Government of the People's Republic of Bangladesh

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

BANGLADESH ACTION PLAN FOR FLOOD CONTROL

COMPARTMENTALIZATION PILOT PROJECT (FAP 20)

SIRAJGANJ INTERIM REPORT

ANNEX 4: AGRICULTURE

(FINAL DRAFT)

June 1993

Euroconsult/Lahmeyer International/Bangladesh Engineering & Technological Services/House of Consultants

under assignment to

DIRECTORAAT GENERAAL INTERNATIONALE SAMENWERKING
Government of the Netherlands

and

KREDITANSTALT FÜR WIEDERAUFBAU
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INTERIM REPORT - SIRAJGANJ COMPARTMENT

ANNEX 4 : AGRICULTURE

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i SUMMARY AND CONCLUSIONS

The area of the Compartmentalization Pilot Project, Tangail is situated in the Agro-Ecological Zone-4 (Young Karatoya-Bangali Floodplain) and consists of 12057 hectares. This is located in the drier regime of Bangladesh with annual rainfall of 1779mm. Traditionally, Sirajganj had been a jute and B. Aman area. Locally produced jute were utilized in the Quami Jute Mills, located adjacent to the project area. The area used to be submerged due to annual inflow of flood water from the Jamuna. The BRE provided relief to local farmer and changed the face of agriculture of Sirajganj. Between construction and 1984 the primary flood protection objective of the BRE was achieved. Since 1984, however, there have been frequent embankment breaches due to erosion by the Jamuna river. The area is now subjected to unpredictable floods. Sugarcane, a minor crop in the past, dictates agriculture of Sirajganj.

Under constant fear of the BRE breach, HYV Boro produces much needed food for the area. With high concentration of STWs and DTWs, a total of 4759 ha of the project area is irrigated. Presently, Boro HYVs are planted on 4501 ha producing 81% of total paddy production of the area. With a net cultivable area of 9579 ha. land is well utilized with cropping intensity of 184%. The cropping pattern is mainly rice-based. Being an old trading centre, opportunities for marketing of agricultural produce are adequate. There is a shortage of livestock. Poultry population is on the increase. Natural forests in the project area are non-existent. Proshika and BRAC run an active social forestry programme.

One of the main objective of the CPP is to facilitate agricultural production through field or chawk level water management. To a farmer, this means a safe crop environment, planned water utilization and a permanent opportunity to derive economic benefit from agriculture. This realisation among farmers will start a new batch of agricultural activities:

a) a shift from single to double and double to triple crop patterns.
b) a shift from dominant variety Purbachi to BR14 and BR26 as HYVs of irrigated Boro.
c) a shift from local to HYV Aman, specially BR22, BR23 and BR25.
d) a gradual release of land to diversified crop in dry season.

This means that the cropping intensity will gradually increase from 184% to 191% in option 1, 205% in option 2A and 206% in option 2B.

There will be modest increase of Boro HYV area and sugarcane but a substantial increase in HYV T.Aman area (Table i1). In the 'with project' situation, crop damage will be prevented. The areas to vegetables, mustard, potato and pulses will increase and to wheat and jute will decrease. A crop diversification will occur with crops like maize, cotton, kaon and cheena established in the cropping pattern. A M&E programme will monitor trend in changes. Chawk level water management with active participation of farmers as members of Water Users Groups (WUG) will certainly prove compartmentalization a profitable, sustainable and viable development option to a farmer.

Table i1: Summary of impact on crop hectareage and production in the CPP area, Sirajganj

	Base Situation		Without Project		With Project					
					Option 1		Option 2 A		Option 2B	
	Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)
Total rice area	8558	23444	8639	25109	8642	33114	9065	35830	8952	35992
Boro (HYV)	4501	19093	4501	20544	4504	21282	4731	22355	4591	21693
T.Aman (HYV)	1236	1841	1236	1932	2036	7708	2722	10305	3146	11908
T.Aman (Local)	2795	2480	2879	2605	2086	4103	1612	3170	1215	2390
Aus (Local)	26	30	23	28	16	21	0	0	0	0
Wheat	956	2321	946	2355	805	2307	724	2075	782	2241
Sugarcane	3711	183666	3768	191086	3815	199052	3917	203436	4011	208312
Jute	967	1371	948	1344	852	1512	781	1386	841	1493
Potato	785	7685	793	8041	932	9954	1156	12346	1032	11021
Mustard	1178	931	1202	978	1376	1170	1613	1371	1545	1313
Pulses	1027	1058	1027	1111	1169	1309	1401	1569	1510	1691
Veg. +Spices	349	1662	356	1784	474	2332	677	3410	731	3682
Others	138	-	246	-	260	-	334	-	360	-
Ratios										
Rice/Non-rice crop	1 :	1.06	1 :	1.07	1 :	1.12	1 :	1.17	1 :	1.21
Local/HYV rice	1 :	2.03	1 :	1.98	1 :	3.11	1 :	4.62	1 :	6.37
Boro T.Aman rice	1 :	0.90	1 :	0.91	1 :	0.92	1 :	0.92	1 :	0.95
Dependency on Boro	0.52	0.81	0.52	0.82	0.52	0.64	0.52	0.62	0.51	0.60

Source: Project Computation

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iii ABBREVIATIONS

ASSP - Agricultural Support Services Programme
AEZ - Agro-Ecological Zone
AST - Agricultural Sector Team
BADC - Bangladesh Agricultural Development Corporation
BARI - Bangladesh Agricultural Research Institute
BARC - Bangladesh Agricultural Research Council
BAU - Bangladesh Agricultural University
BBS - Bangladesh Bureau of Statistics
BJRI - Bangladesh Jute Research Institute
BRDB - Bangladesh Rural Development Board
BRRI - Bangladesh Rice Research Institute
BWDB - Bangladesh Water Development Board
CPP - Compartmentalization Pilot Project
CDP - Crop Diversification Programme
DAE - Department of Agricultural Extension
DTW - Deep Tube Well
DDC - Development Design Consultants
DTC - District Technical Committee
FAP - Flood Action Plan
GIS - Geographic Information System (FAP 19)
HYV - High Yielding Variety
ISPAN - Irrigation Support Project for Asia and the Near East
LLP - Low-lift Pump
MIWDFC - Ministry of Irrigation, Water Development and Flood Control
MOA - Ministry of Agriculture
MPO - Master Plan Organization
MARC - Multidisciplinary Action Research Centre
MOT - Manually Operated Tube Wells
NCA - Net Cultivable Area
NAS - Need Assessment Survey
PWD - Public Works Department
PHE - Public Health Engineering
RTC - Regional Technical Committee
SRDI - Soil Resources Development Institute
SRTI - Sugarcane Research and Training Institute
STW - Shallow Tube Well
SMS - Subject Matter Specialist
SMO - Subject Matter Officer
SD - Standard Deviation
SIRDP - Sirajganj Integrated Rural Development Project
WUG - Water Users Group

iv MEASUREMENTS AND CONVERSIONS

Land

1 hectare = 2.471098 acres = 0.003861 sq. mile

1 acre = 0.404676 hectare = 3.025 bigha

1 sq. mile = 640 acres = 258.994 hectares

1 katha = 66.87 sq. meters (approx.)

Length

1 inch = 25.4 mm. = 2.54 cm

1 mile = 1609.344 meters = 1.609344 km.

1 km = 0.6241 mile

Weight

1 metric ton = 1000 kg = 26.79 mds.

1 quintal = 100 kg = 2.679 mds.

1 maund = 37.324172 kg. = 0.037324 m tons.

1 LAND AND CLIMATE

1.1 The Area

The Sirajganj Compartmentalization Pilot Project area is located between latitude 24.26° and 24.37° North and between longitude 89.37° and 89.43° East.

The compartment is bordered in the east by the Brahmaputra Right Embankment (BRE) between Sirajganj town and Banglabazar and in the west by the Ichamati river between Bhadraghat and Brahmagacha. In the south, the border follows new Bogra road from Bhadraghat to crossing of Soyadhan Khara road going still southward and along Qaumi Jute Mill road to the BRE. In the north, Ichamati branch upto Bagbati Ghat and then along Ichamati khal crossing Chilgacha bridge, then paved road to Ratankandi and Banglabazar.

The compartment composed mainly of Sirajganj Sadar (95%). Other Thanas involved are Kazipur (2%), Raiganj (2%) and Kamarkhand (1%). Total area of the CPP, Sirajganj compartment is 12057 ha. (Table 1.1). Net cultivable area is 9579 ha. which is 79.5% of the gross area.

Table 1.1: Area in the CPP, Sirajganj

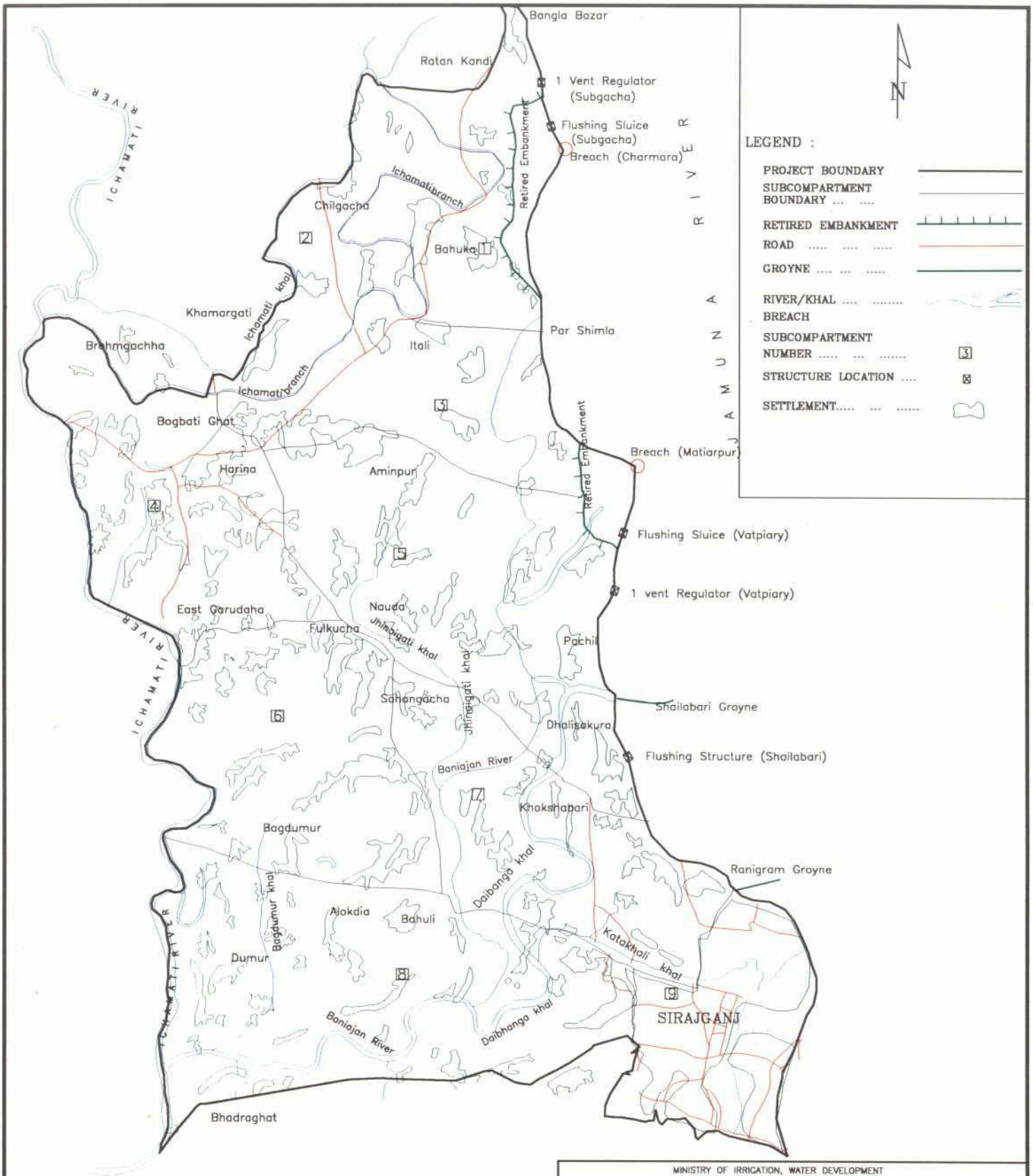
Sub-Compartment	Gross area (ha)	Settlement** area (ha)	Water* bodies (ha)	Net cultivable area (ha)
1	873	101	22	750
2	797	83	5	709
3	1061	160	8	893
4	1371	223	16	1132
5	2012	294	62	1656
6	1455	238	21	1196
7	1283	169	43	1071
8	2319	259	79	1981
9	886	685	10	191
Total	12057	2212	266	9579
%	100.0	18.3	2.2	79.5

* Based on area calculated from aerial photographs of December 1990.
**Includes homesteads, markets, brick-fields, infrastructure and homestead vegetation.

Source: Estimated using the GIS facilities of the DDC.

1.2 The Sub-Compartments

Sirajganj CPP area is divided into 9 sub-compartments including one involving Sirajganj urban area (Figure 1.1). Physical parameters and manageability were considered most in sub-compartment designation.


Bangla Bazar
Ratan Kandi
1 Vent Regulator (Subgacha)
Flushing Sluice (Subgacha)
Breach (Charmara)
Retired Embankment
Ichamati branch
Chilgacha
Bahuka
RIVER ICHAMATI
JAMUNA RIVER
Khamargati
Ichamati khal
Brahmgachha
Par Shimla
Itali
Ichamati branch
Bogbati Ghat
Harina
Aminpur
Breach (Matiarpur)
Retired Embankment
Flushing Sluice (Vatpiary)
1 vent Regulator (Vatpiary)
East Garudaha
Nauda
Fulkucha
Jhinaigati khal
Pachil
Jhinaigati khal
Sahangacha
Shailabari Groyne
Dhalisakura
Flushing Structure (Shailabari)
Baniajan River
Khokshabari
Bagdumur
Ranigram Groyne
Daibanga khal
Bagdumur khal
Alokdia
Bahuli
Katakholi khal
Dumur
RIVER ICHAMATI
Baniajan River
Daibhanga khal
SIRAJGANJ
Bhadraghat
N
LEGEND :
PROJECT BOUNDARY
SUBCOMPARTMENT BOUNDARY
RETIRED EMBANKMENT
ROAD
GROYNE
RIVER/KHAL
BREACH
SUBCOMPARTMENT NUMBER
STRUCTURE LOCATION
SETTLEMENT
Km 0 1 2 3 4 Km
SCALE
C
FAP20
P
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BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANISATION
COMPARTMENTALIZATION PILOT PROJECT
SIRAJGANJ (FAP 20)
SETTLEMENT AREA MAP
Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL
Figure No. 1.1

Sub-Compartment-1: The area is bounded by the BRE in the east, Ichamati branch in the west, Ratankandi-Banglabazar paved road in the north and Italy-Par Simla earthen road in the south.

Sub-Compartment-2: The area is bounded by Ichamati branch in the east and the south and Ichamati khal in the north and the east.

Sub-Compartment-3: The area is bounded by the BRE in the east, Par Simla-Itali road in the north, Ichamati branch in the north-west, Bagbati-Harina road in the west and Harina-Aminpur-Bhatpiari earthen road in the south.

Sub-Compartment-4: The area is bounded by Ichamati branch in the north and Ichamati river in the west; Fulkocha-East Garudaha earthen road in the south and Fulkocha-Harina-Bagbati Ghat road in the east.

Sub-Compartment-5: The area is bounded by the BRE in the east; Harina-Aminpur-Bhatpiari road in the north and Harina-Sahangacha-Ranigram road in the west and the south.

Sub-Compartment-6: The area is bounded by Bahuli-Sahangacha earthen road in the east, Ichamati river in the west, Fulkocha-East Garudaha earthen road in the north and Old Bogra road between Bahuli and Pangashi in the south.

Sub-Compartment-7: The area is bounded by old Railway track between Bahir Gola and Ranigram in the east, Bahuli-Sahangacha earthen road in the west, old Bogra road between Bahuli and Bahirgola in the south and Sahangacha-Khokshabari-Ranigram road in the north.

Sub-Compartment-8: The area is bounded by old Bogra road between Rahmatganj and Pangashi in the north; New Bogra road between Sialkohl and Bhadraghat in the south, Ichamati river in the west and Sialkohl-Rahmatganj paved road in the east.

Sub-Compartment-9 (Sirajganj Urban Area): The area is bounded by the BRE between Ranigram Groyne and Haripur in the east, Soyadhan Khara road and Kazipur road (upto Rahmatganj) in the west, Old Bogra road upto Bahirgola bazar and old Railway track between Bahirgola and Ranigram Groyne in the north and Qaumi Jute Mill road in the south.

1.3 Agro-Ecological Zone (AEZ)

Bangladesh includes a wide range of environmental conditions. Environmental diversity occurs not only at national and regional levels, but also at Thana and village levels. In fact, small scale complexity of soil and hydrological conditions is an important characteristics of the Bangladesh environment. Thirty agro-ecological regions and 88 sub-regions are known.

The Sirajganj pilot project area is situated in sub-region, south-eastern (AEZ 4b) of the Karatoya-Bangali Floodplain (AEZ 4). Sub-region 4b has more irregular relief and includes a higher proportion of young soils, including recent Jamuna spill deposits.

1.4 Soil

A Reconnaissance Soil Survey of Pabna district was carried out between November, 1964 and April 1965 by the Dept. of Soil Survey. Field observations were made again in 1972. Based on the findings of a revised report (DSS, 1976), five soil associations are found in the project area (Figure 1.2).

A. The Young Karatoya-Bangali Floodplain:
   a) Sonatala - Kamarkhanda - Silamandi
   b) Kamarkhanda - Silamandi - Sabhar Bazar
   c) Silamandi - Sabhar Bazar

B. The Mixed Active Brahmaputra-Jamuna Floodplain and Young Karatoya-Bangali Floodplain:
   a) Maldaha - Chormara - Jamtail
   b) Silamandi - Chormara

Soil Association Descriptions

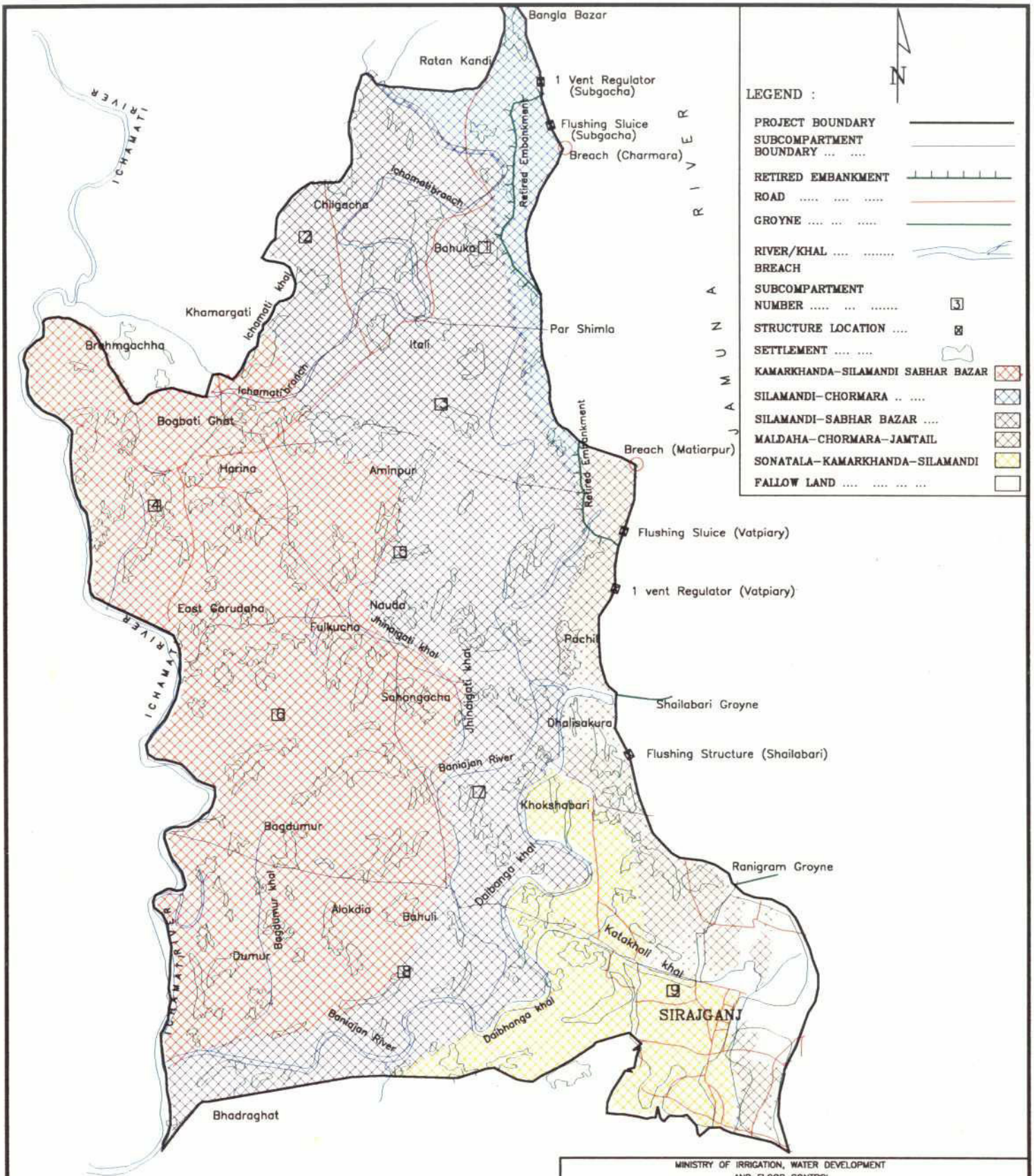
a) **Sonatala-Kamarkhanda-Silamandi**: This association occurs in a small area around Sirajganj town. Soils are usually silty loam to silty clay loam. Mainly medium high land with some high land ridges. Predominantly good agricultural land.

b) **Kamarkhanda-Silamandi-Sabhar Bazar**: This association covers a major area, encompassing western half of the project along the river Ichamati. Soils are usually silt loam or silty clay loam. Landscape is of very gently undulating ridges and basins. Mainly good but some moderate agricultural land.

c) **Silamandi-Sabhar Bazar**: This association, also a major, covers the central part of the project. Soils are of fine sandy loam, silt loam, clay loam and silty clay. Differences in elevation is slight. Some soil types, loamy sand, sandy loam, have lower water holding capacity. Good to moderate agricultural land.

d) **Maldaha-Charmara-Jamtail**: This association, covers the area along the present BRE. Soils are of silt loam and silty clay loam type. Huge sand deposition has occurred in soils near the breach points. Water stress occurs in dry season. Mainly moderate agricultural land.

e) **Silamandi-Chormara**: This association, covers the north-eastern part of the project along the BRE. Soils are of silt loam and silty clay loam type. Differences in elevation is slight. Mainly high land with some medium high land ridges. Predominantly good agricultural land.



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BANGLADESH WATER DEVELOPMENT BOARD
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COMPARTMENTALIZATION PILOT PROJECT
SIRAJGANJ (FAP 20)

SOIL ASSOCIATIONS

Consultant: Euroconsult, Lahmeyer Int., Bets Ltd., HCL

Figure No. 1.2

The area estimated from the soil association map of the DSS (1976) are:

	Area (ha)
Sonatala-Kamarkhanda-Silamandi	575
Kamarkhanda-Silamandi-Sabhar Bazar	4694
Silamandi-Sabhar Bazar	3640
Maldaha-Chormara-Jamtail	383
Silamandi-Chormara	287

1.5 Climate

1.5.1 General

Bangladesh is a scene of perpetual battle among three air streams of different thermodynamic characteristics. The south-west monsoon, which originates over the Indian Ocean, carries air that is warm, moist and unstable. The easterly trades are also warm, but relatively drier. The north-east monsoon, coming from the bleak Siberian anticyclones, is dry and cold. Having originated from an ice-covered land mass, it has preserved most of its pristine cold as it blows, usually in gusts, over Bangladesh during the winter months.

Sirajganj is located in the drier region of Bangladesh with generally extreme temperatures, less rainfall, with aridity index of <0.50 for six months between November to April (Table 1.2).

The critical aspects of climate in relation to crops are:

- the occurrence and reliability of the pre-monsoon rains and the onset of the monsoon
- the occurrence of storms and cyclones that damage standing crops (boro HYV rice)
- the reliability of the monsoon rains, and the rise, duration and cecession of floods associated with the monsoon rains; and
- the reliability, amount and distribution of the end-of-monsoon rains.

Table 1.2: Climatological parameters* of the CPP area, Sirajganj

Mean altitude : 12.4 m			**Longitude : 89.37-89.43°E**							**Latitude : 24.26-24.3**	
Month	Temperature (°C)				Sunshine (hrs./day)	Wind speed (km/hrs.)	Rain fall (mm)	Humidity (%)		Evapo trans-piration (mm)	Arid Inde #
	Mean		Absolute					9 a.m.	6 p.m.		
	Max	Min	Max	Min							
January	25.1	11.7	30.6	5.0	8.7	3.0	8	77	68	96	0.0
February	28.2	13.4	35.0	7.2	9.2	3.3	14	71	55	119	0.1
March	32.6	17.9	40.6	11.1	8.7	5.0	31	67	44	179	0.1
April	35.3	22.1	42.8	13.3	8.4	7.6	94	71	41	208	0.4
May	33.6	24.3	42.8	17.8	8.5	8.4	239	79	61	199	1.2
June	31.6	25.3	37.9	20.6	4.3	7.4	344	85	81	147	2.3
July	30.9	26.0	40.0	21.7	5.0	7.0	352	86	85	146	2.4
August	31.1	26.4	39.4	23.3	4.9	6.0	278	85	84	140	1.9
September	31.3	25.9	38.3	21.7	6.9	4.8	251	84	85	135	1.8
October	30.9	23.4	37.2	17.2	7.6	3.2	139	79	81	105	1.3
November	28.5	17.8	33.9	10.6	9.0	2.3	20	75	76	105	0.1
December	26.3	13.6	31.7	7.2	8.8	5.8	10	76	75	90	0.1
Annual							1779				

Source : Temperature, Sunshine, Wind speed, Humidity: Manalo, E.M.; Agro-Climatic Survey of Bangladesh, BRRI/IRRI, 19 Based on >70 years of data between 1902-1974 of Bangladesh Water and Power Development Authority.

