat (HYV)	2,989	3,417	963	0	456	652	330	53	7,369	1,492	8,860
Potato	189	607	72	0	20	45	80	0	868	145	1,013
Pulses	327	471	708	0	5,894	713	2,145	1,479	1,506	10,231	11,737
Oilseeds	1,740	2,459	524	0	3,145	443	1,384	243	4,724	5,215	9,939
Spices	47	14	0	0	622	199	75	0	61	897	958
Minor crops	737	2,007	112	0	426	414	13	0	2,856	853	3,709
Orchards	0	0	0	0	1,313	0	0	0	0	1,313	1,313
Totals	23,500	38,504	9,160	927	45,659	20,251	15,633	5,148	72,091	86,691	158,782
Total NCA	9,786	16,654	7,213	1,060	27,010	11,661	9,304	4,067	34,713	52,042	86,755
Average CI	240%	231%	127%	87%	169%	174%	168%	127%	208%	167%	183%

SW10	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	7,105	6,859	7,096	0	0	21,059	21,059
Aus (HYV)	1,080	745	0	0	95	12	0	0	1,826	106	1,932
Aman (B)	0	0	0	0	0	1,739	20,414	5,160	0	27,313	27,313
Aman (L T)	586	1,551	287	0	3,694	9,601	2,888	0	2,425	16,183	18,608
Aman (HYV)	1,875	1,256	0	0	2,965	2,036	0	0	3,132	5,001	8,133
Jute	0	0	0	0	1,298	1,559	1,041	0	0	3,897	3,897
Sugarcane	144	61	0	0	617	284	0	0	205	901	1,106
Rabi											
Boro (L)	0	0	0	760	0	0	4	1,783	760	1,787	2,548
Boro (HYV)	1,057	1,564	2,461	990	0	0	0	0	6,072	0	6,072
Wheat (HYV)	1,112	766	323	0	145	278	151	29	2,201	602	2,803
Potato	41	42	28	0	488	13	1,911	0	112	2,412	2,524
Pulses	122	105	40	0	2,050	1,840	5,102	974	267	9,966	10,233
Oilseeds	275	622	265	0	1,818	2,566	5,025	1,035	1,162	10,444	11,606
Spices	39	61	0	0	89	149	3	0	101	241	341
Minor crops	109	557	55	0	262	742	321	0	722	1,325	2,047
Orchards	0	0	0	0	1,309	0	0	0	0	1,309	1,309
Totals	6,442	7,333	3,459	1,750	21,933	27,678	43,956	8,980	18,984	102,546	121,531
Total NCA	2,709	3,160	2,870	1,946	13,286	16,233	33,732	8,371	10,685	71,621	82,306
Average CI	238%	232%	121%	90%	165%	171%	130%	107%	178%	143%	148%

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Source : MPO (1989 - 1990)

Cropped Areas According to Planning Unit (Ha)

SW11 Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	1,442	5,941	150	0	0	7,533	7,533
Aus (HYV)	482	3,865	0	0	0	0	0	0	4,347	0	4,347
Aman (B)	0	0	0	0	0	0	2,951	92	0	3,043	3,043
Aman (L T)	370	14,292	75	0	13,139	112,980	780	0	14,737	126,899	141,636
Aman (HYV)	1,892	9,572	0	0	4,090	14,709	0	0	11,464	18,799	30,263
Jute	0	0	0	0	752	5,905	143	0	0	6,801	6,801
Sugarcane	35	0	0	0	288	0	0	0	35	288	323
Rabi											
Boro (L)	0	0	0	765	0	0	566	0	765	566	1,331
Boro (HYV)	1,653	20,199	705	79	0	0	0	0	22,635	0	22,635
Wheat (HYV)	579	3,398	41	0	26	37	1	1	4,018	64	4,082
Potato	12	262	8	0	0	1,467	0	0	281	1,467	1,749
Pulses	1	2	33	0	1,936	11,726	288	36	36	13,986	14,021
Oilseeds	116	178	32	0	2,337	17,587	428	37	325	20,389	20,715
Spices	18	0	0	0	297	1,469	0	0	18	1,766	1,784
Minor crops	53	83	3	0	296	4,406	0	0	139	4,702	4,841
Orchards	0	0	0	0	2,536	0	0	0	0	2,536	2,536
Totals	5,210	51,850	897	844	27,139	176,227	5,308	166	58,800	208,840	267,641
Total NCA	2,332	24,175	754	970	28,766	146,744	7,100	316	28,231	182,926	211,157
Average CI	223%	214%	119%	87%	94%	120%	75%	53%	208%	114%	127%

SW12 Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	1,147	1,416	607	0	0	3,170	3,170
Aus (HYV)	267	644	0	0	0	0	0	0	911	0	911
Aman (B)	0	0	0	0	0	8	1,354	506	0	1,868	1,868
Aman (L T)	166	1,499	60	0	2,786	16,632	189	0	1,725	19,607	21,332
Aman (HYV)	427	1,007	0	0	980	2,257	0	0	1,433	3,236	4,670
Jute	0	0	0	0	366	1,100	140	0	0	1,607	1,607
Sugarcane	3	0	0	0	80	1	0	0	4	81	85
Rabi											
Boro (L)	0	0	0	64	0	0	80	9	64	89	153
Boro (HYV)	291	1,788	474	77	0	0	0	0	2,631	0	2,631
Wheat (HYV)	223	506	101	0	0	0	51	6	830	57	887
Potato	10	61	6	0	3	206	10	0	77	218	295
Pulses	39	61	54	0	467	1,727	386	246	154	2,826	2,980
Oilseeds	84	92	30	0	528	2,481	277	39	205	3,326	3,531
Spices	6	0	0	0	97	227	13	0	7	337	344
Minor crops	55	169	11	0	59	652	2	0	235	713	949
Orchards	0	0	0	0	492	0	0	0	0	492	492
Totals	1,571	5,828	736	141	7,004	26,708	3,108	806	8,276	37,626	45,903
Total NCA	626	2,603	598	162	5,861	21,706	2,445	659	3,989	30,671	34,659
Average CI	251%	224%	123%	87%	120%	123%	127%	122%	207%	123%	132%

Continued

Source : MPO (1989 - 1990)

Cropped Areas According to Planning Unit (Ha)

SW13 Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	4,250	15,479	10,077	0	0	29,806	29,806
Aus (HYV)	412	462	0	0	97	151	0	0	874	248	1,122
Aman (B)	0	0	0	0	0	4,534	18,728	12,673	0	35,934	35,934
Aman (L T)	188	1,499	322	0	2,934	31,580	1,692	56	2,009	36,261	38,271
Aman (HYV)	706	1,122	0	0	2,912	6,681	0	22	1,829	9,615	11,444
Jute	0	0	0	0	471	2,163	1,091	0	0	3,726	3,726
Sugarcane	33	31	0	0	837	805	0	0	64	1,642	1,706
Rabi											
Boro (L)	0	1	340	656	0	0	0	1,397	997	1,397	2,394
Boro (HYV)	430	1,895	2,695	1,418	0	0	0	0	6,439	0	6,439
Wheat (HYV)	417	415	139	0	97	1,883	37	1,509	971	3,527	4,498
Potato	16	50	16	0	601	1,466	1,035	0	82	3,103	3,185
Pulses	1	4	0	0	1,054	10,908	5,236	2,118	5	19,317	19,322
Oilseeds	135	447	128	0	1,113	7,972	4,711	1,891	710	15,687	16,397
Spices	12	45	0	0	210	762	89	0	57	1,061	1,118
Minor crops	32	433	28	0	239	1,296	306	0	493	1,840	2,333
Orchards	0	0	0	0	2,398	0	0	0	0	2,398	2,398
Totals	2,382	6,404	3,669	2,073	17,213	85,680	43,002	19,667	14,528	165,562	180,091
Total NCA	950	2,892	3,219	2,230	11,779	57,683	26,491	15,902	9,291	111,855	121,146
Average CI	251%	221%	114%	93%	146%	149%	162%	124%	156%	148%	149%

SW14 Crop	Irrigated				Non-Irrigated				Totals		
	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	828	4,030	349	0	0	5,207	5,207
Aus (HYV)	40	273	0	0	0	0	0	0	313	0	313
Aman (B)	0	0	0	0	0	285	2,426	217	0	2,928	2,928
Aman (L T)	28	991	8	0	7,308	64,594	559	4	1,028	72,465	73,493
Aman (HYV)	119	677	0	0	2,330	8,507	0	1	796	10,838	11,634
Jute	0	0	0	0	327	3,316	113	0	0	3,756	3,756
Sugarcane	4	1	0	0	186	38	0	0	5	224	228
Rabi											
Boro (L)	0	0	9	73	0	0	314	63	83	377	459
Boro (HYV)	101	1,402	67	19	0	0	0	0	1,589	0	1,589
Wheat (HYV)	43	240	5	0	0	58	0	0	289	58	346
Potato	1	18	1	0	35	899	69	0	19	1,003	1,022
Pulses	0	0	0	0	977	7,094	371	52	0	8,494	8,494
Oilseeds	4	8	4	0	1,298	10,248	472	58	16	12,076	12,092
Spices	2	1	0	0	161	846	0	0	3	1,007	1,010
Minor crops	2	13	1	0	164	2,489	12	0	16	2,665	2,681
Orchards	0	0	0	0	1,532	0	0	0	0	1,532	1,532
Totals	343	3,624	96	92	15,145	102,403	4,685	394	4,155	122,628	126,783
Total NCA	151	1,692	83	105	16,091	84,601	5,293	459	2,031	106,445	108,476
Average CI	227%	214%	115%	88%	94%	121%	89%	86%	205%	115%	117%

Continued

Source : MPO (1989 - 1990)

Cropped Areas According to Planning Unit (Ha)

SC1	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	7,294	20,265	14,451	0	0	42,010	42,010
Aus (HYV)	338	2,270	0	0	273	343	0	0	2,608	616	3,224
Aman (B)	0	0	0	0	0	2,357	22,492	3,365	0	28,214	28,214
Aman (L T)	1	3,718	932	0	274	38	0	0	4,651	311	4,963
Aman (M)	822	1,250	0	0	1,365	702	0	0	2,073	2,067	4,139
Jute	0	0	0	0	1,081	4,734	1,838	0	0	7,654	7,654
Sugarcane	85	0	0	0	2,834	1,686	0	0	85	4,520	4,605
Rabi											
Boro (L)	0	0	0	389	0	0	0	2,376	389	2,376	2,765
Boro (HYV)	607	3,926	9,322	603	0	0	0	0	14,459	0	14,459
Wheat (HYV)	0	0	0	0	275	3,377	3,031	42	0	6,725	6,725
Potato	75	0	0	0	4	339	308	0	75	650	725
Pulses	85	1,166	461	0	1,891	13,123	8,864	887	1,711	24,764	26,475
Oilseeds	134	824	461	30	1,216	5,709	4,290	249	1,449	11,464	12,913
Spices	169	1,104	0	0	945	1,017	610	0	1,273	2,572	3,845
Minor crops	0	0	0	0	406	2,365	308	0	0	3,079	3,079
Orchards	0	0	0	0	952	0	0	0	0	952	952
Totals	2,316	14,258	11,176	1,023	18,809	56,054	56,192	6,919	28,773	137,973	166,746
Total NCA	945	6,196	9,322	1,065	13,513	33,742	30,597	5,614	17,529	83,466	100,994
Average CI	245%	230%	120%	96%	139%	166%	184%	123%	164%	165%	165%

SC2	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	3,231	12,865	1,817	0	0	17,912	17,912
Aus (HYV)	45	302	0	0	342	942	0	0	347	1,284	1,631
Aman (B)	0	0	0	0	0	5,635	13,059	2,160	0	20,854	20,854
Aman (L T)	101	3,729	196	0	1,199	8,516	316	0	4,026	10,030	14,056
Aman (M)	680	2,323	0	0	491	559	0	0	3,003	1,050	4,053
Jute	0	0	0	0	561	3,043	757	0	0	4,360	4,360
Sugarcane	11	0	0	0	965	884	0	0	11	1,849	1,860
Rabi											
Boro (L)	0	0	0	68	0	0	0	900	68	900	968
Boro (HYV)	752	5,913	1,959	236	0	0	0	0	8,861	0	8,861
Wheat (HYV)	0	0	0	0	165	1,745	1,107	45	0	3,063	3,063
Potato	10	0	0	0	63	265	39	0	10	367	377
Pulses	183	155	61	0	1,998	4,976	4,367	334	400	11,676	12,075
Oilseeds	193	2,806	94	4	576	719	4,114	117	3,096	5,526	8,622
Spices	22	147	0	0	424	1,026	183	0	169	1,633	1,803
Minor crops	0	0	0	0	234	1,409	144	0	0	1,787	1,787
Orchards	0	0	0	0	734	0	0	0	0	734	734
Totals	1,998	15,375	2,309	308	10,981	42,585	25,903	3,555	19,991	83,025	103,016
Total NCA	797	6,215	1,959	341	7,785	26,545	14,430	3,007	9,312	51,768	61,079
Average CI	251%	247%	118%	91%	141%	160%	180%	118%	215%	160%	169%

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Source : MPO (1989 - 1990)

Cropped Areas According to Planning Unit (Ha)

SC3	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	1,854	9,063	3,537	0	0	14,453	14,453
Aus (HYV)	34	229	0	0	235	550	0	0	263	784	1,048
Aman (B)	0	0	0	0	0	1,341	8,283	4,783	0	14,407	14,407
Aman (L T)	89	3,756	557	0	499	3,591	12	0	4,402	4,102	8,504
Aman (M)	585	2,380	0	0	920	1,246	0	0	2,964	2,165	5,130
Jute	0	0	0	0	238	1,474	420	0	0	2,132	2,132
Sugarcane	9	0	0	0	662	624	0	0	9	1,287	1,295
Rabi											
Boro (L)	0	0	0	951	0	0	0	392	951	392	1,343
Boro (HYV)	651	6,030	5,572	65	0	0	0	0	12,319	0	12,319
Wheat (HYV)	0	0	0	0	408	457	217	2	0	1,084	1,084
Potato	8	0	0	0	80	128	91	0	8	298	306
Pulses	19	118	47	0	468	2,820	1,748	327	183	5,363	5,546
Oilseeds	200	2,901	48	3	195	1,145	1,047	61	3,152	2,448	5,600
Spices	17	112	0	0	250	690	185	0	129	1,126	1,255
Minor crops	0	0	0	0	109	683	95	0	0	887	887
Orchards	0	0	0	0	520	0	0	0	0	520	520
Totals	1,610	15,525	6,225	1,020	6,438	23,812	15,635	5,564	24,380	51,449	75,829
Total NCA	685	6,260	5,572	1,162	3,646	12,832	9,459	4,851	13,679	30,787	44,467
Average CI	235%	248%	112%	88%	177%	186%	165%	115%	178%	167%	171%

SC4	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	2,283	11,221	7,378	0	0	20,882	20,882
Aus (HYV)	0	1	0	0	311	687	0	0	1	998	999
Aman (B)	0	0	0	0	0	1,282	12,773	12,065	0	26,120	26,120
Aman (L T)	52	2,098	390	0	567	4,301	2	0	2,540	4,871	7,411
Aman (M)	298	1,372	0	0	1,335	1,951	0	0	1,670	3,286	4,956
Jute	0	0	0	0	317	2,077	742	0	0	3,135	3,135
Sugarcane	0	0	0	0	785	744	0	0	0	1,529	1,529
Rabi											
Boro (L)	0	0	2	530	0	0	0	650	532	650	1,182
Boro (HYV)	350	3,476	3,897	817	0	0	0	0	8,540	0	8,540
Wheat (HYV)	0	1	0	0	530	804	0	954	1	2,288	2,288
Potato	0	0	0	0	160	188	185	0	0	533	533
Pulses	0	0	0	0	531	3,209	2,784	1,367	0	7,892	7,892
Oilseeds	117	1,669	0	0	277	1,126	1,720	937	1,786	4,060	5,847
Spices	0	0	0	0	291	870	230	0	0	1,391	1,391
Minor crops	0	1	0	0	159	935	185	0	1	1,279	1,281
Orchards	0	0	0	0	711	0	0	0	0	711	711
Totals	817	8,619	4,290	1,347	8,258	29,393	26,000	15,974	15,072	79,625	94,697
Total NCA	350	3,478	3,900	1,443	4,516	15,593	13,868	13,009	9,171	46,986	56,157
Average CI	233%	248%	110%	93%	183%	189%	187%	123%	164%	169%	169%

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Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SC5	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	1,840	5,043	668	0	0	7,551	7,551
Aus (HYV)	2,424	1,044	0	0	152	274	0	0	3,468	425	3,893
Aman (B)	0	0	0	0	0	312	1,651	1,142	0	3,105	3,105
Aman (L T)	1,739	8,156	840	0	1,351	5,818	1	0	10,735	7,170	17,905
Aman (M)	13,634	5,559	0	0	966	1,858	0	0	19,192	2,824	22,016
Jute	0	0	0	0	74	342	73	0	0	489	489
Sugarcane	3	0	0	0	280	191	0	0	3	471	474
Rabi											
Boro (L)	0	2,583	7	1,667	0	0	0	57	4,257	57	4,313
Boro (HYV)	12,933	10,309	8,394	2	0	0	0	0	31,639	0	31,639
Wheat (HYV)	802	43	0	0	97	122	1	0	845	220	1,065
Potato	1,589	787	0	0	22	44	18	0	2,377	84	2,461
Pulses	20	31	0	0	412	1,843	275	67	50	2,597	2,647
Oilseeds	2,690	4,918	1	0	123	1,189	167	11	7,609	1,491	9,100
Spices	1,584	11	0	0	120	382	36	0	1,595	537	2,132
Minor crops	50	75	0	0	66	405	18	0	125	488	614
Orchards	0	0	0	0	268	0	0	0	0	268	268
Totals	37,469	33,514	9,242	1,670	5,771	17,821	2,908	1,277	81,895	27,777	109,672
Total NCA	17,010	14,113	8,401	1,919	3,210	10,826	1,819	1,120	41,443	16,974	58,417
Average CI	220%	237%	110%	87%	180%	165%	160%	114%	198%	164%	188%

SC6	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	2,933	11,004	289	0	0	14,226	14,226
Aus (HYV)	107	34	0	0	333	885	0	0	141	1,218	1,359
Aman (B)	0	0	0	0	0	4,659	9,361	1,908	0	15,928	15,928
Aman (L T)	150	2,629	77	0	1,661	9,977	278	0	2,857	11,915	14,772
Aman (M)	1,029	1,759	0	0	751	1,209	0	0	2,788	1,960	4,748
Jute	0	0	0	0	392	2,234	479	0	0	3,106	3,106
Sugarcane	0	0	0	0	658	657	0	0	0	1,315	1,315
Rabi											
Boro (L)	0	117	1	58	0	0	0	540	176	540	715
Boro (HYV)	1,071	4,256	768	120	0	0	0	0	6,215	0	6,215
Wheat (HYV)	38	1	0	0	146	1,154	627	38	38	1,965	2,003
Potato	71	33	0	0	61	200	8	0	103	268	372
Pulses	127	1	0	0	1,716	3,678	2,896	220	128	8,510	8,637
Oilseeds	244	2,123	24	0	428	613	3,117	81	2,391	4,239	6,630
Spices	72	0	0	0	317	935	105	0	72	1,358	1,430
Minor crops	0	2	0	0	190	1,150	97	0	2	1,437	1,439
Orchards	0	0	0	0	634	0	0	0	0	634	634
Totals	2,909	10,953	871	177	10,220	38,355	17,257	2,787	14,910	68,619	83,530
Total NCA	1,252	4,407	770	204	6,815	23,895	9,750	2,393	6,632	42,853	49,485
Average CI	232%	249%	113%	87%	150%	161%	177%	116%	225%	160%	169%

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Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SC7	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	1,992	4,894	0	0	0	6,887	6,887
Aus (HYV)	4,260	2,441	0	0	130	210	0	0	6,701	340	7,041
Aman (B)	0	0	0	0	0	98	26	3	0	128	128
Aman (L T)	2,772	5,846	20	0	1,961	8,339	40	0	8,638	10,340	18,978
Aman (M)	23,102	3,978	0	0	960	2,262	0	0	27,080	3,222	30,302
Jute	0	0	0	0	60	93	1	0	0	154	154
Sugarcane	27	0	0	0	197	77	0	0	27	274	301
Rabi											
Boro (L)	0	4,417	112	0	0	0	0	1	4,529	1	4,530
Boro (HYV)	21,469	3,026	85	5	0	0	0	0	24,586	0	24,586
Wheat (HYV)	1,541	220	0	0	0	181	2	0	1,761	182	1,943
Potato	2,671	1,440	0	0	10	45	0	0	4,111	55	4,166
Pulses	88	171	7	0	450	2,262	11	0	266	2,724	2,990
Oilseeds	3,965	257	1	0	134	1,298	8	0	4,223	1,441	5,663
Spices	2,741	49	0	0	97	342	1	0	2,790	440	3,230
Minor crops	220	390	7	0	57	374	0	0	617	431	1,048
Orchards	0	0	0	0	261	0	0	0	0	261	261
Totals	62,856	22,236	232	5	6,310	20,475	90	5	85,329	26,880	112,210
Total NCA	28,880	10,553	202	6	3,683	13,281	65	5	39,641	17,033	56,674
Average CI	218%	211%	115%	87%	171%	154%	139%	117%	215%	158%	198%

SC8	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	12,938	38,224	0	0	0	51,162	51,162
Aus (HYV)	709	547	0	0	380	1,297	0	0	1,256	1,677	2,933
Aman (B)	0	0	0	0	0	226	855	71	0	1,152	1,152
Aman (L T)	713	4,750	120	0	24,261	114,989	4,088	0	5,583	143,338	148,921
Aman (M)	10,062	2,828	0	0	1,847	2,538	0	0	12,890	4,385	17,275
Jute	0	0	0	0	385	1,363	22	0	0	1,771	1,771
Sugarcane	118	0	0	0	393	28	0	0	118	421	539
Rabi											
Boro (L)	0	704	717	0	0	0	0	26	1,421	26	1,447
Boro (HYV)	9,476	6,561	451	7	0	0	0	0	16,495	0	16,495
Wheat (HYV)	1,181	469	0	0	5	57	31	2	1,650	95	1,745
Potato	0	78	0	0	369	9	0	0	78	379	457
Pulses	125	391	47	0	3,010	25,335	606	10	564	28,960	29,523
Oilseeds	125	504	1	0	1,485	6,298	237	4	631	8,025	8,656
Spices	590	78	0	0	380	2,557	47	0	669	2,984	3,652
Minor crops	236	860	47	0	375	2,567	4	0	1,144	2,946	4,089
Orchards	0	0	0	0	2,227	0	0	0	0	2,227	2,227
Totals	23,336	17,772	1,384	7	48,054	195,490	5,891	112	42,498	249,546	292,044
Total NCA	11,838	8,047	1,203	8	36,942	126,911	4,693	95	21,096	168,641	189,737
Average CI	197%	221%	115%	87%	130%	154%	126%	117%	201%	148%	154%