Rainfall, Evapotranspiration: FAP-2 (1992). Draft Final Report, Volume-10, Hydrology and groundwater. Based on 28 years d of period 1962-90.

Aridity Index : Classified "dry" when the reading is < 0.50.

The crop environment during the monsoon season (Kharif-II) is not favourable for achieving full potential yields because of uneven distribution of rainfall, flooding at variable depths, insect attack, low solar radiation and high temperatures and humidity. In contrast, the rabi season has favourable conditions for achieving full potential yields only with available irrigation water: high solar radiation, low humidity and wide variation in day and night temperatures.

1.5.2 Temperature

Among the meteorological factors, temperature is one of the most important to crops. Photosynthesis demonstrates the influence of temperature and light intensity on crops. In Sirajganj, temperature is highest in April or May, the absolute maximum reaching to 42.8°C. It decreases slightly during the monsoon period and rises slightly in September when the rains begin to diminish. Water has a buffering effect on the temperature. The results of a detailed temperature analysis of Sirajganj, is presented in Table 1.3.

Table 1.3: Detailed analysis of temperatures of Sirajganj

	Begin period day/mth	SD (days)	End period day/mth	SD (days)	Length period (days)	SD (days)
Minimum <15°C	25/11	8	25/02	16	100	18
Minimum <17.5°C	16/11	5	12/03	8	116	11
Minimum <20°C	04/11	5	31/03	11	147	13
Mean <17.5°C	26/12	10	04/01	5	8	15
Mean <20°C	06/12	12	31/01	16	56	21
Mean <22.5°C	19/11	9	26/02	8	99	14
Maximum <35°C during the hot period					330.9	16
Maximum >35°C during the hot period					34.3	16
Maximum >37.5°C during the hot period					14.9	
Maximum >40°C during the hot period					2.6	
Minimum >10°C during the cool period					354.5	5
Minimum >10°C during the cool period					10.7	5
Minimum <7.5°C during the cool period					0.7	
Minimum <5°C during the cool period					0.1	

Source: UNDP/FAO Land Resources Database, 1988.

1.5.3 Rainfall

Life in Bangladesh depends, literally, upon rainfall. For five months between November to March each year the land used to lie perched and brown under a blistering tropical sun. About fully exploited irrigation effort have changed that scene in recent years. Dust storm is common in Sirajganj. By April or May, the first rains bring relief to people and to over-tired tubewells. Mean annual rainfall of Sirajganj is only 1779 mm which is on the lower side (Table 1.2). However, even this annual rainfall occurs in only six months between May to October. Late transplanted T. Aman rice often suffers moisture stress.

1.5.4 Cropping Seasons

There are three distinct climatic patterns (Table 1.4) which are inter-related with three overlapping cropping seasons as:

Table 1.4: Period and duration of three seasons in Sirajganj

Seasons	Begin period	SD (days)	End period	SD (days)	Length period (days)	SD (days)
Kharif-I	March 18	16	May 09	19	51	21
Kharif-II	May 24	20	Oct. 15	18	141	18
Rabi	Oct. 15	18	Mar. 01	21	135	18

Source: FAO (1988). Land Resources Appraisal of Bangladesh for Agricultural Development. Report 5. Volume 2-7.

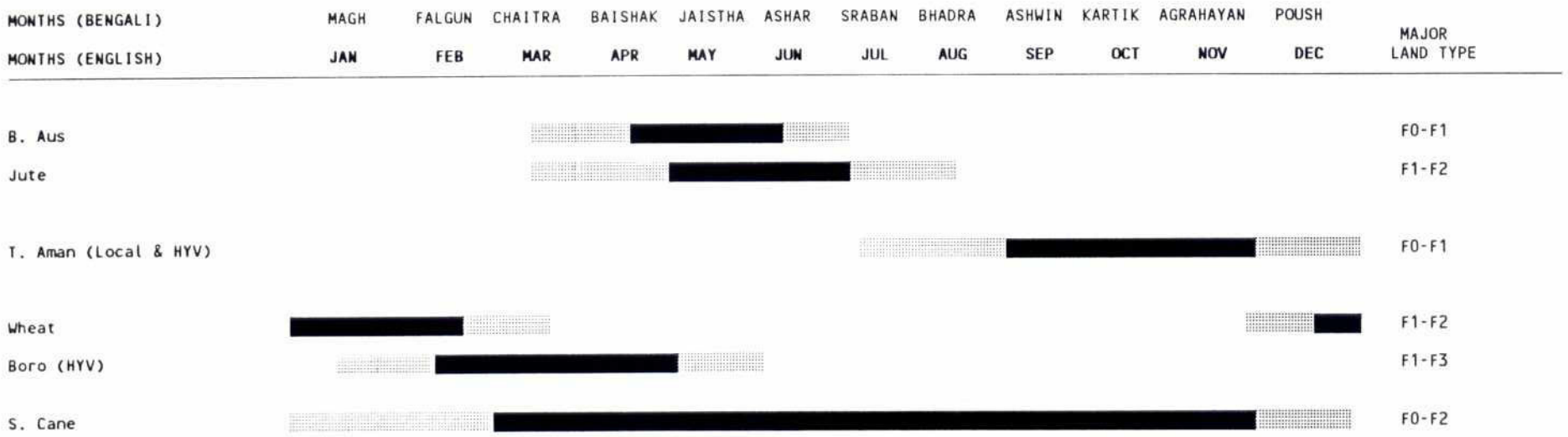
Kharif-I: This season is characterised by moderate humidity and high temperatures and evaporation rates. Rainfall in this season consists of occassional heavy showers. The crop environment during this season is less favourable for high yield because of uneven distribution of rainfall, high temperature and humidity.

Kharif-II: The most important of all cropping seasons is characterized by high humidity, low solar radiation, frequent rainy periods and by both monsoon and riverine floods. The depth and nature of flooding determine the crops that can be grown in a given area.

Rabi: This season is characterized by scanty or no rainfall, low temperatures and clear skies. Crop environment during this season is very favourable for high yields because of high solar radiation, low humidity and greater sunshine hours. Because of favourable crop weather, extensive irrigation facilities are utilized to obtain an economically profitable crop yield.

A crop calender and its relation to climate prevalent in the CPP, Sirajganj area is presented in Figure 1.3.

Figure 1.3: Crop calender and weather in the CPP, Sirajganj



		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainfall (min.)		8	14	31	94	239	344	352	278	251	139	20	10
Sunshine (hrs.)		8.7	9.2	8.7	8.4	8.5	4.3	5.0	4.9	6.9	7.6	9.0	8.8
Temperature (oc)	(Maximum)	25	28	33	35	34	32	31	31	31	31	29	26
	(Minimum)	12	13	18	22	24	25	26	26	26	23	18	14

1.6 Land Types

The term commonly used to refer to area under different flood depths in the monsoon season is land types which, through long time usage, has come to mean the categories of land under particular flood depths during the maximum flooding period in an average year. The Soils Resources Development Institute (SRDI) developed a system of 11 land types which was used as a basis in the five land types used in Agro-Ecological Zoning (AEZ) system. Then a condensed system was introduced by the Master Plan Organization (MPO) and is in general use for agricultural assessment. FPCO (1993) defines land types (Table 1.5) on MPO classification using the assumed water level occuring with a 1 in 5 year return period and having a duration of more than 72 hours.

Table 1.5: Land type classification

Land Type	Elevation (meter)
F_0	1 in 5 year water level (Polder Water Level or PWL) minus 0.3m
F_1	Between F_0 and PWL minus 0.9m.
F_2	Between F_1 and PWL minus 1.8m.
F_3	Below 1.8m from PWL

Source: FPCO (1993), Soil and Agricultural Data Collection and Analysis (Draft).

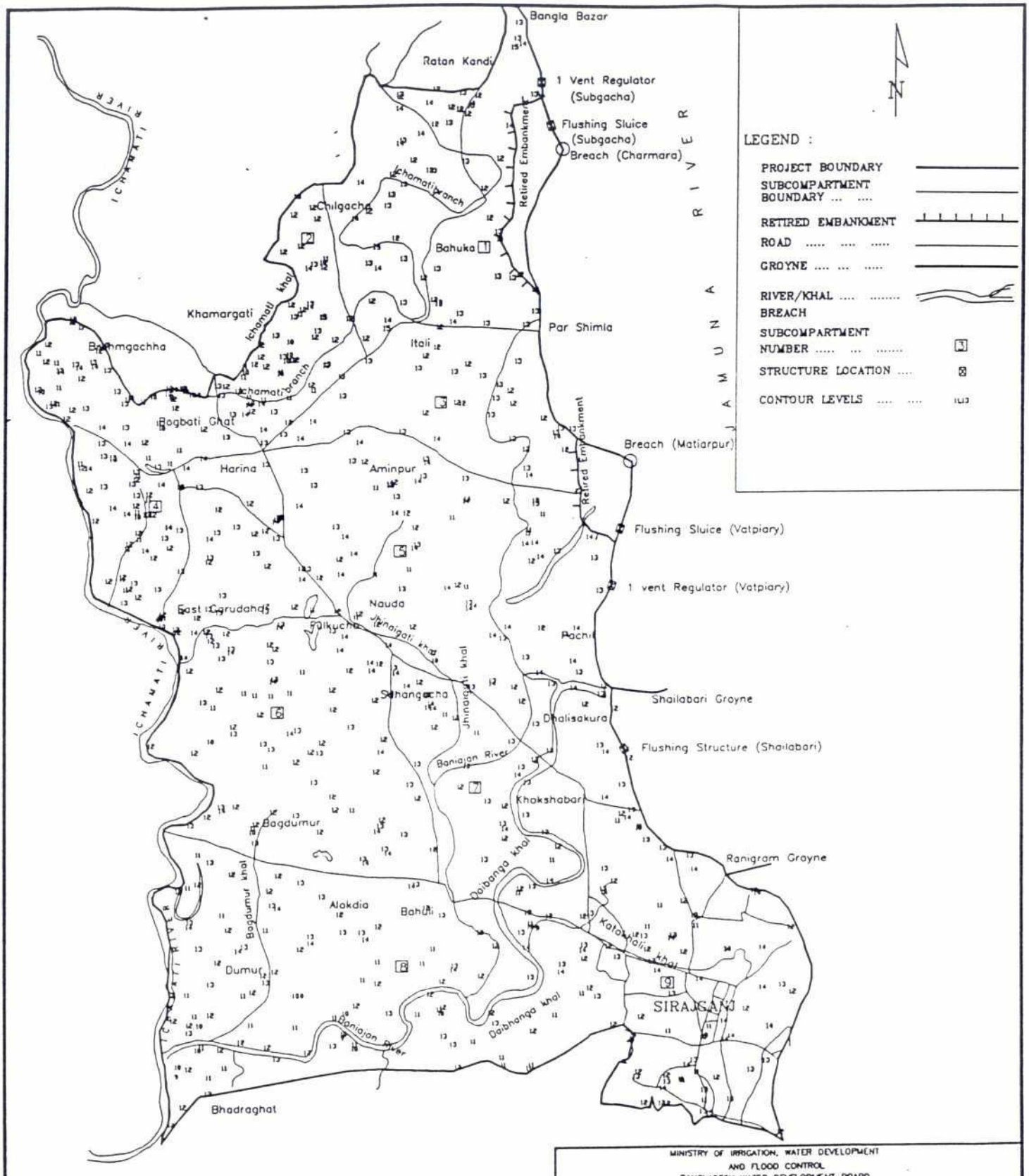
In order to generate land types, two important data are required:

* The area-elevation data/curve of the project area
* The calculated 1 in 5 year (more than 72 hours) water level during the monsoon season.

1.6.1 Computation of Land Types

1.6.1.1 The Area-Elevation Data/Curve of the Project Area

For area-elevation, contour map available with the BWDB, at a scale of 4" to a mile was used. It is recognized that these maps are about 30 years old. Updated Finnmap of the Sirajganj area was available only during the last week of writing this report. So, for present use, 1964 contour map was digitized using the facility of GIS at the DDC (Table 1.6 and Figure 1.4).



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SIRAJGANJ (FAP 20)

CONTOUR MAP

Consultant: Euroconsult, Lahmeyer Int., Bets Ltd., HCL

Drawing no. 1.4

Table 1.6: Sub-compartment-wise elevation of the area of the CPP, Sirajganj

Sub-Compartment	Land elevation (m)		
	Highest	Lowest	Mean
1	15.2	11.3	13.25
2	15.2	8.9	12.05
3	15.5	10.4	12.95
4	14.6	8.9	11.75
5	14.9	10.1	12.50
6	14.9	9.5	12.20
7	14.9	9.2	12.05
8	14.9	8.9	11.90
9	15.8	10.1	12.95

Source: 1964 contour map digitized using the GIS facility of the DDC.

Sub-compartment 4 and 8 are low lying among all other sub-compartments (Figure 1.5).

1.6.1.2 1:5 year water level

Monsoon season water level (more than 72 hours) data were used. For this, historical water level data of 2 sites, Dhunot, 30 km north and Nalkasengati 3 km of South-West of the project area were used. A 25 year (1964-1991) water level data of Dhunot station was available. Sub-compartmental 1:5 year water level were generated through extrapolation using Mike11 model run. Water level used in calculating land types are shown in Table 1.7. This water level, includes the rainfall and flood water combined using the peak flood during 1st decade of August.

1.6.1.3 Computation

Land types were calculated by super imposing the computed water level on the area elevation curve. Area under settlements were deducted from the gross area under highest elevation and area under waterbody were deducted from the lowest elevation.

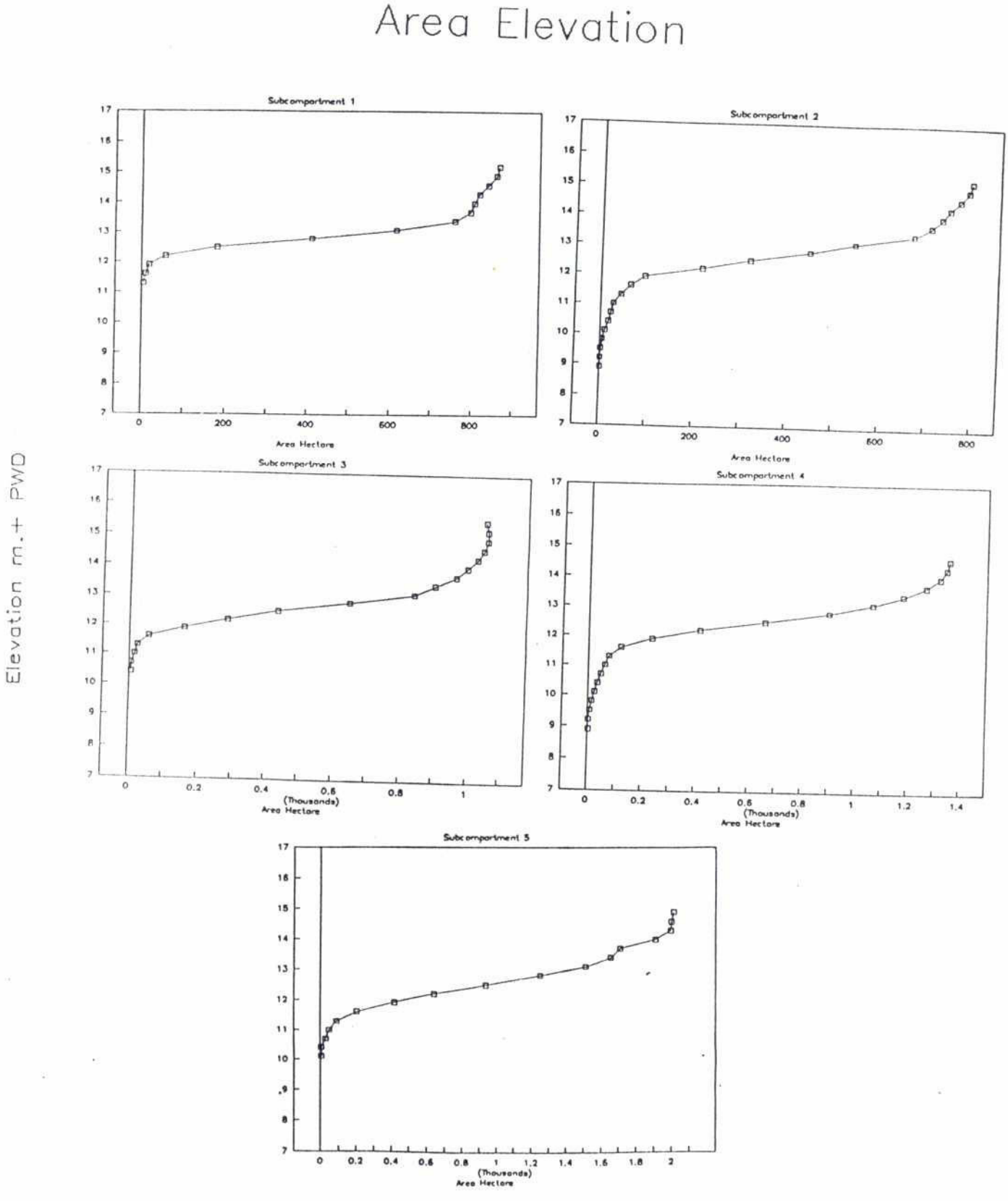
For the net cultivable area of the CPP, Sirajganj, 30% is estimated as F0, 39% as F1, 28% as F2 and 3% as F3 (Table 1.8).

1.6.1.4 Potential errors in classifying land types

In classifying land types (Table 1.8), certain areas of error are recognized. Some of these are:

a) Area elevation curve based on a 1960 map. Micro-relief and localised works carried out at different field were not considered. Siltation, soil erosion and huge sand deposition, specially at sub-compartments 3 and 5, may have changed land-elevation. On an average the error in land elevation is estimated to be $\pm$ 10 cm (ISPAN, 1992).

Figure 1.5: Area elevation curves of 9 sub-compartments of the CPP, Sirajganj



Area Elevation

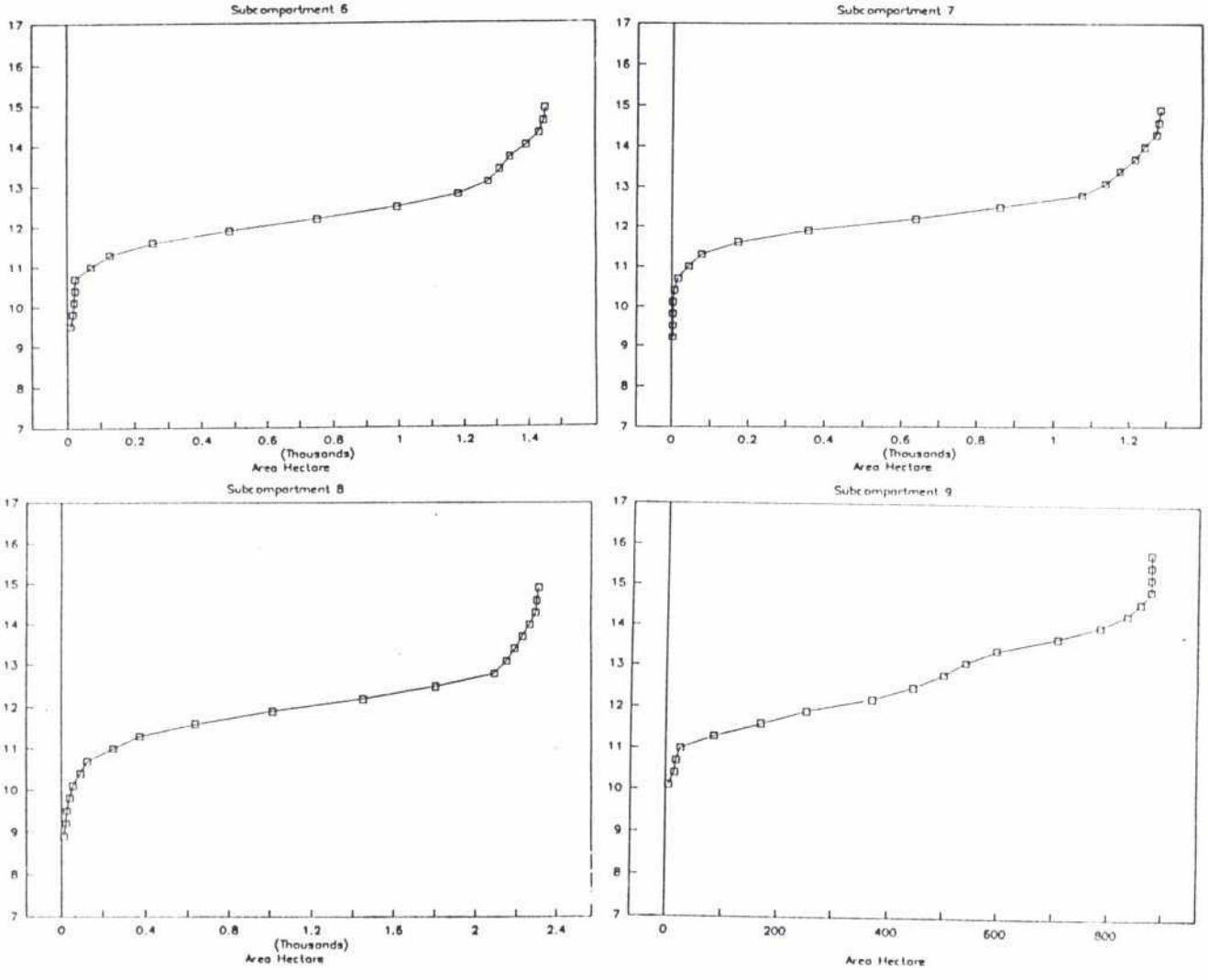


Table 1.7: Sub-compartmentwise 1:5 year water level for the CPP area, Sirajganj

Sub-Compartment	1:5 year WL (m)
1	13.31
2	13.43
3	12.96
4	13.38
5	12.98
6	12.98
7	12.44
8	12.43
9	12.40

Source: CPP Computation.

Table 1.8: Landtypes of the net cultivable area (NCA) in the CPP, Sirajganj

Sub-Compartment	Net cultivable area (ha)	Land types			
		F_0 0-30cm	F_1 30-90cm	F_2 90-180cm	F_3 >180cm
1	750	224	409	117	0
2	709	160	224	265	60
3	893	359	322	206	6
4	1132	98	411	526	97
5	1656	596	575	479	6
6	1196	119	462	541	74
7	1071	534	429	108	0
8	1981	722	774	458	27
9	191	101	75	15	0
Total	9579	2913	3681	2715	270
	% of NCA	30.4	38.5	28.3	2.8

Source: CPP computation based on assumed 1:5 water level.

b) The Mike11 computed water levels has limitation because of inadequate caliberation of regional model that supplies the boundary condition and also the inability of the model to recognize micro-reliefs. The error is believed to be about $\pm$ 20 cm (ISPAN, 1992).

Taking these potential errors, the classification of land types should be taken as of indicative rather than absolute type. However, within the limitation, these are the best estimates available and as such will be used as basis for projections in both with and without project situations.

2 SURVEYS

2.1 Preliminary Survey

The objective of this preliminary survey of the Sirajganj compartment was to get an overview of the situation prevailing in the area. This survey, conducted during April 1992, gathered a general agro-environmental and agri-statistical information of the project. As the exact boundary of the project was not known, then data were obtained on 15 unions covering Sirajganj and Kazipur Thanas. This report is presented as Annexure 4.1 to this Annex. Some salient features of the findings were:

- Agriculture in Sirajganj CPP mainly depends on reliability of the BRE to provide protection
- With breaches occurring almost every year since 1984, farmers have shifted their agricultural activities in the dry season utilizing mainly irrigation water.
- With sand layer deposits carried in by the Jamuna floods, utilization of irrigation facilities has its limitation.
- Hence in the dry season, apart from irrigated HYV Boro, diversified low input non-irrigated crops, such as millets, groundnut, potato, pulses etc. are grown.
- Areas under Jute and Aman crops are decreasing.
- Sugarcane is extensively grown, mostly intercropped. 2-3 other crops in a sugarcane field is common.
- Ground water table and aquifer discharges appeared to be satisfactory. Even in March'92 the water Table is found only 5-6 meter in depth (as per report collected from PHE Deptt.)
- General drainage is impeded and prolonged due to silted-up condition of the draining rivers and canals, and also due to indiscriminate construction of roads, local embankments, raised house-clusters, bridges-culverts etc. and the back-water stages of outfall rivers.
- The most burning agricultural or farming constraints as pointed out by the farmers and the DAE staff are as below:
  - Small and marginal farmers are mostly deprived of farm-credit for which they are not able to follow high-production technology
  - High price of inputs, especially of fertilizers, pesticides, fuel for irrigation, pumps, seeds etc.
  - Comparatively low farm-gate price of crop produces in post-harvest periods.
  - Difficulties in threshing and drying of Boro and Aus paddy due to rains or cloudly days
  - Scarcity of animal draft power; and non-availability of price-subsidized mechanical implements like power tillers, harrows, weeder, thresher, dryer etc.

2.2 Household Survey

The household survey is designed to provide statistically valid baseline data mainly covering social and economic issues covering households including farm households. This survey is of the questionnaire type. The data will be used to some extent in the planning process, but the main use will be in the economic analysis and the post-project evaluation.

The household survey of Sirajganj compartment has been contracted out to a firm called "Multi-Disciplinary Action Research Centre (MARC)". Preliminary results are available.

2.3 Need Assessment Survey (NAS)

The focus of the needs assessment survey is the inter-relation between all the relevant facets of life in both inside and outside the compartment. Typical items are, hydrological situation, agricultural status, fisheries, environment, status of women and landless. Data is collected using a Rapid Rural Appraisal approach using a team of multi-disciplinary expertise. The main use of the information is in planning and designing of compartment and testing of options. The objectives of the Needs Assessment are, for each sub-compartment:

a) to get a broad, inter-disciplinary, descriptive overview of the existing situation
b) to identify the existing water management related situation, particularly the different ways in which water resources are used and the problems caused by flooding and/or local water congestion
c) to find out people's opinion on the potential solutions, structural and non-structural, to overcome the constraints identified

The agronomist participated as a member of the NAS team and identified needs and constraints of agricultural production system (briefly mentioned in Section 3.7). Details are reported in Annex 1, Needs Assessment Survey. A number of potential solution identified have been incorporated in the planning of options or scenarios.

2.4 Landuse Survey

Landuse survey is one of the major components of the baseline survey. The main objective of the survey was:

a) to obtain detailed picture of the way land is used for crop production
b) to determine the existing cropping patterns, varieties used and production level
c) general land types in relation to crops and cropped area
d) estimation of crop damages
e) information on irrigation mode uses with location

Using a designed format, the survey was conducted visiting each discrete block of land (chawk) with the help of recent 1:20,000 aerial photograph. In this survey 100% of the cropped area was covered. The results of this survey was the basis of describing base situation reported in Chapter 3. The complete landuse survey is presented in Annexure 4.2.

2.5 Survey on Irrigation

Minor irrigation activity in Sirajganj is increasing like elsewhere in Bangladesh. It is important to monitor this development on a continual basis. Agricultural Sector Team (AST), a CIDA-GOB funded project, conducted Census of Lift Irrigation of Bangladesh previously in 1987 and 1991. The CPP conducted a similar survey in 1993 in three thanas including Sirajganj.

The objective of the survey was to obtain a complete enumeration of minor irrigation activity. This included information on Deep Tubewells (DTW), Shallow Tubewells (STW), Low Lift Pumps (LLP), Manually Operated Tubewells (MOT) and irrigation by traditional methods. This survey was conducted jointly by the CPP and Dept. of Agricultural Extension (DAE). CPP was responsible for the overall management; providing necessary forms, tabulating the data and reporting results. DAE was responsible for mobilizing all Block Supervisors within the area, distributing materials and collecting completed questionnaires. There is an increase in number of STW over 1991 survey, however, covering more or less same command area. Detailed results of the survey covering only of Sirajganj Thana is presented in Annexure 4.3.

3 BASE SITUATION

In order to assess agricultural situation of the CPP area, Sirajganj, a landuse survey was conducted in January - April, 1993 (report, Annexure 4.2). Based on landuse survey results, a base situation, as reported below, is constructed using the land types calculated on assumed water levels of 1:5 return period.

3.1 Agricultural Land Utilization

Of 12057 ha gross area, 9579 ha. is cultivable (NCA). 3.2% of the NCA remain temporarily fallow (Table 3.1). Depending on land type, soils and irrigation availability, rice cropping may be single, double or even triple. Triple cropping is practiced in only about 2% of the NCA. Doubly cropped area is predominant and covers 8022ha. A large portion of this double cropped area consists of sugarcane intercropped with another rabi crop. Cropping intensity is 184. There is variation in cropping intensity between sub-compartments.

Table 3.1: Agricultural land utilization* in the CPP area of Sirajganj, Base Situation

Sub-Compartment	Gross area (ha)	NCA (ha)	Temporarily fallow (ha)	Single cropped (ha)	Double cropped (ha)	Triple cropped (ha)	Total cropped area (ha)	Cropping intensity %
1	873	750	35	118	566	31	1343	179
2	797	709	12	65	628	4	1333	188
3	1061	893	15	256	616	6	1506	169
4	1371	1132	27	39	1000	66	2237	198
5	2012	1656	15	320	1314	7	2969	179
6	1455	1196	19	62	1093	22	2314	193
7	1283	1071	54	13	999	5	2026	189
8	2319	1981	90	98	1747	45	3727	188
9	886	191	36	96	59	0	214	112
Total	**12057**	**9579**	**304**	**1067**	**8022**	**186**	**17669**	**184**
% of NCA			3.2	11.1	83.8	1.9		

* Computation based on Landuse Survey.

3.2 Irrigation

Irrigation in Bangladesh has a long history but modern irrigation is practised for only two decades. In the mid sixties low-lift pumps (LLPs) were introduced which made use of surface water for Boro paddy, grown in the dry season (December to April). Later in the early seventies, tubewells - deep and shallow have been installed to irrigate modern varieties of rice, grown on medium high (F1) and medium low (F2) lands where there is lack of surface water.

3.2.1 Mode

There are 913 STWs, 107 DTWs, 23 LLPs and 11 MOTs now in operation in the project area (Table 3.2 and Figure 3.1). Number of STWs have increased over the years. No new DTWs have been installed in recent years. More than 20% of installed DTW are out of operation (Annexure 4.2). LLPs are located along the rivers Ichamati and Doibhanga and around perenneal beels. Around 32 ha. of land around water source is irrigated by traditional method.

Table 3.2: Number of tubewells and pump of the CPP area, Sirajganj, Base Situation

Sub-Compartment	NCA	Numbers				Area irrigated (ha)			% of NCA
		STW	DTW	LLP	MOT	Mech.	Trad.	Total	
1	750	76	6	0	2	412	0	412	55
2	709	79	9	0	0	487	0	487	69
3	893	77	17	0	0	369	0	369	41
4	1132	150	14	3	0	664	12	676	60
5	1656	124	21	3	0	729	0	729	44
6	1196	110	18	12	0	618	4	622	52
7	1071	63	11	0	2	424	6	430	40
8	1981	209	8	5	7	865	10	875	44
9	191	25	3	0	0	159	0	159	83
Total	9579	913	107	23	11	4727	32	4759	50

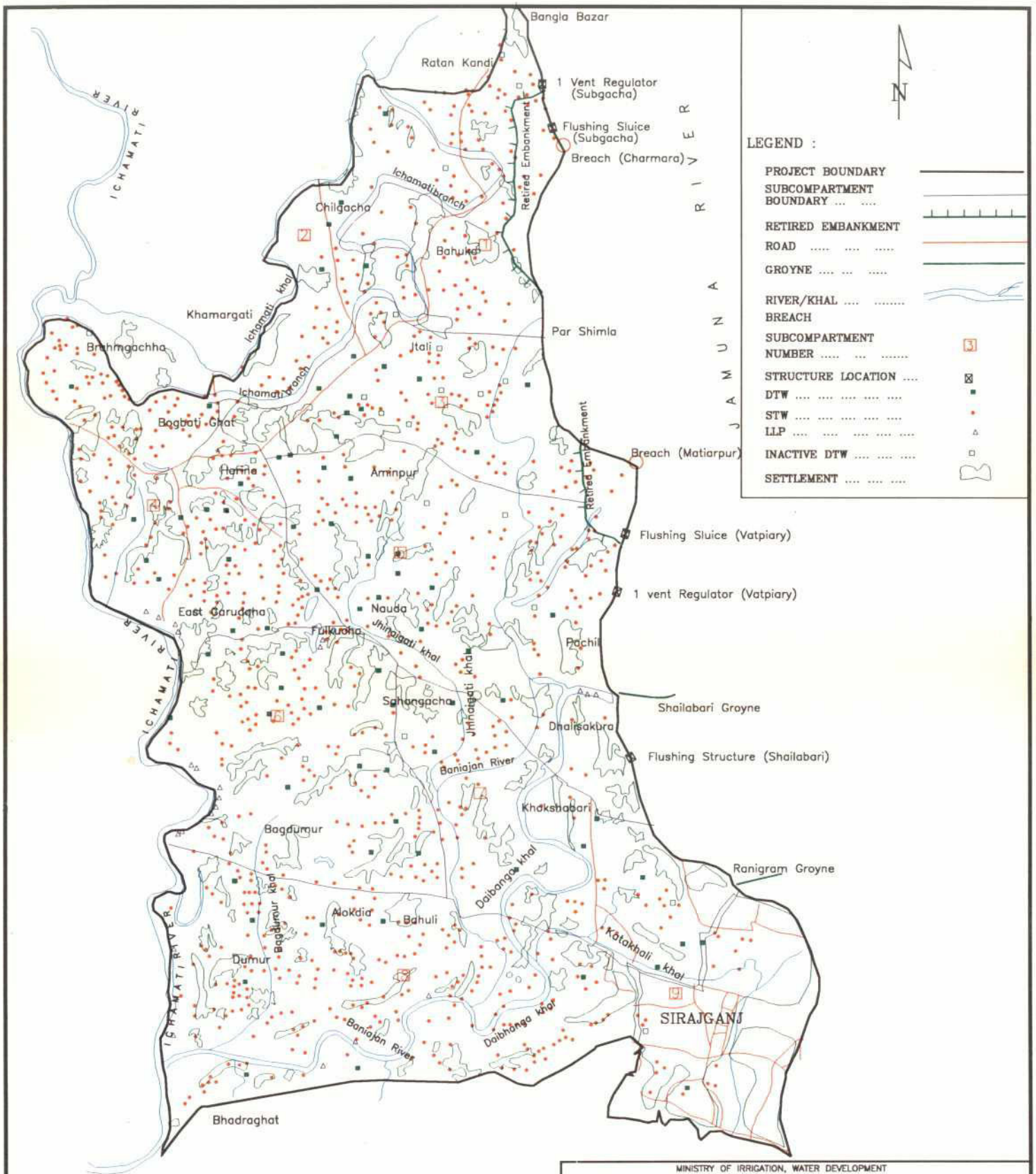
Source: Based on Landuse Survey, CPP, 1993.

3.2.2 Groundwater

A detailed information and analysis of groundwater resources has been presented in Annex 6, Section 4.1.5. In Table 3.3 groundwater levels of six drier months of two different wells located within the project area is presented. In general, water levels are in the reach of suction lift pumps. The data from different sources, as shown in Annex 6, indicate that there is groundwater available to cover all urban and rural needs during all seasons.

3.3 Cropping Patterns

A cropping pattern is an arrangement of crops within a cropping year and is largely determined by factors such as soils, flood depths, irrigation possibilities, available inputs and market expectations. Rice, being the major crop, dominates the cropping patterns of the project area specially with the rapid expansion of irrigation.



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DISTRIBUTION OF WELLS AND PUMPS

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 3.1

Table 3.3: Depth(m) below groundlevel of groundwater in two wells during 1986 - 1992 dry months

Wells	Months					
	November	December	January	February	March	April
SS72(Fulkocha, SC6)						
1986-87	3.53	4.50	4.09	4.12	4.32	4.27
1987-88	2.92	3.05	3.29	3.37	3.38	3.55
1988-89	1.52	1.77	3.73	3.92	4.37	4.37
1989-90	3.62	4.24	4.45	4.73	5.41	5.56
1990-91	1.92	3.94	4.68	4.72	5.43	5.33
1991-92	2.75	3.26	4.70	4.97	5.68	5.83
1992-93	3.72	3.93	4.26	5.43	5.73	5.96
B203(Par Simla SC3)						
1986-87	3.64	4.29	4.09	4.26	4.40	4.57
1987-88	2.03	2.10	2.41	2.67	3.28	3.51
1988-89	1.42	1.74	3.25	3.60	4.44	4.62
1989-90	2.84	3.63	3.64	3.98	4.40	4.98
1990-91	1.15	2.07	2.81	3.91	5.08	5.00
1991-92	2.04	2.54	3.99	4.35	6.13	5.24
1992-93	2.73	2.94	3.26	4.29	4.59	4.67

Source: Executive Engineer (Irrigation) BADC, Sirajganj

At least 27 different cropping patterns are practiced (Table 3.4). Most of these patterns are composed of two crops with at least one rice crop. Of these, 10 major patterns cover 92.5% of the NCA (Table 3.5). Boro (HYV)-T.Aman (local or HYV) pattern occupies 39.4% of the NCA. Sugarcane is grown inter-cropped with at least another crop. These are pulses, potato, mustard, spices, winter vegetables and others. This practice provides farmers with opportunities of harvesting different crops from the same land increasing total land productivity.

Cropping patterns are directly related with land types. F_0 and F_1 land types show wide variability (Table 3.6). When 15 different cropping patterns are observed on F_1 land type, only 2 cropping patterns can be seen on F_3 land type. Although T.Aman HYVs are grown normally on F_0 land, in the Sirajganj areas, they are also grown on F_1 land types with expectation of damage in case of water level exceeding 1:5 year return period (Table 3.7). However, T. Aman HYVs are grown on higher elevations of F_1 land type.
The non-rice crops are generally grown as a sequential with rice. Most of the non-rice crops are dry land crops, although some crops like jute and sugarcane can tolerate some degree of flooding at later stages of growth (Appendix D).

Table 3.4: Area (ha) under different cropping patterns planted in the CPP area, Sirajganj, base situation

Pattern	Sub-Compartments									Total	% of NCA
	1	2	3	4	5	6	7	8	9		
Single											
Sugarcane	118	52	256	4	267	11	0	32	0	740	7.73
Boro (HYV)	0	13	0	21	53	47	13	40	71	258	2.69
T.Aman (HYV)	0	0	0	0	0	0	0	0	25	25	0.26
Others	0	0	0	14	0	4	0	26	0	44	0.46
Total	118	65	256	39	320	62	13	98	96	1067	11.14
Double											
S.Cane + Pulses	36	27	84	69	254	142	225	185	0	1022	10.67
S.Cane + Potato	6	4	15	79	123	163	180	209	0	779	8.13
S.Cane + Mustard	12	23	11	62	121	115	98	304	0	746	7.79
S.Cane + Spices	8	18	38	58	42	35	23	81	0	303	3.16
S.Cane + Winter Vegetables	0	0	0	1	2	3	1	31	0	38	0.40
S.Cane + Others	12	0	0	0	0	3	38	30	0	83	0.87
Boro (HYV)-T.Aman (Local)	291	295	219	418	417	346	227	528	21	2762	28.83
Boro (HYV)-T.Aman (HYV)	72	104	120	160	200	156	119	90	19	1040	10.86
Boro (HYV)-Mustard	20	51	0	22	32	29	27	154	18	353	3.69
Boro (HYV)-Others	0	0	0	0	0	0	6	7	0	13	0.13
Wheat - Jute	109	106	129	141	123	100	49	107	1	855	8.93
B. Aus - Others	0	0	0	0	0	0	6	4	0	10	0.10
T.Aman (HYV)-Jute	0	0	0	0	0	0	0	17	0	17	0.18
T.Aman(HYV)-Winter Veg.	0	0	0	0	0	1	0	0	0	1	0.01
Total	566	628	616	1000	1314	1093	999	1747	59	8022	83.75
Triple											
Boro(HYV)-T.Aman(HYV)-Mustard	13	0	0	22	0	12	2	26	0	75	0.78
Wheat-Jute-T.Aman (Local)	0	0	6	4	0	0	0	16	0	26	0.27
Wheat-Jute-T.Aman (HYV)	9	4	0	37	7	4	2	0	0	63	0.66
Jute-T.Aman(HYV)-Pulses	5	0	0	0	0	0	0	0	0	5	0.05
Jute-T.Aman(HYV)-others	0	0	0	0	0	0	1	0	0	1	0.01
B.Aus-T.Aman(HYV)-Wheat	0	0	0	3	0	6	0	0	0	9	0.09
B.Aus-T.Aman(Local)-Wheat	0	0	0	0	0	0	0	3	0	3	0.03
B.Aus-T.Aman(Local)-Mustard	4	0	0	0	0	0	0	0	0	4	0.04
Total	31	4	6	66	7	22	5	45	0	186	1.94
Temporarily fallow	35	12	15	27	15	19	54	90	36	304	3.17
NCA	750	709	893	1132	1656	1196	1071	1981	191	9579	100.0

Source: Based on Landuse Survey, CPP, 1993

Table 3.5: Major cropping patterns of the CPP area, Sirajganj, base situation

Patterns	Area (ha)	% of NCA
Boro (HYV) - T.Aman (Local)	2762	28.8
Boro (HYV) - T. Aman (HYV)	1040	10.9
Sugarcane + Pulses	1022	10.7
Wheat - Jute	855	8.9
Sugarcane + Potato	779	8.1
Sugarcane + Mustard	746	7.8
Sugarcane	740	7.7
Boro (HYV) - Mustard	353	3.7
Sugarcane + Spices	303	3.2
Boro (HYV)	258	2.7
Others (17 patterns)	417	4.3
Temporarily fallow	304	3.2
Total NCA	9579	100.0

Source: Based on Landuse Survey, CPP, 1993

Table 3.6: Practiced cropping patterns and its coverage on different land types in the CPP, Sirajganj, base situation

Land type	Cropping Patterns	Area (ha)	% of land type
F_0	Boro (HYV) - T. Aman (HYV)	236	8.10
	Wheat - Jute	519	17.82
	Sugarcane + inter crops	1241	42.60
	Sugarcane	740	25.40
	Others	85	2.92
	Temporarily Fallow	92	3.16
	Total	2913	100.00
F_1	Boro(HYV) - T. Aman(HYV)-Mustard	75	2.04
	Wheat - Jute - T.Aman (HYV)	63	1.71
	Boro (HYV) - T. Aman (HYV)	804	21.84
	Boro (HYV) - T.Aman (local)	1427	38.77
	Boro (HYV) - Mustard	100	2.72
	Wheat - Jute	336	9.13
	Sugarcane + inter crops	744	20.21
	Others (8 patterns)	47	1.27
	Temporarily Fallow	85	2.31
	Total	3681	100.00
F_2	Wheat - Jute - T. Aman (Local)	26	0.96
	Boro (HYV) - T. Aman (Local)	1323	48.73
	Boro (HYV) - Mustard	253	9.32
	Sugarcane + inter crops	986	36.32
	Temporarily Fallow	127	4.68
	Total	2715	100.00
F_3	Boro (HYV) - T.Aman (Local)	12	4.44
	Boro (HYV)	258	95.56
	Total	270	100.00

Source: Based on Landuse Survey, CPP, 1993

Table 3.7: Cropping pattern by land type in the CPP area in Sirajganj, base situation

Pattern	Land Types				Total
	F_0	F_1	F_2	F_3	
Single					
Sugarcane	740	-	-	-	740
Boro (HYV)	-	-	-	258	258
T. Aman (HYV)	25	-	-	-	25
Others	32	12	-	-	44
Double					
S.Cane + Pulses	286	220	516	-	1022
S.Cane + Potato	211	419	149	-	779
S.Cane + Mustard	320	105	321	-	746
S.Cane + Spices	303	-	-	-	303
S.Cane + Winter Vegetables	38	-	-	-	38
S.Cane + Others	83	-	-	-	83
Boro (HYV) - T.Aman (local)	-	1427	1323	12	2762
Boro (HYV) - T.Aman (HYV)	236	804	-	-	1040
Boro (HYV) - Mustard	-	100	253	-	353
Boro (HYV) - Others	-	13	-	-	13
Wheat - Jute	519	336	-	-	855
B.Aus - Others	10	-	-	-	10
T. Aman (HYV) - Jute	17	-	-	-	17
T. Aman (HYV) - Winter Vegetables	1	-	-	-	1
Triple					
Boro(HYV)-T.Aman(HYV)-Mustard	-	75	-	-	75
Wheat-Jute-T.Aman (Local)	-	-	26	-	26
Wheat-Jute-T.Aman(HYV)	-	63	-	-	63
Jute-T.Aman(HYV)-Pulses	-	5	-	-	5
Jute-T.Aman(HYV)-others	-	1	-	-	1
B.Aus-T.Aman(HYV)-Wheat	-	9	-	-	9
B.Aus-T.Aman(Local)-Wheat	-	3	-	-	3
B.Aus-T.Aman(Local)-Mustard	-	4	-	-	4
Temporarily Fallow	92	85	127	-	304
NCA	2913	3681	2715	270	9579

Source: Based on Landuse Survey, CPP, 1993

3.4 Crops

3.4.1 Rice

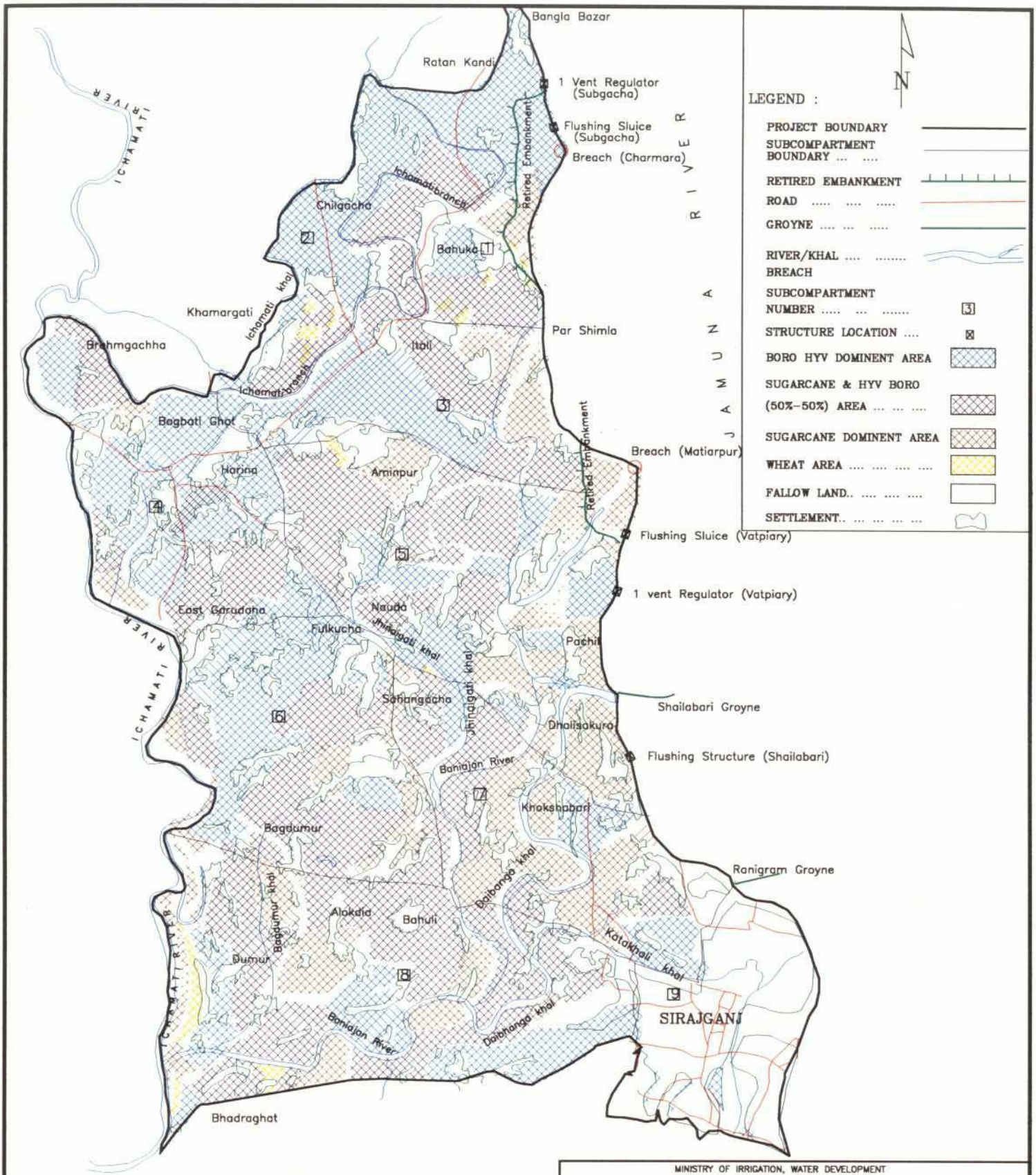
Rice is the most important crop and is grown throughout the year (Figure 3.2). The traditional rice crops Aus, Aman and Boro are grown in Kharif-I, Kharif-II and Rabi seasons respectively.

Aus: Aus is a photo-period insensitive group of rice varieties. It is generally direct seeded, rainfed and traditionally competes with jute. Direct seeded Aus is sown in March-April and harvested in June-August. Due to uncertain environmental condition such as unpredictable and irregular rainfall pattern, the Aus varieties have evolved to a quickly-maturing, low-input crop with lower yield. In the CPP Sirajganj area, direct seeded Aus is grown on only 26 hectares of land (Table 3.8).

Aman: Aman varieties are traditionally photo-period sensitive i.e. they flower during mid-October to 1st week of November depending on the degree of sensitivity, irrespective of their seeding or transplanting date. They are of different types adapted to different micro-environments of Kharif-II season. Two easily recognized types: of fixed height and one that can expand with rising water, deep water or floating rice. Traditionally, the former are transplanted and the latter broadcasted. Broadcasted Aman used to be extensively grown in the region before the construction of the BRE. Although B.Aman is grown in certain unions of Sirajganj Sadar Thana, it is almost non-existent in the CPP area.

Transplanted Aman, local or HYV, is popular in the area. All local T.Aman varieties are photo-period sensitive and can be transplanted as late as end of September. The only HYV of T.Aman season is BR11 which is moderately photoperiod sensitive and need to be transplanted not later than mid-August. Recently released BR22, BR23 and BR 25 are all photoperiod sensitive, with taller seedling height and can be transplanted, as like local T.Aman, even in the end of September (Appendix B). The area covered with local and HYV T.Aman are 2795 and 1236 ha, respectively (Table 3.8). The coverage between local and HYVs fluctuates with flooding pattern of a particular year.