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Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SC9	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	4,297	15,626	0	0	0	19,922	19,922
Aus (HYV)	100	161	0	0	167	497	0	0	262	664	926
Aman (B)	0	0	0	0	0	145	122	0	0	267	267
Aman (L T)	85	723	13	0	8,485	40,706	1,138	0	821	50,329	51,151
Aman (M)	1,199	433	0	0	900	3,313	0	0	1,632	4,213	5,845
Jute	0	0	0	0	196	352	0	0	0	548	548
Sugarcane	14	0	0	0	124	0	0	0	14	124	138
Rabi											
Boro (L)	0	83	82	0	0	0	0	0	165	0	165
Boro (HYV)	1,111	884	48	0	0	0	0	0	2,043	0	2,043
Wheat (HYV)	139	66	0	0	0	580	0	0	205	580	785
Potato	5	28	0	0	124	145	0	0	33	269	302
Pulses	19	54	5	0	970	9,644	130	0	78	10,745	10,823
Oilseeds	15	54	0	0	453	2,339	24	0	69	2,815	2,884
Spices	70	12	0	0	146	993	12	0	83	1,151	1,233
Minor crops	43	120	5	0	102	848	0	0	168	951	1,119
Orchards	0	0	0	0	960	0	0	0	0	960	960
Totals	2,800	2,620	154	0	16,924	75,188	1,425	0	5,574	93,537	99,112
Total NCA	1,424	1,210	134	0	12,399	49,670	1,189	0	2,768	63,259	66,027
Average CI	197%	217%	115%	ERR	136%	151%	120%	ERR	201%	148%	150%

SC10	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	2,747	14,634	0	0	0	17,382	17,382
Aus (HYV)	199	579	0	0	197	444	0	0	778	641	1,419
Aman (B)	0	0	0	0	0	351	31	0	0	382	382
Aman (L T)	95	1,336	6	0	5,618	27,582	214	0	1,436	33,414	34,851
Aman (M)	1,100	820	0	0	1,209	6,618	0	0	1,920	7,826	9,747
Jute	0	0	0	0	247	85	0	0	0	331	331
Sugarcane	10	0	0	0	115	18	0	0	10	133	144
Rabi											
Boro (L)	0	115	37	0	0	0	0	0	152	0	152
Boro (HYV)	941	1,191	21	0	0	0	0	0	2,153	0	2,153
Wheat (HYV)	103	92	0	0	0	1,364	0	0	195	1,364	1,559
Potato	64	125	0	0	70	341	0	0	189	411	600
Pulses	36	71	2	0	599	7,754	25	0	109	8,378	8,487
Oilseeds	72	71	0	0	204	1,952	4	0	143	2,161	2,304
Spices	85	21	0	0	140	869	2	0	106	1,012	1,117
Minor crops	97	163	2	0	32	547	0	0	262	579	841
Orchards	0	0	0	0	959	0	0	0	0	959	959
Totals	2,801	4,584	68	0	12,138	62,559	276	0	7,452	74,973	82,426
Total NCA	1,392	2,189	59	0	7,642	42,549	232	0	3,640	50,423	54,064
Average CI	201%	209%	115%	ERR	159%	147%	119%	ERR	205%	149%	152%

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Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SC11	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	3,386	14,403	0	0	0	17,789	17,789
Aus (HYV)	2,849	4,564	0	0	258	485	0	0	7,413	744	8,157
Aman (B)	0	0	0	0	0	363	9	0	0	372	372
Aman (L T)	1,538	9,362	2	0	5,132	24,241	10	0	10,902	29,382	40,284
Aman (M)	13,321	5,947	0	0	1,753	7,280	0	0	19,269	9,033	28,301
Jute	0	0	0	0	235	86	0	0	0	321	321
Sugarcane	33	0	0	0	251	83	0	0	33	334	368
Rabi											
Boro (L)	0	2,376	24	0	0	0	0	0	2,401	0	2,401
Boro (HYV)	11,812	6,565	7	0	0	0	0	0	18,385	0	18,385
Wheat (HYV)	893	514	0	0	0	1,266	0	0	1,408	1,266	2,674
Potato	1,557	1,392	0	0	48	317	0	0	2,949	365	3,314
Pulses	221	387	1	0	743	7,085	1	0	609	7,829	8,438
Oilseeds	2,119	387	0	0	214	2,442	0	0	2,505	2,656	5,161
Spices	1,505	128	0	0	182	888	0	0	1,633	1,070	2,703
Minor crops	630	901	1	0	59	654	0	0	1,532	713	2,245
Orchards	0	0	0	0	904	0	0	0	0	904	904
Totals	36,480	32,524	35	0	13,166	59,593	20	0	69,039	72,779	141,818
Total NCA	17,030	15,662	32	0	7,702	40,248	19	0	32,724	47,968	80,692
Average CI	214%	208%	110%	ERR	171%	148%	108%	ERR	211%	152%	176%

SC12	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	2,542	9,725	3	0	0	12,270	12,270
Aus (HYV)	186	315	0	0	117	309	0	0	501	426	927
Aman (B)	0	0	0	0	0	151	74	1	0	227	227
Aman (L T)	139	1,157	18	0	4,848	23,380	550	0	1,314	28,779	30,093
Aman (M)	1,808	701	0	0	686	2,719	0	0	2,509	3,405	5,914
Jute	0	0	0	0	130	183	0	0	0	313	313
Sugarcane	19	0	0	0	94	13	0	0	19	107	127
Rabi											
Boro (L)	0	152	112	5	0	0	0	0	268	0	268
Boro (HYV)	1,663	1,311	64	0	0	0	0	0	3,038	0	3,038
Wheat (HYV)	197	99	0	0	0	484	0	0	297	484	781
Potato	36	66	0	0	69	129	0	0	102	198	300
Pulses	30	79	7	0	571	5,761	67	0	116	6,400	6,516
Oilseeds	59	79	0	0	249	1,515	18	0	138	1,783	1,921
Spices	119	19	0	0	96	612	6	0	138	713	852
Minor crops	70	180	7	0	57	502	0	0	257	559	816
Orchards	0	0	0	0	609	0	0	0	0	609	609
Totals	4,325	4,159	208	5	10,069	45,484	720	2	8,697	56,275	64,972
Total NCA	2,173	1,936	181	6	7,104	30,221	598	2	4,296	37,925	42,221
Average CI	199%	215%	115%	87%	142%	151%	120%	117%	202%	148%	154%

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Source : MPO (1989 - 1990)

Continued

Cropped Areas According to Planning Unit (Ha)

SC13	Irrigated				Non-Irrigated				Totals		
Crop	F0	F1	F2	F3	F0	F1	F2	F3	Irrigated	Rainfed	Overall
Kharif											
Aus (B)	0	0	0	0	3,671	10,805	0	0	0	14,477	14,477
Aus (HYV)	70	54	0	0	105	360	0	0	124	465	589
Aman (B)	0	0	0	0	0	0	121	0	0	121	121
Aman (L T)	70	456	12	0	6,923	32,777	1,165	0	538	40,865	41,402
Aman (M)	992	270	0	0	524	720	0	0	1,262	1,245	2,507
Jute	0	0	0	0	105	360	0	0	0	465	465
Sugarcane	12	0	0	0	105	0	0	0	12	105	117
Rabi											
Boro (L)	0	70	71	0	0	0	0	0	140	0	140
Boro (HYV)	933	626	42	0	0	0	0	0	1,601	0	1,601
Wheat (HYV)	117	46	0	0	0	0	0	0	163	0	163
Potato	0	8	0	0	105	0	0	0	8	105	113
Pulses	12	39	5	0	839	7,204	134	0	55	8,176	8,231
Oilseeds	12	39	0	0	420	1,801	24	0	50	2,245	2,295
Spices	58	8	0	0	105	720	12	0	66	837	903
Minor crops	23	85	5	0	105	720	0	0	113	825	938
Orchards	0	0	0	0	629	0	0	0	0	629	629
Totals	2,299	1,700	134	0	13,636	55,468	1,456	0	4,132	70,560	74,692
Total NCA	1,167	773	116	0	10,489	36,018	1,214	0	2,056	47,721	49,777
Average CI	197%	220%	115%	ERR	130%	154%	120%	ERR	201%	148%	150%

cland\sc\sc7

Source : MPO (1989 - 1990)

Continued

APPENDIX B

Labour Requirements by Crop

Labour Requirement by Operation (Mandays/ha)

1 : B. Aus (L)

Yield Assumed : 1.1 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation			15	25									40
2. Sowing/Transplanting				2									2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)				25	30								55
4. Harvesting							15	5					20
5. Post Harvest Operation							7	6					13
6. Total (Rainfed)			15	52	30		22	11					130
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													35

2 : T. Aus HYV

Yield Assumed : 2.9 T/ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation				45									45
2. Sowing/Transplanting				28									28
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)					28	19							47
4. Harvesting								30					30
5. Post Harvest Operation								25					25
6. Total (Rainfed)				73	28	19		55					180
7. Irrigation				2	2	1							5
8. Total (Irrigated)				75	30	20		55					180
Draught Pair Days													42

Continued

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

3 : B. Aman LV

Yield Assumed : 1.2 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation			20	20									40
2. Sowing/Transplanting				2									2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)					15	5							20
4. Harvesting											20	5	25
5. Post Harvest Operation											10	5	15
6. Total (Rainfed)			20	22	15	5					30	10	102
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													35

4 : T. Aman LV

Yield Assumed : 1.8 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation							10	30					40
2. Sowing/Transplanting							5	25					30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)									10				10
4. Harvesting											25		25
5. Post Harvest Operation												20	20
6. Total (Rainfed)							15	55	10		25	20	125
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													35

Continued

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

5 : T. Aman HYV

Yield Assumed : 3.2 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation							20	20					40
2. Sowing/Transplanting							20	10					30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)									19	13			32
4. Harvesting											30		30
5. Post Harvest Operation											10	15	25
6. Total (Rainfed)							40	30	19	13	40	15	157
7. Irrigation									1	2			3
8. Total (Irrigated)							40	30	20	15	40	15	160
Draught Pair Days													

6 : Boro (L)

Yield Assumed : 2 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation											15	30	45
2. Sowing/Transplanting	15											15	30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)		15	17										32
4. Harvesting				20	10								30
5. Post Harvest Operation				10	15								25
6. Total (Rainfed)													
7. Irrigation	1	1	1								1	1	5
8. Total (Irrigated)	16	16	18	30	25						16	46	167
Draught Pair Days													42

Continued

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

7 : Boro (HYV)

Yield Assumed : 3.8 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation	15											30	45
2. Sowing/Transplanting	25											5	30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)		10	15	10									35
4. Harvesting				5	20	15							40
5. Post Harvest Operation					15	15							30
6. Total (Rainfed)													
7. Irrigation	2	2	2	1								1	8
8. Total (Irrigated)	42	12	17	16	35	30						36	188
Draught Pair Days													42

8 : Wheat (HYV)

Yield Assumed : 2.4 T/Ha Irrigated
1.7 T/Ha Rainfed

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation											20	20	40
2. Sowing/Transplanting											1	1	2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	15	5											20
4. Harvesting			20 (25)										20
5. Post Harvest Operation			10	15 (20)									25
6. Total (Rainfed)	15	5	30	15							21	21	107
7. Irrigation	1	1									1	1	4
8. Total (Irrigated)	16	6	35	20							22	22	121
Draught Pair Days													35

continued

Figures in parenthesis refer to irrigated crop

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

9 : Jute

Yield Assumed : 1.7 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation			25	20									45
2. Sowing/Transplanting			1	1									2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)				10	30	10							50
4. Harvesting						5	20	10					35
5. Post Harvest Operation							10	35	3				48
6. Total (Rainfed)			26	31	30	15	30	45	3				180
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													42

10 : Sugarcane

Yield Assumed : 50 T/Ha Irrigated
42 T/Ha Rainfed

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation	10	5								15	10	10	50
2. Sowing/Transplanting	5	5								5	0	5	30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	5	5	5	15	15			10	10				65
4. Harvesting	15 (20)	10 (15)	5 (8)								10 (12)	15 (20)	55 (75)
5. Post Harvest Operation	12 (15)	8 (10)	3 (5)								8 (10)	12 (15)	43 (55)
6. Total (Rainfed)	47	33	13	15	15			10	10	20	38	42	243
7. Irrigation	1	2	2	2								1	8
8. Total (Irrigated)	56	42	20	17	15			10	10	20	42	51	283
Draught Pair Days													42

Figures in parenthesis refer to irrigated crop
Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

LBD

11 : Potato

Yield Assumed : **12 T/Ha Irrigated**
8 T/Ha Rainfed

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										10	30	10	50
2. Sowing/Transplanting											15	15	30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	20	10										10	40
4. Harvesting		10 (15)	40 (60)	10 (15)									60 (90)
5. Post Harvest Operation			10	5									15
6. Total (Rainfed)	20	20	50	15						10	45	35	195
7. Irrigation	2	2										2	6
8. Total (Irrigated)	22	22 (27)	50 (70)	15 (20)						10	45	37	201 231
Draught Pair Days													45

Figures in parenthesis refer to irrigated crop

12 : Lentil

Yield Assumed : **0.7 T/Ha**

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										10	18		28
2. Sowing/Transplanting											2		2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)													
4. Harvesting			15										15
5. Post Harvest Operation			15	10									25
6. Total (Rainfed)			30	10						10	20		70
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													25

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

13 : Lathyrus

Yield Assumed : 0.7 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation													0
2. Sowing/Transplanting									1	1			2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)													
4. Harvesting			15	5									20
5. Post Harvest Operation			10	15									25
6. Total (Rainfed)			25	20					1	1			47
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													

14 : Chick-pea

Yield Assumed : 0.8 T/Ha

Task	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation											12	18	30
2. Sowing/Transplanting											1	1	2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc.)													
4. Harvesting			15	10									25
5. Post Harvest Operation			10	15									25
6. Total (Rainfed)			25	25							13	19	82
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													25

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

15 : Mung bean

Yield Assumed : 0.5 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation		* (60)	* (5)							5	10		15
2. Sowing/Transplanting	(1)										1		1
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)													
4. Harvesting		15	10		* (15)	* (10)							25
5. Post Harvest Operation		10	10		(10)	(10)							20
6. Total (Rainfed)		25	15							5	11		61
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													14

* For February sowing in the Barisal & Patuakhali area

16 : Blackgram

Yield Assumed : 0.7 T/Ha

Task	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation			* (5)	* (10)					5	10			15
2. Sowing/Transplanting				(1)						1			1
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)													
4. Harvesting	15											10	25
5. Post Harvest Operation	12											8	20
6. Total (Rainfed)	27								5	11		18	61
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													14

* Summer sowing mainly for ----

continued

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

17 : Mustard

Yield Assumed : 0.7 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										18	12		30
2. Sowing/Transplanting										1	1		2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	2										1	2	5
4. Harvesting		10	15										25
5. Post Harvest Operation		10	10										20
6. Total (Rainfed)	2	20	25							19	14	2	82
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													25

18 : Sesame

Yield Assumed : 0.6 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation											12	12	24
2. Sowing/Transplanting											1	1	2
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	5	5											10
4. Harvesting			10	10									20
5. Post Harvest Operation			5	5									10
6. Total (Rainfed)	5	5	15	15							13	13	66
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													21

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

19 : Groundnut

Yield Assumed : 1.02 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation											10	20	30
2. Sowing/Transplanting	5										5	10	20
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	15	20											35
4. Harvesting			5	15	5								25
5. Post Harvest Operation			10	20	10								40
6. Total (Rainfed)	20	20	15	35	15						15	30	150
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													28

20 : Onion/Garlic

Yield Assumed : Onion, 4.1 T/Ha
Garlic 3.2 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										5	30	15	50
2. Sowing/Transplanting	20											20	40
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	15	25	5										45
4. Harvesting			10	20									30
5. Post Harvest Operation			10	20									30
6. Total (Rainfed)	35	25	25	40						5	30	35	195
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													45

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

21 : Chilli

Yield Assumed : 0.6 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										5	15	30	50
2. Sowing/Transplanting	10										5	10	25
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	20	20											40
4. Harvesting			15	25	15								55
5. Post Harvest Operation			2	5	3								10
6. Total (Rainfed)	30	20	17	30	18					5	20	40	180
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													42

22 : Tomato

Yield Assumed : 6.0 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										5	30	15	50
2. Sowing/Transplanting											10	10	20
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)												10	35
4. Harvesting													40
5. Post Harvest Operation													6
6. Total (Rainfed)										5	40	35	151
7. Irrigation	2	2										2	6
8. Total (Irrigated)													
Draught Pair Days													42

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

23 : **Cabbage/Cauliflower**

Yield Assumed : **Cabbage 9.7 T/Ha**
Cauliflower 8.55 T/Ha

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation									5	20	20		45
2. Sowing/Transplanting										10	15	5	30
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	20										15	20	55
4. Harvesting	15	5	5									5	30
5. Post Harvest Operation	5	5	2									3	15
6. Total (Rainfed)													
7. Irrigation	4	2										4	10
8. Total (Irrigated)	44	12	7						5	30	50	37	185
Draught Pair Days													42

24 : **Sweet Potato**

Yield Assumed : **9.0 T/Ha**

Operation	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1. Land Preparation										15	20		35
2. Sowing/Transplanting										15	20		35
3. Intercultural Operations (Weeding, Insect & Fert. Appl. etc)	10											5	15
4. Harvesting			25	30									55
5. Post Harvest Operation			10	5									15
6. Total (Rainfed)	10		35	35						30	40	5	155
7. Irrigation													
8. Total (Irrigated)													
Draught Pair Days													30

Source : Estimated from MPO, BRRI, BARI, BJRI and BARC data

continued

APPENDIX C

Area, Production and Yield of Major Crops by Greater District, 1983-84 to 1990-91

Area, Production and Yield of Major Crops by Greater Districts

Aus (Local)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	101093	82959	0.82	129698	130585	1.01	147310	16038	0.11	138130	155655	1.13	108472	120800	1.11	99951	124490	1.25
Jessore	183334	124244	0.68	186727	176620	0.95	201279	18185	0.09	192820	203275	1.05	135267	139170	1.03	112785	112500	1.00
Khulna	40219	39120	0.97	29913	31715	1.06	37217	9230	0.25	43645	46615	1.07	36113	36490	1.01	31640	34800	1.10
Barisal	147885	124762	0.84	175126	155940	0.89	196662	19000	0.10	205690	184970	0.90	167800	170475	1.02	168462	162920	0.97
Patuakhali	66573	66290	1.00	92269	72560	0.79	109421	10077	0.09	115965	89200	0.77	63783	54745	0.86	66223	58240	0.88
Faridpur	217854	158347	0.73	239676	202180	0.84	258763	21494	0.08	278665	232300	0.83	238103	206125	0.87	198660	133330	0.67
Total	756958	595722	0.79	853409	769600	0.90	950652	94024	0.10	974915	912015	0.94	749538	727805	0.97	677721	626280	0.92
National	2639958	2214589	0.84	2362065	2163395	0.92	2291421	210183	0.09	2266745	2127195	0.94	1903275	1865635	0.98	1743781	1630000	0.93

C-1

Aus (HYV)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	23792	56267	2.36	30727	67220	2.19	22300	49185	2.21	19460	37920	1.95	15809	29165	1.84	19955	41890	2.10
Jessore	14648	23568	1.61	28694	63755	2.22	22526	45180	2.01	16125	25760	1.60	18670	32945	1.76	18623	38180	2.05
Khulna	5350	9297	1.74	4243	5713	1.35	4283	8465	1.98	6525	11500	1.76	5312	9555	1.80	5875	13890	2.36
Barisal	28672	49703	1.73	34628	59665	1.72	36652	73870	2.02	15835	27855	1.76	13931	25855	1.86	9911	18590	1.88
Patuakhali	2899	4222	1.46	12186	15660	1.29	11464	17555	1.53	920	1475	1.60	7148	13525	1.89	13425	22880	1.70
Faridpur	2401	4552	1.90	4263	9480	2.22	4269	9925	2.32	185	400	2.16	267	670	2.51	2575	5810	2.26
Total	77762	147609	1.90	114741	221493	1.93	101494	204180	2.01	59050	104910	1.78	61137	111715	1.83	70364	141240	2.01
National	451773	839548	1.86	531449	948445	1.78	489221	877255	1.79	411820	719960	1.75	352992	608890	1.72	364579	691090	1.90

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

clandl\crop\tab1

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Area, Production and Yield of Major Crops by Greater District

Broadcast Aman

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	25769	23177	0.90	29099	26945	0.93	26963	26585	0.99	18306	19115	1.04	21491	23090	1.07	21518	22460	1.04
Jessore	118841	124416	1.05	91598	87265	0.95	75281	71805	0.95	86128	98935	1.15	58857	64300	1.09	57143	56890	1.00
Khulna	40320	47416	1.18	32428	28260	0.87	371542	33280	0.09	41808	35265	0.84	40083	43840	1.09	35221	30290	0.86
Barisal	88620	77539	0.87	65536	69325	1.06	64340	61050	0.95	51611	54955	1.06	62365	83410	1.34	43549	52250	1.20
Patuakhali																		
Faridpur	242374	175724	0.73	267183	243455	0.91	493766	192515	0.39	263897	166895	0.63	196344	166210	0.85	182639	163880	0.90
Total	515924	448272	0.87	485844	455250	0.94	1031892	385235	0.37	461750	375165	0.81	379140	380850	1.00	340070	325770	0.96
National	1464282	1539305	1.05	1348928	1346925	1.00	1229849	1123660	0.91	934976	805440	0.86	943260	1039740	1.10	397811	996930	2.51

C-2

Aman HYV

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	24291	49631	2.04	31868	66190	2.08	35364	72325	2.05	58362	112665	1.93	65296	144520	2.21	71170	160360	2.25
Jessore	29538	60869	2.06	44123	89895	2.04	58358	115895	1.99	72585	144740	1.99	182504	40894	0.22	190304	410680	2.16
Khulna	30283	62404	2.06	25484	51190	2.01	27524	53165	1.93	39126	94105	2.41	44198	107440	2.43	71866	175730	2.45
Barisal	33431	65503	1.96	39729	86560	2.18	42186	85650	2.03	32520	60440	1.86	18569	44830	2.41	21648	40850	1.89
Patuakhali	12119	26093	2.15	7992	16820	2.10	8107	17680	2.18	6640	11735	1.77	10943	23230	2.12	7182	10840	1.51
Faridpur	2763	4227	1.53	2885	4225	1.46	4980	9690	1.95	1292	2515	1.95	6719	12800	1.91	9915	19730	1.99
Total	132425	268727	2.03	152081	314880	2.07	176519	354405	2.01	210525	426200	2.02	328229	373714	1.14	372085	818190	2.20
National	638765	1326717	2.08	806524	1713300	2.12	817237	1725620	2.11	995723	1935640	1.94	1364731	3080420	2.26	1602709	3237472	2.02

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

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Area, Production and Yield of Major Crops by Greater Districts