Boro: A total of 4501 ha. of the project area is under Boro (Table 3.9), which is totally irrigated, transplanted from December to February and harvested in May-June. All of these are HYVs such as Purbachi and BR11. Transplanting HYVs earlier does not mean an earlier harvest: the usually cool weather until mid-February prevents the crop from developing and only adds to production costs.



C
FAP20
P

MINISTRY OF IRRIGATION, WATER DEVELOPMENT AND FLOOD CONTROL
BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANISATION

COMPARTMENTALIZATION PILOT PROJECT SIRAJGANJ (FAP 20)

CROP AREAS

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 3.2

Table 3.8: Area (ha) under different crops planted in the CPP area, Sirajganj, base situation

Crops	Sub-Compartments									Total
	1	2	3	4	5	6	7	8	9	
B.Aus	4	0	0	3	0	6	6	7	0	26
T.Aman (Local)	295	295	225	422	417	346	227	547	21	2795
T.Aman (HYV)	99	108	120	222	207	179	124	133	44	1236
Boro (HYV)	396	463	339	643	702	590	394	845	129	4501
Total rice	794	866	684	1287	1326	1115	745	1525	194	8558
Wheat	118	110	135	175	130	110	51	126	1	956
Sugarcane	192	124	404	273	809	472	565	872	0	3711
Jute	123	110	135	172	130	104	52	140	1	967
Pulses	41	27	84	69	254	142	225	185	0	1027
Mustard	49	74	11	106	153	156	127	484	18	1178
Potato	6	4	15	79	123	163	186	209	0	785
Spices	8	18	38	58	42	35	23	81	0	303
Winter Vegetables	0	0	0	1	2	4	1	38	0	46
Others	12	0	0	14	0	7	45	60	0	138
Total cropped	1343	1333	1506	2237	2969	2314	2026	3727	214	17669
NCA	750	709	893	1132	1656	1196	1071	1981	191	9579
Cropping intensity (%)	179	188	169	198	179	193	189	188	112	184

Source: Based on Landuse Survey, CPP, 1993

Table 3.9: Popular varieties of different crops grown in the CPP area, Sirajganj

Crop	Varieties
Aman (HYV)	BR11
Aman (Local)	Sabahar, Bashful, Patzag, Zatagaza, Mug, Jat
Boro (HYV)	Purbachi (Chinese), BR11, BR14, BR3, Iriton(?)
Wheat	Sonalika, Kanchan
Sugarcane	Iswardi, Lalbatary, Nilbatary

Source: Landuse Survey, CPP, January-April, 1993.

3.4.2 Sugarcane

Sugarcane is extensively grown although there is no commercial sugar mill around. Sugarcane is grown either for making gur (molasses) or for chewing purposes, perhaps the biggest and the most continuous year-round market. There is a research station in Iswardi which has developed some HYVs. Yields have increased from 25-30 t/ha to about 55-60 t/ha. Sugarcane can be grown on permeable land, medium high land, high land and even on low land. Sugarcane is extensive near the BRE where huge sand deposition through the BRE breach has turned the soil unsuitable to other crops and sugarcane remains to be the only possibility. Besides, sugarcane can sustain certain degree of high floods.

Sugarcane is grown on 3711 ha. usually with another crop of mustard, pulses in between rows during the first few months of planting canes. Ratoon establishment of sugarcane field is common in the region. Sugarcane is also grown in fields suitable for Boro rice cultivation. In the Sirajganj CPP area, a huge area exists where irrigated HYV Boro and non-irrigated sugarcane are grown side by side. The price of Boro rice and available family labour determine the crop grown.

3.4.3 Jute

Jute is grown on 967 ha (Table 3.8) of land in the project area. Two species are grown. *Corchorus olitorius*, tossa matures later than *Corchorus capsularies*, deshi.

Jute has been regarded as a dying crop for many year, the expectation being that artificial fibres will replace it. But the market is holding up for other uses. Jute sticks are extensively used for making walls and fences. It is also the main source of fuel in the villages. Jute is a cash crop to farmers.

Last week of March to mid-April is the recommended sowing time for deshi jute, while third week of April to mid-May is ideal for sowing of tossa. Jute varieties are sensitive to day-lengths. Growing jute earlier than the recommended time leads to premature flowering, stunted growth and low yield. Jute will stand a greater depth of water than direct seeded Aus after about mid-May: upto about 1.5m. Thus, while jute can be grown with the water regime suitable for direct seeded Aus, the reverse is not the case.

Jute is obtained from the bark of the plants. For extraction of good quality fibre, there should be plenty of water close of jute fields. Slow flowing water is ideal for retting of jute. Bundles of plants are steeped in water of the canals, rivers, beels, road side ditches or in the standing flood water on the field. Stagnant water enhances the retting process but it lowers the quality of fibres. Low quality jute has no local or export market. Sirajganj had been one of the important jute trading centre. Quami Jute Mill is situated adjacent to the CPP area.

3.4.4 Wheat

Wheat is the only other cereal crop next to rice. It is cultivated in the rabi season. Farmers choice of wheat cultivation depends on the irrigation facilities, price and availability of seed, time of releasing of land after flood, rainfall during October to November, price and demand of rice etc.

The sowing time for wheat is very short. It is recommended that seeds to be sown between second week of November and first week of December. Delayed sowing reduces yield and grain quality.

In the CPP Sirajganj area, wheat is planted only on 956 ha (Table 3.8). Sonalika and Kanchan are usually grown.

3.4.5 Pulses

Lentil, Chickpea, Mungbean, Pea, Blackgram, Khesari are the most common and the cheapest source of protein for rural people of the CPP area. Rice and dal (pulses) is considered as a balanced diet to the rural mass. Broken pulses, residues, wastes at crushing and dry plants are used as the concentrated cattle feed. Cows grazing on green plants of blackgram and khesari produce more milk and maintain better health. The fertility of soil is improved if a crop of pulses is grown. Pulses are usually grown inter-cropped with sugarcane.

3.4.6 Mustard

Mustard, alongwith kaon groundnut, cheena are grown as compensatory crop in years when T.Aman crop is damaged due to flood or embankment breach. It is the major oilseed crop. Oil is extracted either by traditional bullock powered presses or by electric powered expellers. Mustard cakes are used as cattle feed.

3.4.7 Others

Potato is the most important among other crops grown in the CPP Sirajganj area. It is grown on 785 ha (Table 3.8) mostly as an intercrop with sugarcane. Vegetables and spices occupy a major place in the agriculture of the project area. However, growing of vegetables is not yet popular on agricultural fields except in areas around Sirajganj town. A major portion of vegetables and spices are grown around settlement areas. Other crops include sweet potato, linseed, groundnut, cotton, kaon etc.

3.5 Input Use

Of the different material inputs, seed, fertilizer, irrigation equipment and pesticides are essential. Irrigation and its use have already been described (Section 3.2). Present level of input use on different crops within the CPP, Sirajganj is presented in Table 3.10.

Table 3.10: Present level of input use within the CPP area, Sirajganj, base situation

Crop	Fertilizers (kg/ha)					Pesticide (kg/ha)	Seed (kg/ha)	Labour (Person days/ha)
	Urea	TSP	MP	Gypsum	Zn			
Boro (HYV)	237	91	45	58	4	1.0	30	234
T. Aman (HYV)	120	66	25	25	2	1.0	32	173
T. Aman (Local)	66	53	26	5	0	0.4	25	140
B. Aus (Local)	25	24	18	0	0	0	44	147
Jute	61	52	29	0	0	0	10	226
Wheat	92	71	37	4	0	0	74	90
Sugarcane	261	178	167	7	0	0	29000 stick	271
Potato	102	121	54	0	0	1.0	1500	185
Mustard	90	97	42	0	0	0	10	70

Source: Input Use Survey, CPP, April 1993 and MPO (1986), Technical Report 14.

o Fertilizers

The fertilizers used by the farmers are mainly Urea, TSP and MP. The recent privatisation of fertilizer distribution (March 1989) has given new impetus to their distribution. With increasing area planted to HYVs, the use of fertilizer is expected to rise steadily. However, cost of fertilizer remains excessively high for small farmers who do not have any cash in hand. Small farmers are seriously handicapped and are incapable of using fertilizers at the right time and in the right quantity, which adversely affects productivity.

Fertilizers are applied on most crops - major or minor. Use of Gypsum and Zinc have started recently. Urea is used more than the recommended doses in case of Boro HYVs (Table 3.11). In other cases, fertilizer use is less than recommended dose.

Table 3.11: Comparison between recommended and used doses (kg/ha)* of chemical fertilizer in the CPP area Sirajganj

Crop	Urea		TSP		MP	
	Recommended	Used	Recommended	Used	Recommended	Used
Boro (HYV)	217	237	133	91	67	45
T. Aman (HYV)	152	120	89	66	67	25
T. Aman (Local)	109	66	44	53	33	26
Wheat	130	92	89	71	50	37
Jute	65	61	-	52	17	29
Sugarcane	-	261	-	178	-	167

- no recommendation

*Recommended as per Fertilizer Recommendation Guide (BARC, 1989) and uses as per Input Use Survey (CPP, 1993).

o Labour Use

Agriculture in Bangladesh is still traditional where human labour (Table 3.12) and bullock power are widely used. Use of power tillers by common farmers is limited in the project area. Labour use is greater in transplanting of Aman and Boro (HYV) and in weeding jute and Boro (HYV). Besides family labour, manpower is hired whenever necessary. Hiring is done mainly in the transplanting and harvesting seasons.

There are three categories of hired labour:

(i) permanent labour or labour attached to a family for a season or a year;
(ii) casual hired labour - contracted on a day to day basis;
(iii) contract labour, where labourers either individually or in a group take specific jobs under contract.

Large farm households engage permanent hands besides engaging casual labour in different farm operations. Casual labour is the principal class of wage labour in the study area.

o Draft Power

Animal power is quite commonly used in agricultural operations.

The predominant use of draft power in land operation, threshing of crops and transportation. A large number of farm households, especially the small farmers, do not possess any draft animals. Instead, they hire in or exchange draft power either on a daily basis or under contract.

Land preparation for crop growing is done by bullock-driven wooden ploughes. One pair of bullocks can plough 0.15 ha of land in a day. To prepare the land for seeding or transplanting, 4-6 ploughing are necessary.

o Pesticides

Most of the farmers are now familiar with pesticides. Their application are currently limited, however, to HYVs. The major difficulty encountered in using pesticides is their selection appropriate to the crops infested and the diseases. Farmers are unaware of the proper doses to be applied, resulting in ineffective use of the pesticides. Major pesticides are Basudin, Furadan, Dimecron, Diazinon and Malathion. Integrated pest management is not practiced.

Table 3.12: Agricultural labourer employed in the base situation within the CPP, Sirajganj

Crop	Area(ha)	Person days per hectare												Total
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
B.Aus	26			15	35	37	20	30	10					**147**
T.Aman (Local)	2795						10	40	25	15	10	20	20	**140**
T.Aman (HYV)	1236							50	48	20	10	25	20	**173**
Boro (HYV)	4501	50	50	30	39	45	20							**234**
Sugarcane	3711	40	36	20	10	10	10	5	5	25	30	40	40	**271**
Wheat	956	10	10	20							10	20	20	**90**
Jute	967			20	50	36	30	50	40					**226**
Pulses	1027	5	10	10							5	8	10	**48**
Mustard	1178	15	10								5	25	15	**70**
Potato	785	20	20	55	10							30	50	**185**
Spices	303	20	20	25	9						20	30	30	**154**
Vegetables	46	30	30	40	27						40	60	50	**287**
Others	138	20	20	20	20	20	20	20	20	20	20	20	20	**240**
Total(000 person days)		**432**	**426**	**314**	**276**	**279**	**187**	**244**	**189**	**162**	**183**	**330**	**329**	

Source: MPO (1986) Agricultural Production System: HH Survey, CPP

o Credit

Credit to finance inputs at the right time and right quantities has become an essential facility for most farmers, especially when growing HYVs. There are two main sources of rural credit - the institutional, such as private and nationalized banks and non-institutional, being money lenders, friends and relatives.

Non-institutional credit is prevalent in both rural and urban areas. About 65% of the total credit needs are met by non-institutional sources because of the relative ease of access compared to the institutional credit. The landless and marginal farmers prefer this form of credit, because of equity problems which are rather easy for medium and large farmers.

3.6 Crop Yield and Production

The main agricultural activity of the Sirajganj CPP is in the safe crop environment of rabi season. Rice production mainly depends on irrigation and on HYV Boro. Expansion in irrigated Boro area has its potential and limitations. Cropping intensity of the area is 184%. A large area is covered by sugarcane (39% of the NCA) - an annual crop. Being located in the drier region of Bangladesh and under constant threat of embankment breach, input use is not high.

Area cropped, production and production loss due to flood in the CPP area is shown in Table 3.13. It would appear that a total of 25765 tons of cereal including 23444 tons of paddy are produced in the project area. 81% of the total paddy production is at present derived from irrigated HYV Boro. A production loss of 4130 tons of paddy is estimated mainly by flood.

Table 3.13: Crop area, production and production loss due to flood in the CPP area, Sirajganj, base situation

Crop	Damage free		Damaged		Production (tons)	Production loss (t)
	Area (ha)	Yield (t/ha)	Area (ha)	Yield (t/ha)		
B. Aus	19	1.28	7	0.79	30	3
T.Aman (Local)	1434	1.35	1361	0.40	2480	1293
T.Aman (HYV)	279	3.17	957	1.00	1841	2077
Boro (HYV)	2655	4.41	1846	4.00	19093	757
Total paddy					23444	4130
Wheat	930	2.44	26	2.00	2321	11
Sugarcane	2725	50.20	986	47.54	183666	2623
Jute	941	1.43	26	0.98	1371	12
Pulses	1027	1.03	-	-	1058	-
Mustard	1178	0.79	-	-	931	-
Potato	785	9.79	-	-	7685	-
Spices	303	1.31	-	-	397	-
Winter Vegetables	46	4.76	-	-	219	-
Others	138	-	-	-	-	-

Source: Based on Landuse Survey, CPP, 1993

3.7 Constraints to Agricultural Production

Agriculture in the CPP, Sirajganj faces a number of problems. The main constrains are:

a. The BRE

Agriculture in Sirajganj CPP depends on reliability of the BRE to provide protection. The BRE has often failed to provide that protection, due largely to embankmewnt breaching river erosion or structural failure. Embankment breaches occurred in areas of *Khokshabari, Chormara, Bhatpeari, Matiarpur, and Subhagacha* within the CPP project area. On-rush of breach water destroys crops, houses, properties, livestock and household belongings. An unreliable BRE will limit agricultural development.

b. Land Availability

There are no posibilities to raise agricultural production through expanding net cultivable area in the project. Moreover, the expansion of urban areas around Sirajganj may consume more agricultural land. More than that, a great proportion of agricultural land along the Jamuna is lost through bank erosion and continuous retiring of embankment. Hence, to feed the increasing population from limited agricultural land, the only solution is to improve the production through elevation of productivity per unit area.

c. Water Congestion

The silted-up rivers and canals are affecting proper drainage of breach water. Areas around *Bahuka* (SC1), *Chilgacha-Saratail* (SC2), *Harina* and *Beel Pukuria* (SC4), Changacha and Khokshabari (SC5) are poorly drained, due to the low overall gradient and lack of maintenance of drainage channels. Water congestion problems are, often caused by man-made obstructions like roads without proper drainage provisions.

d. Soils

With the BRE breach, sand deposition has occurred on good agricultural land along the BRE and *Doibhangha* khal such as areas of *Par Shimla* (SC3), *Changacha, Aminpur, Gupirpara* (SC5) and on both sides of *Doibhanga* river (SC7 and 8). Rice area has been turned into sugarcane area.

e. Credit

Although credit facilities are available but processing of credit application is cumbersome. Institutional credit cannot be obtained without bribe in most cases. However, such credit is even not available in areas of expected river bank erosion near the BRE (e.g. SC3).

g. Other Constraints

Some additional constraints are mentioned below:

- Many of the households are so-called marginal (<0.40 ha of land) or small (<1.00 ha of land) farm households. Many of them are illiterate and are hiring themselves out as labourers. Resources like credit through normal channels are not available to assist them to generate additional income from agricultural activities.
- Pressure of population has led to a shrinking of land/man ratio.
- Farmers are lacking security needed to invest in modern agricultural technology due to BRE breach occuring very often.

h. Farmer's own Mitigation Measures:

- Because of less environmental hazard, HYV Boro has become the predominant crop of the area.
- Because of regular occurrence of the BRE breach, farmers grow transplanted Aman as a chance crop using very low dose of input.
- Mustard, alongwith kaon, groundnut, cheena are grown as compensatory crops in case of T. Aman crop failure.
- In areas of recent sand deposition, rice area has been turned into sugarcane area.

3.8 Livestock

Livestock in the CPP Sirajganj area virtually kept on small farms. It is an integral part of the farming system. Cattle, goats and chicken are the most important animals of the rural households in the project area (Table 3.14). Bullocks are kept mainly for draft purposes and for transportation, but cows for milk. Goats, sheep, chickens and ducks are kept for cash income and as a source of protein food. Cowdung is used as fuel in rural areas, owing to shortage of firewood and also as manure.

Table 3.14: Number of livestock and poultry alongwith area and production grazing within Sirajganj Thana

Unions	Number		Poultry	Fallow	Animal Feed	
	Draft animals	Cows, goat and calf		Land (ha) for grazing	Production (tons)	Demand (tons)
Ratankandi	1508	4570	25210	4.5	12	35
Bagbati	1340	4430	22320	4.0	10	30
Bahuli	1160	3460	13120	2.4	7	24
Shialkole	1320	3640	22310	2.8	8	30
Kalia Haripur	860	2545	10050	3.2	10	24
Saidabad	1140	3255	15150	6.1	12	28
Mechra	670	2170	9010	13.0	20	12
Chougacha	1025	3230	15015	2.0	6	28
Khokshabari	980	2800	14205	2.0	6	28
Kaoakhola	508	1890	7430	10.1	15	12
Pourashava	430	1470	20115	-	-	15
Total*	10941	33460	173935	50.1	106	266
CPP area(estimate)	5896	18124	108935	14.0	33	141

*Source: Thana Livestock Officer, Sirajganj, January 1993.

Traditional cultivation, as is practiced now, depends on draft animal. There is shortage of draft power and this shortage is usually made up by using cows, hire-in arrangements and through exchange among households, either on daily basis or under contract. The use of power tiller as substitute for draft animal is very limited. The number of draft animal is declining because of high mortality rate, shortage of cash in hand, lack of medicare facilities and high price of cattle heads. In need, draft animal reaches the market from neighbouring districts or elsewhere.

Cattle are fed mainly on crop residues and by products. Paddy straw is the main feed though cattle are grazed on temporarily fallow land after harvesting of paddy crops as well as on road sides, canal embankments and other unused grounds. Char lands along the Jamuna produce cattle feed in excess. However, fodder shortage is acute after a flood season. Import of straw occurred in some years.

The poultry numbers are increasing. This is because of higher price support and NGO activities with women's participation. High mortality rate among poultry birds is due both to lack of vaccinations and also to impure or out of date vaccinations. There is regular attack of foxes hiding in sugarcane fields specially in areas near to the BRE.

Different types of epidemics generally break out during and after floods if adequate preventative measures are not taken. In case of cattle and goats. Foot & mouth disease, anthrax, pasteurellisis are frequent. Black quarter, frequent in previous years, did not occur in 1992. However, occurrance of liverfluke infestation is most severe in Sirajganj than in other parts of Bangladesh. A Field Disease Investigation Laboratory serving the region is located in Sirajganj. The average health condition of the animals in the area is not good.

3.9 Forestry

Natural forests are non-existent in the CPP Sirajganj area. There is an active programme on social forestry or roadside tree plantation programme executed by Thana Forest Development Programme or even NGOs, like Proshika. Proshika maintains 13km. of road side tree plantations within the CPP area. A total of 90000 trees were planted. These are mainly Mehogoni, Sissoo, Raintree, Eucalyptus and Segun.

4 GENERAL DESCRIPTION OF COMPARTMENT DEVELOPMENT

4.1 Introduction

The CPP is mandated to test the concept of compartmentalization under the Flood Action Plan. This concept was introduced in the Bangladesh Flood Policy Study (UNDP/GOB, May 1989). It is planned, according to the concept that the flood water will flow into the compartment and spread over the area in a (semi)-controlled way by means of regulating structures in the primary embankments along the river Brahmaputra and the gated or ungated openings in the secondary embankments between the compartments. The way the flood, as well as the drainage of excess rainfall, has to be controlled will be determined by the demands from inside the compartment. The concept of compartmentalization is instrumental for the implementation of detailed water management interventions.

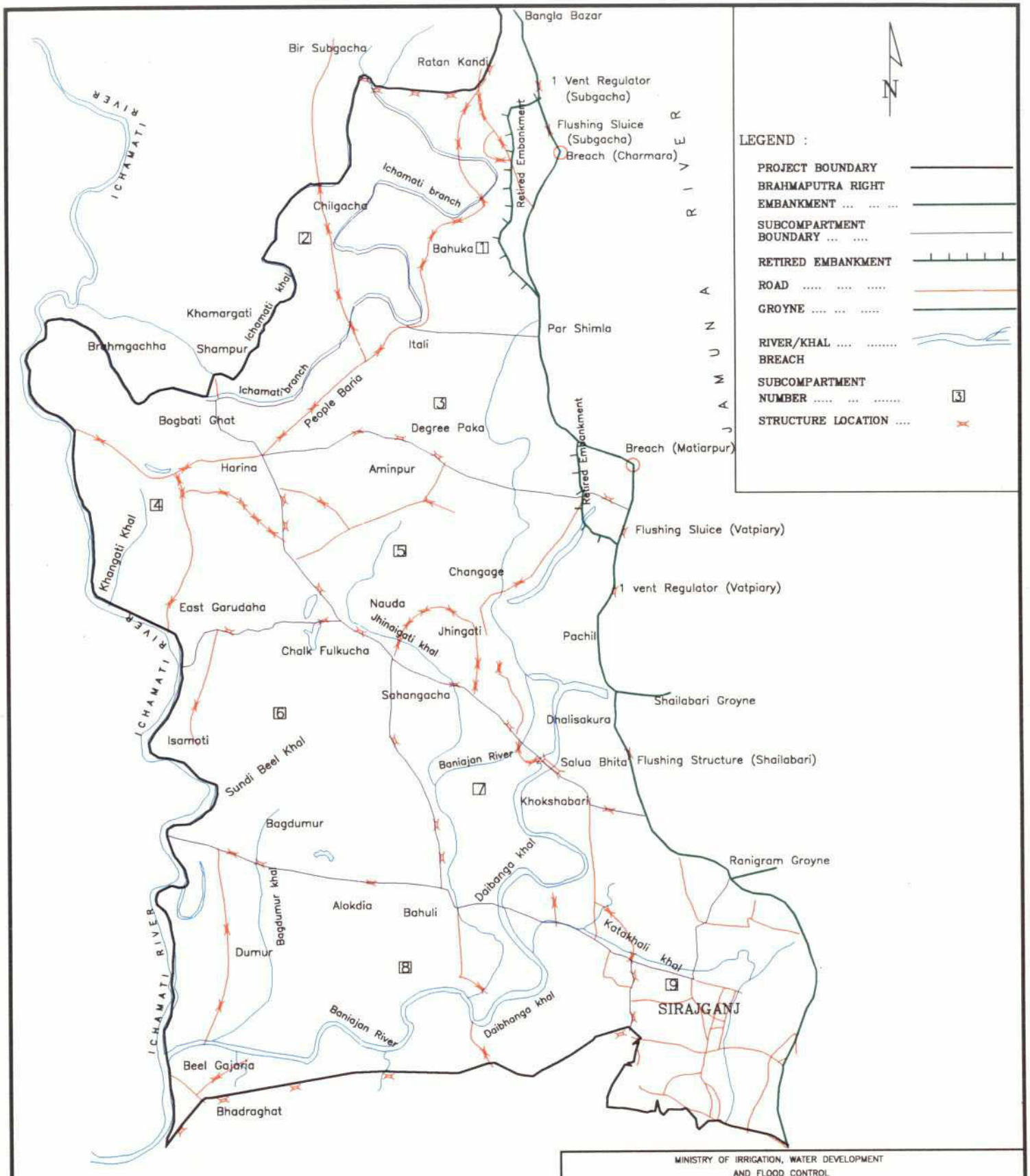
A full description of base situation and options are given in Annex 2. A general description is presented here to help in understanding the impact on agricultural situation.

4.2 Base situation

The Sirajganj compartment is situated behind the Brahmaputra Right Embankment (BRE) and therefore largely depends on the quality of the BRE (Figure 4.1). The objective of the BRE is to protect the land behind the embankment from flooding. So the protection from the Brahmaputra flood is assumed to be provided by the BRE. An additional complication to the project area is formed by the runoff quantities conveyed by the Ichamati river which originates from the upper catchment. Inside the compartment, the Baniajan river and Ichamati branch are the only rivers that flow through the compartment.

During flood, flow pattern of the Ichamati river which generally flows from north to south changes in reverse direction which ultimately effects the flow pattern of SC 8, 6, 9 and partly 7. Flow of the above mentioned SC turns in reverse direction but due to high elevation and existance of Sirajganj-Kazipur road back water of the Ichamati river cannot change the flow pattern of the other SC's appreciably. Flow pattern of SC 1,2,3,4,5 & 7 sometimes also change due to breach of BRE and it depends on the location, size and discharge of flood water through the breach.

At present, the status of the BRE is not sealed. The BRE is eroded near Par Simla. In the current situation, the BRE breach possibility remains existing and together with the increased waterlevels in the Ichamati river this will cause considerable drainage problem in the CPP area.



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BANGLADESH WATER DEVELOPMENT BOARD
FLOOD PLAN COORDINATION ORGANISATION

COMPARTMENTALIZATION PILOT PROJECT SIRAJGANJ (FAP 20)

BASE MAP

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 4.1

4.3 Development components

Flood Protection

Flood protection measures are which are taken for the protection of certain areas and are necessary due to flooding caused by:

1) a local BRE breach on the boundaries of CPP Sirajganj;
2) major runoff as a result of local rainfall upstream of the CPP Sirajganj;
3) backwater (or backflow) effect from the Karatoya river back into the Ichamati river and Baniajan river;
4) any combination of the above three.

Breach Mitigation

Breach mitigation measures are those which can cope with the impact of breaches occurring as a result from the erosive power of the Jamuna river. Breaches are observed in the eastern boundary and north of the CPP area, Sirajganj. The direct impact of the BRE breach are damage of infrastructure and damage of crops. The velocity developed in the incoming water are high such that the existing bridges and culverts cannot cope with this velocity and are considerably eroded.

In physical terms this means that the actual impact of a breach occurrence is mitigated through the construction or upgrading of roads which serve as embankments. Also the water control structures need to be constructed for control of excess floodwater to be conveyed from the SC's to the drainage system. These roads/embankments confine the floodwater to a certain area (subcompartments) and subsequently the excess floodwater will be conveyed through waterconveyance structures to the drainage system.

Drainage Improvement

Drainage congestion in pre-monsoon and post-monsoon within the context of the existing infrastructure is one of the constraint in further developing the area with an improved water resources control. Re-excavation of all khals is planned.

Compartment Watermanagement

The flood water will flow into the compartment and spread over the area in a (semi)-controlled way by means of regulating structures in the primary embankments along the Jamuna river and the gated or ungated openings in the secondary embankments between the compartments. The way the flood, as well as the drainage of excess rainfall, has to be controlled will be determined by the demands from inside the compartment.

Water requirements for each SC will be the basis for water management. As indicated earlier, the boundaries as defined are preliminary boundaries. In due course sub-

compartmental boundaries may need to be changed as a result of agronomic, hydrologic, economic or other reasons. The components for water management are as follows:

- retention structure
- developments of internal channels
- developments of internal roads

Water Retention

Water retention may play a considerable role in the overall watermanagement practices in the CPP area. The objective is to retain rainfall or flood water in a specific area and gradually release into the next sub-compartment. Water retention measures may by performed by:

- the construction of bunds on the fields
- by actual construction of water retention structures in order to create a storage of surface water.

4.4 Options for Development

The following options are developed for analysis.

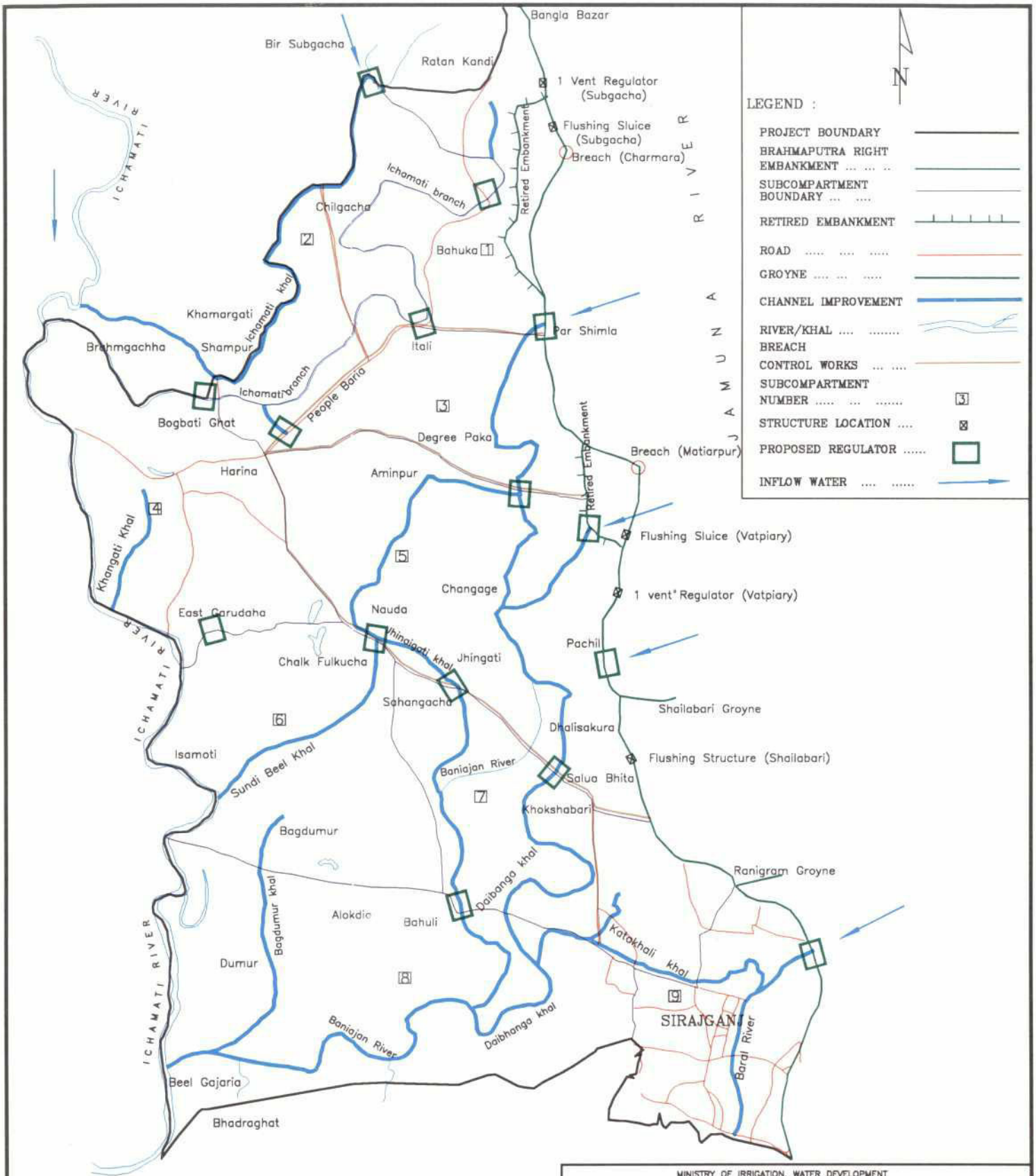
OPTION 1	:	COMPARTMENT SITUATION WITHOUT AN ICHAMATI EMBANKMENT
OPTION 2A	:	COMPARTMENT SITUATION WITH THE ICHAMATI EMBANKMENT FOLLOWING EXISTING ROAD
OPTION 2B	:	COMPARTMENT SITUATION WITH THE ICHAMATI EMBANKMENT FOLLOWING RIVER BANK

The difference between option 1 and options 2A-2B is that for option 2A and 2B an embankment along the Ichamati river/khal is foreseen.

4.4.1 Option 1

DESCRIPTION OPTION 1:
COMPARTMENT SITUATION WITHOUT THE ICHAMATI EMBANKMENT

This option consists of improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention structures, irrigation and internal water management control structures. Some of these components are described under option 2A (Fig.4.2)



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COMPARTMENTALIZATION PILOT PROJECT SIRAJGANJ (FAP 20)

OPTION 1 : COMPARTMENTALIZATION WITHOUT ICHAMATI EMBANKMENT

Consultant: Euroconsult, Lahmeyer Int.,Beta Ltd.,HCL

Figure No. 4.2

4.4.2 Option 2A

DESCRIPTION OPTION 2A:

COMPARTMENT SITUATION WITH ICHAMATI EMBANKMENT FOLLOWING EXISTING ROAD

This option consists of measures for flood protection, improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention, BRE post-breach control, internal watermanagement control structure, and Ichamati embankment (Fig.4.3).

Comparing Option 2A and Option 1, there is an improvement of the OPTION 1 situation by including an embankment along the Ichamati river. The purpose of this embankment is to protect the Ichamati left bank from flooding.

In general, this option provides features for a watermanagement system in the CPP area which assumes that the status of the BRE is sufficiently stable.

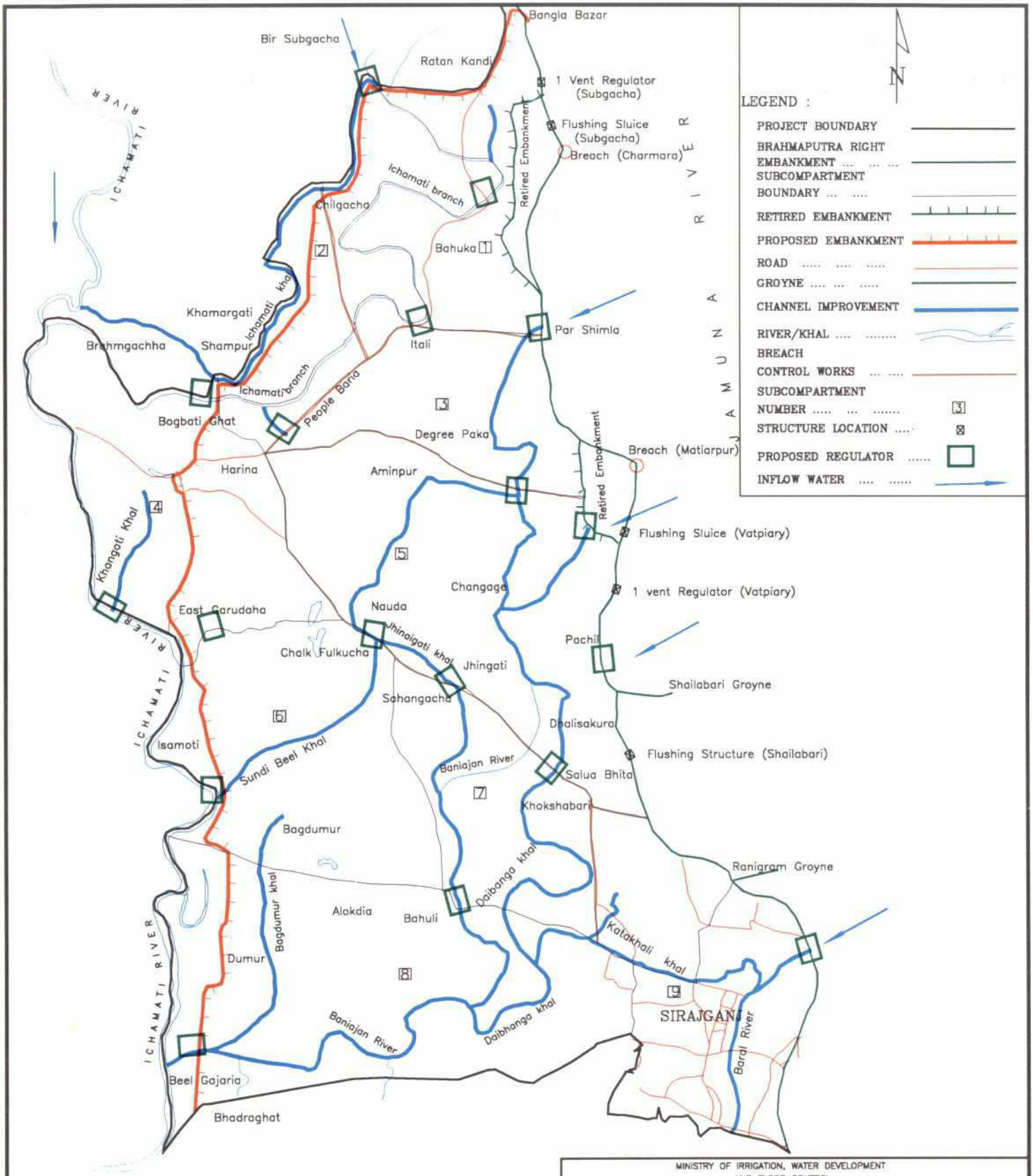
The drainage congestion is caused by two sources:
1) by BRE breach impact
2) by local rainfall

In case there is a direct breach in the CPP area, the following approach is suggested:
1) confine incoming BRE breach floodwater to a restricted number of subcompartments; and
2) convey these floodwaters adequately and quickly through water regulators in the subcompartment boundaries to improved drainage canals.

The maximum time period in which the floodwater is allowed to remain in the subcompartment is not more than 48 hours and should definitely not exceed 72 hours. This time limit is related to the submergence tolerance of the Aman crops.

The main drainage system within the compartment is proposed to be improved. A drainage diversion regulator is proposed which receives incoming water from the adjacent areas north of the CPP compartment. This drainage diversion regulator diverts incoming water to the Ichamati khal in order to keep the inside drainage system as empty as possible. In other words, the Ichamati branch capacity will be available for drainage water from inside the compartment. Any major waterflow which originates from the area north of the compartment will only partially not enter into the compartment area and will be diverted through the Ichamati khal to the Ichamuti river.

Four inlet structures at the BRE are proposed and access canals will be maintained for proper access from Jamuna river to the project area. The purpose of these inlet structures is to regulate water during the pre-monsoon season especially in relation to migration.



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COMPARTMENTALIZATION PILOT PROJECT
SIRAJGANJ (FAP 20)

OPTION 2A : COMPARTMENTALIZATION WITH ICHAMATI EMBANKMENT (ALIGNMENT I)

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 9.4

It is assumed that BRE breaches might occur and therefore the principle of sub-compartmental development will be used to guide the water entered into the project area. After the breach has occurred, the affected SC will drain into the neighbouring SC and/or will drain into a major khal/river without causing excess damage. For this purpose the existing structures will be adjusted/developed and new specially designed structures will be proposed to handle the breach water. Through a comprehensive set of water control structures, this floodwater will be released to neighbouring khals/rivers in a gradual fashion so that the actual damage to agriculture and infrastructure will be minimized.

The structures which take care of the internal watermanagement have as purpose to regulate the waterresources entering and exiting the subcompartments in such mode that the waterlevels are carefully balanced for the proper allocation in time and space.

For development of Sirajganj town, it is proposed that the main drainage canal (Baral river) needs to be re-excavated from its intake at the BRE upto the Hurasagar river with provision of one flushing sluice at its intake for flushing purposes. Existing culverts need to be modified to increase their flowing capacity and new culverts need to be constructed at suitable locations. The existing internal drainage system within town are also needed to be improved to remove waterlogging. Existing drains are inadequate in size, length and number.

Fieldlevel watermanagement are all those measures which are to be taken regarding the control of water within a subcompartment to regulate the waterlevels in certain uniform areas within the subcompartment.

SPECIFIC FEATURES OPTION 2A

*) Flood protection from Ichamati back into CPP project area.
*) Improved Drainage
*) Improvement inlet structures at the BRE
*) Structures at Ichamuti branch and khal
*) Structures at subcompartmental boundaries
*) Structures at Ichamati East embankment
*) Water retention structures
*) Construction of structures which regulate inlet/outlet from subcompartment to subcompartment
*) Diversion of major quantities of drainage water which comes from north of the CPP-project area through the Ichamati khal/branch
*) BRE breach control works
*) Sirajganj town inlet for sewage system
*) Field Level Watermanagement (no details ready yet)

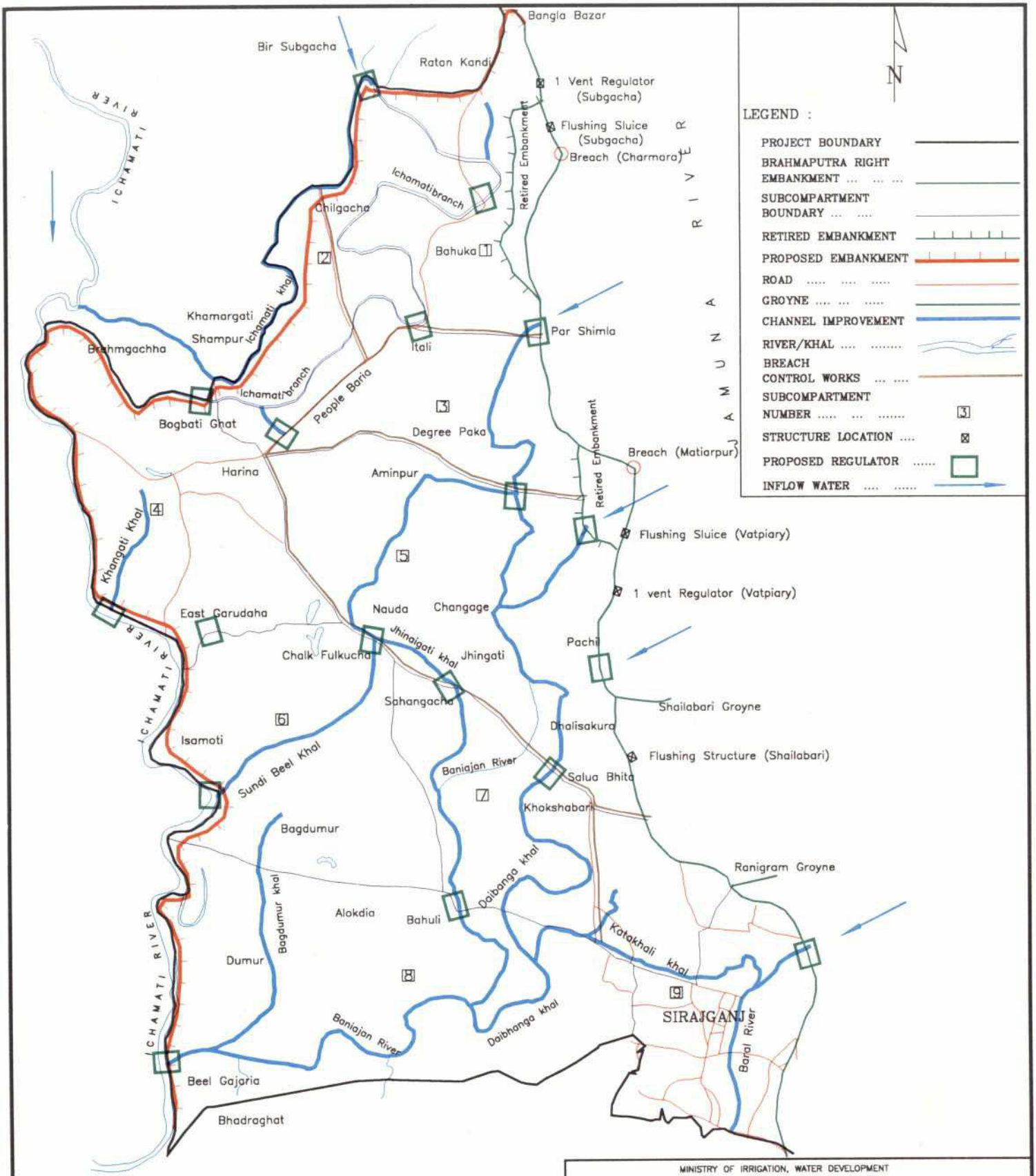
4.4.3 Option 2B

DESCRIPTION OPTION 2B:

COMPARTMENT SITUATION WITH ICHAMATI EMBANKMENT ALONG RIVERBANK

This option consists of measures for flood protection, improved drainage, construction and/or rehabilitation of (BRE) inlet structures, water retention, internal watermanagement control structures, BRE post-breach control and Ichamati embankment.

In this option an alignment is proposed which actually follows the Icahmati river bank closely (Figure 4.4).



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OPTION 2B : COMPARTMENTALIZATION WITH ICHAMATI EMBANKMENT (ALIGNMENT II)

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 4.4

5 AGRICULTURAL IMPACT AND DEVELOPMENT POTENTIAL

5.1 Regional Trend in Crops and Crop Production

The major economic benefit to be derived from the CPP are expected to accrue in the crop production sector, both through the crop intensification during monsoon and through prevention of crop damage. It is therefore pertinent to examine current trends in the crop and crop production sector to understand the context of the options under consideration.

The dominant crop is, of course, rice, followed by sugarcane and wheat. In terms of production of foodgrains, rice accounts for about 95% and wheat only 5%. Until recently, there was a national deficit in production of both types of foodgrains and both were imported. With continual bumper crop production nationally for the last 3 seasons, imports of rice have effectively ceased. Bangladesh is already exploring the market for possible export of fine quality rice grains.

For Sirajganj CPP project, crops and crop production is to an extent dependent on stability and security provided by the BRE (Brahmaputra Right Embankment). This BRE is one of the oldest in Bangladesh, originally started in 1963. Major rehabilitation was carried out from 1975 onwards. FAP-12 provides information on pre-BRE crops and cropping patterns of the region as:

> *Broadcast Aus, Broadcast Aus-Aman mixed, Jute, Oilseeds and Pulses (Lathyrus, Lentil, Chickpea, Blackgram and Mungbean) were the main crops grown during the pre-BRE period, both in terms of acreage and production. B. Aus, mixed B.Aus-Aman and Jute were grown in 85 per cent of the net cropped area. B. Aus and Jute were grown in March and harvested in June. Mixed B.Aus-Aman was also grown in March; the Aus was harvested in June leaving the Aman crop in the field to grow normally and be harvested in December. Local T.Aman covered about 61 per cent of the area while mixed B. Aus-Aman covered about 20 per cent of the net cropped area. Jute occupied about 30 per cent of the net cropped area. In winter, pulses, oilseeds, and some vegetables were grown and occupied about 30 per cent of the net cropped area. Crops grown and cropping patterns of the area were almost similar for similar types of land. However, growing of crops in low lands was dependent on the flood situation and drainage conditions. HYV Boro and T.Aman HYV were not grown in the area.*

Since 1975, agriculture in the Sirajganj area has changed dramatically. This was due primarily to a BRE provides protection and expansion of irrigation facilities in a protected environment.

The growth of minor irrigation is of fundamental importance to the overall growth in foodgrain output. There were only 22 DTWs and no STWs in Sirajganj area in 1976 (SIRDP, 1976). This has changed altogether. As expected, the BRE did successfully change the B.Aus/Jute-B.Aman-Rabi cropping pattern into a B.Aus/Jute-T.Aman pattern in the initial years and then into irrigated HYV Boro-HYV T.Aman. However,

the embankment breaches since 1984 have again caused uncertain and serious flood inundation, causing HYV T.Aman production to have declined in some areas. Another element that has added dimension to agriculture in the CPP area is the sand deposition through embankment breach and subsequent popularity of sugarcane as a substitute crop. The choice of a farmer for sugarcane limits the availability of land for any other crop including rice. Land suitability, market price and even available family labour situation guide a farmer regarding choice of sugarcane or not.

To analyse trend in crop sector of an area, the usual practice is to use BBS data. A 10-year data for Sirajganj Thana is not readily available from the local BBS office. However, DAE Sirajganj Sadar Office provided a rich information base to analyse the trend. These are presented in Tables 5.1, 5.2 and Figure 5.1.

5.2 Agricultural Development Potentials

The CPP, Sirajganj has immense potential for agricultural development. A farmer within the CPP area will be benefitted directly at least from four structural and non-structural interventions. These are :

a) Flood protection
b) Field level water management
c) Participation in water management
d) Institutionalization of water and agricultural management activities

It is these latter three factors that place the CPP at a distinct advantageous positions than other similar projects, mentioned in FAP 12 studies.

The BRE provides, in general, protection to the region including the CPP. Agriculture, since the construction of the BRE, has adjusted with the level of protection it provides. A description of these changes is evident is FAP 12 study and discussed below. The CPP assumes in its project planning a stable BRE to provide full protection to the area. CPP will ensure this level of protection through its own or coordinated effort. Hence the main contribution of the CPP to the farmer of the area will be prevention of flood damage to the crops normally grown. This will enable a further increase in cropping intensities to the limits of land suitability and price incentives. In the following sections the likely changes in cropping patterns based on the expected 'with project' water levels are analysed. Yield improvements, apart from prevention of losses through damage by flood waters, is not attributed directly to water level management. However, the CPP advocates an integrated agricultural development involving the local agricultural offices such as DAE, BADC, Credit Institutions, NGOs and the main actor, the farmer (outlined in Section 7). That is, the CPP has a crop husbandry improvement component. Such yield improvement will not only come from use of recently released HYVs or possibly better farming practices but also from farmer's participation and willingness for agricultural development. A grassroot level farmers participation in the CPP activities is planned.