Transplanted Aman (L)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	8150	8830	1.08	16882	20960	1.24	20245	30205	1.49	6328	8530	1.35	5866	9070	1.55	1960	2570	1.31
Jessore	113251	143057	1.26	130964	199935	1.53	128650	170005	1.32	70468	97640	1.39	43134	64094	1.49	42263	61440	1.45
Khulna	321209	393896	1.23	343014	405080	1.18	299340	421280	1.41	304089	315385	1.04	341500	486530	1.42	287680	397440	1.38
Barisal	274285	317389	1.16	293194	388680	1.33	289577	371935	1.28	297893	336970	1.13	304599	444580	1.46	315105	438580	1.39
Patuakhali	270372	345271	1.28	305935	362420	1.18	306077	393370	1.29	311081	298830	0.96	299988	371150	1.24	303348	321080	1.06
Faridpur	26700	24620	0.92	8273	9960	1.20	8670	8290	0.96	6036	5325	0.88	8885	8340	0.94	7708	8390	1.09
Total	1013967	1233063	1.22	1098262	1387035	1.26	1052559	1395085	1.33	995895	1062680	1.07	1003972	1383764	1.38	958064	1229500	1.28
National	3481267	4347582	1.25	3457411	4395370	1.27	3165459	4116310	1.30	2814022	3470130	1.23	2999777	4306090	1.44	2874089	3923520	1.37

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

cland\crop\tab3

Area, Production and Yield of Major Crops by Greater Districts

Name of Crop : Boro (HYV)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	2939	6081	2.07	5923	20010	3.38	8657	25370	2.93	16704	45605	2.73	19628	53070	2.70	22389	59880	2.67
Jessore	29221	76255	2.61	37854	113765	3.01	63287	208463	3.29	131656	400935	3.05	113093	315490	2.79	111101	354830	3.19
Khulna	14132	34410	2.43	17375	47570	2.74	23206	66231	2.85	30727	76545	2.49	31615	76720	2.43	34773	85090	2.45
Barisal	28148	71173	2.53	16119	40835	2.53	16284	41192	2.53	23842	59705	2.50	55134	143720	2.61	58955	140350	2.38
Patuakhali	4043	8490	2.10	1020	1935	1.90	579	1171	2.02	2547	3970	1.56	1661	2740	1.65	2138	3250	1.52
Faridpur	32443	81125	2.50	52190	152615	2.92	63250	200585	3.17	102601	314060	3.06	88810	316680	3.57	89984	310620	3.45
Total	110926	277534	2.50	130481	376730	2.89	175263	543012	3.10	308077	900820	2.92	309941	908420	2.93	319340	954020	2.99
National	981676	2667014	2.72	1231885	3327935	2.70	1505588	3996089	2.65	2066555	5282460	2.56	2155190	5672330	2.63	2210453	4816200	2.18

C-4

Boro (L)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	524	987	1.88	678	1120	1.65	958	1538	1.61			ERR			ERR	611	1140	1.87
Jessore	1445	1753	1.21	887	1535	1.73	964	1846	1.91	247	405	1.64	862	1250	1.45	826	1300	1.57
Khulna	6152	7992	1.30	9034	11785	1.30	9016	12077	1.34	12164	14010	1.15	10887	14150	1.30	11134	15200	1.37
Barisal	3785	3973	1.05	3769	4425	1.17	3781	3925	1.04	5433	7960	1.47	5377	7570	1.41	4283	5780	1.35
Patuakhali	5794	4893	0.84	3842	3450	0.90	3830	3118	0.81	174	140	0.80	259	220	0.85	462	500	1.08
Faridpur	6943	9719	1.40	7107	7410	1.04	10441	15151	1.45	35978	46705	1.30	31389	34710	1.11	30405	38320	1.26
Total	24643	29317	1.19	25317	29725	1.17	28990	37655	1.30	53996	69220	1.28	48774	57900	1.19	47721	62240	1.30
National	335336	517891	1.54	312237	431095	1.38	303911	437164	1.44	307314	408460	1.33	300178	361430	1.20	282223	406670	1.44

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

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Area, Production and Yield of Major Crops by Greater District

Wheat

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	53049	131936	2.49	43998	73190	1.66	45901	97410	2.12	43603	96195	2.21	46219	67530	1.46	45065	72380	1.61
Jessore	24553	59340	2.42	35692	70795	1.98	44611	104505	2.34	44534	91245	2.05	45862	66250	1.44	42919	74230	1.73
Khulna	1943	4710	2.42	4727	9630	2.04	3292	6835	2.08	3490	7330	2.10	3676	6460	1.76	3142	5070	1.61
Barisal	1858	1785	0.96	4583	3950	0.86	7375	13840	1.88	6377	8950	1.40	6414	8670	1.35	3988	4790	1.20
Patuakhali	32	36	1.13	81	80	0.99	142	210	1.48	134	215	1.60	117	120	1.03	219	240	1.10
Faridpur	40632	100472	2.47	44419	62945	1.42	48939	74490	1.52	48377	82420	1.70	49142	57000	1.16	45676	67550	1.48
Total	122067	298279	2.44	133500	220590	1.65	150260	297290	1.98	146515	286355	1.95	151430	206030	1.36	141009	224260	1.59
National	526217	1211501	2.30	585020	1090990	1.86	597688	1048015	1.75	560336	1021950	1.82	592332	890000	1.50	599211	1004290	1.68

Jute

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	33008	52624	1.59	38670	54530	1.41	22144	43259	1.95	27057	54285	2.01	33741	63187	1.87	36470	71736	1.97
Jessore	94927	103094	1.09	64455	106233	1.65	59634	110069	1.85	49040	83294	1.70	50085	88622	1.77	53607	103762	1.94
Khulna	12672	22137	1.75	17713	27285	1.54	7241	13560	1.87	10731	20159	1.88	10360	19542	1.89	10911	21904	2.01
Barisal	2587	2277	0.88	3417	2962	0.87	3053	2440	0.80	2891	4451	1.54	1854	2456	1.32	1733	2475	1.43
Patuakhali	455	331	0.73	458	355	0.78	498	380	0.76	455	306	0.67	397	249	0.63	470	307	0.65
Faridpur	73587	105885	1.44	83565	124594	1.49	61840	95813	1.55	62103	81906	1.32	61607	98495	1.60	69296	104564	1.51
Total	217236	286348	1.32	208278	315959	1.52	154410	265521	1.72	152277	244401	1.60	158044	272551	1.72	172487	304748	1.77
National	688541	948301	1.38	772644	1227899	1.59	512532	854510	1.67	543628	806508	1.48	541935	843502	1.56	583688	963960	1.65

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

Area, Production and Yield of Major Crops by Greater Districts

Tobacco

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	8158	8255	1.01	6010	4705	0.78	5964	4827	0.81	5901	4843	0.82	6061	4422	0.73			
Jessore	2055	1795	0.87	1417	1240	0.88	1480	1322	0.89	1519	1639	1.08	1517	1385	0.91			
Khulna	291	165	0.57	186	100	0.54	174	85	0.49	117	46	0.39	109	39	0.36			
Barisal	1255	870	0.69	368	210	0.57	372	213	0.57	384	218	0.57	370	211	0.57			
Patuakhali	530	245	0.46	433	200	0.46	411	180	0.44	223	90	0.40	134	49	0.37			
Faridpur	3850	1745	0.45	2634	1710	0.65	2164	1579	0.73	2089	1568	0.75	2111	1680	0.80			
Total	16139	13075	0.81	11048	8165	0.74	10565	8206	0.78	10233	8404	0.82	10302	7786	0.76			
National	51696	47840	0.93	46354	39990	0.86	47192	41545	0.88	45797	39301	0.86	45087	40613	0.90			

Sugarcane

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	18285	886920	48.51	19385	787780	40.64	20259	838040	41.37	20905	849040	40.61	21905	974645	44.49	24032	1040460	43.29
Jessore	10834	479400	44.25	10356	398685	38.50	10949	417050	38.09	11203	447055	39.90	12103	460255	38.03	12154	506435	41.67
Khulna	3516	152355	43.33	3346	135080	40.37	3403	153695	45.16	3603	203695	56.53	3870	235770	60.92	3877	245265	63.26
Barisal	3306	118575	35.87	3733	116040	31.08	3739	115030	30.76	3840	112010	29.17	4186	109915	26.26	3798	117135	30.84
Patuakhali	577	16290	28.23	585	17485	29.89	577	16740	29.01	502	14140	28.17	429	13140	30.63	462	13890	30.06
Faridpur	18769	813135	43.32	18798	858060	45.65	20802	950996	45.72	21802	960970	44.08	22253	810565	36.42	23281	904095	38.83
Total	55287	2466675	44.62	56203	2313130	41.16	59729	2491551	41.71	61855	2586910	41.82	64746	2604290	40.22	67604	2827280	41.82
National	166696	6960415	41.76	164678	6895910	41.88	173358	7207345	41.57	198356	7503745	37.83	179536	7409945	41.27	176535	7527355	42.64

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

Area, Production and Yield of Major Crops by Greater Districts

Mustard & Rape

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	12094	8878	0.73	10179	6729	0.66	8227	5583	0.68	8309	5213	0.63	8723	5927	0.68			
Jessore	34746	19798	0.57	38008	22042	0.58	39631	25249	0.64	41142	25907	0.63	41813	30145	0.72			
Khulna	8045	5207	0.65	7425	4361	0.59	5367	3147	0.59	5632	2435	0.43	6030	2770	0.46			
Barisal	4401	2561	0.58	5631	3011	0.53	4431	2361	0.53	7322	2452	0.33	7847	3064	0.39			
Patuakhali	278	129	0.46	474	210	0.44	438	179	0.41	442	144	0.33	451	128	0.28			
Faridpur	32062	18475	0.58	37762	27739	0.73	35312	28943	0.82	35375	27349	0.77	35699	27511	0.77			
Total	91626	55048	0.60	99479	64092	0.64	93406	65462	0.70	98222	63500	0.65	100563	69545	0.69			
National	364217	253654	0.70	342846	228573	0.67	318004	222008	0.70	98222	206943	2.11	338549	217418	0.64			

Potato (Local + HYV + Indian)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	953	9850	10.34	1133	9510	8.39	1158	9990	8.63	1251	11443	9.15	1253	11465	9.15	1334	14105	10.57
Jessore	1700	25560	15.04	2336	30355	12.99	2498	33415	13.38	2313	22598	9.77	2552	25370	9.94	2696	36370	13.49
Khulna	2998	35420	11.81	2913	35175	12.08	2937	42140	14.35	1510	10912	7.23	1520	11465	7.54	1486	11885	8.00
Barisal	1253	11595	9.25	1213	11080	9.13	1316	11990	9.11	1250	12565	10.05	1308	13000	9.94	545	5005	9.18
Patuakhali	194	1335	6.88	168	1075	6.40	174	1095	6.29	499	2994	6.00	534	2990	5.60	381	2360	6.19
Faridpur	753	6715	8.92	800	7440	9.30	802	7630	9.51	818	7703	9.42	836	7885	9.43	1004	9200	9.16
Total	7851	90475	11.52	8563	94635	11.05	8885	106260	11.96	7641	68215	8.93	8003	72175	9.02	7446	78925	10.60
National	110243	1166165	10.58	106409	1069295	10.05	123445	1275650	10.33	111726	1089298	9.75	116639	1065680	9.14	123899	1236805	9.98

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

Area, Production and Yield of Major Crops by Greater Districts

Lentil

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	28842	23826	0.83	29420	19639	0.67	28975	18913	0.65	28685	20618	0.72	30802	17955	0.58	31374	25650	0.82
Jessore	48912	29809	0.61	42291	26631	0.63	41584	29483	0.71	45139	30549	0.68	42638	30435	0.71	53648	30904	0.58
Khulna	6001	3862	0.64	4055	2071	0.51	4533	2261	0.50	4609	1867.00	0.41	4872	2575	0.53	6292	2565	0.41
Barisal	8572	5042	0.59	7391	5690	0.77	7268	5227	0.72	7268	5099	0.70	6409	4260	0.66	5814	4350	0.75
Patuakhali	1600	671	0.42	2006	903	0.45	2015	971	0.48	1814	708	0.39	1423	545	0.38	601	285	0.47
Faridpur	54825	38012	0.69	8035	6230	0.78	10180	7790	0.77	50989	54717	1.07	49540	46620	0.94	50166	38290	0.76
Total	148752	101222	0.68	93198	61164	0.66	94555	64645	0.68	138504	113558	0.82	135684	102390	0.75	147895	102044	0.69
National	240526	161243	0.67	212838	148988	0.70	216404	158719	0.73	215393	158040	0.73	209178	155120	0.74	210172	157280	0.75

Chickpea

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	12327	12547	1.02	9195	8503	0.92	8381	5888	0.70	8381	6687	0.80	8870	10275	1.16	7379	8330	1.13
Jessore	35351	20567	0.58	32662	22495	0.69	31766	20648	0.65	31005	17844	0.58	32180	18680	0.58	30332	23750	0.78
Khulna	14283	18940	1.33	1969	1572	0.80	1804	1472	0.82	2370	1376.00	0.58	2816	2325	0.83	2854	2135	0.75
Barisal	4831	3202	0.66	3546	2315	0.65	3718	2396	0.64	3766	2595	0.69	3765	2315	0.61	3816	2420	0.63
Patuakhali	1330	761	0.57	2448	1535	0.63	2892	1688	0.58	2651	1421	0.54	2692	1430	0.53	2010	1080	0.54
Faridpur	30946	27105	0.88	31077	28108	0.90	31160	25741	0.83	31138	19612	0.63	28449	18270	0.64	27472	17370	0.63
Total	99068	83122	0.84	80897	64528	0.80	79721	57833	0.73	79311	49535	0.62	78772	53295	0.68	73863	55085	0.75
National	113325	86790	0.77	103737	81710	0.79	103090	74568	0.72	102803	66156	0.64	102913	70120	0.68	96757	91005	0.94

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

Lathyrus

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Productic Pr	Yield	Area	Productic Pr	Yield	Area	Productic Pr	Yield	Area	Productic Pr	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Khushtia	4530	3237	0.71	5336	3852	0.72	4973	3604	0.72	5111	3727	0.73	4812	3607	0.75	4812	3566	0.74	5178	3745	0.72	4923	3600	0.73
Jessore	12877	8110	0.63	13070	9303	0.71	12239	8508	0.70	11028	7615	0.69	12107	8584	0.71	12429	7951	0.64	13692	8995	0.66	14476	10835	0.75
Khulna	4636	2812	0.61	4457	3086	0.69	2891	1762	0.61	2447	1737	0.71	2389	1835	0.77	2673	1499.00	0.56	2069	1020	0.49	2026	1075	0.53
Barisal	42104	34278	0.81	47224	47241	1.00	46043	37654	0.82	42105	34511	0.82	42348	38497	0.91	42348	29288	0.69	46945	33975	0.72	49950	35780	0.72
Patuakhali	19206	10005	0.52	26073	15169	0.58	27371	16176	0.59	27587	18109	0.66	30240	19907	0.66	29706	15042	0.51	34682	16960	0.49	33761	20430	0.61
Faridpur	41982	22489	0.54	39419	19735	0.50	39164	22784	0.58	38621	24961	0.65	38012	27652	0.73	38030	27898	0.73	33690	29290	0.87	33109	30015	0.91
Total	125335	80931	0.65	135579	98386	0.73	132681	90488	0.68	126899	90660	0.71	129908	100082	0.77	129998	85244	0.66	136256	93985	0.69	138245	101735	0.74
National	240112	139620	0.58	244581	182689	0.75	232346	166865	0.72	221894	164419	0.74	231627	181996	0.79	232895	156853	0.67	242641	169915	0.70	243846	177045	0.73

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

Area, Production and Yield of Major Crops by Greater Districts

Garlic

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	557	2304	4.14	498	1965	3.95	514	1990	3.87	536	2113	3.94	599	2335	3.90	492	1615	3.28
Jessore	781	3090	3.96	887	2665	3.00	939	2295	2.44	992	2764	2.79	984	2895	2.94	513	2925	5.70
Khulna	306	1285	4.20	391	865	2.21	316	985	3.12	355	379.00	1.07	344	555	1.61	354	680	1.92
Barisal	757	2195	2.90	545	1445	2.65	551	1480	2.69	556	1500	2.70	474	1180	2.49	478	1075	2.25
Patuakhali	152	325	2.14	170	310	1.82	184	375	2.04	221	454	2.05	212	395	1.86	213	445	2.09
Faridpur	2725	6460	2.37	2591	6120	2.36	2601	8770	3.37	2607	8541	3.28	2678	8230	3.07	2765	9495	3.43
Total	5278	15659	2.97	5082	13370	2.63	5105	15895	3.11	5267	15751	2.99	5291	15590	2.95	4815	16235	3.37
National	13077	42801	3.27	12385	35875	2.90	12518	38815	3.10	12697	38192	3.01	13006	39055	3.00	12597	37965	3.01

Onion

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Khushtia	1308	6000	4.59	1233	5990	4.86	1496	7015	4.69	1605	7785	4.85	1709	9370	5.48	1660	7690	4.63
Jessore	2223	12605	5.67	2621	12900	4.92	2684	13260	4.94	2706	12785	4.72	2949	4805	1.63	2846	15480	5.44
Khulna	901	4450	4.94	860	3965	4.61	836	3540	4.23	713	2936.00	4.12	587	1365	2.33	593	1590	2.68
Barisal	745	1965	2.64	642	1685	2.62	648	1725	2.66	656	1744	2.66	528	1265	2.40	553	1235	2.23
Patuakhali	168	410	2.44	196	420	2.14	202	420	2.08	172	443	2.58	202	380	1.88	277	640	2.31
Faridpur	6933	24905	3.59	7051	25350	3.60	7065	31010	4.39	7069	30240	4.28	7417	30135	4.06	7366	29675	4.03
Total	12278	50335	4.10	12603	50310	3.99	12931	56970	4.41	12921	55933	4.33	13392	47320	3.53	13295	56310	4.24
National	33498	135885	4.06	33109	130125	3.93	33933	140545	4.14	34051	138589	4.07	35251	147845	4.19	34777	143305	4.12

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

continued

Area, Production and Yield of Major Crops by Greater Districts

Chillis (Rabi - Kharif)

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)	(ha)	Tonnes	(T/ha)
Kushtia	773	495	0.64	694	390	0.56	605	345	0.57	546	324	0.59	631	340	0.54	695	490	0.71
Jessore	1561	1135	0.73	1705	1355	0.79	1763	1520	0.86	1802	1937	1.07	1775	2015	1.14	1812	2610	1.44
Khulna	1303	816	0.63	1192	770	0.65	1149	765	0.67	1095	666	0.61	1008	700	0.69	984	730	0.74
Barisal	6951	4455	0.64	6623	4105	0.62	6656	4355	0.65	6680	4333	0.65	6565	5010	0.76	7348	4585	0.62
Patuakhali	5751	2770	0.48	6577	3070	0.47	6660	5310	0.80	6477	3344	0.52	6612	3085	0.47	7166	4135	0.58
Faridpur	6392	2855	0.45	6249	3890	0.62	6261	4390	0.70	6275	3387	0.54	5852	3055	0.52	6074	3320	0.55
Total	22731	12526	0.55	23040	13580	0.59	23094	16685	0.72	22875	13991	0.61	22443	14205	0.63	24079	15870	0.66
National	75561	46020	0.61	66518	43000	0.65	67423	45270	0.67	67827	47485	0.70	69696	51520	0.74	70212	51895	0.74

Source : Statistical year book 1990 and 1991, and unpublished but offical data for 1990-91, B.B.S

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Area, Production and Yield of Major Crops by Greater Districts

Mungbean

District	1983 - 84			1986 - 87			1987 - 88			1988 - 89			1989 - 90			1990 - 91		
	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)	Area (ha)	Production Tonnes	Yield (T/ha)
Kushtia	1999	1395	0.70	1785	1178	0.66	1857	1267	0.68	1855	1306	0.70	1935	1345	0.70	1968	1355	0.69
Jessore	3704	2175	0.59	3489	2953	0.85	3186	2521	0.79	3649	2866	0.79	3555	2750	0.77	2864	2475	0.86
Khulna	575	342	0.59	431	199	0.46	478	211	0.44	429	161.00	0.38	536	205	0.38	601	270	0.45
Barisal	16608	10657	0.64	15850	9660	0.61	15832	7138	0.45	15757	4787	0.30	15808	4805	0.30	16251	6020	0.37
Patuakhali	15750	7638	0.48	17053	9041	0.53	17476	9797	0.56	18320	8824	0.48	18642	9210	0.49	17658	8940	0.51
Faridpur	4759	2707	0.57	4389	2942	0.67	4362	3297	0.76	4353	2785	0.64	4249	2675	0.63	4051	2530	0.62
Total	43395	24914	0.57	42997	25973	0.60	43191	24231	0.56	44363	20729	0.47	44725	20990	0.47	43393	21590	0.50
National	60040	34120	0.57	57434	34563	0.60	57934	33116	0.57	58887	29408	0.50	60126	31283	0.52	61955	31550	0.51

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APPENDIX D

On-going Projects

APPENDIX D

AGRICULTURAL DEVELOPMENT PROJECTS

Major on-going agricultural development projects are described below:

Bangladesh Agriculture Development Corporation (BADC)

Seed Development Project (funded by GOB/EEC)

It is a national project which provides for cereal seed production and processing. Foundation seeds are produced in seed multiplication farms at Dattanagar (Jessore), Barodi (Meherpur), Nurnagar (Chuadanga) and Sadhuhati (Jhinaidah). Certified seeds are produced by the contact growers system in the Zilas of Chuadanga, Meherpur, Jessore, Barisal and Faridpur. Seed processing and storing centres are located at Chuadanga, Meherpur, Faridpur, Jessore, Barisal and Dattanagar farms.

Vegetables Seed Production Project (funded by GOB/FAO)

This project provides for the production and processing of summer and winter vegetable seeds. Production and processing centres have been located at farms in Amjhupi (Jessore) and Barodi (Meherpur).

Crop Diversification Project (funded by GOB/Dutch grant)

This is a national project involving various components. The BADC is responsible for seed production of CDP crops.

Potato, oilseed and pulse seeds are produced on seed multiplication farms at Jessore, Meherpur and Faridpur and a pulse and oilseed processing centre is located at Meherpur.

Agro-Service Centre Project (funded by GOB/British Commodity Aid Grant)

Sale Centres have been located at Jessore and Khulna. Poultry birds and eggs are sold at Jessore. Parent stock one day old chicks are supplied from U.K. and France.

Horticulture Development Project (funded by GOB/ADB)

Horticulture crop grants, goodies (layer), seedings and seeds produced, processed and sold at a centre in Jessore.

Jute Seed Project (funded by GOB/FRG)

Foundation jute seed production farm at Chitla (Meherpur). Contact growers are located in selected Upazilas of greater Kushtia and Jessore district. Jute seed processing plants at Manirampur (Jessore) and Chitla.

Contact Growers Scheme (funded by GOB/FRG)

This scheme is operational in the Southwest Region in selected Upazilas in the Faridpur, Barisal, Jessore, Chuadanga and Meherpur Zilas.

Fertiliser Project (funded by GOB/IFDC under USAID)

Fertiliser demonstration and farmers' training are provided in selected Upazilas of greater districts of Faridpur, Khulna, Jessore and Kushtia. Primary fertiliser distribution points are provided in Zila headquarters.

Seed Production Farms (funded by GOB)

Production farms in the Southwest Region are located at Dattanagar (Jessore), Barodi (Meherpur), Nurnagar (Chnadandga), Sadhuhati (Jhinaidah), Tambulkhana (Faridpur), Pangsha (Faridpur), Boalia (Khulna) and Lakhutia (Barisal).