Table 5.1: Area and production of different crop in Sirajganj* Sadar Thana for the last 9 years

Crops	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Aus HYV Planted (ha)	263	263	390	243	91	243	2185	1619	335
Harvested (ha)	NA**	20	390	243	91	81	2185	1498	11
Production (t)	-	50	980	540	202	180	8478	7982	24
Yield (t/ha)	-	0.19	2.51	2.22	2.22	0.74	3.88	4.93	0.07
Local Planted (ha)	9450	9450	9450	10927	8620	9470	4050	6475	2645
Harvcested (ha)	NA	7491	9450	10927	8179	7568	4050	5769	1273
Production (t)	NA	7404	17513	6750	5070	6358	6700	3626	1195
Yield (t/ha)	-	0.78	1.85	0.62	0.59	0.67	1.65	0.56	0.45
Aman HYV Planted (ha)	231	1041	2347	2088	2631	1538	4008	1416	1639
Harvested (ha)	231	0	2347	1238	0	0	4008	1295	1186
Production (t)	545	0	10382	3732	0	0	18765	4534	4395
Yield (t/ha)	2.36	0	4.42	1.79	0	0	4.68	3.20	2.68
Local Planted (ha)	7082	4582	7082	6835	2024	7266	3493	5471	4604
Harvested (ha)	7082	505	7082	4791	729	56	3493	3339	3547
Production (t)	8500	500	12645	5718	NA	63	6702	6911	7382
Yield (t/ha)	1.20	0.11	1.79	0.83	NA	0.01	1.92	1.26	1.60
Boro HYV Planted (ha)	4047	3136	3642	4856	6607	7082	11340	11291	13857
Harvested (ha)	4047	3136	3642	4856	6607	7082	11064	11271	11857
Production (t)	10600	8835	10080	15440	32400	34125	60856	59878	70329
Yield (t/ha)	2.62	2.82	2.77	3.18	4.90	4.82	5.37	5.30	5.08
Wheat Planted (ha)	4330	6922	6495	4759	4759	2388	4047	3642	NA
Production (t)	7770	12381	14040	NA	7149	5255	6000	7960	NA
Yield (t/ha)	1.79	1.79	2.16	NA	1.50	2.20	1.48	2.19	-
S.Cane Planted (ha)	NA	NA	NA	1214	NA	2833	3642	4694	4735
Harvested (ha)	NA	NA	NA	809	NA	2833	3642	4477	4735
Production (t)	NA	NA	NA	NA	NA	NA	NA	180000	221300
Yield (t/ha)	-	-	-	-	-	-	-	38.34	46.74
Jute Local Planted (ha)	1230	2226	2034	1214	1230	1230	340	1052	1095
Harvested (ha)	1179	1902	2034	1214	1179	1230	340	1005	877
Production (t)	1428	1974	2110	1533	1428	1489	423	1043	909
Yield (t/ha)	1.16	0.89	1.04	1.26	1.16	1.21	1.24	0.99	0.83
Tossa Planted (ha)	1484	1902	2054	1255	1484	1484	607	1416	1043
Harvested (ha)	270	1819	2054	890	270	1484	607	1093	557
Production (t)	336	1887	2841	1416	336	2053	945	1323	482
Yield (t/ha)	0.23	0.99	1.38	1.13	0.23	1.38	1.56	0.93	0.46
Mustard Planted (ha)	2036	3027	2113	NA	1801	3440	2064	2023	2436
Production (t)	1355	2387	1742	NA	1380	317	1386	1500	997
Yield (t/ha)	0.67	0.79	0.82	-	0.77	0.09	0.67	0.74	0.41
Potato Planted (ha)	206	364	322	NA	576	972	364	809	528
Production (t)	1414	2175	3035	NA	5446	8241	4261	3765	6971
Yield (t/ha)	6.86	5.96	0.42	-	9.45	8.48	11.71	4.65	13.20
Vegetables									
Summar Planted (ha)	NA	NA	NA	NA	405	NA	238	567	NA
Production (t)	NA	NA	NA	NA	NA	NA	4363	8625	NA
Yield (t/ha)	-	-	-	-	-	-	18.33	15.21	-
Winter Planted (ha)	NA	NA	NA	NA	607	1223	951	933	1601
Production (t)	NA	NA	NA	NA	4875	9970	12220	14972	26708
Yield (t/ha)	-	-	-	-	8.03	8.15	12.85	16.05	16.68

Source: DAE, Sirajganj Sadar Thana, April 1993. *Net Cultivable Area (NA) = 23860 ha. ** NA = Not available.

Table 5.2: Cropped area affected and production loss of different crops due to flood in Sirajganj Sadar Thana for the last 9 years

Crops	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Aus HYV Area (ha)	NA*	243	0	0	0	162	0	121	324
Loss (t)	-	717	-	-	-	478	-	357	956
Local Area (ha)	NA	1959	0	0	441	1902	0	706	1372
Loss (t)	-	1175	-	-	348	1350	-	579	1276
Aman HYV Area (ha)	0	1041	0	850	2631	1538	0	121	453
Loss (t)	-	3800	-	1581	9603	5614	-	54	439
Local Area (ha)	0	4077	0	2044	1295	7210	0	2132	1057
Loss (t)	-	6197	-	1635	NA	11680	-	788	32
Boro HYV Area (ha)	0	0	0	0	0	0	276	20	0
Loss (t)	-	-	-	-	-	-	1482	106	-
S.Cane Area (ha)	NA	NA	NA	405	NA	0	0	217	0
Loss (t)	-	-	-	NA	-	-	-	8318	-
Jute Tossa Area (ha)	1214	83	0	364	1214	0	0	324	486
Loss (t)	1511	86	-	579	1511	-	-	392	421
Local Area (ha)	51	324	0	0	51	0	0	47	218
Loss (t)	62	336	-	-	62	-	-	49	226

Source: DAE, Sirajganj Sadar Thana, April 1993. * NA - Not available.

5.3 Impact Findings of FAP 12's BRE- Kazipur Reach

The CPP is located within the reach described above. From that report, only impact on agriculture and livestock is mentioned here.

***Agriculture**: The BRE did successfully change the B.Aus/Jute-B.Aman - minor rabi crops cropping pattern into a B.Aus/Jute-T.Aman pattern in the initial years and then into irrigated HYV Boro-HYV T. Aman over a large area. There has been a 50 percent increase in T. Aman production and about a 10 percent increase in the total monsoon rice production due to the project.*

The embankment breaches since 1984 have again caused uncertain and serious flooding in 3 out of every 5 years, making T. Aman production vulnerable to flood damage. Consequently both acreage and output of T.Aman has declined due to flooding caused by breaches of the BRE.

In the pre-BRE situation B.Aman used to be followed by minor rabi crops such as pulses and oilseeds. In the post-BRE period there has been a significant reduction in the production of these crops. However this is largely due to the expansion of HYV Boro cultivation which is not related to BRE.

Figure 5.1: Trend in cropped areas

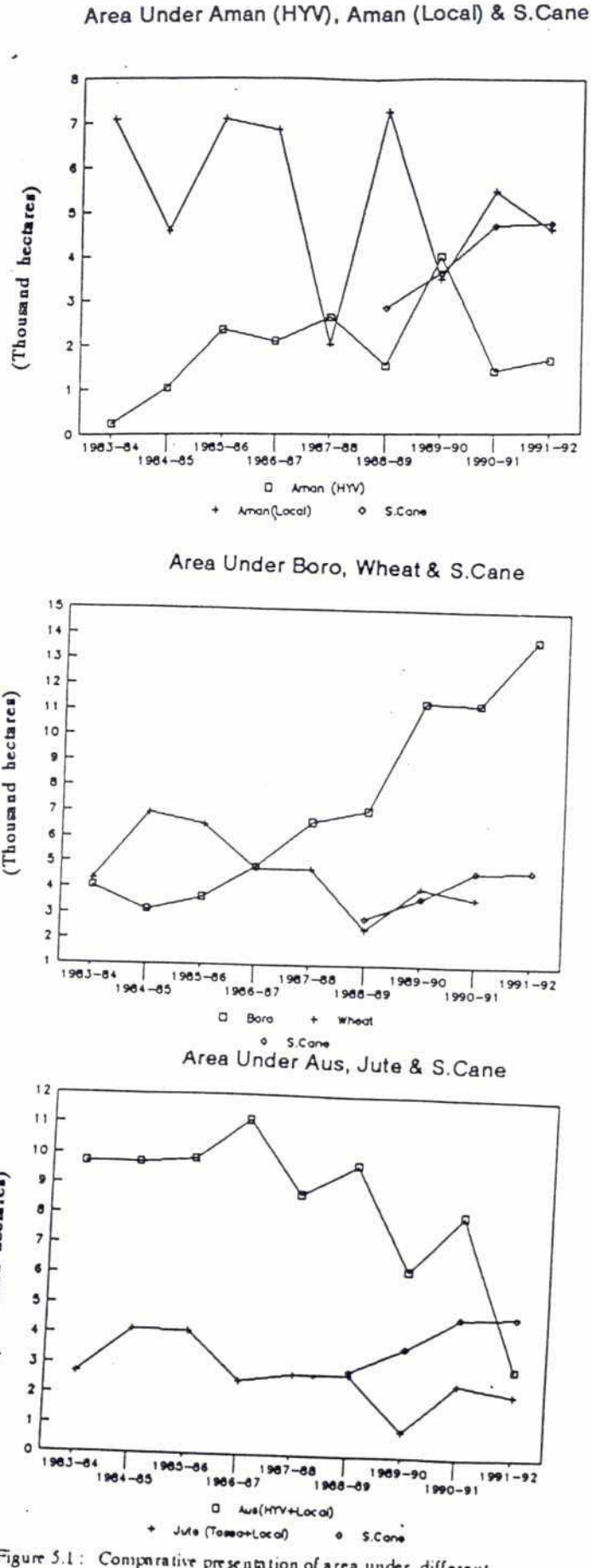


Figure 5.1 : Comparative presentation of area under different crops in Sirajganj Sadar Thana during 1983 – 84 to 1991 – 92.

(Source : DAE, Sirajganj Sadar)

The reemerged risk of annual flooding due to breaches and overtopping has seriously reduced the scope for monsoon season crop intensification, which requires a controlled water regime.

If full flood protection is ensured HYV T.Boro/T.Aus followed by HYV T.Aman could be grown covering about 75% of net cropped area and leading to higher production.

***Livestock:** The cattle population has seriously declined compared to the pre-project situation due to:*

i. abrupt and severe inundation caused by the embankment breaches/flooding.
ii. shortage of straw for fodder from HYV paddy production in the monsoon.

5.4 The Development Components

5.4.1 Compartmentalization and Water Management

The overall objective (FAP 20, ToR, 1990) is to establish appropriate water management systems for the development of protected areas so that criteria and principles for design, implementation and operation can be made available for the Action Plan. Specifically this will entail the testing of the compartmentalization concept in the field under real operating conditions, addressing all the relevant socio-economic, institutional and environmental issues, and trying out water control works and water management systems.

The Flood Policy Study (UNDP/GOB, May 1989) describes water management within compartmentalization concept as:

The principle of controlled flooding is to allow natural flooding of floodplain land to occur without causing damage to crops, fisheries, infrastructure and urban land. Within flood protection compartments, intake regulators and drainage sluices will be managed to control the timing, depth and duration of flooding on the land during the rainy season within the limits that ensure secure growing conditions for the major rice and other crops. The migration of fish to and from natural floodplain spawning and production areas must be allowed. To the extent possible in different agro-ecological regions, flooding will be managed to maximise opportunities for increased agricultural production through the use of high-yielding crop technologies.

Controlled flooding will be effected by opening and closing regulators and sluices in embankments at critical periods of the agricultural and fisheries calendars. In addition, submersible embankments may need to be provided around some deep floodplain basins to protect boro paddy against flooding by local run-off resulting from heavy pre-monsoon or early monsoon rainfall. In many compartments, internal minor rivers and khals will need to be desilted to improve their capacity to drain excess rainwater flooding during periods of heavy monsoon rainfall. Increased numbers and sizes of bridges and culverts may also be needed in road and railway

embankments to facilitate rapid drainage.

In years when excessive monsoon rainfall over a compartment coincides with high river levels, it will not be possible to evacuate excess floodwater through embankment drainage sluices for a number of days or weeks. This may cause extensive damage to crops by submergence. Consideration needs to be given to the feasibility of evacuating floodwater to neighbouring lower compartments or to providing pump drainage in such circumstances. Requirements will vary among compartments because of differences in their size, in their rainfall, topography, soils and associated cropping patterns, and in their populations and development infrastructure.

The conclusion is that compartmentalization spreads flooding to a larger area and to a shallower depth.

Water management in the compartmentalization concept has three tiers such as:
a) compartment level
b) sub-compartment level
d) field or chawk level

Compartment and sub-compartment level water management with its control and regulation mechanism has been dealt in project options described before. The most crucial part to a farmer will be chawk level water management. This management plan is yet to be detailed up and needs active participation of farmers operating lands on a chawk. However, methodology and approach to be adopted is described in Section 8.1 and Appendix F.

5.4.2 Irrigation

Irrigation development is likely to continue to its limit in areas free of flooding in the Boro rice season where groundwater is available. There is a steady conversion from DTWs to STWs because of its manageability and low investment cost. Last DTW was installed 4-5 years ago in the project area. Because of scarcity of surface water during dry season, LLPs are not popular. Manually operated tubewells have started to appear. There do not appear to be restriction on exploitable groundwater. Farmers complain about lower groundwater level but this is not at crisis point. Absence of deep-set STWs is indicative of annual recharge. Irrigation covers about 50% of the NCA at present. Sugarcane area not expanding further, another 10% of the NCA can be available for expansion. Expansion of irrigation will depend on the competition in what is now termed as a growing 'water market'.

5.4.3 Water Level and Land Type

Water level, soil and land types clearly dictate choice of crops and cropping pattern in a certain area. Based on 1:5 year water level at the base situation and crops planted, a desired water is calculated using area elevation curve. This desired water level, calculated on sub-compartment basis, optimizes the use of water on lands spread over the elevations. This desired water level was provided to the Modeller. With the

operation of compartmental and sub-compartmental control mechanism it is possible to regulate water flow in the project area. Mike11 model calculates water level in different 'with project' situation (Table 5.3). This water level is used to reclassify the existing land (Tables 5.4, 5.5 and Figure 5.2) and its capacity to grow certain crops and establish a cropping pattern. Apart from lowering peak water level, regulation of flood water will allow effective use of abundant monsoon water. Differences between desired and with project water levels will again be manipulated through simultaneous operation of sub-compartment and field level water control structures.

It is recognized that with the expansion of Sirajganj town and increased population in rural Sirajganj, a certain portion of the present NCA will be reduced. This is assumed to be 3% generally for all sub-compartments except for SCs 7, 8 and 9 where a 7% expansion is expected. For this, a readjustment in the NCA in with or without project situation is desirable but as the loss due to urbanization will be same in both cases, it is decided not to readjust the NCA. Changes in land types have been shown in Table 5.5. F_0 lands are subdivided into dry and area flooded to 30 cm.

5.4.3 Crop Selection

Sugarcane and Boro (HYV), like present time, will continue to dominate in with project situation. Direct seeded Aus will not exist because of economics and because of competition from more profitable crops. High yielding varieties of rice will dominate in monsoon season. Tailor-made HYVs, suitable for any water regimes, will be available in the field. Pulses, potato, mustard, spices and vegetables will expand. Their expansion will be more around settlement areas. Crops, like Kaun (*Setaria italica*) and Cheena (*Paniuum miliaceum*) will be on the increase. Cotton Development Board has set up new field offices in the CPP, Sirajganj area. Cotton will have limited expansion initially. Finally, Dhoncha (*Sesbania sesban*) may find its place around field boundaries or near homesteads as this is grown for fuel. Maize, sunflower, soybean may flourish with available processing facilities and market demand. Maize is already in demand for use as poultry feed. The CDP (Crop Diversification Programme) of the DAE has not yet started operation in the CPP Sirajganj area.

5.4.4 Expected Future Cropping Patterns

5.4.4.1 The Farmer's Criteria for Selecting Cropping Pattern

A farmer's decision to select a crop and cropping pattern and his ability for a rightful choice is often under estimated. We, as experts, try to dictate his selection of crop, varieties or even pattern. No prediction model can play with parameters a farmer considers for a single crop. Parameters are so varied, so location specific, so demand specific that an attempt to generalize a farmer's decision making process will be futile. However, a cause-effect relationship can be described, generally, as such:

a) Food security is of prime concern to a farmer. Profitability or not, his cropping pattern will go for a food crop. Rice, will undoubtedly be a crop.
b) Once food is secured, economics start to determine his choice of crop.
c) With availabile irrigation facilities, HYV Boro rice will continue to dominate the pattern of farmer's choice.

Table 5.3: Sub-compartmentwise 1:5 year water level for base, desired and with project situation for the CPP area, Sirajganj.

Sub-Compartment	Desired Water level (ha)	1:5 year Water Level (m)		
			With Project	
		Base	Option 1	Options 2A & 2B
1	13.00	12.31	12.44	12.44
2	13.00	13.43	13.43	12.44
3	12.50	12.96	12.43	12.43
4	12.50	13.38	13.38	13.02
5	12.20	12.98	12.43	12.43
6	12.10	12.98	12.98	12.43
7	12.00	12.44	12.30	12.30
8	12.00	12.43	12.43	12.33
9	11.80	12.40	12.30	12.30

*There will be certain external areas within the project, specially in SC4 (767 ha), SC6 (124 ha) and SC 8 (249 ha) in Option 2A with water levels in those areas as of 13.47, 13.06 and 12.70 m, respectively.

Source: Base and with project water levels are Mike11 model results. Desired water level is compution of the Agronomist.

Table 5.4: Sub-compartmentwise land types of the NCA in three different options of with project situation

SC	NCA	Option 1				Option 2A				Option 2B			
		F0	F1	F2	F3	F0	F1	F2	F3	F0	F1	F2	F3
1	750	727	23	0	0	727	23	0	0	727	23	0	0
2	709	160	224	265	60	524	131	39	15	524	131	39	15
3	893	651	206	36	0	651	206	36	0	651	206	36	0
4	1132	98	411	526	97	92	409	533	98	314	470	294	54
5	1656	1132	413	111	0	1132	413	111	0	1132	413	111	0
6	1196	119	462	541	74	526	257	343	70	537	464	195	0
7	1071	666	343	62	0	666	343	62	0	666	343	62	0
8	1981	722	774	458	27	698	780	472	31	868	716	381	16
9	191	105	80	6	0	105	80	6	0	105	80	6	0
Total	9579	4380	2936	2005	258	5121	2642	1602	214	5524	2846	1124	85
%		46	30	21	3	53	28	17	2	57	30	12	1

Source: CPP computation based on 1:5 year WL at different options.

Table 5.5: Land types of net cultivable area (9579 ha) in the CPP area, Sirajganj in base and with project situation

Land types	Base	With Project		
		Option 1	Option 2A	Option 2B
F0 Total	2913	4380	5121	5524
Dry	1322	2722	3496	3788
Flooded to 30cm	1591	1658	1625	1736
F1	3681	2936	2642	2846
F2	2715	2005	1602	1124
F3	270	258	214	85
Settlement	2212	2212	2212	2212
Waterbodies	266	266	266	266
Gross area	12057	12057	12057	12057

Source: CPP computations based on 1:5 water level.

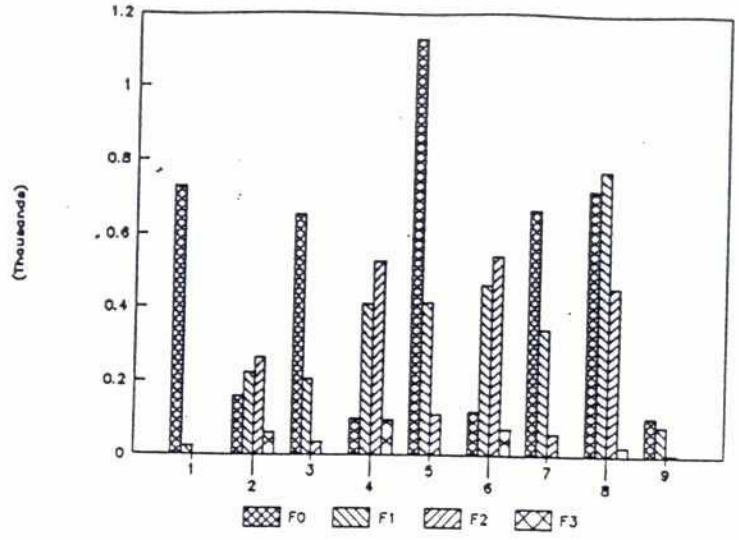
d) A growing 'water market' will ensure irrigation facilities at farmers field only to the limit of land suitability.
e) About 1/4th of the NCA along the BRE is now suitable only for sugarcane. Sugarcane cultivation is profitable with additions from more inter cropping.
f) Sugarcane is also approaching in areas suitable for rice. Economics and available family labour determine the choice between rice and sugarcane. With sugarcane field established from ratoons, it is much less labour intensive compared to two or more rice crops.
g) In monsoon, farmers desired rice will be a HYV. The CPP aims at control and efficient use of water. With the establishment of a compartment, farmers will go for HYV. Extension work is needed to offer farmers choice of newly released T.Aman HYVs.
h) The issue of growing three crops in a year, or five crops in two years, is often raised. Given suitable water levels, there is no agronomic reasons against it: a number of such patterns are being practiced on a small scale.
i) Farmers very often talk about diverse crops grown in early years. With pressure of rice off in dry season, farmers cherished goal of growing diverse crop will be possible. This needs good harvest of rice crop in Aman season.

5.4.2.2 Future Cropping Patterns

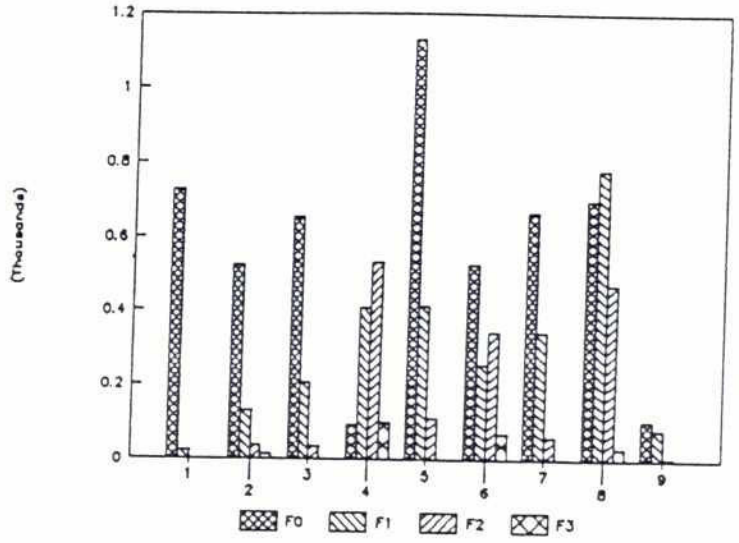
Future cropping patterns shall essentially remain the same as it is practiced now with certain modification. Single crop pattern will be replaced by double crop pattern.

Cropping pattern with B.Aus will cease. It is the reclassification of lands into new type such as F_1 lands turned into F_0 will ensure higher crop coverage and crop production. Triple crop pattern will be introduced even on F_0 land type. Future cropping pattern on different land types are shown in Table 5.6. Selected patterns are analysed for economic parameters. Triple cropping pattern of Boro (HYV)-T.Aman (HYV)-Mustard and double pattern of S.Cane+Potato provides highest gross margin and value added per hectare basis. Within reasonable investment, rice pattern of Boro (HYV)-T.Aman (HYV) is also lucrative.

Option 1



Option 2A



Option 2B

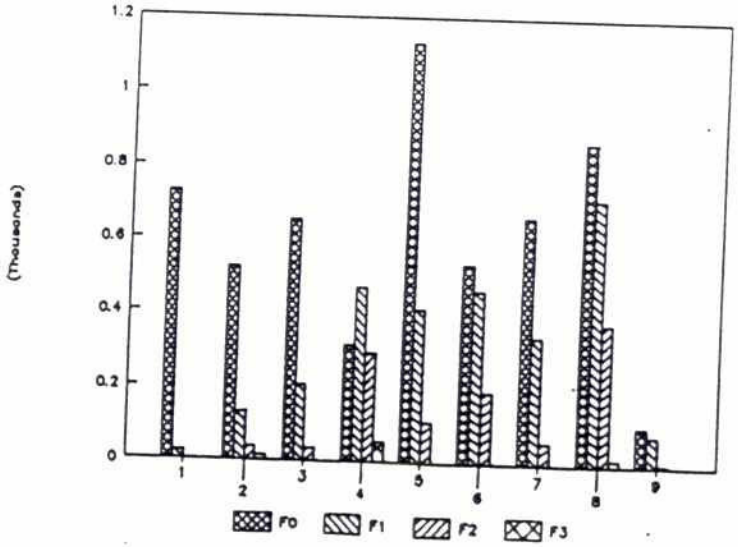


Fig 3.2 : A comparative presentation of Sub-Compartmentwise land types under different options, CPP Sirajganj

Table 5.6: Future cropping patterns (options 2A & 2B)* on different land types in the CPP, Sirajganj

Land type	Cropping Patterns
F_0	Boro (HYV) - T. Aman (HYV)
	Boro (HYV) - T. Aman (HYV) - Mustard
	Wheat - Jute
	Boro (HYV)-T.Aman(HYV)-Others
	Sugarcane + inter crops
	T. Aman (HYV) - Jute
	T. Aman (HYV) - Winter Vegetables
	Wheat - Jute - T.Aman (HYV)
	Others
F_1	Boro (HYV) - T. Aman (HYV) - Mustard
	Wheat - Jute - T. Aman (HYV)
	Jute - T. Aman (HYV) - Pulses
	Jute - T. Aman (HYV) - Others
	Boro (HYV) - T. Aman (HYV)
	Boro (HYV) - T. Aman (Local)
	Boro (HYV) - Mustard
	Boro (HYV) - Others
	T.Aman (HYV)-Winter Veg.
	T.Aman (HYV)-Jute
	Boro(HYV)-T.Aman(HYV)-Others
	Wheat - Jute
	Sugarcane + inter crops
	Others
F_2	Boro (HYV) - T. Aman (Local)
	Boro (HYV) - Mustard
F_3	Boro (HYV) - Mustard
	Boro (HYV)

*In option 1, cropping patterns using B.Aus will also be used

5.5 Crop yield

Prediction of crop yield in with project situation is the most sensitive factor in the estimation of the agricultural benefits. Studying trends in crop yields is particularly complicated because it is necessary to assess the progress of new varieties, changes in input use, climate influence and other factors.

Estimation of yields for different crops grown in the area is shown in Table 5.7. Base situation yield is from a landuse survey. Without project yield accomodates nine-year trend of Sirajganj Sadar Thana which is in the range of 0-3.8% for different crops. In estimating with project yield, a consideration is given on regional yield estimates and

projections such as FAP 2. With project yield estimated assumes implementation of structural interventions such as compartment development with control structures and field level water management and non-structural interventions such as active DAE participation and institutionalization of Water Users Groups explained in Chapter 7).