Minor Irrigation Project (funded by GOB/Various Aid Agencies)

BADC sells STWs and LLPs direct to the farmers and installs DTWs, operating in the Southwest Region in areas where neither ground water nor surface water is suitable for irrigation due to salinity.

The above projects are operating in the Southwest Region as part of national projects.

Small Scale Irrigation Section Project (funded by GOB/EEC)

A DTW irrigation project operating in the Southwest Region in three Upazilas of Faridpur and Rajbari Zilas.

Department of Agricultural Extension (DAE)

Second Extension Research Project (funded by GOB/IDA/World Bank)

The project objective is to transfer technology through the training and visit (T&V) system and to establish a linkage between research and extension. It is operating throughout the Southwest Region as part of national programme. Field level workers from district up to Union level, organise farmers training, workshops and establish demonstration blocks etc. The project has been strengthened by the ongoing Agricultural Support Service Project (ASSP).

Strengthening of Plant Protection Services (funded by GOB/DANIDA)

This project provides for (i) the construction of an airstrip at Patuakhali and (ii) the supply of pesticides and sprayers. The Project was due to be completed in June 1991, but its work is still continuing.

Horticulture Development Project (funded by GOB/UNDP/ADB)

In the Region, the project will strengthen base nurseries at Meherpur, Barisal, Khulna, Jessore and Rajbari to raise seedings and produce seeds for horticultural crop for the farmers. Part of a national programme.

Crop Diversification Project (funded by GOB/CIDA)

This is a national project in which the DAE is involved in the extension component of CDP. They provide farmers' training, field demonstrations and other extension services in selected Upazilas of eleven districts of the Southwest Region to improve the production of pulses, oilseeds and potato. The project will continue.

Southern District Development Project (funded by GOB)

The project is located in the Greater Barisal and Patuakhali and Gopalganj districts and is intended to introduce cropping intensification for development of small farmers. This will continue up to June 1995.

Improved Ratting Practices for Augmenting Quality of Jute (funded by GOB/EEC)

This project is part of a national programme, operating in the Southwest Region in Jessore, Kushtia and Faridpur. The project objectives are to the popularisation of ribbon ratting of jute and the augmentation of ratting facilities by excavation of new and reexcavation of derelict ponds, tanks, roadside ditches etc.

Cotton Development Board (CDB)

Cotton Development Project (funded by GOB/EEC)

CDB provides cotton seeds, arranges loans and gives expert advise to the cotton growers. They also provide ginning facilities at Kalaroa (Khulna), Jikargacha (Jessore) and Meherpur.

1. Co-ordinated Soil Fertility and Fertiliser Management Project

This is a national project. Agencies involved are: BARI, BRRI, SRTI, SRDI, BARC, BJRI and BAU.

Lead Agency - DAE

Objective:
(a) To determine fertility status of soils of different soil types of agro-ecological regions and manage fertilise use accordingly
(b) To set up demonstration plots
(c) To create trained manpower

Financing : GOB/DANIDA

Period : July 1991 - June 1996

2. Coconut Development and Large Scale plantation of useful trees

National Project

Financing : GOB

Objective:
(a) Educate people on the devastating consequences of cutting trees.
(b) To motivate and help people to plant more useful trees specially coconut around homestead areas.

Period : July 1991 - June 1996

Executing Agency: DAE

3. Agriculture Support Services Project (ASSP)

Funding : IDA/ODA

Period : July 1991 - June 1998

National Project

Objective : (a) Making technology transfer more responsive to farmers needs and improve outreach capabilities for rural community including women

(b) Upgrading extension training programme

(c) Help improve seeds available to farmers through privatisation of seed sector

Components : DAE (Lead Agency), BARI, BRRI, BJRI, MOA.

4. Accelerating Sugarcane Production in the non-mill zones

Implementing Agency - DAE/MOA

National Programme - Selected Thanas.

Objective : (a) To increase Sugarcane production in the non-mill zones through introduction of disease free HYV seeds.

(b) To increase production of Gur (Brown sugar)

Funding : GOB

Period : July 1991 - 1996.

5. Transfer of technology and Project identification at the Thana level (TAPP) Project

National Project

Executing Agency : DAE

Objective : Development of agricultural research at Thana level and motivate the farmers to use the research results for intensification of crop production

Funding : GOB/UNDP/IDA

Period : July 91 - June 1996.

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IMPORTANT LIVESTOCK DEVELOPMENT PROJECT IN THE SWA

1. Live stock Development for small and marginal farmers in selected thanas.

   Funding : GOB/IFAD

   The project will operate through BRAC who will organize farmers group and training.

   Cattle of improve breeds will be provided to farmers (small and marginal) on loan.

   Period : July 1991 - June 1996.

2. Establishment of Buck rearing units for Goat Development at each Division.

   Funding : GOB

   Period : 1990 -1993.

   The objective is to improve Black Bengal Goat through selection and breeding.

3. Expansion of Artificial Insemination network with introduction of deep frozen semen.

   Funding : GOB

   On going project semen is collected from selected bulls of improved breeds of the Central Dairy and Cattle Breeding Station located at Savar and transported to different artificial insemination centres for use in their breeding programme.

4 Expansion of Animal Health Care Management Project

   Funding : GOB

   National project involving all Thanas. The project aims at (a) extension of livestock treatment facilities upto the union level, (b) extension of intensive vaccination programme against infectious diseases.

   Period : July 1992 - June 1995.

5. Establishment of Dairy and Cattle Development Farm at Barisal, Chittagong and Bogra.

   Funding : GOB

   The stations at Chittagong and Bogra have already been established. The Barisal unit will come into operation in 1993-1994.

   Objective of the project is to improve local cattle through cross breeding.

   The above projects are in addition to the existing (a) Cattle Breeding Station at Faridpur, (b) Buffalo breeding station at Bagerhat, and (c) Duck farm at Satkhira.

   Project : Improved Fodder cultivation Programme

   Funding : GOB/ADB

   Objective :
   (1) Introduction of improved fodder species at the union level through establishment of base mercerise at the thana level. Fodder crops involved - Maize, Necpier grass, epil-epil etc.

   (2) Training of farmers.

   National project. Will continue indefinitely.

Fisheries

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SOUTHWEST AREA WATER RESOURCES MANAGEMENT PROJECT

FISHERIES

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
BFDC	Bangladesh Fisheries Development Corporation
CEP	Coastal Embankment Project
DANIDA	Danish International Development Agency
DOF	Department of Fisheries
FAO	Food and Agriculture Organisation
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FCD/I	Flood Control Drainage/Irrigation
FRSS	Fisheries Resource Survey System
FRI	Fisheries Research Institute
GOB	Government of Bangladesh
IDA	International Development Agency
IFAD	International Fund for Agricultural Development
MFL	Ministry of Fisheries & Livestock
MPO	Master Plan Organisation
NCA	Net Cultivable Area
NFMP	New Fisheries Management Policy
NGO	Non Government Organisation
PRE	Padma Right Embankment
SAP	Second Aquaculture Project
SPARRSO	Space Research and Remote Sensing Organisation
SC	South Central
SW	Southwest
SWA	Southwest Area
TFP	Third Fisheries Project

Figure 1.1

South West Area Location Map

1 INTRODUCTION

Fisheries in the South West Area (SWA) of Bangladesh comprise inland open water capture fisheries in rivers, estuaries, beels and floodlands, marine capture fisheries along the coast and culture fisheries, mainly for carp production in freshwater ponds and other closed water bodies and brackish water shrimp farming. The only detailed sequence of data covering these fisheries are the annual fish production statistical bulletins published by the Fisheries Department (DOF), which are considered to be assessments of at least the correct orders of magnitude and a reasonably accurate reflection of production trends and changes in fish stock abundance during recent years. The most recent year for which a full set of data is available is 1988/89. However, partial information has been obtained on 1989/90 fish and shellfish production, along with 1990/91 shrimp farming results. Fishing area data and a summary of SWA fish production statistics for the seven years from 1983/84 to 1989/90, together with shrimp production data for 1990/91, are shown in Tables 1.1 and 1.2.

MPO (Technical Report No 17, 1985) and other sources, the most recent of which is the FAP 12 Agricultural Impact Evaluation Study, have identified fisheries as one of the sectors worst affected by flood control developments throughout Bangladesh. The negative impacts arise mainly because flood control structures also block the spawning and feeding migrations of many species of fish to and from the flood plains, beels, rivers and tidal khals, and have thus reduced the breeding stocks and reproduction to a stage where several species of fish may be verging on extinction. In the interests of increasing the area of rice land inside FCD project boundaries, many permanently flooded beel areas have also been completely drained or converted to seasonal floodland which dries out during the winter months, thus causing the destruction of resident breeding stocks of fish. River flows have been altered, in terms of both depth and duration of flooding and the pattern of siltation has changed to the probable detriment of riverine fish species or the food organisms on which they depend. Fishermen's catches and earnings have inevitably been badly affected by these changes and consequently some erstwhile fulltime fishermen have had to seek other work or move elsewhere.

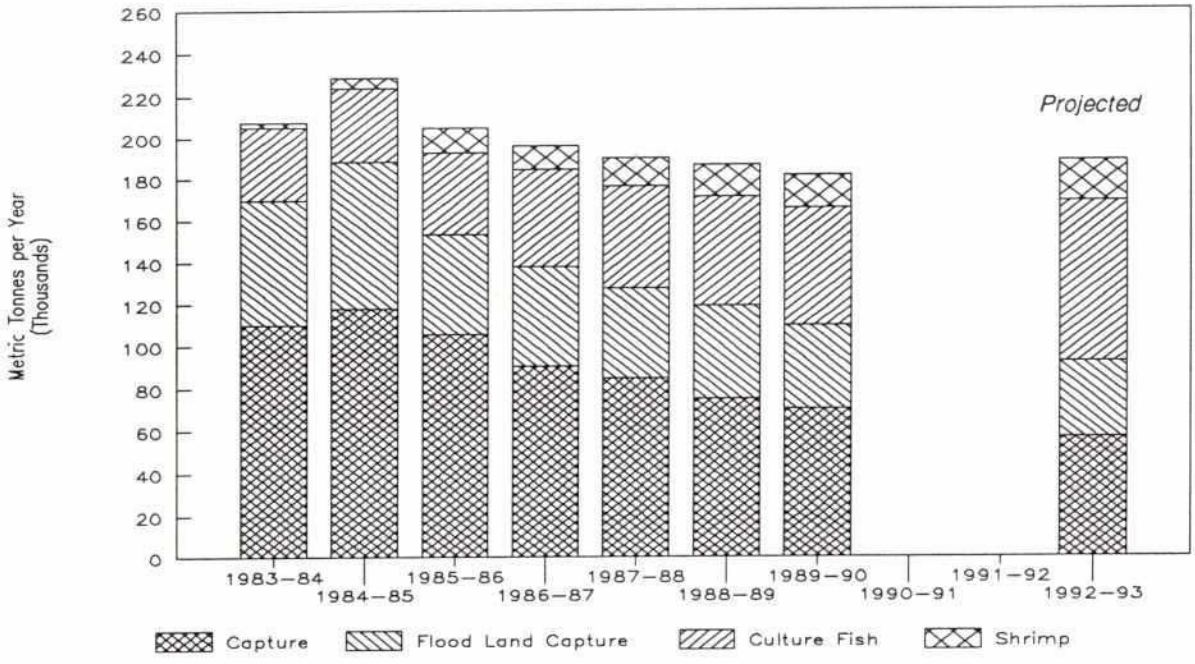
Figure 1.1 shows the Southwest Area.

Investigations by the FAP 4 team have led to similar conclusions, especially as regards FCD impacts on the inland capture fisheries in SWA. Most of the spawning grounds for the more important migratory fish species are located upstream in northern Bangladesh or India but, as far as is known, in most cases they do still exist. The problem is that relatively few mature fish from the diminishing beel areas are now able to migrate into the rivers and thence upstream to spawn, because so many of the beel/river connections have been blocked. Fewer spawners inevitably result in reduced stocks of many riverine and floodplain fish species.

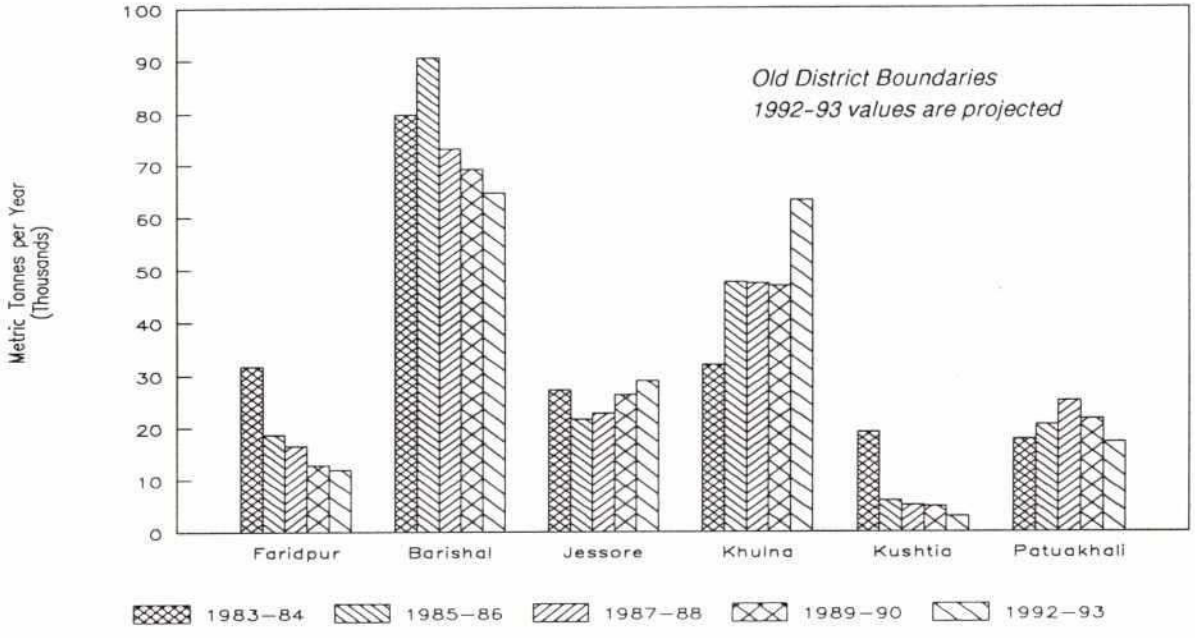
It is recognised that there have also been other contributory factors involved, such as a fish disease epidemic, continually escalating demand for fish and the almost total inability of the authorities concerned to restrict fishing effort and catches from diminishing stocks to sustainable levels. In addition there are direct benefits from FCD works to freshwater pond aquaculture and in some cases to brackish water shrimp farming, resulting in increased production from ponds no longer at risk of being inundated.

Table 1.2 shows the overall effect of these changes in SWA. During the six years to 1988/89 annual capture fisheries production fell sharply from 169,600 to 119,100 mt and is continuing to decline. This loss has been partly offset by the incremental production of farmed fish from ponds, ox-bow lakes (baors) and shrimp farms, which increased from 38,000 to 67,300 mt by 1988/89 and thus reduced the impact on regional fish supply of the gross loss of 50,500 mt/year from the capture fisheries. Figure 1.2 shows the fish production trends in SWA.

Figure 1.2



Trends in types of fishing



Regional Production Trends

Source: DOF Fish Catch Statistics of Bangladesh 1983/90
1992/93 figures: Consultants Estimate

Fish Production Trends

TABLE 1.1

SW Area - Inland Water Areas by New Districts
(Rounded to Nearest 10 ha)

New District	Rivers and Estuaries	Beels	Baors	Ponds	Shrimp Farms	Floodland
Faridpur	15280	570	290	1910	-	60210
Rajbari	8050	300	150	1010	-	31700
Gopalganj	11020	410	210	1360	-	43410
Madaripur	8490	320	160	1020	-	33450
Sariatpur	8680	320	160	1010	-	34210
Barisal	64160	80	-	4290	-	53090
Bhola	55690	-	-	3720	110	46090
Jhalakhati	19920	-	-	1330	-	16490
Perojpur	36330	-	-	2430	-	30060
Jessore	7100	2050	1050	2820	330	54250
Jhenaidah	4790	1380	1330	2130	-	36650
Magura	2850	820	180	1130	-	21810
Narail	2740	790	170	1070	-	20920
Khulna	9010	360	330	2650	26010	43440
Bagerhat	9090	-	-	1280	37900	42930
Satkhira	10010	-	-	1460	24300	47240
Kushtia	5210	1010	670	700	-	77600
Chuadanga	3780	730	490	520	-	56290
Meharpur	2330	450	300	320	-	34690
Patuakhali	71400	-	-	4390	-	37770
Barguna	36040	-	-	2210	230	19010
Sundarbans	175510	-	-	-	-	-
	567480	9590	5490	38760	88880	841310

Based on : DOF Fisheries Information Bulletin, Vol 3 No 1, December 1986, SPARRSO (1982-84); DOF Shrimp Survey 1982, 1986 and 1990 and FAP 4 Estimates.

TABLE 1.2

SW Area - Fish Production by Sub-sectors, 1983/84 - 1989/90
(Rounded to nearest 100 Metric tons)

Fishery	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
A. Capture Fishery							
1. Rivers and Estuaries	105700	116000	103500	88600	81600	72500	na
2. Beels	4300	2100	2000	2100	3100	2600	2400
3. Floodlands	59600	70300	47600	47400	43000	44000	39600
Total Capture Fish	169600	188400	153100	138100	127700	119100	-
B. Culture Fisheries							
5. Pond Fish	32200	32300	34100	39400	41400	43800	47700
6. Baors	900	1000	1000	1200	1300	1300	1400
7. Shrimp Farms							
- shrimp	2500	5000	12100	11400	13600	15200	15400
- fish	2400	2000	4400	6000	6100	7000	7000
Total Culture Fish	38000	40300	51600	58000	62400	67300	71500
Overall Total	207600	228700	204700	196100	190100	186400	-

Source: DOF Fish Catch Statistics of Bangladesh 1984/1990

Note : There was a further increase in shrimp farm output during 1990/91 to 16,900 tons of shrimps and 7600 tons of fish. No other fish production data is yet available for 1990/91.

2 INLAND CAPTURE FISHERIES

2.1 Fish Resources

Inland waters in SWA are believed to contain at least 200 of the 260 species of freshwater and anadromous fish which have been recorded for the whole of Bangladesh. Six species of exotic carp, two species of tilapia and one exotic catfish species have also been introduced to local waters. Nearly all of these fish are commercially marketed although some have always been quite rare. A checklist of all the indigenous species in SWA is attached as Appendix 1. A further list of species which, according to fishermen, traders and DOF staff are now scarce although they were abundant in the past, is shown in Appendix 2. It has been reported that several of these species may now be endangered and verging on extinction.

Shellfish are represented by 16 species of freshwater shrimp, of which one, Macrobrachium rosenbergii or Golda chingri, is of especial commercial importance. According to the Chandpur Fisheries Research Station, Research Report No 7 (M K Ahmed, 1983), there are about 44 species of marine shrimp some of which are the principal target of a substantial offshore trawling industry and 4 or 5 of which are also widely used for brackish water shrimp farming. A list of the most important species of fresh and brackish water shrimp is given as Appendix 3.

The crucial importance of the flood season for successful spawning by a wide range of riverine and floodplain species, can be seen from Appendix 4. In most cases the breeding period coincides with the early flood, whilst others breed throughout the monsoon flood season.

Capture fishing takes place in the rivers, beels and floodplain areas. It is the subsector most severely affected by FCD works because of the obstruction to fish spawning and feeding migrations, the draining of many formerly productive beel fisheries, the consequent reduction in recruitment and natural annual restocking of the floodplains and the enforced concentration of artisanal fishing effort onto the already diminished river fisheries.

2.2 River Fisheries

DOF's data for SWA riverine and estuarine production figures are combined and unfortunately this serves to divert attention from the virtual collapse of freshwater river fish stocks because estuarine fish are not so directly affected. As can be seen in Table 2.1, the combined figures show that the 1983/84 catch of 105,700 mt was reduced by 33,200 mt, or 31%, to 72,500 mt in 1988/89. Since most of this loss is from the river fishery, the percentage decline in freshwater river fish is accordingly much greater. This trend is further illustrated by major changes in the upper and lower Padma River fishery, as shown in Table 2.2, which produced nearly 7600 mt in 1984/85 down to only 1100 mt in 1988/89, a fall of some 85%.

TABLE 2.1

SW Area, Fish Production from Rivers and Estuaries

(Old) District	River Area(ha)	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Faridpur	51530	12593	8112	2111	2885	2887	1535	na
Barisal	176105	59850	50418	70550	60496	48300	48101	na
Jessore	17482	7786	1858	667	1260	1289	770	na
Khulna*	203612	12255	14425	19186	11397	12874	8676	na
Kushtia	11311	4862	4547	318	515	527	1400	na
Patuakhali	107443	8346	36639	10706	12021	15752	11981	na
Total	567483	105692	115999	103538	88574	81629	72463	na
Mean Catch kg/ha.		186	204	182	156	144	128	na
Sunderbans only		7783	6825	7112	6035	8066	6416	na
kg/ha		39	34	36	30	40	32	na

Note* Khulna data includes Sundarbans production
Source : DOF Fish Catch Statistics of Bangladesh.

TABLE 2.2

SW Area Riverine Catches, by River

District	Lower Meghna	Lower Padma	Upper Padma	Other Rivers	Total
1984/85					
Faridpur	34	4360	1322	2396	8112
Barisal	30866	-	-	19552	50418
Jessore	-	-	-	1858	1858
Khulna	-	-	-	14425	14425
Kushtia	-	-	1895	2652	4547
Patuakhali	-	-		36639	36639
	30900	4360	3217	77522	115999
1986/87					
Faridpur	168	1971	183	563	2885
Barisal	43124	-	-	17372	60496
Jessore	-	-	-	1260	1260
Khulna	-	-	-	11397	11397
Kushtia	-	-	219	296	515
Patuakhali	-	-	-	12021	12021
	43292	1971	402	42909	88574
1988/89					
Faridpur	127	792	111	475	1535
Barisal	31575	-	-	16526	48101
Jessore	-	-	-	770	770
Khulna	-	-	-	8676	8676
Kushtia	-	-	164	1236	1400
Patuakhali	-	-	-	11981	11981
	31702	792	275	39664	72463

Source : DOF, Fish Catch Statistics of Bangladesh

Further confirmation of these changes was obtained during interviews with fishermen who pointed to beel drainage, embankments, excessive river siltation in recent years and interference with river flows such as by the Kumar River regulator near Faridpur, as the primary causes of decline in fish stocks, catches and fishermen's earnings. The number of traditional fulltime Hindu fishing families was continuing to decline as people gave up and sought other work or emigrated to India. Unfortunately this did not result in any easing of fishing pressure on the fish stocks because the departing fishermen were replaced by even greater numbers of landless Muslim families who have taken up part-time fishing. These findings tally closely with the results of FAP 12 studies in SWA, as regards progressively lower catches, enforced over-concentration or fishing effort in the rivers and reductions in fulltime fishing in favour of an increased part-time fishing force.