The expected increases in yields are modest and remain within the potentials identified. The average increase in damage free paddy yield will be 0.13 t/ha for the without project situation and 0.40 t/ha for the options in with project situation. FAP 2 has estimated an increase of 0.58 t/ha in future situation.

Table 5.7: Yield (t/ha) of crops grown in the CPP area, Sirajganj

Crops	Sirajganj Thana		Regional (FAP 2)		CPP Projections				
	Damage free	Damaged	Present	Future	Base Situation		Without Project		With Project (all options)
					Damage free	Damaged	Damage free	Damaged	Damage free
Rice									
B. Aus	1.75	0.61	1.60	1.68	1.28	0.79	1.32	0.81	1.32
T.Aman (Local)	1.55	0.32	2.25	3.26	1.35	0.40	1.38	0.41	1.97
T.Aman (HYV)	3.67	0.45	3.75	4.31	3.17	1.00	3.27	1.03	3.79
Boro (HYV)	4.10	-	4.50	5.18	4.41	4.00	4.58	4.15	4.73
Wheat	1.87	-	1.70	1.79	2.44	2.00	2.47	2.02	2.87
Jute	1.53	1.00	1.70	1.79	1.43	0.98	1.43	0.98	1.78
Sugarcane	42.54	-	42.00	44.10	50.20	47.54	50.20	48.40	52.18
Pulses	NA	NA	0.80	0.84	1.03	-	1.05	-	1.12
Potato	8.72	-	10.00	10.50	9.79	-	9.97	-	10.68
Mustard	0.70	-	0.70	0.74	0.79	-	0.79	-	0.85
Spices	NA	NA	NA	NA	1.31	-	1.35	-	1.75
Vegetables + others	NA	NA	NA	NA	4.76	-	4.90	-	5.04

Sources: Thana = DAE, Sirajganj Sadar Thana, average of 9 years between 1983-84 to 1991-92
Regional = FAP-2 Estimates
Base = Landuse Survey, CPP, January-April 1993
Without Project = Estimation based on trend with yield increase in the range of 0-3.8%
With Project = Full implementation of control structures + internal water management + WUG participation + active DAE involvement. Attainable in 10 years.

5.6 Impact on land utilization, area and production

A comparative presentation of land utilization in different project situations is presented in Table 5.8. Triple cropped area will rise sharply with proportionate decrease in single cropped area. This will result in cropping intensity changes from 184 in base situation to 191 in otpion 1, 205 in option 2A and 206 in option 2B. These changes in land utilization will occur from changes in land types (described in Table 5.4) and cropping patterns. Cropping patterns by land types for different project situations and options are shown in Tables 5.9 to 5.12. A summary on crop hectarage and production is presented in Table 5.13.

There will be gradual increase in areas for a number of crops except wheat and jute. Sugarcane area will still increase. Govt. of Bangladesh is getting up a sugar mill in Belkuchi, adjacent to the CPP area. At present, the CPP area is in non-mill sugarcane zone. A favourable rice/non-rice ratio will be achieved. Extensive use of HYVs of paddy will occur. Dependency on Boro will be reduced in paddy production but not in area. There will be substantial increase in Aman rice production.

Table 5.8: A comparative presentation of land utilization in the CPP area, Sirajganj

	Base	Without project	With Project		
			Option 1	Option 2A	Option 2B
Gross area (ha)	12057	12057	12057	12057	12057
NCA (ha)	9579	9579	9579	9579	9579
Temporarily fallow (ha)	303	214	200	145	132
Single crop area	1068	999	845	45	40
% of NCA	11.1	10.4	8.8	0.5	0.4
Double crop area	8022	8175	8124	8544	8499
% of NCA	83.7	85.3	84.8	89.2	88.7
Triple crop area	186	192	410	845	908
% of NCA	1.9	2.0	4.3	8.8	9.5
Cropped area	17670	17925	18323	19670	19760
Cropping intensity(%)	184	187	191	205	206

Source: Project Computations

Table 5.9: Cropping pattern by land type in the CPP area in Sirajganj, base situation

Pattern	Land Types				Total
	F_0	F_1	F_2	F_3	
Single					
Sugarcane	740	-	-	-	740
Boro (HYV)	-	-	-	258	258
T. Aman (HYV)	25	-	-	-	25
Others	32	12	-	-	44
Total	797	12	-	258	1067
Double					
S.Cane + Pulses	286	220	516	-	1022
S.Cane + Potato	211	419	149	-	779
S.Cane + Mustard	320	105	321	-	746
S.Cane + Spices	303	-	-	-	303
S.Cane + Winter Vegetables	38	-	-	-	38
S.Cane + Others	83	-	-	-	83
Boro (HYV) - T.Aman (local)	-	1427	1323	12	2762
Boro (HYV) - T.Aman (HYV)	236	804	-	-	1040
Boro (HYV) - Mustard	-	100	253	-	353
Boro (HYV) - Others	-	13	-	-	13
Wheat - Jute	519	336	-	-	855
B.Aus - Others	10	-	-	-	10
T. Aman (HYV) - Jute	17	-	-	-	17
T. Aman (HYV) - Winter Vegetables	1	-	-	-	1
Total	2024	3424	2562	12	8022
Triple					
Boro(HYV)-T.Aman(HYV)-Mustard	-	75	-	-	75
Wheat-Jute-T.Aman (Local)	-	-	26	-	26
Wheat-Jute-T.Aman(HYV)	-	63	-	-	63
Jute-T.Aman(HYV)-Pulses	-	5	-	-	5
Jute-T.Aman(HYV)-Others	-	1	-	-	1
B.Aus-T.Aman(HYV)-Wheat	-	9	-	-	9
B.Aus-T.Aman(Local)-Wheat	-	3	-	-	3
B.Aus-T.Aman(Local)-Mustard	-	4	-	-	4
Total	-	160	26	-	186
Temporarily Fallow	92	85	127	-	304
NCA	2913	3681	2715	270	9579

Source: Based on Landuse Survey, CPP, 1993

Table 5.10: Cropping pattern by land type in the CPP area in Sirajganj, with project situation, Option 1

Pattern	Land Types				Total
	F_0	F_1	F_2	F_3	
Single					
Sugarcane	420	-	-	-	420
Boro (HYV)	-	-	-	233	233
T.Aman (HYV	192	-	-	-	192
Total	612	-	-	233	845
Double					
S.Cane + Pulses	722	335	-	-	1057
S.Cane + Potato	462	470	-	-	932
S.Cane + Mustard	384	400	-	-	784
S.Cane + Spices	400	-	-	-	400
S.Cane + Winter Veg.	32	-	-	-	32
S.Cane + Others	166	24	-	-	190
Boro(HYV)-T.Aman(HYV)	920	520	-	-	1440
Boro(HYV)-T.Aman(Local)	-	297	1749	-	2046
Boro(HYV)-Mustard	-	313	203	-	516
Boro(HYV)-Winter Veg.	42	-	-	-	42
Wheat - Jute	332	303	-	-	635
B.Aus - Others	16	-	-	-	16
Jute - T.Aman (Local)	-	27	-	-	27
Jute - T.Aman (HYV)	7	-	-	-	7
Total	3476	2689	1952	-	8124
Triple					
Boro(HYV)-T.Aman(HYV)-Mustard	40	36	-	-	76
Boro(HYV)-T.Aman(HYV)-Pulses	91	8	-	-	99
Boro(HYV)-T.Aman(HYV)-Others	32	20	-	-	52
Jute-T.Aman(Local)-Pulses	-	13	-	-	13
Wheat-Jute-T.Aman(HYV)	60	110	-	-	170
Total	223	187	-	-	410
Temporarily Fallow	62	60	53	25	200
NCA	4380	2936	2005	258	9579

Source: Project Computation

Table 5.11: Cropping pattern by land type in the CPP area in Sirajganj, with project situation, Option 2A

Pattern	Land Types				Total
	F_0	F_1	F_2	F_3	
Single					
Boro (HYV)	-	-	-	45	45
Total	-	-	-	45	45
Double					
S.Cane + Pulses	1016	167	-	-	1183
S.Cane + Potato	743	300	-	-	1043
S.Cane + Mustard	821	57	-	-	878
S.Cane + Spices	502	-	-	-	502
S.Cane + Winter Veg.	98	-	-	-	98
S.Cane + Others	213	-	-	-	213
Boro(HYV)-T.Aman(HYV)	1098	744	-	-	1842
Boro(HYV)-T.Aman(Local)	-	299	1201	112	1612
Boro(HYV)-Mustard	-	165	366	47	578
Boro(HYV)-Potato	-	113	-	-	113
Boro(HYV)-Winter Veg.	-	72	-	-	72
T.Aman(HYV)-Jute	30	-	-	-	30
T.Aman(HYV)-Winter Veg.	5	-	-	-	5
Wheat - Jute	221	164	-	-	375
Total	4737	2081	1567	159	8544
Triple					
Boro(HYV)-T.Aman(HYV)-Mustard	60	97	-	-	157
Boro(HYV)-T.Aman(HYV)-Pulses	127	78	-	-	205
Boro(HYV)-T.Aman(HYV)-Others	76	31	-	-	107
Wheat-Jute-T.Aman(HYV)	84	265	-	-	349
Jute-T.Aman(HYV)-Pulses	-	13	-	-	13
Jute-T.Aman(HYV)-Others	-	14	-	-	14
Total	347	498	-	-	845
Temporarily Fallow	37	63	35	10	145
NCA	5121	2642	1602	214	9579

Source: Project Computation

Table 5.12: Cropping pattern by land type in the CPP area in Sirajganj, with project situation, Option 2B

Pattern	Land Types				Total
	F_0	F_1	F_2	F_3	
Single					
Boro (HYV)	-	-	-	40	40
Total	-	-	-	40	40
Double					
S.Cane + Pulses	1096	180	-	-	1276
S.Cane + Potato	586	324	-	-	910
S.Cane + Mustard	886	61	-	-	947
S.Cane + Spices	542	-	-	-	542
S.Cane + Winter Veg.	106	-	-	-	106
S.Cane + Others	230	-	-	-	230
Boro(HYV)-T.Aman(HYV)	1400	801	-	-	2201
Boro(HYV)-T.Aman(Local)	-	322	848	45	1215
Boro(HYV)-Mustard	-	178	252	-	430
Boro(HYV)-Potato	-	122	-	-	122
Boro(HYV)-Winter Veg.	-	78	-	-	78
Jute - T.Aman(HYV)	32	-	-	-	32
T.Aman(HYV)-Winter Veg.	5	-	-	-	5
Wheat - Jute	228	177	-	-	405
Total	5111	2243	1100	45	8499
Triple					
Boro(HYV)-T.Aman(HYV)-Mustard	63	105	-	-	168
Boro(HYV)-T.Aman(HYV)-Pulses	137	84	-	-	221
Boro(HYV)-T.Aman(HYV)-Others	82	33	-	-	115
Wheat-Jute-T.Aman(HYV)	91	286	-	-	377
Jute-T.Aman(HYV)-Pulses	-	12	-	-	12
Jute-T.Aman(HYV)-Others	-	15	-	-	15
Total	373	535	-	-	908
Temporarily Fallow	40	68	24	0	132
NCA	5524	2846	1124	85	9579

Source: Project Computation

Table 5.13: Summary of impact on crop hectareage and production in the CPP area, Sirajganj

	Base Situation		Without Project		With Project					
	Area(ha)	Production (t)	Area(ha)	Production (t)	Option 1		Option 2 A		Option 2B	
					Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)
Total rice area	8558	23444	8639	25109	8642	33114	9065	35830	8952	35992
Boro (HYV)	4501	19093	4501	20544	4504	21282	4731	22355	4591	21693
T.Aman (HYV)	1236	1841	1236	1932	2036	7708	2722	10305	3146	11908
T.Aman (Local)	2795	2480	2879	2605	2086	4103	1612	3170	1215	2390
Aus (Local)	26	30	23	28	16	21	0	0	0	0
Wheat	956	2321	946	2355	805	2307	724	2075	782	2241
Sugarcane	3711	183666	3768	191086	3815	199052	3917	203436	4011	208312
Jute	967	1371	948	1344	852	1512	781	1386	841	1493
Potato	785	7685	793	8041	932	9954	1156	12346	1032	11021
Mustard	1178	931	1202	978	1376	1170	1613	1371	1545	1313
Pulses	1027	1058	1027	1111	1169	1309	1401	1569	1510	1691
Veg.+Spices	349	1662	356	1784	474	2332	677	3410	731	3682
Others	138	-	246	-	260	-	334	-	360	-
Ratios										
Rice/Non-rice crop	1 :	1.06	1 :	1.07	1 :	1.12	1 :	1.17	1 :	1.21
Local/HYV rice	1 :	2.03	1 :	1.98	1 :	3.11	1 :	4.62	1 :	6.37
Boro/T.Aman rice	1 :	0.90	1 :	0.91	1 :	0.92	1 :	0.92	1 :	0.95
Dependency on Boro	0.52	0.81	0.52	0.82	0.52	0.64	0.52	0.62	0.51	0.60

Source: Project Computation

5.7 Input requirement in with project situation

In situations of increased cropping intensity and higher yield, input requirement will increase also. This is presented in Table 5.14. Additional paddy seed requirement will range from 7 - 23 tons. Additional requirements will be 430-699 tons for Urea, 140-390 tons for TSP and 97-174 tons for MP.

Table 5.14: Input use and requirements (tons) base, without project and in all options of with project situations in the CPP area, Sirajganj

Situation	Paddy seed	Fertilizer				Plant protection
		Urea	TSP	MP	Gypsum	
Base	246	2755	1653	1097	335	7.9
Without project	247	2786	1676	1113	336	8.0
With project						
Option 1	253	3185	1783	1194	411	9.4
Option 2A	269	3421	2033	1261	448	10.5
Option 2B	269	3454	2043	1271	453	10.5

Source: Project Computation

6 AGRICULTURAL ECONOMICS

6.1 Farm Size

Average farm size and number of households within the Sirajganj Thana is presented in Table 6.1. In a total of 39032 households, 27168 are farm households. The average farm size of farm households is 0.57ha. 53% small farm households occupy only 33.7% of the total operated land whereas 2.2% large farm households occupy 19.6% of the total operated land. It is assumed that the % age will follow the same pattern in the CPP Sirajganj area.

Table 6.1: Farm size and number of households in the Sirajganj Sadar Thana

Farm Size (ha)	Households		Operated Area (ha)		Average Farm Size (ha)
	Number	%	Area	%	
Non-Farm	11864	30.4	941	4.2	-
Small <0.2	7648	19.6	751	3.4	0.10
0.21-0.4	4466	11.4	1281	5.8	0.29
0.41-0.6	3777	9.7	1834	8.3	0.49
0.61-1.00	4559	11.7	3581	16.2	0.79
Medium 1.01-3.00	5874	15.0	9420	42.5	1.60
Large >3.00	844	2.2	4348	19.6	5.15
Total	**39032**	**100.0**	**22156**	**100.0**	-

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

6.2 Markets

In the chain of agricultural production system, market facilities is crucial to producers and consumers alike. Farm price of agricultural produces very often depends on the accessibility to and from a market. Sirajganj, being a very old trade centre, has a strong network of markets, hats and bazars (Table 6.2).

6.3 Crops Prices

In the crop production economics, crop price is the decisive factor. Information regarding average market price of selected commodities were collected (Tables 6.3 to 6.5). The price of jute is fluctuating. The price of milk and meat is stable. However, the price of rice, paddy and wheat is increasing over the years. Seasonal variation in Aman paddy and rice price vary around 80% and respective seasonal price variation is 31% and 44% for Boro HYV paddy and rice (Table 6.6).

Table 6.2: Sub-compartment-wise market information in the CPP area, Sirajganj

Sub-Compartment	Market Name	Attendance (000)	Market days
1	Subhagacha	1.5 - 2.0	Wednesday
	Bahuka	1.5	Friday & Monday
	Ratankandi	25.0	Wednesday
	Banglabazar	10.0	Friday & Monday
2	Gazaria	0.5 - 1.0	Saturday & Tuesday
3	Sonali Bazar	0.5 - 1.0	Friday & Monday
	Junkail	0.7 - 1.0	Saturday
	Baliaghugli	0.5 - 0.7	Sunday & Thursday
	Baroital	0.5 - 0.6	Saturday & Tuesday
4	Bagbati	20.0	Sunday & Thursday
	Brahmagacha	5.0	Saturday & Tuesday
5	Hat Changacha	8.0 -10.0	Wednesday & Saturday
	Ziamore	3.0 - 5.0	Friday & Monday
	Bhatpiary	8.0 -10.0	Wednesday & Saturday
	Brahmanbaria	0.4 - 0.5	Sunday & Friday
6	Alampur	0.5	Daily
	Hat Pangashi (adjacent)	10.0	Saturday & Tuesday
7	Gunaigati	9.0 -10.0	Saturday & Tuesday
8	Sialkhole	5.0 - 6.0	Twice in a week
	Bahuli	5.0 - 6.0	Twice in a week
	Chandidasgati	2.0 - 3.0	Monday
	Bazar Bhadraghat	3.0 - 3.5	Twice in a week
9	Bara Bazar	8.0 -10.0	Daily
	Kalibari	3.0 - 4.0	Daily
	Bahirgola	1.5 - 2.0	Daily

Source: Needs Assessment Survey, CPP, March 1993 and District Marketting Office, Sirajganj.

Table 6.3: Average market price (TK.) of selected commodities at the Sirajganj market during 1987-88 to 1991-1992

Item	Unit	1987-88	1988-89	1989-90	1990-91	1991-92	Remarks
Paddy	Quintal	482	520	591	628	656	increasing
Rice	"	905	860	888	985	1068	increasing
Wheat	"	606	635	680	737	831	increasing
Pulse(Musur)	"	1893	1995	1997	2456	2590	increasing
Mustard	"	3717	1358	1718	1442	1695	fluctuates
Onion	"	1137	1023	872	1515	1196	fluctuates
Jute	"	697	550	716	710	619	fluctuates
Potato	"	469	622	548	505	565	fluctuate
Egg	100s	176	190	198	205	209	increasing
Milk	litre	13	14	14	14	14	stable
Meat	Kg	41	42	44	46	45	stable
Fertilizers							
Urea	Quintal	470	473	467	481	500	increasing
TSP	"	490	493	483	538	623	increasing
MP	"	400	393	392	362	475	increasing

*Source: District Marketing Office, Sirajganj, 1993.

Table 6.4: Average monthwise market price (Tk/Kg) at Sirajganj for 1992

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rice Aman(Local)	13.5	14.0	14.0	15.5	17.0	17.0	-	-	16.0	15.0	-	10.7
(Medium)	12.5	13.0	13.0	14.0	-	-	-	-	-	-	10.3	10.0
(HYV)	11.0	11.5	11.8	11.8	-	-	-	-	-	-	8.5	7.6
Boro(HYV)	-	-	-	11.5	10.3	10.3	11.5	11.0	10.5	9.5	8.5	8.1
Scented	20.0	21.0	21.0	22.0	22.0	24.0	24.0	24.0	24.0	26.0	30.0	28.0
Flour(White)	10.0	12.0	8.5	9.5	8.5	8.5	9.0	9.0	9.0	9.0	9.0	9.0
Pulses(Musur)	28.0	28.0	26.0	26.0	28.0	28.0	28.0	27.0	27.0	28.0	28.0	28.0
(Mug)	30.0	28.0	28.0	32.0	32.0	32.0	32.0	30.0	30.0	34.0	32.0	34.0
Oils(Mustard)	54.0	54.0	56.0	56.0	56.0	56.0	56.0	56.0	56.0	54.0	54.0	54.0
(Soybean)	40.0	40.0	40.0	40.0	40.0	40.0	44.0	40.0	40.0	39.0	38.0	38.0
Onion	8.0	6.0	8.0	8.0	10.0	10.0	10.0	10.0	10.0	9.0	10.0	8.0
Green Chilli	20.0	16.0	10.0	12.0	8.0	8.0	4.0	8.0	6.0	10.0	16.0	8.0
Corriander	20.0	22.0	22.0	24.0	32.0	32.0	32.0	28.0	24.0	24.0	24.0	24.0
Potato(New)	5.0	4.0	-	-	-	-	-	-	-	-	-	7.0
(Old)	-	-	6.0	8.0	10.0	10.0	12.0	10.0	10.0	10.0	10.0	-
Sugar	26.0	26.0	26.0	26.0	26.0	26.0	28.0	26.0	26.0	30.0	26.0	27.0
Gur(S.Cane)	14.0	19.0	18.0	21.0	24.0	24.0	28.0	28.0	20.0	15.0	13.0	13.0
(Date)	15.0	17.0	18.0	20.0	-	-	-	-	-	-	22.0	15.0
Salt	7.0	7.0	7.0	7.0	6.5	6.5	7.0	7.0	6.0	6.0	6.0	6.0

Source: District Marketing Office, Sirajganj, 1993.

Table 6.5: Average monthwise market price (Tk/Kg) of livestock and poultry products at Sirajganj for 1992

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Milk (litre)	14	14	14	14	14	14	14	14	14	14	14	12
Butter	240	240	240	220	220	240	240	240	240	240	240	240
Fowls	50	50	50	55	60	60	60	60	60	60	60	60
Chicken	55	55	55	60	65	65	65	65	65	65	65	65
Ducks	36	36	36	36	40	40	45	40	40	40	40	40
Beef	40	40	40	45	50	50	50	50	50	50	50	50
Mutton	70	70	70	75	75	80	80	80	80	80	80	80
Eggs (4s)	10	9	8	8	9	9	9	10	10	11	10	10
Fishes												
Ruhi	80	80	85	90	90	90	100	-	-	-	75	75
Katla	75	75	80	85	85	85	90	-	-	-	70	70
Koi	65	65	65	65	-	-	-	-	-	80	80	90
Telapia	36	36	36	40	40	40	40	-	-	35	34	40

Source: District Marketing Office, Sirajganj, 1993.

Table 6.6: Seasonal variation in average monthwise wholesale price (Tk/Quntal) paddy and rice at Sirajganj market for 1992

Month	Paddy		Rice	
	Aman (Local & HYV)	Boro HYV	Aman(Local & HYV)	Boro HYV
January	695	-	1194	-
February	775	-	1237	-
March	775	-	1248	-
April	-	630	1327	1110
May	-	590	1600	985
June	-	590	1600	985
July	-	670	-	1100
August	-	665	-	1060
September	-	670	1540	1060
October	-	580	1440	900
November	428	510	900	820
December	536	-	902	770
Mean	642	613	1299	977
Highest in % of lowest	181	131	178	144

Source: Computation on the basis of price supplied by District Marketing Officer, Sirajganj, 1993

6.4 Labour Wages

Wage rate of seasonal peak period and lean period ranges between Tk.30-40 and Tk.15-25, respectively (Table 6.7). Meal is usually not included. Seasonal peak period is of short duration of 15 days during harvesting and transplanting. Lean season wage rate is higher in areas around or near Sirajganj town. It is only Tk.15 per day without meal in areas of sub-compartments of 1 to 3 in the northern side of the compartment near the BRE.

Table 6.7: Sub-compartment-wise wage rate of daily and agricultural labourers in the CPP area, Sirajganj

Sub-Compartment	Peak Season	Lean Season
SC1	30 Tk.	15 Tk.
SC2	40 Tk. (+ one meal occassionally)	15 Tk.
SC3	35 Tk.	15 Tk.
SC4	40 Tk.	20 Tk.
SC5	38 Tk.	23 Tk.
SC6	35 Tk.	25 Tk.
SC7	37 Tk. (+ meal)	20 Tk. (+ meal)
SC8	40 Tk.	25 Tk.

Source: CPP, Need Assessment Survey, February - April, 1993.

6.5 Input Costs

Fertilizer

Since early 1989 private distributors have been able to buy urea fertilizer from domestic factories at the same price as that charged to BADC. They are also allowed to purchase directly from ships delivering imported fertilizers, mainly Triple Superphosphate (TSP) and Muriate of Potash (MP). Since the opening-up of competition, the private sector has managed to market over 85 per cent of total urea, and 70 per cent of all fertilizers.

Sirajganj had been the Primary Distribution Point (PDP) of fertilizers of BADC serving three thanas: Sadar, Kazipur and Belkuchi. Fertilizer sale from this point was closed about two years ago. However, BADC still maintains two empty godowns of total 5000 tons capacity. Average monthwise market price of fertilizers is shown in Table 6.8. With intensive use of fertilizers and HYV Boro cultivation, the price of fertilizer is increasing annually.

Table 6.8: Average monthwise market price (Tk/Kg) of fertilizers at Sirajganj for 1992

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Urea	5.2	6.0	5.5	5.5	5.2	5.3	5.3	-	5.5	5.4	5.5	5.3
TSP (Granular)	7.0	7.0	7.0	7.0	7.0	7.0	7.2	-	8.2	8.0	8.5	8.5
(Powder)	6.0	6.0	-	-	-	-	-	-	-	-	-	-
MP	6.0	6.0	6.0	6.0	5.8	5.8	6.0	-	7.2	7.3	7.8	7.7
Gypsum	3.0	3.0	3.0	3.2	3.0	3.0	3.2	-	3.0	3.0	3.3	4.0
Zinc(White)	42.0	42.0	-	-	-	-	-	-	-	-	-	-
(Black)	22.0	22.0	19.0	20.0	18.0	18.0	18.0	-	22.0	24.0	25.0	30.0

Source: District Marketing Office, Sirajganj, 1993.

Seeds

Farmers generally use their own seed for local rice and only 15 per cent purchase seed from private suppliers (13 per cent) or BADC (2 per cent) for HYV crops. Supplies of good quality seed are scarce and this imposes a considerable constraint on the improvement of productivity. Problems also exist with regard to the availability of varieties which can safeguard the improvements in productivity which have been achieved over the past few years.