In contrast, the Sundarbans estuarine fishery appears to have remained fairly stable, around a mean annual catch of about 7000 mt but with indications of the possible start of a decline since 1989/90, if unofficial figures obtained by FAP 4 field teams in April 1992 prove to be correct. Given that with the exception of penacid shrimp larvae and possibly the fry of some fin-fish species, the estuarine fish fauna is much less vulnerable to changes such as might be caused by FCD developments upstream, and that the additional control exercised by Forestry Dept. staff on access to fishing areas within the Sundarbans, to some extent limits the risk of overfishing, it should be possible to manage this fishery even more effectively in future, provided that the Forestry and Fisheries Departments can improve the arrangements for coordinating their control and resource management functions.

The capture fisheries of other coastal districts of SWA which are characterised by large estuarine areas and therefore relatively unaffected by FCD changes, have also remained generally stable. In Patuakhali, Barguna and Bhola districts production actually increased, although this may be attributed to increased fishing effort for Hilsha which accounts for more than 80% of the total catch in the three districts. The catch of major carps in these districts has markedly declined and has virtually disappeard from catches in the lower Meghna River since about 1987/88.

The composition of SWA fish catches, by main species groups and source, is shown in Appendix 5. This is a composite tabulation of the most recent data from DOF, rather than a breakdown of catches for a particular year. It demonstrates the importance of Hilsa which comprised 45% of overall capture fish production and over 70% of river and estuarine catches in SWA. The combined catches of major and minor carps constitutes only about 1% of total capture fish, whereas the miscellaneous group total 36% of capture fish, 16% of culture fish output and 28% overall.

The dominant role of Hilsa in fish market supply throughout Bangladesh and the present very high intensity of fishing effort, both at sea around the river mouths and inland when the fish carry out their upstream spawning migration, necessitates very close monitoring by fisheries research scientists to guard against any risk of overfishing. Clupeid stocks are notoriously unstable but the consequences of a Hilsa collapse would be catastrophic. In this regard there has been frequent reference during the past 18 months to the probable adverse effects of the seasonal fishery for juvenile Hilsa (Jatka) whilst on their downstream migration to the sea. Urgent consideration should be given to restricting or regulating this fishery, as a prudent conservation measure pending the outcome of research studies which have yet to be initiated.

2.3 Beel Fisheries

Beel fisheries in SWA are not as numerous as in some other parts of Bangladesh and were assessed by SPARRSO, during their 1983 surveys to total about 9600 ha. In the meantime, as a consequence of various FCD or irrigation projects, some beels have been

drained altogether with the aim of creating additional rice growing land, and others converted from perennial to only seasonal water bodies. Unfortunately there are no data available showing how much former beel area has been lost in this way and DOF still has to use the original 1983 survey data when calculating beel production. DOF figures reproduced in Table 2.3, show that beel fish production has declined by about 45% between 1983/84 and 1989/90, from 4300 to 2400 mt. It seems likely that this may be an underestimate of the decline whereas FAP12 findings suggested losses of up to 75%. Fishermen stated that they are often denied access to areas which they once fished because the remaining small water bodies, after drainage are claimed as private property by neighbouring farmers. In consequence, the fishermen have been forced to concentrate on catching riverain fish.

TABLE 2.3

SW Area, Beel Fisheries Production (Metric tons)

(Old) District	Beel Area(ha)	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Faridpur	1915	862	421	414	336	445	408	414
Barisal	79	36	14	17	14	27	24	25
Jessore	5037	2267	1083	1106	1232	1731	1458	1280
Khulna	365	164	78	80	89	125	106	93
Kushtia	2197	989	472	383	390	755	636	558
Patuakhali	-		-	-	-	-	-	-
Total	9593	4318	2068	2000	2061	3083	2632	2370
Mean Catch kg/ha		450	216	208	215	321	274	247

Source : DOF Fish Catch Statistics of Bangladesh.

Efforts are in hand, under the IDA Third Fisheries Project (TFP), ADB Second Aquaculture Project (SAP) and other DOF initiatives, to replace some of the lost natural stocks of major and minor Indian carp species in certain selected beel areas by means of annual introductions of hatchery produced carp fingerlings. Action is also necessary to prevent any further loss of perennial beel area as a result of drainage works, at least for any remaining publicly owned "khas" beels and for their improvement by means of re-excavation if necessary, bunding, stock enhancement and rational management.

Although it should be possible to restore at least some of the lost production from such of these waters as still exist, by restocking, the fish species diversity will be greatly reduced because the available technology enables only a few indigenous and exotic carp species to be induced to spawn in hatcheries. A few resident species will survive and breed in the beels, eg Magur and Koi, but restocking will have to be an annual and costly event because none of the carp species involved will be able to breed naturally in beel waters where access to the rivers is obstructed.

The possibility of expanding the beel restocking programme by the addition of other fish species which can be bred in ponds and which should be able to breed and grow well in perennial beel water, such as the Thai barb (Puntius goniotus), large gouramies and tilapia, seems well worth consideration. It is acknowledged that the introduction of exotic species

should be treated with caution but the Thai barb apparently grows better than most of its local close relatives, gouramies support important fisheries in many S.E. Asian countries and to start with would justify a carefully controlled trial by FRI. Tilapia have been stocked in parts of Bangladesh for many years with few, if any ill-effects especially in waters containing active predators, such as the snake-heads, to control the numbers of tilapia fry. The more recently introduced tilapia, Oreochromis niloticus appears to be the best prospect for wider distribution in open water bodies as well as ponds.

Such broadening of the fish stocking programme would assist in increasing the range of resident fish species, particularly those of lower market value for the benefit of poorer people. At the same time, research is urgently needed into propogating some of the lesser Cyprinids, or minor carps and other selected indigenous species, with the same object in mind and also possibly saving endangered species such as Labeo nandina.

2.4 Floodplain Subsistence Fisheries

According to MPO/1990 data the area F1 to F4 floodland in SWA totals 20,131 sq.km (total NCA, including FO land is 26,916 sq. km). However, much of this area would be intermittently flooded for limited periods, or because of standing crops or other vegetation would be inaccessible for fishing. The area of fishable floodplain would also vary from one year to another depending on the severity and depth of the annual monsoon flood. Available data suggest a range in recent years of from 10,190 km² down to 5820 km², and it was concluded that an average figure, for planning purposes should be around 8415 km².

Most of the fishing in this area during the flood season is carried out on a subsistence basis by the local population as a whole rather than by professional fishermen, and this customary right of free access to catch fish has been of particular importance to the poorest families. As shown in Tables 2.4 and 2.5, the fish production from this area by some 2.4 million subsistence fishing households was estimated by DOF in 1983/84 to be 59,600 mt. The estimate for 1989/90 was 39,600 mt, indicating that the decline in fish stocks was continuing and that the shortfall in annual floodplain fish production had grown to about 20,000 mt per year.

TABLE 2.4

SW Area Floodland Fish Production by Subsistence Households (Metric tons)

(Old) District	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Faridpur	14375	12541	11481	10041	7451	6696	5355
Barisal	10320	12077	10962	11496	11391	12213	11284
Jessore	9464	12619	10475	9515	9417	10019	9367
Khulna	9464	10002	6395	8981	8973	9688	8484
Kushtia	11938	9652	3619	3602	2511	2340	1591
Patuakhali	4021	13363	4678	3766	3222	3078	3515
Total Floodland Catch	59582	70254	47610	47401	42965	44034	39596

Source: DOF; Fish Catch Statistics of Bangladesh.

TABLE 2.5

SW Area Fishing Households ('000)

(Old) District	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Faridpur	680	579	497	421	447	447	447
Barishal	639	547	521	578	573	590	520
Jessore	202	497	547	493	474	496	493
Khulna	202	289	313	458	625	625	497
Kushtia	207	201	189	175	129	129	129
Patuakhali	249	253	229	180	180	180	219
Total SW Area	2179	2366	2296	2305	2428	2467	2305
Average Catch/H'hold (kg)	27.3	29.7	20.7	20.6	17.7	17.8	17.2

Source : DOF Fish Catch Statistics of Bangladesh.

Floodplain fish stocks originate each year from fish which have over-wintered in the beels or from the rivers, either as fry in the case of fish which spawn prior to the monsoon flood, or as adult fish seeking suitable spawning areas in the newly flooded lands. It follows that beel draining and riverside embankment greatly reduces the annual recruitment of fish which constitute the floodplain catch.

The impact of future FCD in reducing even further the area of former floodplain subject to inundation, and in reducing flood depths, ie converting F4 and F3 land into F1 or F2, will cause further reductions in floodplain fish production to the detriment or many of the poorest families who have relied on this freely available food source during the monsoon season hitherto.

2.5 Capture Fisheries Management

The overall annual loss to inland capture fisheries in SWA by 1988/89 was 50,500 mt per year, compared with 1983/84 production levels, and it is apparent that the decline is still continuing. Minimum net mesh size and other regulations intended to protect fish stocks do exist, but appear to be generally ignored by the fishing community. It also appears that these regulations are viewed by the authorities responsible for their enforcement as being virtually unenforceable, notwithstanding that such an attitude jeopardises most if not all the remaining 120,000 mt of capture fisheries production. Other means of restricting fishing effort, such as by limited numbers of fishing licenses or by closed seasons, are not being used but a number of breeding reserve areas have been created.

FAP 4 teams were informed that thana fishery officers have only limited powers to arrest offenders under existing fisheries protection legislation and usually have to seek assistance from the police. Such support is frequently not forthcoming because of other police commitments and even when prosecutions do follow, there are very long delays caused by the huge back-log of cases before the courts.

3 CULTURE FISHERIES

3.1 Introduction

The culture fisheries in SWA which are at least potentially positive beneficiaries of FCD, comprise freshwater pond fish farming with associated hatchery services and wild spawn/fry collection, the baor fisheries which also depend on hatcheries to enhance their fish stocks and productivity, and brackish water shrimp and fish farming.

3.2 Freshwater Fish Ponds

Freshwater pond fish farming yielded nearly 48,000 mt of fish during 1989/90 and has made steady progress during recent years in SWA, as can be seen in Table 3.1. The area of ponds in the region is estimated at about 38,800 ha, of which 24,400 ha, or 63%, are being cultured. These figures, as shown in Table 3.2, are based on the results of a SPARRSO survey in 1983, supported by ground level verification which also established the proportions of cultured, culturable and derelict ponds. Unfortunately DOF has been unable to update this information, either by means of a repeat survey or by routine reporting from thana fisheries staff, so that changes such as rehabilitation of formerly derelict ponds and construction of new ones, which must have occurred since the 1983 survey, are not recorded.

TABLE 3.1

SW Area - Freshwater Pond Fish Production, by Districts (Metric ton)

(Old) District	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Faridpur	3727	3414	4599	6145	5573	5063	5517
Barisal	9563	9563	8996	13920	13384	13088	10980
Jessore	7192	7788	8616	8816	9418	9928	14021
Khulna	5144	5121	5418	4662	5696	7012	8251
Kushtia	1165	1101	1453	1094	1159	1326	1321
Patuakhali	5365	5297	5047	4765	6134	7381	7645
Total SW Area	32156	32284	34129	39402	41364	43798	47735

Source: DOF Fish Catch Statistics of Bangladesh.

TABLE 3.2

SW Area - Fish Ponds Area & Status, by Districts.

New Districts	Area of Ponds (ha)				Total Nos of Ponds	Average pond size (ha)
	Cultured	Culturable	Derelict	Total		
Faridpur	687	776	450	1913		
Rajbari	364	411	238	1013		
Gopalganj	490	553	321	1364		
Madaripur	367	415	240	1022		
Sariatpur	363	409	237	1009		
Total	2271	2564	1487	6322	49994	0.12
Barisal	2384	914	598	3896		
Bhola	2718	1042	682	4442		
Jhalokati	741	284	186	1211		
Perojpur	1356	520	340	2216		
Total	7199	2760	1806	11765	156023	0.07
Jessore	2316	380	125	2821		
Jhenaidah	1751	287	95	2133		
Magura	925	152	50	1127		
Narail	879	144	48	1071		
Total	5871	963	318	7152	88281	0.08
Khulna	2047	335	267	2649		
Bagerhat	989	162	129	1280		
Satkhira	1125	184	147	1456		
Total	4161	681	543	5385	57099	0.09
Kushtia	392	161	146	699		
Chuadanga	290	119	108	517		
Meherpur	178	73	66	317		
Total	860	353	320	1533	31609	0.05
Patuakhali	2616	1003	656	4275		
Barguna	1423	545	357	2325		
Total	4039	1548	1013	6600	87534	0.07
SW Area Total	24401	8869	5487	38757	470540	0.08

FAP 12 studies showed that an expansion of interest and investment in pond fish farming was possible in areas which became less vulnerable to flooding as a result of FCD developments. However, although signs of new pond construction were observed in several project impacted areas the overall increase in farmed fish production and pond area and the reduction in proportion of derelict ponds, fell short of expectations. Among the reasons given were the lack of any effective rural credit system to assist with the cost of pond rehabilitation, and DOF's inability to field the necessary scale of extension effort to ensure that appropriate technical knowledge was disseminated to the pond owners concerned.

The benefits to fish farming which result from FCD projects cannot be properly monitored and quantified unless the data base can be revised at appropriate intervals and, if possible by repeat surveys at least every 10 years. At this stage it is difficult to state more than that there are at least 470,000 ponds in the region, averaging about 0.08 ha each in size and producing around 1230 kg/ha/year.

Fish farming in SWA is being conducted at a relatively higher level of technology than in many other parts of the country, and cultured ponds in Jessore greater district are recorded as producing 2262 kg/ha/year, which must be one of the highest averages in Bangladesh. DOF demonstrations have shown that by stocking the right combinations of fish species coupled with systematic feeding and pond water fertilisation, or by integrating fish farming with poultry or duck production, yields and profitability can be increased still further to at least 4200 kg/ha. By definition, cultured ponds are those which are regularly restocked and where the fish are fed at predetermined rates to achieve satisfactory growth. Culturable ponds are only rarely restocked and receive no inputs, whilst 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, or about 400 kg/ha and derelict ponds are unlikely to produce more than the surrounding floodplain, ie less than 70 kg/ha.

3.3 Freshwater Fish Hatcheries

The fish farmers are well supported by a network of carp hatcheries covering most of the region except for the brackish zone. In addition to 34 government owned hatcheries there are at least 46 privately financed commercial hatcheries, especially in Jessore Sadar Thana which boasts more than 26 private hatcheries. In addition to the hatcheries, many pond owners are now specialising as nursery operators, taking hatchery produced or wild caught hatchlings and rearing them on to the fingerling stage for sale to nearby fish farmers or to specialist traders who transport the young fish to other parts of Bangladesh, where they are sold for growing on to market size.

3.4 Wild Spawn Collection

This specialised fishery was the traditional source of carp fry for stocking ponds, prior to the introduction of carp hatchery technology. There are more than 40 known collection centres in SWA, located at various points along the Upper and Lower Padma, Gorai, Madhumati, Arial Khan, Kumar and Kirtenasa rivers. Over 2500 people have been recorded engaged in this fishery which has produced nearly 4900 kg of hatchling/fry as recently as 1987, down to less than 1000 kg in 1989. The fishery is highly seasonal, occurring during May to July each year. Its importance to the fish farming industry is much less now that hatchery production is so well established, although some pond owners claimed that the wild stock is stronger and grows faster than hatchery products. However, the diminished state of the riverine fish stocks, as described above, is now so serious that consideration should be given to imposing further restrictions, such as prohibiting wild spawn harvesting during part of the spawning period, in the interest of conservation of the remaining stocks of fish. Details of spawn quantities and principal collection centres are shown in Tables 3.3 and 3.4.

TABLE 3.3

Wild Carp Spawn Collection in SW Area.

Year	Collection Centres	People Employed	No. of Nets	Quantity of Spawn (kg)	Catch per Net (kg)	Price Range Tk/kg
1984	43	2558	5724	4353	0.76	na
1985	34	1844	6148	4356	0.71	na
1986	50	1592	6380	4145	0.65	600-4000
1987	51	2666	7273	4882	0.67	1200-3500
1988*	(48)	(772)	(2629)	(1706)	(0.65)	1000-3200
1989	35	817	2566	926	0.36	500-2500

(*) 1988 data incomplete.

Source : DOF Fish Catch Statistics of Bangladesh 1989/90.

TABLE 3.4

Principal Carp Spawn Collection Centres in SW Area

District	Location/Upazila	River
Kushtia	Bheramara	Upper Padma
"	Dhaulatpur	"
"	Kushtia Sadar	Gorai
"	Kumarkhali	"
"	Mirpur	"
Faridpur	Faridpur Sadar	Lower Padma
"	Char Badrason	"
"	Modhukhali	Madhumati
Rajbari	Rajbari Sadar	Lower Padma
Magura	Magura Sadar	Madhumati
"	Mohamadpur	"
Madaripur	Sibchar	Arial Khan
"	Rajor	Kumar
Sariatpur	Naria	Kirtenasa

Source : DOF Fish Catch Statistics of Bangladesh 1989/90

3.5 Fish Production from Baors

A feature of the northern and north-western parts of the region are a number of ox-bow lakes, known locally as baors, which have become separated from their parent rivers. Unlike beels which are shallow depressions in the flood plain rarely exceeding more than a few feet in depth, baors can hold up to 40 feet of water and are perennial lakes of considerable potential. There are 5488 ha of these waters in SWA which yielded 1357 mt during 1989/90, equivalent to 247 kg/ha, as shown in Table 3.5. The IDA Ox-bow Lakes Fishery Project which was completed in 1986, demonstrated that fish stock enhancement using culture based technology and effective fishery management can enable productivity to be increased to at least 950 kg/ha/year. This experience is now being extended to other baors under a new IFAD/DANIDA development project just started.

TABLE 3.5

SW Area - Fish Production from Baors

(Old) District	Baor Area (ha)	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90
Faridpur	965	130	169	125	172	162	182	187
Jessore	2734	491	531	612	685	793	802	823
Khulna	331	44	58	43	59	55	62	64
Kushtia	1458	197	204	188	258	244	275	283
Patuakhali	-	-	-	-	-	-	-	-
Barisal	-	-	-	-	-	-	-	-
Total	5488	862	962	968	1174	1254	1321	1357
Mean Prod'n (Kg/ha)		157	175	176	214	228	241	247

Sources: Area data established by SPARRSO, February 1983
Production from DOF Annual Fish Catch Statistical Bulletins.

It is considered that baors should be treated in the same way as khas beels, so far as any future FCD/FCDI projects are concerned, namely that where baors occur within a project area, provision should be included for improving the fishery, by defining boundaries, restocking, and assigning the fishing rights to bonafide groups of fishermen under the New Fisheries Management Policy arrangements.

3.6 Brackish Water Shrimp Farming

Coastal aquaculture, which consists mainly of brackish water shrimp farming is dependent on the collection of shrimp fry from the wild, for release into large ponds or bunded enclosures known as "bheries"or "ghers", where they are grown to marketable size. Shrimp farming has expanded very rapidly in recent years under the stimulus of keen export market demand and especially favorable local conditions, although not without some difficulty caused by social conflict, lack of an enforceable regulatory system and some concern about the size and well-being of the wild stocks of shrimp on which everything depends, given the failure hitherto, of efforts to establish an effective hatchery in Bangladesh for the production of the "Tiger Shrimp" (Penaeus monodon) post-larvae.

The collection of shrimp post-larvae from saline tidal areas, lagoons and khals, provides an important livelihood and source of income for many thousands of coastal zone residents, including women and children. It also supports a network of buyers and agents who undertake the task of delivery and distribution of the post-larvae to the various shrimp farms. In 1988 about 1.5 billion shrimp fry were collected, rising to more than 2 billion in 1990, but of these it was estimated on average, that less than 20% survived to be harvested from the ponds, because of rough handling, lack of technical knowhow and inadequate facilities for transport and distribution. Significantly higher survival rates have been claimed in the IDA Polder 20 scheme, where stocking and subsequent feeding of the post-larvae was supervised by project extension workers.

Concern is being expressed that the post-larval catch together with the offshore trawled catch of adult shrimp of the same species, may be subjecting the stocks to an excessive degree of exploitation. It is noted that the composition of tiger shrimp (P. monodon) in trawl catches has halved, from 22% of the catch in 1979 to only 12% of last year's trawl catch and that the collectors are having difficulty in catching the quantities of post larvae which the shrimp farmers need. In consequence, the price which farmers have to pay has increased during the past two years, to more than Tk 1.00 per single post-larva. The evidence is not conclusive, but at the same time there is pressure to increase shrimp pond yields by the use of more intensive culture systems, and figures as high as 1700 kg/acre (4 mt/ha) have been quoted in recent reports. This implies stocking at more than twenty times the present rate which may well be more than the natural stocks can support, and adds urgency to the need for a reliable Penaeid shrimp hatchery to be established as soon as possible.

The social conflicts associated with shrimp farming stem from a number of cases in which small landowners and share croppers have been forced by landlords and other more powerful interests to surrender the use of their land, in exchange for cash compensation, for seasonal incorporation into large salt water ''shrimp ghers''. Sometimes certain gher operators have failed to make these payments in full and sometimes shrimp harvesting has been unreasonably delayed beyond the time when the land can be prepared for the following rice crop. The position is made worse because upazila and district level committees were established by Government, vide Ministry of Fisheries and Livestock Notification No MFL (Misc) 2/86/17, published in the Bangladesh Gazette on 6/3/1986, to regulate shrimp farming and thereby avert such conflicts, but unfortunately they were not provided with the necessary legally enforceable means and have remained powerless to intervene. Action may be needed only in a minority of cases, but in general it is considered right that salt water shrimp farmers should be required to obtain a license and be permitted to operate only in specified areas. Licenses should not be transferable and breaches of license conditions should be punishable offences. Government could still introduce such regulations and is strongly urged to do so.

As is shown in Table 3.6, the area in SWA under brackish shrimp culture has grown from 32,280 ha in 1983/84 to nearly 89,000 ha by 1990/91 and shrimp production from 2,550 mt to over 16,900 mt in the same period. It is reported that a further 89,000 ha in Khulna, Jessore, Barisal and Patuakhali districts are suitable for development as shrimp farms. However, it is also noted that average shrimp farm productivity has stagnated since 1985/86, at around 190 kg/ha/year and is likely to decline unless the post-larval supply problem can be resolved quickly. It should be possible to increase productivity to at least 300 kg/ha, which is the reported average for India and Thailand. In fact, the IDA Shrimp Culture Project centred on Polders 20 and 20/1 which has demonstrated the feasibility of small scale shrimp/rice rotations within polders, has already achieved an average of 214 kg/ha, whilst one of the farmers involved produced 409 kg of shrimp per hectare. Thus, at full development, and subject to establishment of the necessary hatcheries, it seems quite feasible to anticipate that brackish shrimp production from SWA can be trebled to around 53,000 mt/yr.

TABLE 3.6

SW Area - Shrimp Farm Fish and Shrimp Production

(Old) District	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91
(a) Pond Area (ha)								
Jessore	422	523	328	328	690	690	690	327
Khulna	31817	39453	62120	62120	68363	79728	79728	88209
Patuakhali	42	52	26	26	64	326	326	230
Barisal	-	781	45	45	112	22	22	110
Total	32281	40809	62519	62519	69229	80766	80766	88876
(b) Shrimp Production (mt)								
Jessore	33	57	34	44	118	130	132	62
Khulna	2514	4878	12016	11361	13493	15049	15193	16758
Patuakhali	3	5	3	4	11	62	62	43
Barisal	-	85	5	6	19	4	4	21
Total	2550	5025	12058	11415	13641	15245	15391	16884
(Kg/ha)	79	123	193	183	197	189	190	190
(c) Fish Production (mt)								
Jessore	31	37	11	17	35	60	60	28
Khulna	2354	1951	4432	5977	6064	6938	6905	7587
Patuakhali	3	4	1	1	3	28	28	19
Barisal	-	55	2	2	6	2	2	9
Total	2388	2047	4446	5997	6108	7028	6995	7643
(Kg/ha)	74	50	71	96	88	87	87	86

Source: DOF Fish Catch Statistics of Bangladesh.

The IDA Shrimp Culture Project developments in Polders 20 and 20/1 are a pilot trial to demonstrate the feasibility of small-holder shrimp farming, provided that an appropriate water management infrastructure can be supplied. Polder 20 was laid out with a network of flushing and drainage channels and structures serving all the plots, so that each can be operated independently. Results of the work to date are set out in Tables 3.7 and 3.8, and show that not only were the shrimp yields better than average, but there has been no decline in rice yields even after 4 years of rotation. As a result, the new IDA Third Fisheries Project includes a shrimp component in which the Polder 20 experience will be extended to polders 5 and 23 initially, and thereafter to Polders 16, 18/19, 31, 32 and 33.

TABLE 3.7

Production of Exportable Shrimp, 1991 from Polder : 20 & 20/1 (Paikgacha, Khulna) and Polder 5 (Shymnagar, Khulna)

Polder No	Area Under Shrimp Culture (ha)	No. of Shrimp Farm	Avg. size of Shrimp Farm (ha)	No of postlarvae Stocked/ha			Yield of Shrimp Kg/ha			Remarks
				Highest	Lowest	Average	Highest	Lowest	Average	
20 & 20/1	1178	88	13.38	25,000	4,615	13,493	409.00	75.00	214.00	One Crop
05										
Belt-A	257	29	8.86	32740	5000	22056	509.25	68.00	264.40	Two/ more crops
Belt-B	404	18	22.44	83750	12181	27167	650.50	135.70	275.00	
Belt-C	285	26	10.96	51000	10800	20750	508.50	72.88	213.07	

Source : IDA Shrimp Culture Project, Khulna

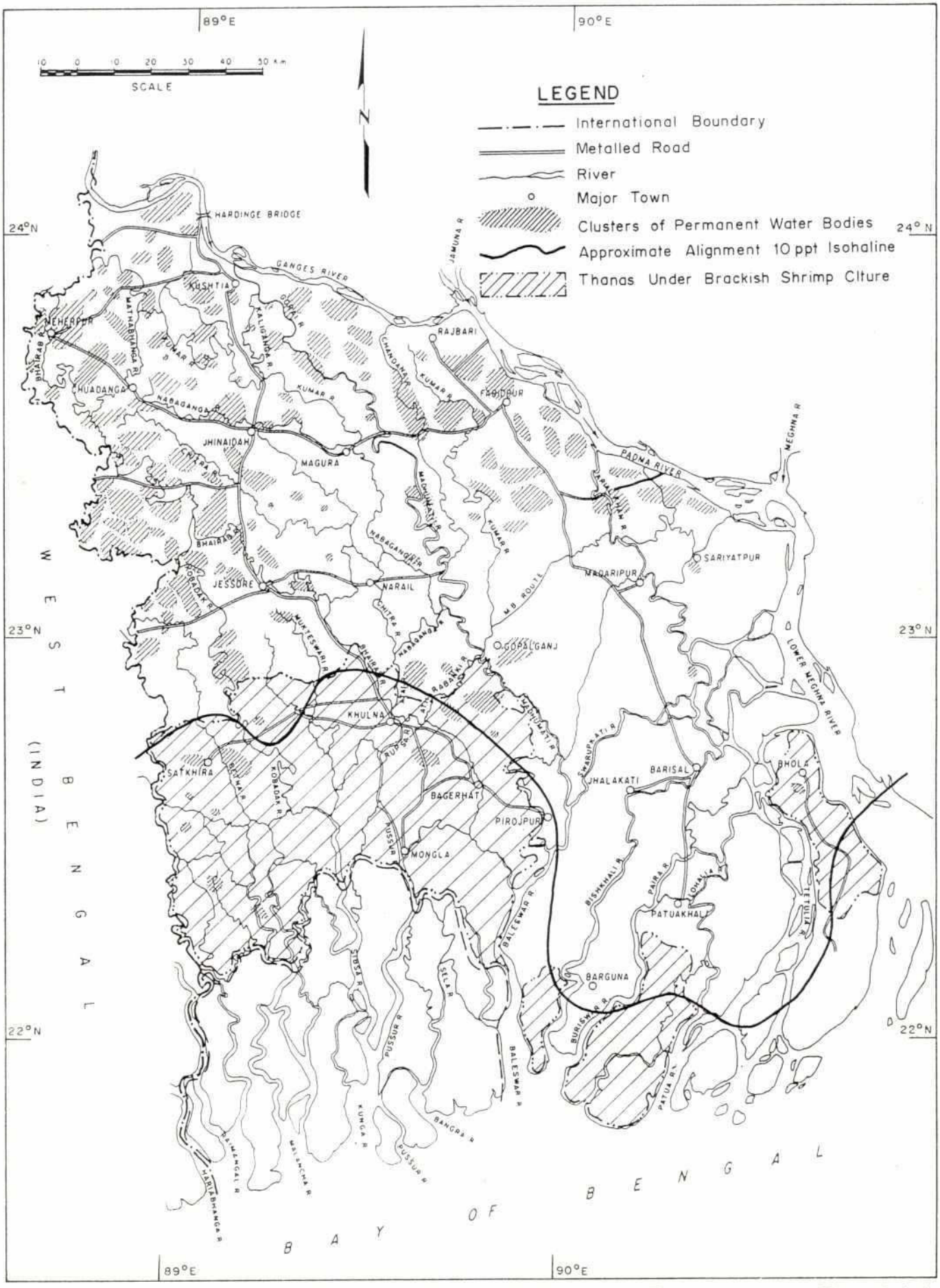
TABLE 3.8

IDA Shrimp Culture Project Results Polders 20 & 20/1, Paikgacha, Khulna

Items	Pre-project Position	Position during project implementation				Remarks
	1987	1988	1989	1990	1991	
No. of Shrimp Farm	29	39	50	84	88	
Area of Shrimp Farm (ha)	756	937	1219	1176	1178	
Highest yield/ha (kg)	-	222	270	375	409	One crop
Avg. yield/ha (kg)	68	92	132	175	214	-do-
Avg. yield of rice/ha (kg)	1961	1292	2046	1960	na	T. aman
Avg. yield of Upshi/ha (kg)	-	-	5800	4920	na	High yielding variety rice B.R-10 & 11

Source : IDA Shrimp Culture Project, Khulna.

Figure 3.1



Distribution of Beels Baors and Brackish Shrimp Farming in SWA

3.7 Shrimp Hatcheries

To be successful, a Penaeid shrimp hatchery must have continuous access to ample supplies of good quality fresh water and sea-water. Unfortunately, there does not seem to be any site in SWA which can satisfy both requirements. However, it is understood that there are sites along the coast south of Cox's Bazar towards Teknaf which appear to be more suitable and as a matter of urgency, they should be surveyed for site selection and early construction. Although it was not possible to visit the area, it is understood that an ADB funded shrimp hatchery for the production of both Macrobrachium and Penaeid shrimp, has been constructed at Cox's Bazar, but it has also suffered from water supply problems which have affected the production of post-larvae. An IDA funded Penaeid hatchery is also under construction at Cox's Bazar, but was badly damaged by the 1991 cyclone and is not yet operational. The transportation of hatchery produced post-larvae to SWA shrimp farms should not present any problems, because wild caught larvae are already being transported in both directions over the same routes.

The requirements for producing juveniles of the giant freshwater prawn, Macrobrachium rosenbergii, whilst still involving ample supplies of freshwater and lesser quantities of saline water, seem less restrictive and the first hatchery in SWA for this purpose has now been established at Kaligonj in Satkhira District. Hatching and larval rearing commenced only in February 1992 and appeared to be progressing well during a FAP 4 visit in April, but has run into survival problems since then. The unit is intended for training and demonstration purposes as well as post-larval production. It is anticipated that once the system can be demonstrated to work, private interests will take up freshwater shrimp hatcheries as they already have with carp fry production and there should be no difficulty in finding suitable sites for Macrobrachium hatcheries.

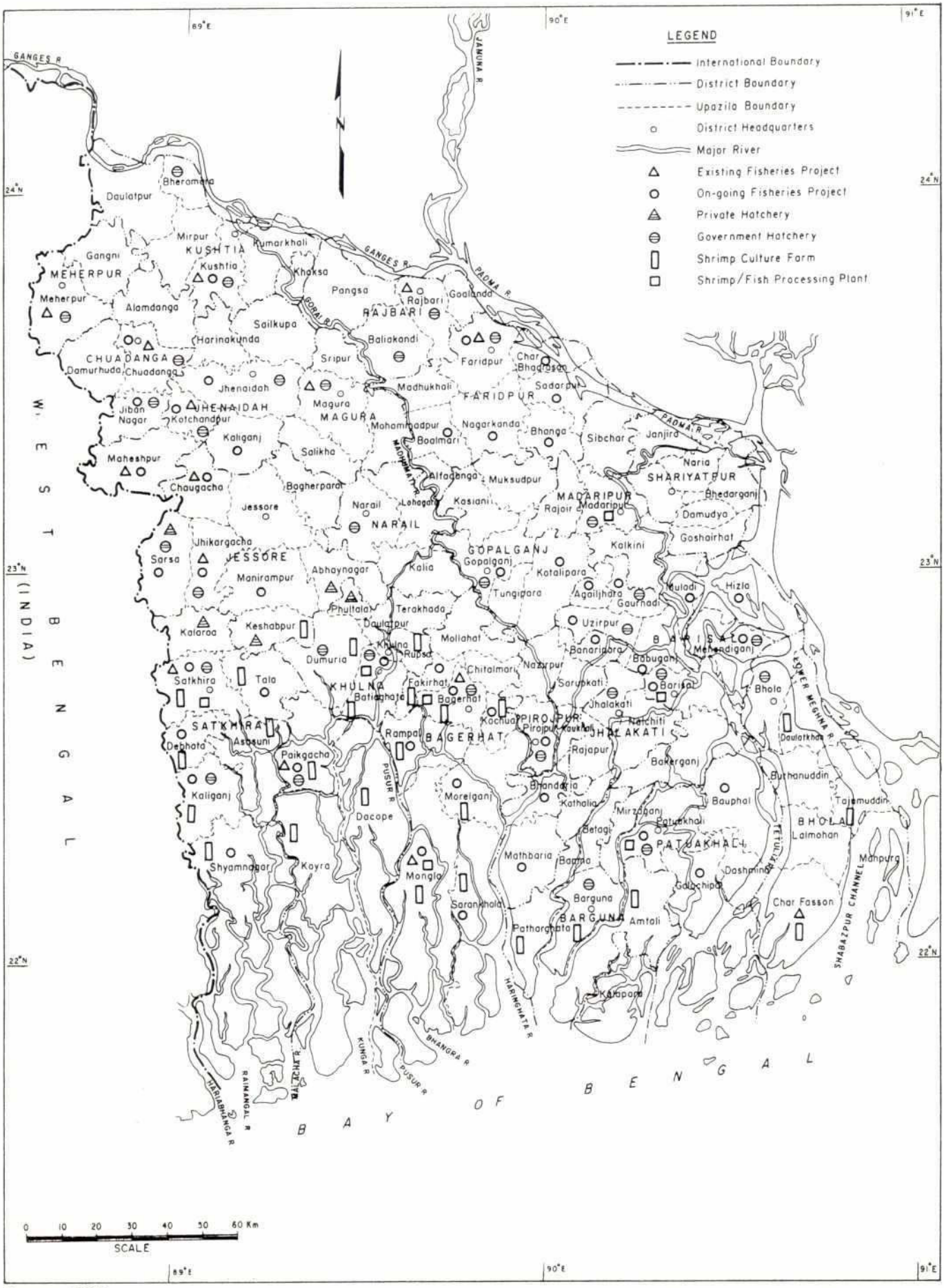
3.8 Freshwater Shrimp Farming

It has never been as easy to collect Macrobrachium juveniles from the wild in quantity, as it has been with Penaeids, and although they have been stocked into ponds along with carp, it has been on a generally smaller scale hitherto. The main center to date is in Bagerhat District where, during the past 3 years nearly 1300 freshwater shrimp farms have been established. These ghers are mostly individually owned and vary in size from 0.3 to 10.0 ha, with an overall average of 0.6 ha, which contrasts with the very much larger brackish water ghers in Khulna and Satkhira districts. Production of the giant prawn, Golda chingri from these ponds is not recorded separately but is estimated to have been about 230 mt last year.

The Macrobrachium hatchery development will open up the prospect for more widespread production of freshwater prawns in ponds, regulated khals and even in paddy fields where they can be grown at the same time as the rice.

Figure 3.1 shows the distribution of beels, baors and brackish shrimp farming in SW Area and Figure 3.2 shows the location of fisheries projects, hatcheries and processing plants.

Figure 3.2



Source: DOF

Location of Fisheries Projects Hatcheries and Processing Plants

4 MARKETING, PROCESSING AND EXPORTS

4.1 Fish and Shellfish Processing and Marketing

Virtually all fin-fish in SWA is marketed as fresh, whole fish, sometimes on ice but is mostly retailed within the same day as it is caught. Consequently there is little or no need for any processing. About 20% of farmed shrimp production are small sized and unsuitable for export but find ready markets within Bangladesh. The remaining 80% of exportable grade, large sized shrimp are sold by the shrimp farming industry to about 50 processing factories where the shrimp are cleaned, headed, graded, packaged and frozen, mainly for export. The main center is Khulna with 35 processing enterprises, of which 24 are currently operational. Satkhira has 7 factories, Bagarhat has 5 and Barisal, Patuakhali and Madaripur have one each. About 15-20% of SWA shrimp is taken to Chittagong for processing and export. Production of these factories prior to export, has to comply with quality control testing and certification by a specialist unit of DOF and thereafter with strict hygiene and quality standards at ports of entry. The factories, freezing plant and cold storage are therefore well maintained and operated to high standards of cleanliness.

A list of processing factories in SW and SC Regions is given in Appendix 7.

Unfortunately the same cannot be said of the condition of the majority of domestic fish markets in most of the principal urban centres visited so far. The wholesale market in Khulna is in a dockside building belonging to the Bangladesh Fisheries Development Corporation (BFDC) which leases space to the traders. This area is in reasonable condition, has facilities for washing down and some ice was seen on fish being created for transport up-country. However, the retail markets in Faridpur and Satkhira, along with others seen elsewhere in the country, are overcrowded and very dirty with fish displayed for sale on basket lids or plastic sheets on the ground instead of on washable raised slabs. Little or no ice was seen, even on shrimps said to be intended for sale to processing factories. Washing down and personal hygiene facilities were not evident, drains were clogged and floors cracked, uneven and filthy. All were in urgent need of renovation to bring them up to an acceptable standard, but Khulna retail market was in slightly better condition than the others, as were some of the lesser township markets, at centres such as Rajbari, Bhanga and Goalandha. A project to finance fish market rehabilitation would seem to be highly desirable, in terms of its contribution to improved fish quality and public health.

The traditional arrangements governing fish marketing structures, involving wholesale agents (arotdars), various middlemen and categories of village and urban retail traders (eg pikars and beparis) may appear cumbersome and costly, but has worked reasonably well over the years. It succeeds in transporting surplus fish to other areas of particular need and in a generally acceptable condition, whereas official interventions, such as BFDC, have not proved much more efficient or beneficial to the fishermen or to the public, except insofar as BFDC has been able to provide services, such as ice supplies in areas where none would have been available otherwise.

4.2 Fisheries Exports

75% by weight of fisheries exports and 86% by value comprise frozen shrimp and more than 52% of shrimp exports were produced by SWA shrimp farms. Other fisheries exports include major carp, Hilsa, and live-fish to the Middle East and frog legs to USA and Europe, but totalled less than 24% by weight and barely 12% by value, compared with shrimp. Fishery exports have grown from 9,420 mt worth Tk 1.09 billion in 1981 to 23,340 mt valued at Tk 4.79 billion in 1990.

5 FISHING INPUTS SUPPLY

5.1 Nets, Twine and Cordage, etc.

A commonly voiced complaint by fishermen was that fishing gear is in increasingly short supply and excessively costly. Most fishermen said that they preferred to braid their own nets from twine rather than purchase manufactured netting, as a means of minimising their cash outlay on each occasion. Prices of the synthetic materials (nylon, polyethylene and polypropylene, etc) from which twines and cordage are made nowadays, are subject to international petrochemical market fluctuations and therefore largely beyond local control. There appeared to be fairly good supplies of twine, hooks, cord and other basic materials in shops in most of the areas visited, so that the problem seems not to be especially severe.

BFDC operates three net factories in Comilla, Mongla and Chittagong, which can produce up to 320,000 lb of netting from imported nylon twine and monofilament. Actual production was much less, at 190,000 lb in 1990/91 and only 52,000 lb last year, whereas total annual demand for fishing nets is said to be 2900 tons. The balance, less whatever is imported, is produced by 20 private net factories which are variously located near Dhaka and in Narsingdi and Chandpur districts.

There was frequent reference during field visits, to the widespread use of illegal and harmful fishing methods and in particular to the use of nets made of very small mesh monofilament nylon, known as "current jal". It ought to be possible to control the supply of these nets at the point of sale or manufacture because, as a prohibited article, it should be an offence to import, make or be in possession of such a net, in addition to the offence of using the net to catch fish. It is recognised that there are difficulties in defining illegal gear and, for example, small mesh netting is widely used for making seine nets and larger mesh monofilament nets are needed for catching Hilsa and other large species in coastal and estuarine waters. Nevertheless, appropriate descriptions must be devised and enforced.

5.2 Boats

The supply of boats for fishing and general use in the riverine and flood-prone areas, is a matter for greater concern. Data on boat numbers are not readily available, but observation suggests that the fishing fleet is very large and in SWA as a whole must number several thousand craft of various lengths up to about 30 ft. Assuming an average working life of 10 years, the numbers of new boats needed each year to maintain fleet size would also be substantial. Fishermen suggested that the preferred timber for boat building, eg Chatka (Albizzia spp), was now very scarce and in consequence other much less durable wood had to be used which resulted in boats lasting only 2-3 years before needing major repairs. A 25 ft fishing boat was said to cost about Tk 8000 if built with cheaper wood, but over Tk 12,000 with Chatka. In the Faridpur area a 30 ft fishing boat built of Sundri (Heritiera fomes) planks on Sal (Shorea robusta) frames cost just over Tk 10,000 in 1991. A common sight nowadays are boats made of thin galvanised steel sheet nailed to wooden keel and frames. Such craft are light and relatively cheap but much less durable than traditional plank-built vessels and more dangerous.

It would be useful if DOF and the Forest Department could review future timber needs for boat building in the light of current and future supplies, so that tree planting programmes can be planned accordingly. Timber for boat replacement is clearly an issue concerning the country as a whole, and not just SWA. Consideration could also be given to a study of the use of palm timber planks, such as are used by the Maldive islanders for building their traditional sea-going tuna fishing boats. The timber is flexible but durable in sea water and is resistant to attack by marine borers, such as Teredo worm. A study visit to the Maldives by some Bangladesh boat builders could yield some very useful experience about handling this form of wood which, as far as is not known, is widely used for any other purpose except for burning.

6 FISHERIES MANAGEMENT

6.1 Fisheries Regulation

There are three legal enactments governing the inland fisheries, namely;

- The Protection and Conservation of Fish Act, 1950, as amended in 1982, and subsidiary Rules in 1985.
- The Tanks Improvement Act 1939, with amendments to 1986.
- The Fish and Fish Products (Inspection and Quality Control) Ordinance, 1983.

A further ordinance and rules, dated 1983 concern the marine fisheries only. It is considered that the provisions contained in these regulations, and the powers accorded to fishery officers and others, would be adequate to check the ongoing decline in the capture fisheries, except that they are not being properly enforced at present.

6.2 Enforcement

As noted in section 2, annual production from the capture fisheries of SWA alone, fell by 50,500 mt between 1984 and 1989. Landings of illegal undersized fish from prohibited small mesh nets are commonplace and in most places have been allowed to continue unchecked. Failure to take the necessary action puts the remaining 120,000 mt of capture fish production at risk. The problem is not confined to SWA but, as recorded by FAP 12, occurs throughout Bangladesh so that the solution also has to be organised on a national basis. In this regard it is to be hoped that as thana fishery officers have now reverted to direct control by DOF, their duties will once again be standardised and include responsibility for the effective enforcement of all fisheries laws and regulations.

It is further recommended that a working group be appointed in DOF to review the existing legislation and enforcement arrangements and propose improvements. Alternatives could include involving the local fishing communities more directly in the determination and policing of conservation measures, and the establishment of a mobile enforcement unit to reinforce thana staff whenever necessary.

6.3 Data Collection and Analysis

It was found that there was a wide disparity in the kinds and quality of data on their fisheries in the different thana fishery offices. It is urged that such duties should also be standardised and that thana fishery officers should be required to maintain fishery records covering both culture and capture fisheries in their areas. These records should be up-dated at regular intervals and copies forwarded through districts to DOF Dhaka, to supplement the Fisheries Resource Survey System (FRSS) data.

Collection of fish production and fishing effort data from field sampling stations is done by FRSS officers who are outposted to each district fishery office. It appears that no processing of data takes place in the districts and thus there is little opportunity to check the figures for errors or inconsistencies. The raw data is sent to Dhaka for processing but owing to inadequate processing capacity and computer programming problems, there is now more than a two year backlog in data compilation and analysis. Effective fisheries management depends on up to date and accurate information and is difficult if not impossible given such long delays. However, it ought to be possible to resolve this trivial but frustrating bottleneck quite quickly, given the combined resources available to DOF from the UNDP Fisheries Institutional Strengthening, the IDA Third Fisheries and FAP 17 projects.

Once the cause of delay have been resolved and the back-log disposed of it is considered that district, and even thana staff should become more involved with the processing and checking of data which they collect. In this way they will be more aware of the importance of the data base as a means of measuring progress and of the relevance of data collection. They should also become better informed about their areas and of the conclusions which can be drawn from that information.

The areas of perennial water bodies, rivers, beels and baors, and the numbers, area and status of ponds are key factors in the data processing system. In reality they are changing all the time but the last assessment was a UNDP funded exercise undertaken by SPARRSO during 1982/83 and based mainly on February 1980 Landsat imagery, together with a considerable amount of ground level verification. There is urgent need for a repeat survey to correct and up-date this information. The need applies across the whole country and not just in SWA, so that the repeat survey also should be organised nationally and is recommended for funding as a component of the national Flood Action Plan follow-up programme.

6.4 Data for Regional Planning

At the start of FAP 4 fisheries studies, the only information available on fishing areas and production in SWA was based on the six former greater districts. After consultation with district and thana staff in many parts of the study area, the fishing area data was broken down to reflect the boundaries of the 22 districts now comprising SWA, with the results shown in Table 1.1.

These findings were in turn melded with other GIS data so that the area and fish production statistics for the various fishery sub-sectors could be re-apportioned on the basis of Planning Unit boundaries. These results are shown in Appendix 6 and were used as inputs to the optimisation model.

7 SOCIO-ECONOMIC ASPECTS

7.1 The Fishing Communities

In Bangladesh there are three principal categories of people who catch fish, viz;

- Professional fishermen, whose income derives entirely from full-time fishing;
- Part-time fishermen, who supplement their income from other seasonal employment by fishing for part of the year;
- Occasional fishermen, who catch mainly for subsistence especially during the flood season.

Professional/full-time fishermen are traditionally members of particular Hindu castes, such as Jalia, Mala, Tior, Patni, Manjhi, and Kaibarta, and operate mainly in the capture fisheries although some of them also net fishponds on behalf of their owners. As described earlier in the capture fisheries chapter, the number of full-time fishermen has been dwindling in line with the decline in capture fish stocks and catches. In some cases, FAP 12 recorded falls of up to 50% in numbers of full-time Hindu fishermen, but also noted an influx of at least equal numbers of landless Muslims working as part-time fishermen. Many of the casualties were said to have emigrated to India in search of better fishing opportunities there and relatively only a few have sought other part-time work in order to be able to continue fishing on a part-time basis or abandoned fishing altogether.

There are no credible data on the numbers of fishermen working in SWA or on employment in supporting trades and services, such as boatbuilding, fishing gear making, fish processing and marketing. Based on capture fish production and FAP 4/FAP 12 findings that the average annual catch per fisherman was 700 to 800 kg, there must be at least 101,000 professional full and part-time fishermen in the study area. The flooded areas during the monsoon are fished for subsistence purposes by family members from 2.4 million families. There are 470,000 fish ponds owned mostly at the rate of one per family, whilst it is estimated (FAO, 1986) that about 90,000 people are engaged in shrimp farming and processing and a further 100,000 men, women and children, in shrimp post-larvae collection.

7.2 Landless People and Fisheries

Studies to date confirm that virtually all of the full-time and part-time artisanal fishermen are landless although in most areas there are a limited number of recognised permanent fishing villages, where most if not all of the families are involved in fishing. Elsewhere, other fishermen may be seen living in temporary camps on charlands or embankments. In most cases the fishing communities are extremely poor with few assets other than their nets and boats, however, at some villages where fishermen have benefitted from development projects, such as the IDA Ox-Bow Lakes Fisheries Project, there are signs of increasing affluence to be seen, eg tiled roofs to houses in place of thatch and improved water supplies.

The newer part-time recruits to fishing are mainly landless Muslims who need to supplement their earnings from other sources, and who see fishing as the best available option until something better turns up. Many have become quite proficient but according to some reports, take a short term view about fishing, catching whatever they can without regard to fish stock sustainability and the need for conservation.

7.3 Role of Women in Fisheries

FAP 12 studies included investigating the respective roles of family members in fishing communities. It was found that women and younger children contributed about 30% of total family time spent on the fishing business in the inland capture fisheries. The particular role of women was in the repair and upkeep of nets and other fishing gear and occasionally in processing part of the catch. Women did not go out to catch fish and were not involved in the operation or repair of boats. They participated only very rarely in marketing the family catch.

Female members of fishpond owning families assisted in feeding and sometimes in harvesting small quantities of fish from the ponds. Considerable numbers of women from coastal communities engage in collecting shrimp post-larvae for sale to shrimp farm owners. Women are also employed extensively on the production lines in most of the shrimp processing factories.

7.4 Ownership and Leasing of Water Bodies

Although some beels or parts of beel areas may be private property, the majority of perennial beels, baors and rivers are state owned, khas property administered by the Ministry of Land through district revenue offices. The fishing rights in such water bodies, known as ''Jalmohal'', are customarily leased for periods of up to three years to the highest bidder in auctions conducted by District Revenue Officers. In the case of small jalmohals up to 20 acres, leasing was controlled by the Ministry of Local Government through upazila parishads until their recent abolition. The leasing by auction system has been of benefit mainly to wealthier entrepreneurs who recoup their investment by either subleasing, hiring labour to catch the fish or renting the fishing rights to fishermen for a fee or on a catch sharing basis. Inevitably this leads to unsustainable overfishing and in the longer term to low productivity.

The New Fisheries Management Policy was introduced to change the balance more in favour of the fishermen and to facilitate a more rational approach to management and cropping of such fisheries. In place of the entrepreneur, long term fishing rights are being assigned to recognised groups of bonafide fishermen on payment of annual license fees. The stipulations are that the group be formed and managed with NGO assistance, that the license fees equate to the average of the previous three years lease money and are increased by 10% per annum. Restocking and similar costs are the group's responsibility. So far only a few hundred of the national total of 13,000 jalmohals have been transferred to DOF for this purpose.

8 IMPACTS ON FISHERIES OF PROPOSED FCD INTERVENTIONS

8.1 Gorai River Improvement

This project which aims to increase year-round flows down the Gorai, with associated irrigation and drainage development to about 165,000 ha should be generally beneficial to culture fisheries, but with provisos.

Various points along the Gorai from Kushtia as far south as Gopalganj have been centres for the collection of the spawn and fry of wild stock major and minor carps. As far as is known these fish do not breed in the Gorai but rather at some point along the Ganges River between Hardinge Bridge and Farakka Barrage, and the resultant concentrations of floating spawn and pelagic fry are swept back downstream, some to continue on down the Padma and some diverted with the flood into the Gorai. It follows that the construction of a regulator across the river mouth could be detrimental to fisheries in SWA unless the regulator design is such as will permit the upstream movement of adult fish earlier in the year and the return flow of fry. FAP 17 is conducting a study into "fish friendly" structures and should be issuing a report on the subject shortly.

According to the maps there are a number of beel areas situated close to the river line and it is hoped that these areas can be retained and improved for fish production and maintenance of carp breeding stocks, as part of the project. This would involve either diverting the main riverine flood embankment behind the beel, so leaving it with unrestricted connections to the river, or surrounding the beel and its connecting khal with a secondary dyke so that early floodwater can be allowed to flow into the beel without endangering the surrounding croplands. In the latter case, other arrangements would have to be made for the later transfer of fry from the river to the dyked beel.

There may be other perennial beels within the project area but more distant from the river. Clearly it is not feasible to maintain a river connection in all such cases but they can still be preserved and developed for enhanced fisheries production by excavation and embanking to increase depth and water storage capacity and restocking with an appropriate species mix to enhance the surviving natural fish stocks and yields.

The project proposals include bypassing the Kamarkhali Bend, thus creating an isolated ox-bow lake some 6.5 km long by 600 m wide and 5 m deep. With good management the yield of such a fishery could be increased, from the riverine average of about 40 kg/ha to at least 400 kg/ha, thereby providing a livelihood for at least 150 additional fishermen.

To the extent that the associated drainage and irrigation scheme will reduce the area of seasonally inundated fishable floodland, so will there be corresponding reductions in opportunities for subsistence fishing, especially by the poorer classes, and a decline in the range of floodplain fish species as well as in volume of catches. On the other hand, any ponds in this area which were previously vulnerable to over-flooding, could become suitable for rehabilitation, subject to provision being made for credit to cover re-excavation costs and to support the necessary extension work.

There is a further proposal that additional flows be directed down the Gorai/Madhumati/Rupsa route past Khulna, aimed at pushing back the saline front. If this were done it is possible that salinity could be depressed over a sufficient length of Pussur River as to seriously affect Penaeid shrimp post-larval survival in that area. This would be highly detrimental to large areas of tidal shrimp farms in the Khulna, Mongla and Bagerhat districts, which are at the heart of the shrimp farming industry.

8.2 Ganges/Padma/Arial Khan Right Embankment

The Ganges Right Bank improvement proposals involve resectioning the embankment from near the Gorai intake at Kushtia to the vicinity of Goalandha, just below the Jamuna/Ganges confluence. The project areas adjacent to the existing embankment seem relatively well protected already and the irrigable areas would be supplied from the Chandana River which is not especially important for fisheries. However, from the SPARRSO map there are a number of baors and beels within the proposed project areas, which will need attention to minimise damage. These water bodies are a vital source of fish which spread out during the monsoon flood to support the subsistence catch. The area of fishable floodplain will be reduced in the course of improving the irrigation and drainage infrastructure to the disbenifit of the landless who need the subsistence fishery, but people who have access to ponds should benefit.

The Padma Right Embankment (PRE), from Goalandha to the Arial Khan River intake protects a triangular area between the M.B.Route canal and the Madhumati River, known as the Padma-Kumar Scheme. PRE already exists but has uncompleted gaps especially in the Sadarpur section near the mouth of the Arial Khan River, where flood season inflows connect with an extensive beel and floodland complex north of the Takerhat-Gopalganj road. Part of this area is known as Chanda Beel which floods over about 10,000 ha during the monsoon and is one of the areas being restocked by Third Fisheries Project. More than 50 tons of fingerlings were released this year and there appears to be serious risk of a clash between two opposing development programmes which will need to be resolved before it proceeds much further.

It also contains several other beel areas, notably in the Nagarkanda Thana area, which support fishing communities. Some have already been sub-poldered and drained, eg Sukunia Beel south of Faridpur, which was one of the FCD projects studied by FAP 12. Others still remain unaltered although in most cases their fish stocks, which derive mainly from the Kumar River, have suffered since the construction of the regulator at the Kumar River intake near Faridpur. The beel situation will require detailed survey before its plans are finalised so as to minimise the risk of unintentional damage.

The Arial Khan Right Bank-Bisarkandi Scheme involves the construction of 52 km of new FC embankment and associated compartmentalisation in the area southeast of the fewer in number than further north, so that the negative consequences for capture fisheries will be less severe. Even so the area is subject to annual flooding and the resultant subsistence fishery is of great importance to the local population. This fishery is bound to decline concurrently with successful drainage. Pond culture should benefit from reduced flood risks and the new embankment construction provides an opportunity to plan for the creation of a worthwhile borrow-pit fishery. The plans also include the possibility of excavating parts of the principal beel areas and constructing surrounding dykes, with the aim of increasing water holding capacity, fish productivity and a little water for irrigating surrounding land.

8.3 Chenchuri Beel FCD Scheme

Rehabilitation of this existing scheme, which is located in Narail District between the Nabaganga and Chitra rivers provides a chance to review any impacts on the local fisheries and to take such remedical action as is possible. Despite its name, the SPARRSO maps do not show any significant beel or baor areas, and pre-project fish production would have been based mainly on the rivers and the seasonal floodplain subsistence catch. Post-project benefits will have accrued mainly to fish pond owners and to any borrow-pits that have been developed for fish production. The project aims at year round irrigation, so that the rehabilitation work will be intended to restore FCD integrity. This is bound to impact on any remaining flood plain fish and river fishing cannot be expected to improve, however, there may be prospects of expanding the borrow-pit fishery and fish farming should certainly benefit.

The Chenchuri scheme adjoins part of the Narail scheme which lies to the west of Narail astride the Narail to Jessore road. The project aims to utilise surplus flow down the Chitra River under a controlled flooding regime and, as a result some floodplain subsistence fishing may still continue, but less than before. There appears to be one smallish beel area close to the Chitra in the northern part of Narail Scheme which could possibly be developed, but a more detailed survey of the project area is needed before it can proceed. Indications are that the project will be largely neutral as regards fish farming.

8.4 Barisal Irrigation Scheme

The proposal is to reactivate the scheme which is currently non-operational, by dredging various creeks to improve drainage and by raising bunds and water control structures at key points. Although Barisal is an important fishing centre, particularly for landless of Hilsa caught in the estuaries and coastal waters, the project area as a whole is well inland from the saline front in this part of SWA. There are no known beels in the area but the river/flood plain connection is important for subsistence fishing. Fishery data for Barisal District show that floodplains and culture fisheries produce roughly 11,000 mt each, but whereas floodplain production will be rapidly reduced by FCD/I actions, fish pond production will increase but only slowly. The riverine fish stocks will continue to decline as a result of the combined impact of this and all the other upstream FCD/I projects, and excessive fishing pressure.

8.5 Bishkhali FCD/I Scheme

This is a new proposal aimed at providing near flood free year round irrigation in an area which is very close to the saline front. The project consists of 22 km of new embankment and controlled flooding and drainage via a network of flushing canals and drains. There are no beels within the project perimeter and capture fishing therefore depends on the river/floodplain connection. It seems probable that the floodplain subsistence fishery will be virtually eliminated, river fishing will continue to decline, fish farming will increase slowly and there are prospects for a new borrow-pit fishery to assist capture fishermen who would otherwise be disbenefitted.

8.6 Swarupkati Scheme

The project aims for year round irrigation in areas protected by flood control embankments, with structures allowing for controlled flooding and drainage. Flood depth data are scanty but the area is believed to be subject to relatively deep over-bank spillage and congestion. There seem to be no beels in the project area and the impacts are therefore likely to be similar to the Bishkhali Scheme, namely reductions in subsistence and riverine fisheries, a modest increase in pond fish production and, depending on how much new embankment work proves necessary, some development of borrow-pit fisheries.

8.7 Impacts of the Proposed Strategy for Coastal Embankment Projects

In general the re-opening of some of the natural drainage routes to facilitate better circulation of tidal flows and thus reduce the siltation and congested drainage problems that have caused difficulties hitherto, will be of benefit to freshwater pond fish farming in the polders. The impact on capture fisheries in the relatively few beels and rivers will be largely neutral, because they have mostly been destroyed already, but improved flows of saline water may encourage some estuarine fish, e.g. soles and flounders to penetrate further inland than is presently the case.

The main concern is that the improved drainage could reduce salinities in river waters in the Dumuria area (Polders 16, 17/1, 17/2, and 26). This would be very bad news for shrimp farmers, and would need very careful investigation beforehand, particularly in view of the developments now in progress under Third Fisheries Project, to extend the Polder 20 experience of successful artisanal scale shrimp/rice farming to other parts of C.E.P.

9 CONCLUSIONS

9.1 Capture Fish Resources

As shown in Section 2, annual capture fish production in SWA fell by incremental amounts as a result of several factors, including FCD and uncontrolled fishing, to the stage where 1988/89 catches were 50,500 mt less than in 1983/84. The losses are continuing to mount and continued failure to enforce fishery protection regulations is putting much of the remaining 120,000 mt of capture fish production at risk.

It has been suggested that lost capture fish production can easily be replaced by farmed fish. This is not viewed as realistic prospect because Bangladesh will need every scrap of fish in future, both from its capture and culture fisheries, if per capita consumption rates are to be maintained in the face of continuing population growth. It is urged that the decline in fish stocks, however caused, must be checked and if possible reversed, no matter what the diffuculties involved. DOF and the other enforcement agencies concerned must deploy the resources needed to check the use of illegal nets, halt the landing of undersized, immature fish and limit fish catches and fishing effort to safe sustainable levels. The problem is one that requires countrywide action and not only in SWA.

9.2 Preservation of Khas Waters

It is reported that agreement has been reached between the Ministries of Fisheries and Irrigation that any publicly owned (khas) water bodies, such as beels, baors, khals, etc., in any future FCD/I project areas, should not be drained as in the past but should be preserved, improved and restocked as necessary, for the benefit of fishermen's groups established under the New Fisheries Management Policy (NFMP). This agreement is very much to be welcomed as it offers an important means of mitigating oterwise adverse FCD impacts.

In some cases there may be need for breeding sanctuary areas to be set aside, but the means of establishing and demarkating such areas and the possible need for policing still has to be discussed. The technique of using brushwood ''katha'', but over a larger than normal area may be one solution. These are places where bamboo stakes and cut brushwood are put into the water to encourage a concentration of fish where there is shelter and the fish are relatively safe from poaching.

In the same context, there is need to strengthen DOF's response to a further agreement with the Land Administration Dept. regarding the handover of a number of jalmahals in various parts of the country, to DOF for allocation to fishermen's groups under the NFMP, with NGO assistance. Such strengthening is necessary in order that those already transferred will prove successful and so enable more transfers to be requested. Mitigatory provision under an FCD project could be a useful means of achieving such development and of compensating displaced fishermen, because the jalmahals concerned have in most cases, been leased to wealthy individuals whose aim was to make a profit from the work of fishermen.

9.3 Fisheries Credit

The lack of access to institutional low-cost rural credit has long been a constraint to both capture and culture fisheries development. Finance is often needed for the construction of new ponds, or for re-excavating and restocking old derilict ponds or jalmahals, and to cover the cost of building a new boat, etc. Unfortunately, fishermen rarely have any acceptable form of security, and rural credit, including for fisheries, has been bedeviled by bureaucratic

procedures, loan recovery problems and graft. Nevertheless it is still an indispensible requisite for development and there appears to be need for a fresh assessment of how the earlier systems failed to work properly and to determine if better alternative approaches can be devised.

9.4 Shrimp Farming

Now that a Macrobrachium hatchery is operational in SWA, it is reasonable to expect that many pond owners, including some of the shrimp gher owners whose property is furthest inland, and who are faced with increasing problems in obtaining sufficient quantities of Penaeid post-larvae, may convert to farming the freshwater prawn instead. This should help to lessen some of the social conflicts because it would no longer be necessary to introduce saline water into the gher area.

Nevertheless, the overwhelming economic importance of shrimp farming as a major supplier of export quality product, necessitates that one or more Penaeid hatcheries be established as soon as possible. As noted in Section 3.6, the most likely location for such a hatchery is in an area south of Cox's Bazar towards Teknaf. Consideration should also be given to incorporating the water management system developed by the IDA Shrimp Project in Polder 20, in any new projects within the brackish zone. The system provides a network of flushing and drainage channels serving each plot and enabling them to be operated without the social problems which occur in some of the other polders.

9.5 Role of Women in Fisheries

FAP 12 studies included efforts to establish the respective roles of family members in fishing communities. It was found that women and younger children contributed about 30% of total family time spent on the fishing business. The particular role of women was in the repair and upkeep of fishing nets and other gear used for catching fish. Women did not usually go out to catch fish and were not involved in the operation or repair of boats. They participated only very rarely in marketing the family catch.

9.6 Landless People and Fisheries

Studies to date confirm that virtually all of the full time and part time artisanal fishermen are landless. The full time fishermen are mostly Hindu and traditionally function as fishermen by caste as well as by training. An increasing proportion of the part time fishing labour force are Muslim and relative newcomers to fishing, in place of former full time workers who have given up and emigrated to other areas.

The culture fisheries present a different picture, in that fish farmers are either the owners or lease holders of the land areas concerned. Shrimp farmers generally own part of the land and lease in the rest from neighbouring farmers for the winter season (November to June/July).

9.7 Borrow Pit Fisheries Development

In the course of building roads, embankments and other facilities, a very large number of borrow-pits have been dug, with little thought given to their possible productive use afterwards. It should cost no more to ensure that the borrow-pit is dug to a planned shape and depth suitable for fish production, than to allow the contractors to leave the area as an unusable derelict wasteland.

Some areas will be too sandy and porous to hold water, but wherever feasibile it is recommended that the work should be jointly supervised by local BWDB and DOF officers, and that NGO assistance be sought to help organise the fishermen into groups. The cost of stocking, after completion of the physical works should be included in project provision.

9.8 FCD Structures and Regulators

Designs for modifying or rebuilding sluices, regulators and other FCD structures to make them more "fish friendly" and permit two-way traffic by fish stocks, but without jeopardising the protective function of the FCD structures, are still being studied by FAP 17. The problem is one which requires monitored pilot trials of possibly several different designs to determine their effectiveness in allowing fish passage. Until such trials have been completed and evaluated it is not considered sensible to propose including any design changes in new project plans. If necessary, token provision could be included and the matter kept under review pending further advice from FAP 17.

In the meantime the policy should be adopted of leaving gates fully open, especially during the very early flood, for as long as it is safe to do so, to allow the maximum opportunity for fish to pass.

9.9 Fisheries Data Collection and Analysis

The fish production statistical system within DOF was set up in 1983, with FAO assistance following a review and overhaul of earlier methods. The system is designed for computerised compilation and analysis but has deteriorated to the stage where it is now taking more than 2½ years to process the annual figures. Data is still being published on the basis of old "greater" districts and reorganisation of the tables to accord with the much larger number of new districts has not yet been accomplished.

These excessive delays are the result of shortages of trained staff and programming difficulties, but make it extremely hard to manage the fisheries properly because of the lack of accurate and up to date information. There is urgent need for a further injection of equipment, skills and training for local staff. It is also considered that more data processing should be done by district staff and not concentrated wholly in Dhaka.

APPENDICES

APPENDIX 1

PROVISIONAL LIST OF FISH SPECIES OCCURRING IN THE INLAND WATERS OF SOUTH WEST & SOUTH CENTRAL REGIONS

Sl No	Family & Species	Local Name	Estuaries & Tidal Rivers	Fresh Water Rivers	Flood Plain & Beels
1	Family: SOLEIDAE Synaptura pan	Kathal pata	+	+	
2	Family: BOTHIDAE Pseudorhombus arsius	Serbati	+		
3	Family: CYNOGLOSSIDAE Paraplagusia bilineata Cynoglossus cynoglossus Cynoglossus lingua Cynoglossus arel	Kukur jeeb " " "	+ + + +		
4	Family: SYNGNATHIDAE Ichthyocampus carce Dorichthys cuncalus Dorichthys chokderi	Kumirer khil " "	+ + +	+ + +	
5	Family: ANGUILLIDAE Anguilla bengalensis	Bamoch, Banehara	+	+	
6	Family: MURAEENIDAE Lycodontis tile	?	+		
7	Family: OPHICHTHIDAE Pisodonophis boro	Kharu, Hijra	+	+	
8	Family: MORINGUIDAE Moringua rataboura	Rata boura	+		
9	Family: MURAENESOCIDAE Muraenesox bagio Congresox telabonoides Congresox telabon	Kamila " "	+ + +		
10	Family: SYNBRANCHIDAE Monopterus cuchia Ophisternon bengalensis	Kuchia Bamosh	 +	+	+
11	Family: TETRAODONTIDAE Tetraodon cutcutia Chelonodon fluviatilis Chelonodon patoca	Tepa, Potka Potka "	 + +	+ +	+
12	Family: BELONIDAE Xenentodon cancila	Kakila		+	+
13	Family: HEMIRHAMPHIDAE Hyporhamphus gaimardi Zenarchopterus ectuntio Dermogenys brachynopterus Dermogenys pussilus	Ek thuita " Ek thota "	 + +	+ + + +	
14	Family: CYPRINODONTIDAE Aplochellus panchax Oryzias melastigma	Kanpona Bechi	 +	+	+

Sl No	Family & Species	Local Name	Estuaries & Tidal Rivers	Fresh Water Rivers	Flood Plain & Beels
15	Family: CHANNIDAE				
	Channa striatus	Shol			+
	Channa marulius	Gajar			+
	Channa barca	Pipla, Tila			+
	Channa punctatus	Taki, Lata			+
	Channa orientalis	Gachua			+
16	Family: HARPODONTIDAE				
	Harpodon nehereus	Loitta	+		
17	Family: CYPRINIDAE				
	Oxygaster gora	Ghorachela		+	+
	Salmostoma phulo	Fulchela		+	+
	Salmostoma bacaila	Katari		+	+
	Esomus danricus	Darkina			+
	Chela laubuca	Laubuca		+	+
	Aspidoparia morar	Morari		+	
	Rasbora elanga	Along		+	
	Rasbora rasbora	Darkina		+	+
	Rashbora daniconius	"		+	+
	Danio devario	Chapchela		+	+
	Danio rerio	Anju		+	+
	Amblypharyngodon mola	Mola		+	+
	Amblypharyngodon microlepis	"		+	+
	Rohtee cotio	Keti		+	+
	Labeo gonius	Goni		+	+
	Labeo nandina	Nandil		+	+
	Labeo calbasu	Kalibaus		+	+
	Labeo rohita	Rui		+	+
	Labeo angra	Angrot		+	
	Labeo bata	Bata		+	
	Cirrhinus mrigala	Mrigal		+	+
	Cirrhinus reba	Tatkini,Laacho		+	+
	Puntius sarana	Sarpunti		+	+
	Puntius chola	Chalapunti		+	+
	Puntius guganio	Molapunti		+	+
	Puntius phutunio	Phutani punti		+	+
	Puntius conchonius	Takapunti		+	+
	Puntius tieto	Tit punti		+	+
	Puntius gelius	Gili punti		+	+
	Puntius sophore	Jat punti		+	+
	Puntius terio	Teri punti		+	+
	Puntius cosuatis	Kosuati punti		+	+
	Catla catla	Katla, Katal		+	+
	Crossocheilus latius	Kalabata		+	
18	Family: COBITIDAE				
	Botia dario	Rani		+	
	Botia lohachata	Rani, Putul		+	
	Botia dayi	"		+	
	Lepidocephalus guntea	Gutum		+	+
	Lepidocephalus annandaei	Puiya		+	
	Lepidocephalus irrorata	"		+	

Sl No	Family & Species	Local Name	Estuaries & Tidal Rivers	Fresh Water Rivers	Flood Plain & Beels
19	Family: CLARIIDAE				
	Clarias batrachus	Magur		+	+
20	Family: SILURIDAE				
	Wallago attu	Boal		+	+
	Ompok bimaculatus	Kani pabda		+	+
	Ompok pabda	Madhu pabda		+	+
	Ompok pabo	?		+	
21	Family: HETEROPNEUSTIDAE				
	Heteropneustes fossilis	Shingi		+	+
22	Family: PLOTOSIDAE				
	Plotosus canius	Gang Magur	+	+	
23	Family: CHACIDAE				
	Chaca chaca	Cheka		+	+
24	Family: SCHILBEIDAE				
	Silonia silondia	Shillong	+	+	
	Pangasius pangasius	Pangas	+	+	
	Ailia coila	Kajuli		+	
	Ailiichthys punctata	"		+	
	Pseudeutropius atherinoides	Batasi		+	
	Entropiichthys vacha	Bacha		+	
	Clupisoma murius	Muribacha		+	
	Clupisoma garua	Ghaura		+	
25	Family: BAGRIDAE				
	Rita rita	Rita	+	+	
	Chandramara chandramara	?		+	+
	Batasio batasio	Tengra		+	+
	Batasio tengana	"		+	+
	Mystus aor	Ayre, Air		+	+
	Mystus seenghala	Guizza		+	+
	Mystus menoda	Ghagla		+	+
	Mystus cavasius	Golsha		+	+
	Mystus bleekeri	Tengra		+	+
	Mystus tengara	Bajari-tengra		+	+
	Mystus vittatus	Tengra		+	+
	Mystus gulio	Nuna-tangra	+		
26	Family: SISORIDAE				
	Gagata nangra	Gang-tengra		+	
	Gagata gagata	"		+	
	Gagata cenia	Jungla		+	
	Gagata youssoufi	Gang-tengra		+	
	Hara jerdoni	Kutakanti		+	+
27	Family: TACHYSURIDAE				
	Osteogeniosus militaris	Apuia	+	+	
	Batrachocephalus mino	Katabukha	+	+	
	Tachysurus nenga	Kata	+		
	Tachysurus gagora	Gazla	+	+	
	Tachysurus sp		+		

Sl No	Family & Species	Local Name	Estuaries & Tidal Rivers	Fresh Water Rivers	Flood Plain & Beels
28	Family: MEGALOPIDAE				
	Megalops cyprinoides	?	+		
29	Family: NOTOPTERIDAE				
	Notopterus chitala	Chital		+	+
	Notopterus notopterus	Foli		+	+
30	Family: ENGRAULIDAE				
	Coilia ramcarati	Olua	+		
	Coilia dussumeri	"	+		
	Setipinna phasa	Phasa	+	+	
	Setipinna taty	Teli-phasa	+		
	Thryssa purava	?	+		
	Thryssa hamiltoni	?	+		
31	Family: CLUPEIDAE				
	Gudusia chapra	Chapila		+	+
	Hilsa ilisha	Ilish	+	+	
	Hilsa toli	Chaudana	+		
	Corica soborna	Kachki		+	
	Ilisha motius	Choukka		+	
	Pelona ditchela	Choukka	+		
	Nematalosa nasus	Barang	+		
	Gonialosa manminna	Chapila	+	+	
	Anodontostoma chacunda	Chakunda	+		
32	Family: TRICHIURIDAE				
	Trichiurus savala	Churi	+		
	Trichiurus muticus	"	+		
33	Family: MASTACEMBELIDAE				
	Macrognathus aculeatus	Tara baim		+	+
	Mastacembelus armatus	Baim		+	+
	Mastacembelus pancalus	"		+	+
34	Family: STROMATEIDAE				
	Parastromateus niger	Chanda	+		
	Pampus chinensis	Rup-chanda	+		
	Pampus argenteus	Fali-chanda	+		
35	Family: POLYNEMIDAE				
	Polynemus paradiseus	Tapasi	+		
	Eleutheronema tetradactylum	Tailla	+		
	Polydactylus indicus	Lakhua	+		
	Polydactylus sexfilis	Kali, Dagi	+		
36	Family: MUGILIDAE				
	Rhinomugil corsula	Bata, Khalla	+	+	
	Mugil cascasia	Bata	+	+	
	Mugil oligolepis	"	+		
	Mugil dussumieri	"	+		
	Mugil parsia	"	+		

Sl No	Family & Species	Local Name	Estuaries & Tidal Rivers	Fresh Water Rivers	Flood Plain & Beels
37	Family: ANABANTIDAE				
	Colisa sota	Boicha		+	+
	Colisa fasciatus	Khalisha		+	+
	Colisa lalius	Boicha		+	+
	Ctenops nobilis	Neftani		+	+
	Macropodus cupanus	?			+
	Anabas testudineus	Koi		+	+
38	Family: ELEOTRIDAE (Gudgeon)				
	Eleotris lutea	Kuli	+	+	
	Eletris tusca	"	+	+	
	Butis melanostigma	?	+		
	Butis butis	?	+		
39	Family: GOBIIDAE				
	Pseudapocryptes lanceolatus	Chewa	+	+	
	Apocryptes bato	Chiring	+	+	
	Parapocryptes batoides	Dalichewa	+	+	
	Scartelaos viridis	Darak	+		
	Boleophthalmus boddarti	Dahuk	+		
	Periophthalmus koelreuteri	?	+		
	Periophthalmodon schlosseri	?	+		
	Oxyurichthys microlepis	?	+		
	Pogonogobius planifrons	?	+		
	Stigmatogobius oligactis	?	+	+	
	Stigmatogobius sadanundio	?	+		
	Awaous stamineus	Bele	+	+	
	Awaous grammepomus	"	+	+	
	Brachygobius nunus	Nuna bailla	+	+	
	Glossogobius giuris	Bele	+	+	+
	Acentrogobius cyanomos	?	+		
	Acentrogobius canimus	?	+		
	Gobiopterus chuno	?	+	+	
40	Family: TAENIOIDIDAE				
	Trypauchen vaaina	Sada chewa	+		
	Odontamblyopus rubicundus	Lal chewa	+	+	
	Taenioides buchanani	Raja chewa	+		
	Taenioides cirratus	Chewa	+	+	
41	Family: PLATYCEPHALIDAE				
	Platycephalus indicus	Mur bailla	+		
42	Family: SILLAGINIDAE				
	Sillaginopsis panijus	Tular Dandi	+		
43	Family: NANDIDAE				
	Nandus nandus	Bheda		+	+
44	Family: PRISTOLEPIDAE				
	Badis badis	Koi bandi		+	+
45	Family: SCATOPHAGIDAE				
	Scatophagus argus	Bish tara	+		

Sl No	Family & Species	Local Name	Estuaries & Tidal Rivers	Fresh Water Rivers	Flood Plain & Beels
46	Family: LOBOTIDAE				
	Lobotes surinamensis	Samudra	+	+	
	Datnoides polota	?	+		
47	Family: SPARIDAE				
	Acanthopagrus datnia	?	+		
48	Family: SCIAENIDAE				
	Pama pama	Poa	+	+	
	Otolithes maculatus	Lombu	+		
	Johnius cujus	Kuizza poa	+		
	Johnius coitor	Koitor	+	+	
49	Family: TOXOTIDAE				
	Toxotes chatareus	?	+		
50	Family: LEIOGNATHIDAE				
	Secutor ruconius	Takchauda	+	+	
	Leiognathus equulus	"	+	+	
51	Family: CENTROPOMIDAE				
	Lates calcarifer	Bhetki	+	+	
	Chanda nama	Chanda		+	+
	Chanda beculis	"		+	+
	Chanda ranga	"		+	+
52	Family: THERAPONIDAE				
	Therapon jarbua	?	+	+	
53	Family: TRYGONIDAE				
	Trygon Sp.	San Kuch	+	+	

Sources: Account of the Fishes of the Padma; M.S. Islam and M.A. Hossain, 1983.
Freshwater Fishes of Bangladesh, A.K.A. Rahman, 1989.
M.P.O. Technical Reports Nos. 16 and 17; November 1985.
I.D.A. Bangladesh Fisheries Sector Review, October 1990.

APPENDIX 2

SCARCE CAPTURE FISHERIES SPECIES PREVIOUSLY ABUNDANT IN INLAND WATERS OF SW & SC REGIONS

Species Group	Local Name	Scientific Name
Major Carps	Rui	Labeo rohita
"	Kalibaus	Labeo calbasu
"	Mrigal	Cirrhinus mrigala
"	Katla	Catla catla
Lesser Carps	Sarpunti	Puntius sarana
"	Chela	Oxygaster and Chela spp.
"	Nandil	Labeo nandina
Cat fish	Boal	Wallagn attu
"	Rita	Rita rita
"	Air	Mystus aor
"	Kaunia	Mystus menada
"	Tengra	Batasio & Mystus spp
"	Kajuli	Ailia coila
"	Pangas	Pangasius pangasius
"	Magur	Clarias batrachus
"	Singi	Heteropneustes fossilis
Clupeids	Chapila	Gudusia chapra
Climbing Perch	Koi	Anabas testudineus
"	Khalisa	Colisa spp.
Snake Heads	Shol	Channa striatus
"	Gajar	Channa marulius
"	Taki	Channa punctatus

Sources: IDA, Bangladesh Fishery Sector Review, October 1990.
Reports from Fisheries Dept. staff, fishermen & fish traders, during FAP-4 field surveys.

APPENDIX 3

PRINCIPAL SPECIES OF SHRIMP OCCURRING IN THE SOUTHWEST AND SOUTH CENTRAL REGIONS

Family & Species	Local Name	Estuaries and Tidal Rivers	Fresh Water Rivers	Flood Plain and Beels
(a) Freshwater Shrimps Family : PALAEMONIDAE (14 species of Macrobrachium including:)				
Macrobrachium rosenbergii	Golda Chingri	+	+	+
Macrobrachium malcohmsonii	Chatka "	+	+	+
Macrobrachium villosimanus	Dimua "	+	+	?
Macrobrachium dayanus	Woira "	+	+	?
Macrobrachium lamarrei	Kucho "	+	+	+
Macrobrachium mirabilis	Lotia "	+	+	?
plus, at least 2 un-named Caridina species		+	+	
(b) Brackish Water Shrimps Family: PENAEDAE (8 species of Penaeus and 6 species of Metapenaeus, including:)				
Penaeus monodon				
Penaeus indicus	Bagda Chingri	+		
Penaeus semisulcatus	Chaka "	+		
Metapenaeus monoceros	Bagda "	+		
Metapenaeus brevicornia	Honna "	+		
	Saga "	+		

Sources: MPO, Technical Report No 17, November 1985.
IDA, Bangladesh Fisheries Sector Review, October 1990
Research Report No 7, M.K. Ahmed, Chandpur 1983.

APPENDIX 4

SW-SC REGION CAPTURE FISHERIES: FRESHWATER FISH AND PRAWN BREEDING PERIODS

Water Level

Flood Period

FISH SPECIES/GROUPS	J	F	M	A	M	J	J	A	S	O	N	D
Major Carps:												
- Labeo spp, Catla catla				x	x	x	x					
- Cirrhinus Mrigala					x	x	x					
Minor Carps:												
- Oxygaster & Puntius spp				x	x	x	x	x	x			
- Rasbora, Danio, Rohtee spp												
- Esomus danricus				x	x	x	x					
- Amblypharyngodon								x	x	x		
				x	x	x	x	x	x	x	x	
Clupeids												
- Hilsa ilisha	x	x	x				x	x	x	x	x	
Catfish												
- Wallag attu					x	x	x	x				
- Ompok spp.						x	x	x				
- Schilbeids (Pangasius, Clupisoma)			x	x	x	x	x	x				
- Clarias batrachius					x	x	x					
- Mystus spp				x	x	x	x	x				
Minnows												
- Aplocheilus panchax		x	x	x	x	x	x	x	x	x		
Snakeheads												
- Channa spp.				x	x	x						
Perciforms												
- Chanda nama			x	x	x	x	x	x	x	x		
- Nandus nandus				x	x	x	x	x				
Anabantids												
- Colisa spp.						x	x	x	x	x		
- Anabas testudineus						x	x					
Gobies												
- Glssogobius giuris			x	x	x	x	x	x	x	x		
Spiny Eels												
- Mastacembelus				x	x	x	x					
Freshwater Prawn												
- Macrobrachium rosenbergii				x	x	x						

Sources: Account of the Fishes of the Padma; M.S. Islam & M.S. Hossain, 1983.
MPO Technical Report No 17, November 1985.
Freshwater Fishes of Bangladesh, AKA Rahman 1989.

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APPENDIX 6

AREA OF FISHERIES AND TOTAL PRODUCTION

PU CODE	PU Gross Area (Km²)	River and Estuaries		Beels		Flood Lands		Baors		Ponds		Shrimp Farms (Fish and Shrimp)				
			1988-89		1989-90		1989-90		1989-90		1989-90		1986-87		1990-91	
		Area (ha)	Production (mt)	Area (ha)	Production (mt)	Area (ha)	Production (mt)	Area (ha)	Production (mt)	Area (ha)	Production (mt)	Area (ha)	Production -total (mt)	Area (ha)	Production -total (mt)	Shrimp only (mt)
SW1	1,806.9	4,519	790	604	150	39,920	334	401	79	632	545	0	0	0	0	0
SW2	1,891.7	3,466	487	1,439	358	40,285	1,110	1,184	280	1,255	1,577	0	0	0	0	0
SW3	1,652.5	13,298	1,249	793	176	58,373	1,116	439	87	1,561	1,359	0	0	0	0	0
SW4	2,046.9	5,268	467	1,924	479	37,488	2,128	796	235	2,927	5,428	0	0	0	0	0
SW5	718.7	3,374	267	729	182	27,153	1,685	396	121	863	1,693	0	0	0	0	0
SW6	414.6	3,485	216	144	30	15,472	361	72	14	395	345	0	0	0	0	0
SW7	1,949.8	14,855	921	552	117	143,977	3,363	263	52	2,200	1,922	0	0	0	0	0
SW8	1,815.0	7,184	675	1,017	253	27,065	1,291	574	147	1,243	1,991	871	243	1,179	326	224
SW9	1,162.9	1,969	143	1,008	251	32,533	1,988	504	145	961	1,818	776	216	928	256	176
SW10	1,093.8	2,277	148	288	72	71,902	4,314	160	43	832	1,508	292	81	363	100	70
SW11	2,709.8	9,607	380	238	59	13,700	770	216	42	2,928	4,492	27,454	7,646	37,453	10,337	7,115
SW12	585.4	1,864	74	16	4	5,891	331	14	3	343	527	5,336	1,486	7,171	1,979	1,362
SW13	1,626.4	15,663	1,810	168	43	76,083	4,060	103	21	1,805	2,348	1,799	501	3,358	927	638
SW14	1,342.1	4,385	174	73	18	9,382	527	99	20	1,346	2,065	25,920	7,219	38,084	10,511	7,235
SW15	5,810.0	180,000	6,416	0	0	0	0	0	0	0	0	0	0	0	0	0
Sub-total	26,626.7	271,214	14,218	8,993	2,193	599,225	23,380	5,223	1,288	19,292	27,618	62,448	17,392	88,536	24,436	16,820
SC1	1,276.2	8,404	261	190	49	71,748	2,582	96	25	939	846	0	0	0	0	0
SC2	850.8	11,742	1,014	261	75	30,269	1,548	130	34	1,079	986	0	0	0	0	0
SC3	543.4	5,652	712	41	13	32,389	2,008	20	5	420	388	0	0	0	0	0
SC4	713.5	14,081	2,823	41	14	48,663	4,011	19	5	896	844	0	0	0	0	0
SC5	817.4	24,933	7,111	11	4	18,600	1,965	0	0	1,235	1,190	0	0	0	0	0
SC6	712.0	21,874	6,239	12	5	20,144	2,128	0	0	1,471	1,417	0	0	0	0	0
SC7	823.4	22,081	5,834	5	2	404	42	0	0	1,239	1,229	0	0	0	0	0
SC8	2,679.9	60,814	17,345	37	14	11,901	1,257	0	0	5,147	4,958	46	13	110	30	21
SC9	867.1	35,726	4,160	0	0	2,892	244	0	0	1,671	1,997	0.97	0.27	5	1.3	0.9
SC10	677.3	21,171	2,465	0	0	589	50	0	0	1,234	1,476	8.99	2.50	55	15	10.0
SC11	1,053.0	28,711	5,497	4	2	61	6	0	0	1,501	1,640	0.10	0.03	60	16	11.4
SC12	592.3	10,586	1,233	0	0	1,548	131	0	0	825	986	1.18	0.33	51	14	9.7
SC13	782.7	30,495	3,551	0	0	2,894	244	0	0	1,807	2,160	14.33	3.99	59	16.1	11.3
Sub-total	12,388.9	296,269	58,245	602	177	242,101	16,216	265	69	19,463	20,117	71.11	19.80	340	92	64
Coastal/boun	1,434.4															
Total	40,450.0	567,483	72,463	9,595	2,370	841,326	39,596	5,488	1,357	38,755	47,735	62,519	17,412	88,876	24,528	16,884

APPENDIX 7

LIST OF PROCESSING FACTORIES IN SW&SC REGIONS

Sl No	Name of Processing Factories
1	Aqua Resources Ltd., Shiromani, Khulna
*2	Froglegs Export Ltd., Khaleshpur, Khulna
3	Sea Products Ltd., Khulna
*4	Afish Unit No. 1, Khulna
5	Asian Sea Food Ltd., Laban Chara, Khulna
6	Bangladesh Sea Food Industries Ltd., Khulna
7	Haji A. Malek & Co. Store Ltd., Laban Chara, Khulna
8	Star Sea Food Ltd., Milki Deara, Khulna
9	Gazi Ice & Freezing Ltd., Ramnagar, Khulna
10	Imam Ice & Co. Store Ltd., Khulna
11	Sundarban Sea Food Industries Ltd., Ramnagar, Khulna
12	Lokpur Fish Processing Co Ltd., Khulna
13	Rupali Sea Food Industries Ltd., Khulna
14	Modern Sea Food Ltd., Khulna
15	Gazi Fisheries Ltd., Char Rupsa, Khulna
16	Bionic Fish Processing Ltd., Bagmara, Khulna
17	National Sea Food Industries Ltd., Khulna
18	Khulna Frozens Foods Exports Ltd., Khulna
19	Shahanewaz Sea Food Ltd., Khulna
20	Jeminee Sea Food Ltd., Jebusha, Baitaghata
21	Sundarban Trade Syndicate Ltd., Khulna (Ship)
22	Anowara Sea Food Ltd., Khulna
*23	United Fish Exports Ltd., Ramnagar, Rupsa
*24	Shampa Ice & Cold Storage Ltd., Khulna

Sl No	Name of Processing Factories
*25	Hymalyan Ice & Cold Storage Ltd., Khulna
*26	Royal Shrimp Industries Ltd., Khulna
*27	D.R.T.C. Fish Freezing Co Ltd., Khulna
*28	Bangladesh Fishermen Cooperative Society Ltd., Deara, Khulna
*29	Sundarban Fisheries Ltd., Khulna (Ship)
*30	Khulna Sea Food Ltd., Khulna
31	Rupsa Fish Industries Ltd., Khulna
*32	Bangladesh Coldstorage Ltd., Khaleshpur, Khulna
33	Bengal Fish Processing Industries Ltd., Khulna
34	Oriental Fish Processing Ltd., Rupsa, Khulna
35	Prince Sea Food Ltd., East Rupsa, Khulna
36	Satkhira Foods Ltd., Chuknagar, Khulna
37	Sundarban Fish Processing Project Ltd., Benerpota, Satkhira
38	Meghna Frozen Foods Ltd., Benerpota, Satkhira
39	Satkhira Fisheries Ltd., North Kalia, Satkhira
40	Baramendal Fisheries Development Ltd., Batkhali, Satkhira
*41	Delta Fish Ltd., Chandpur, Debhata, Satkhira
*42	Afish Ltd., Unit No. 2, Gazirhat, Satkhira
43	Chalna Marine Products Ltd., Chalna, Bagerhat
44	Fish Exporters Ltd., Bajua, Bagerhat
45	Bangladesh Foods Anociate Products Ltd., Shymbagat, Bagerhat
*46	Bangladesh Fisheries Development Corporation, Digraj, Bagerhat
*47	Dhaka Fisheries Ltd., Mongla, Bagerhat
48	Barisal Fishing Ltd., Rupatali, Barisal
49	Patuakhali Foods Ltd., District Council Road, Patuakhali
*50	Madhumati Foods Products Ltd., Tekerhat, Madaripur

(*) Processing Plants are not in operation presently.

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DATE	BORROWERS NAME	DEG	SIGNATURE	LIB. USE
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17/1/00	"		"	Rabeya 19.1.2000
5/1/02	Motaleb		Mbsc	Rabeya 12.03.02
23/04/02	M. A. Bakar			Rabeya 24.04.02
08/03/03	Md. Ekram Ullah			