Recommended seeds of high yielding varieties of any crop including vegetables are sold through BADC. Seeds of HYVs sold through BADC including price is shown in Table 6.9. Price of paddy seed is much lower in the open market. Seeds of HYV Boro is sold only at Tk.7/kg, however, without the level of quality and purity. Seed sale over the last five years through BADC show a decreasing trend in case of paddy, wheat and jute but an increasing trend for potato and mustard (Table 6.10).

Draft Animals

These are generally available and virtually all farmers use them for land preparation and in many cases for threshing rice and transportation. The daily cost of hiring a working animal is between Tk.15 and 20 exclusive of the cost of operator. The total cost of animal plus operator of land preparation is around Tk.2,500 per hectare. Operators generally receive higher than average daily workers.

Agro-Chemicals

Farmers in the CPP pilot area use only minor quantities of agro-chemicals on the crops. Pest and disease attacks are generally not of major significance and there is little routine application of chemicals; farmers usually apply these only when the problems arise.

Table 6.9: Seeds of high yielding varieties sold through BADC, Sirajganj Sadar during 1991-92

Crop	Varieties	Price (Tk/Kg)
Paddy		
- Aus	BR14 (Gazi), BR21 (Niamat)	12.50
- Boro	BR1 (Chandina), BR14 (Gazi)	12.50
- Aman	BR3 (Biplab), BR11 (Mukta), BR22 (Kiron)	12.50
Wheat	Sonalika, Kanchan	13.00
Jute - Deshi	CVL1, D154	
- Tossa	O4	
Potato	Kardinal grade A, Kardinal grade B	
Maize	Suvra, Barnali	
Mustard	Sampad, SS75, Tori7	23.00

Source: BADC Seed Office, Sirajganj Thana.

Table 6.10: HYV seed sale (in kg) through BADC, Sirajganj Sadar during the last 5 years

Crop	1991-92	1990-91	1989-90	1988-89	1987-88
Rice					
- T. Aman	5790	11920	1190*	30000	17830
- Boro	1200	300	740	7860	2080
- Aus	150	60	480	800	550
Total:	7140	12280	2410	38660	20460
Wheat	30000	27000	20260	60620	33650
Potato	1040	1040	1040	560	720
Jute	361	-	977	2567	2513
Vegetables	27	-	22	45	55
Mustard	565	400	371	80	105

*Low sale due to supply of seed as relief item

Source: BADC Seed Office, Sirajganj Thana.

6.6 Agro-economic analysis

This provides an economic analysis of components related to crops and crop production in base, without project and in three options of with project situations of the CPP area, Sirajganj. The result of this analysis is self-explanatory and solely presented in Tables elaborated as:

Tables 6.12 and 6.13: A comparative presentation of land utilization, crop hectareage and production.

Tables 6.14 and 6.15: Agricultural prices in (Tk/Kg) and financial price conversion factors used in this analysis following guidelines for Project Assessment (FPCO, 1992).

Tables 6.16 to 6.20: Economic parameters in economic prices of base, without project and in three options of with project situation. Important calculations such as gross margins and value added are shown.

Table 6.21: A comparative economic analysis of base, without project and with project (all three options) is presented. Important calculations such as total investment, investment per hectare, net present value and EIRR are presented.

Tables 6.22 to 6.26: Incremental benefit of base, without project and with project (option 1, 2A and 2B) is presented.

Tables 6.27: Economic evaluation of selected cropping patterns is presented.

A detailed cost-benefit analysis including benefit coming from agricultural production, broadened in order to reach a multi-criteria analysis is presented in Annex 9 and in Chapter 8 of the Main Report.

Table 6.12: A comparative presentation of land utilization in the CPP area, Sirajganj

	Base	Without project	With Project		
			Option 1	Option 2A	Option 2B
Gross area (ha)	12057	12057	12057	12057	12057
NCA (ha)	9579	9579	9579	9579	9579
Temporarily fallow (ha)	303	214	200	145	132
Single crop area	1068	999	845	45	40
% of NCA	11.1	10.4	8.8	0.5	0.4
Double crop area	8022	8175	8124	8544	8499
% of NCA	83.7	85.3	84.8	89.2	88.7
Triple crop area	186	192	410	845	908
% of NCA	1.9	2.0	4.3	8.8	9.5
Cropped area	17670	17925	18323	19670	19760
Cropping intensity(%)	184	187	191	205	206

Source: Project Computations

Table 5.13: Summary of impact on crop hectareage and production in the CPP area, Sirajganj

	Base Situation		Without Project		With Project					
	Area(ha)	Production (t)	Area(ha)	Production (t)	Option 1		Option 2 A		Option 2B	
					Area(ha)	Production (t)	Area(ha)	Production (t)	Area(ha)	Production (t)
Total rice area	8558	23444	8639	25109	8642	33114	9065	35830	8952	35992
Boro (HYV)	4501	19093	4501	20544	4504	21282	4731	22355	4591	21693
T.Aman (HYV)	1236	1841	1236	1932	2036	7708	2722	10305	3146	11908
T.Aman (Local)	2795	2480	2879	2605	2086	4103	1612	3170	1215	2390
Aus (Local)	26	30	23	28	16	21	0	0	0	0
Wheat	956	2321	946	2355	805	2307	724	2075	782	2241
Sugarcane	3711	183666	3768	191086	3815	199052	3917	203436	4011	208312
Jute	967	1371	948	1344	852	1512	781	1386	841	1493
Potato	785	7685	793	8041	932	9954	1156	12346	1032	11021
Mustard	1178	931	1202	978	1376	1170	1613	1371	1545	1313
Pulses	1027	1058	1027	1111	1169	1309	1401	1569	1510	1691
Veg.+Spices	349	1662	356	1784	474	2332	677	3410	731	3682
Others	138	-	246	-	260	-	334	-	360	-
Ratios										
Rice/Non-rice crop	1 :	1.06	1 :	1.07	1 :	1.12	1 :	1.17	1 :	1.21
Local/HYV rice	1 :	2.03	1 :	1.98	1 :	3.11	1 :	4.62	1 :	6.37
Boro T.Aman rice	1 :	0.90	1 :	0.91	1 :	0.92	1 :	0.92	1 :	0.95
Dependency on Boro	0.52	0.81	0.52	0.82	0.52	0.64	0.52	0.62	0.51	0.60

Source: Project Computation

Table 6.14: Agricultural prices used in the agro-economic analysis (in Tk/Kg)

Crop	Market price	By-product	Seed	Labour Man/d	Ox/d	Urea	Fertilizer TSP	MP	Plant protect.	Irrig. Tk/ha
Boro HYV	6.21	0.7	10.0	50.0	45.0	4.58	5.40	4.05	504.0	6,561
Boro local	6.21	1.0	10.0	50.0	45.0	4.58	5.40	4.05	504.0	3,281
Aman HYV	6.44	0.7	10.0	50.0	45.0	4.58	5.40	4.05	504.0	0
Aman (T)	6.44	1.0	10.0	50.0	45.0	4.58	5.40	4.05	504.0	0
Aman (DW)	6.44	1.0	10.0	50.0	45.0	4.58	5.40	4.05	504.0	0
Aus HYV	6.07	0.7	8.5	50.0	45.0	4.58	5.40	4.05	504.0	0
Aus local	6.07	1.0	10.5	50.0	45.0	4.58	5.40	4.05	504.0	0
Jute	6.01	2.6	24.0	50.0	45.0	4.58	5.40	4.05	504.0	0
Potato	4.58	0.0	8.5	50.0	45.0	4.58	5.40	4.05	504.0	1,312
Wheat	6.31	0.4	12.0	50.0	45.0	4.58	5.40	4.05	504.0	984
Mustard	13.47	0.6	19.0	50.0	45.0	4.58	5.40	4.05	504.0	984
Pulses	14.92	0.7	13.2	50.0	45.0	4.58	5.40	4.05	504.0	984
Vegetables	4.10	0.0	500.0	50.0	45.0	4.58	5.40	4.05	504.0	3,281
Sugarcane	1.01	0.0	0.3	50.0	45.0	4.58	5.40	4.05	504.0	0
Other crops	6.20	0.0	26.9	50.0	45.0	4.58	5.40	4.05	504.0	2,484

Source: FPCO, Guidelines for Project Assessment (1992)

Table 6.15 : Economic Prices - Conversion Factors

Crop	Market price	By-product	Seed	Labour Man/d	Ox/d	Urea	Fertilizer TSP	MP	Plant protect.	Irrig.
Boro HYV	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Boro local	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Aman HYV	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Aman (T)	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Aman (DW)	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Aus HYV	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Aus local	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Jute	1.06	0.87	1.06	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Potato	0.87	0.87	0.87	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Wheat	1.29	0.87	1.29	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Mustard	0.88	0.87	0.88	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Pulses	0.87	0.87	0.87	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Vegetables	0.87	0.87	0.87	0.75	0.87	1.45	1.88	2.02	0.87	0.83
Other crops	0.87	0.87	0.87	0.75	0.87	1.45	1.88	2.02	0.87	0.83

Source: FPCO, Guidelines for Project Assessment (1992)

Table 6.16: Crop Production - Economic Parameters (financial prices) (base case)

Crop	Output			variable costs														Total var. costs	Gross margin	Value added
	Yield	By-prod.	Gross return	Seed		Urea	Fertilizer TSP	MP 2)	Sub-total	Plant protection		family labour	ratio	Labour hired labour		oxen labour	Irrigat.			
	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	Kg/ha	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	m/d/ha	% 3)	m/d/ha	Tk/ha	ox/d/ha	Tk/ha	Tk/ha	Tk/ha	Tk/ha
Boro HYV	4,242	3,394	29,746	30	300	237	91	103	1,994	1.0	504	126	85	107	5,355	35	6,561	16,289	13,457	25,112
Boro local	0	0	0	0	0	0	0	0	0	0.0	0	0	50	0	0	0	0	0	0	0
T Aman HYV	1,489	1,340	10,927	32	320	120	66	50	1,109	1.0	504	96	80	77	3,840	25	0	6,898	4,029	12,669
T Aman local	887	1,153	6,865	25	250	66	53	31	809	0.4	202	87	60	52	2,610	25	0	4,996	1,869	5,829
DW Aman broad.	0	0	0	0	0	0	0	0	0	0.0	0	0	60	0	0	0	0	0	0	0
DW Aman transpl.	0	0	0	0	0	0	0	0	0	0.0	0	0	65	0	0	0	0	0	0	0
Aus HYV	0	0	0	0	0	0	0	0	0	0.0	0	0	75	0	0	0	0	0	0	0
Aus local	1,150	1,610	8,596	44	462	25	24	18	317	0.2	101	95	55	52	2,613	20	0	4,392	4,204	11,566
Jute	1,418	1,418	12,762	10	240	61	52	29	678	0.0	0	102	120	122	6,120	23	0	8,073	4,709	15,929
Potato	9,790	0	44,838	370	3,145	102	121	54	1,339	1.0	504	100	85	85	4,250	22	1,312	11,540	33,298	42,548
Wheat	2,428	2,185	17,511	74	888	92	71	41	971	0.0	0	82	10	8	410	21	984	4,198	13,313	17,823
Mustard	790	948	11,587	10	190	90	97	42	1,106	0.0	0	64	10	6	320	15	984	3,275	8,311	11,831
Pulses	1,030	1,339	16,706	35	462	0	0	0	0	0.0	0	48	0	0	0	16	984	2,166	14,540	16,940
Vegetables 1)	4,763	0	19,544	1	250	120	50	30	1,491	0.5	252	120	140	168	8,400	24	3,281	14,754	4,790	19,190
Sugarcane	49,720	0	50,317	29,000	8,700	261	178	167	2,833	0.0	0	100	170	170	8,500	25	0	21,158	29,159	42,659
Other crops	5,180	0	32,097	57	1,544	83	57	36	833	0.4	188	71	81	58	2,879	18	2,484	8,735	23,362	29,780

Source: Data for yields and inputs according to official statistics, project land use and input use survey. Data set for yield includes also yield on partially damaged crop

1) incl. manure (veg. = 1 100 Kg ? 0.5 Tk/kg; local T.Aman = 190 Kg)

2) inluding Gypsum in Boro and T.Aman HYV, T.Aman local, Wheat and Sugarcane

3) of family labour

Value added TK/ha average	23,756

Table 6.17: Crop Production - Economic Parameters (financial prices) (future situation without project)

Crop	Output			variable costs														Total var. costs	Gross margin	Value added
	Yield	By-prod.	Gross return	Seed		Fertilizer Urea	Fertilizer TSP	Fertilizer MP 2)	Fertilizer Sub-total	Plant protection		family labour	ratio	Labour hired labour		oxen labour	Irrigat.			
	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	Kg/ha	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	m/d/ha	% 3)	m/d/ha	Tk/ha	ox/d/ha	Tk/ha	Tk/ha	Tk/ha	Tk/ha
Boro HYV	4,564	3,652	32,006	30	300	237	91	103	1,994	1 0	504	126	85	107	5,355	35	6,561	16,289	15,717	27,372
Boro local	0	0	0	0	0	0	0	0	0	0 0	0	0	50	0	0	0	0	0	0	0
T Aman HYV	1,563	1,407	11,473	32	320	120	66	50	1,109	1 0	504	96	80	77	3,840	25	0	6,898	4,576	13,216
T Aman local	905	1,176	7,002	25	250	66	53	31	809	0 4	202	87	60	52	2,610	25	0	4,996	2,006	8,966
DW Aman broad	0	0	0	0	0	0	0	0	0	0 0	0	0	60	0	0	0	0	0	0	0
DW Aman transpl	0	0	0	0	0	0	0	0	0	0 0	0	0	65	0	0	0	0	0	0	0
Aus HYV	0	0	0	0	0	0	0	0	0	0 0	0	0	75	0	0	0	0	0	0	0
Aus local	1,185	1,658	8,854	44	462	25	24	18	317	0 2	101	95	55	52	2,613	20	0	4,392	4,462	11,824
Jute	1,418	1,418	12,782	10	240	61	52	29	678	0 0	0	102	120	122	6,120	23	0	8,073	4,709	15,929
Potato	10,142	0	46,452	370	3,145	102	121	54	1,339	1 0	504	100	85	85	4,250	22	1,312	11,540	34,912	44,162
Wheat	2,489	2,240	17,949	74	888	92	71	41	971	0 0	0	82	10	8	410	21	984	4,198	13,751	18,261
Mustard	814	976	11,934	10	190	90	97	42	1,106	0 0	0	64	10	6	320	15	984	3,275	8,659	12,179
Pulses	1,082	1,406	17,542	35	462	0	0	0	0	0 0	0	48	0	0	0	16	984	2,166	15,375	17,775
Vegetables 1)	5,011	0	20,560	1	250	120	50	30	1,491	0 5	252	120	140	168	8,400	24	3,281	14,754	5,806	20,206
Sugarcane	50,714	0	51,323	29,000	8,700	261	178	167	2,833	0 0	0	100	170	170	8,500	25	0	21,158	30,165	43,665
Other crops	5,326	0	32,997	57	1,544	83	57	36	833	0 4	188	71	81	58	2,879	18	2,484	8,735	24,263	30,680

Source: Data for yields and inputs according to official statistics, project land-use and input use-survey. Data set for yield includes also yield on partially damaged crop

1) incl. manure (veg. = 1,100 Kg ? 0.5 Tk/kg, local T.Aman = 190 Kg)

2) inluding Gypsum in Boro and T.Aman HYV, T.Aman local, Wheat and Sugarcane

3) of family labour

Value added TK/ha average	24,836

Table 6.18: Crop Production - Economic Parameters (financial prices)

Option 1

Crop	Output			variable costs															Total var. costs	Gross margin	Value added
	Yield	By-prod.	Gross return	Seed		Urea	Fertilizer TSP	MP 2)	Sub-total	Plant protection		family labour	ratio	Labour hired labour		oxen labour		Irrigat.			
	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	Kg/ha	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	m/d/ha	% 3)	m/d/ha	Tk/ha	ox/d/ha		Tk/ha	Tk/ha	Tk/ha	Tk/ha
Boro HYV	4,725	3,780	33,134	30	300	264	101	115	2,221	1.1	561	126	85	107	5,355	35		6,561	16,574	16,560	28,215
Boro local	0	0	0	0	0	0	0	0	0	0.0	0	0	50	0	0	0		0	0	0	0
T Aman HYV	3,786	3,407	27,780	32	320	166	91	69	1,536	1.0	524	96	80	77	3,840	25		0	7,345	20,435	29,075
T Aman local	1,967	2,557	15,220	25	250	66	53	31	809	0.5	263	87	60	52	2,610	25		0	5,057	10,163	17,123
DW Aman broad.	0	0	0	0	0	0	0	0	0	0.0	0	0	60	0	0	0		0	0	0	0
DW Aman transpl.	0	0	0	0	0	0	0	0	0	0.0	0	0	65	0	0	0		0	0	0	0
Aus HYV	0	0	0	0	0	0	0	0	0	0.0	0	0	75	0	0	0		0	0	0	0
Aus local	1,150	1,610	8,596	44	462	25	24	18	317	0.2	101	95	55	52	2,613	20		0	4,392	4,204	11,566
Jute	1,775	1,775	15,998	10	240	76	65	36	848	0.0	0	102	120	122	6,120	23		0	8,243	7,755	18,975
Potato	10,680	0	48,914	370	3,145	111	132	59	1,461	1.1	550	100	85	85	4,250	22		1,312	11,708	37,206	46,456
Wheat	2,866	2,579	20,668	74	888	109	84	48	1,146	0.0	0	82	10	8	410	21		984	4,373	16,295	20,805
Mustard	850	1,020	12,466	10	190	97	104	45	1,190	0.0	0	64	10	6	320	15		984	3,359	9,107	12,627
Pulses	1,120	1,456	18,166	35	462	0	0	0	0	0.0	0	48	0	0	0	16		984	2,166	16,000	18,400
Vegetables 1)	4,941	0	20,273	1	250	127	53	32	1,545	0.5	266	120	140	168	8,400	24		3,281	14,822	5,451	19,851
Sugarcane	52,176	0	52,802	29,000	8,700	274	187	175	2,973	0.0	0	100	170	170	8,500	25		0	21,298	31,504	45,004
Other crops	5,736	0	35,537	57	1,544	95	64	41	948	0.4	206	71	81	58	2,879	18		2,484	8,867	26,670	33,087

Source: Data for yields and inputs according to official statistics, project land-use and input use-survey . Data set for yield includes also yield on partially damaged crop

1) incl. manure (veg. = 1.100 Kg ? 0.5 Tk/kg, local T.Aman = 190 Kg)

2) inluding Gypsum in Boro and T.Aman HYV, T.Aman local, Wheat and Sugarcane

3) of family labour

Value added TK/ha average	28,758

Table 6.19: Crop Production - Economic Parameters (financial prices) (future situation with project) Option 2 A

Crop	Output			variable costs															Irrigat.	Total var. costs	Gross margin	Value added
	Yield	By-prod.	Gross return	Seed		Urea	Fertilizer TSP	MP 2)	Sub-total	Plant protection		family labour	ratio	Labour hired labour		oxen labour						
	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	Kg/ha	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	m/d/ha	% 3)	m/d/ha	Tk/ha	ox/d/ha		Tk/ha	Tk/ha	Tk/ha	Tk/ha
Boro HYV	4,725	3,780	33,134	30	300	264	101	115	2,221	1.1	561	126	85	107	5,355	35		6,561	16,574	16,560	28,215
Boro local	0	0	0	0	0	0	0	0	0	0.0	0	0	50	0	0	0		0	0	0	0
T Aman HYV	3,786	3,407	27,780	32	320	166	91	69	1,536	1.0	524	96	80	77	3,840	25		0	7,345	20,435	29,075
T Aman local	1,967	2,557	15,220	25	250	66	53	31	809	0.5	263	87	60	52	2,610	25		0	5,057	10,163	17,123
DW Aman broad	0	0	0	0	0	0	0	0	0	0.0	0	0	60	0	0	0		0	0	0	0
DW Aman transpl	0	0	0	0	0	0	0	0	0	0.0	0	0	65	0	0	0		0	0	0	0
Aus HYV	0	0	0	0	0	0	0	0	0	0.0	0	0	75	0	0	0		0	0	0	0
Aus local	0	0	0	44	462	25	24	18	317	0.2	101	95	55	52	2,613	20		0	4,392	0	0
Jute	1,775	1,775	15,998	10	240	76	65	36	848	0.0	0	102	120	122	6,120	23		0	8,243	7,755	18,975
Potato	10,680	0	48,914	370	3,145	111	132	59	1,461	1.1	550	100	85	85	4,250	22		1,312	11,708	37,206	46,456
Wheat	2,866	2,579	20,668	74	888	109	84	48	1,146	0.0	0	82	10	8	410	21		984	4,373	16,295	20,805
Mustard	850	1,020	12,466	10	190	97	104	45	1,190	0.0	0	64	10	6	320	15		984	3,359	9,107	12,627
Pulses	1,120	1,456	18,166	35	462	0	0	0	0	0.0	0	48	0	0	0	16		984	2,166	16,000	18,400
Vegetables 1)	5,037	0	20,665	1	250	127	53	32	1,545	0.5	266	120	140	168	8,400	24		3,281	14,822	5,843	20,243
Sugarcane	52,176	0	52,802	29,000	8,700	274	187	175	2,973	0.0	0	100	170	170	8,500	25		0	21,298	31,504	45,004
Other crops	5,665	0	35,101	57	1,544	95	64	41	948	0.4	206	71	81	58	2,879	18		2,484	8,867	26,234	32,652

Source: Data for yields and inputs according to official statistics, project land-use and input use-survey. Data set for yield includes also yield on partially damaged crop.

1) incl. manure (veg. = 1,100 Kg ? 0.5 Tk/kg, local T.Aman = 190 Kg)

2) inluding Gypsum in Boro and T.Aman HYV, T.Aman local, Wheat and Sugarcane

3) of family labour

Value added TK/ha average	29,014

Table 6.20: Crop Production - Economic Parameters (financial prices) (future situation with project) Option 2 B

Crop	Output			variable costs															Irrigat.	Total var. costs	Gross margin	Value added
	Yield	By-prod.	Gross return	Seed		Urea	Fertilizer TSP	MP 2)	Sub-total	Plant protection		family labour	ratio	Labour hired labour		oxen labour						
	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	Kg/ha	Kg/ha	Kg/ha	Tk/ha	Kg/ha	Tk/ha	m/d/ha	% 3)	m/d/ha	Tk/ha	ox/d/ha		Tk/ha	Tk/ha	Tk/ha	Tk/ha
Boro HYV	4,725	3,780	33,134	30	300	264	101	115	2,221	1.1	561	126	85	107	5,355	35		6,561	16,574	16,560	28,215
Boro local	0	0	0	0	0	0	0	0	0	0.0	0	0	50	0	0	0		0	0	0	0
T Aman HYV	3,786	3,407	27,780	32	320	166	91	69	1,536	1.0	524	96	80	77	3,840	25		0	7,345	20,435	29,075
T Aman local	1,967	2,557	15,220	25	250	66	53	31	809	0.5	263	87	60	52	2,610	25		0	5,057	10,163	17,123
DW Aman broad	0	0	0	0	0	0	0	0	0	0.0	0	0	60	0	0	0		0	0	0	0
DW Aman transpl	0	0	0	0	0	0	0	0	0	0.0	0	0	65	0	0	0		0	0	0	0
Aus HYV	0	0	0	0	0	0	0	0	0	0.0	0	0	75	0	0	0		0	0	0	0
Aus local	0	0	0	44	462	25	24	18	317	0.2	101	95	55	52	2,613	20		0	4,392	0	0
Jute	1,775	1,775	15,998	10	240	76	65	36	848	0.0	0	102	120	122	6,120	23		0	8,243	7,755	18,975
Potato	10,680	0	48,914	370	3,145	111	132	59	1,461	1.1	550	100	85	85	4,250	22		1,312	11,708	37,206	46,458
Wheat	2,866	2,579	20,668	74	888	109	84	48	1,146	0.0	0	82	10	8	410	21		984	4,373	16,295	20,805
Mustard	850	1,020	12,466	10	190	97	104	45	1,190	0.0	0	64	10	6	320	15		984	3,359	9,107	12,627
Pulses	1,120	1,456	18,186	35	462	0	0	0	0	0.0	0	48	0	0	0	16		984	2,166	16,000	18,400
Vegetables 1)	5,037	0	20,665	1	250	127	53	32	1,545	0.5	266	120	140	168	8,400	24		3,281	14,822	5,843	20,243
Sugarcane	52,176	0	52,802	29,000	8,700	274	187	175	2,973	0.0	0	100	170	170	8,500	25		0	21,298	31,504	45,004
Other crops	5,665	0	35,101	57	1,544	95	64	41	948	0.4	206	71	81	58	2,879	18		2,484	8,867	26,234	32,652

Source: Data for yields and inputs according to official statistics, project land-use and input use-survey. Data set for yield includes also yield on partially damaged crop.

1) incl. manure (veg. = 1.100 Kg ? 0.5 Tk/kg, local T Aman = 190 Kg)

2) inluding Gypsum in Boro and T Aman HYV, T Aman local, Wheat and Sugarcane

3) of family labour

Value added TK/ha average	29,149

Table 6.21: A comparative presentation of economic parameter and incremental benefit from agriculture

	Base	Without project	With Project		
			Option 1	Option 2A	Option 2B
Value Added Financial prices (Tk/ha)	19985	20933	24287	24450	24581
Incremental benefit					
Value of addition production					
Million Tk.	-	7.00	28.82	73.02	78.31
US$ (000)	-	184.16	758.36	1921.47	2060.81
Additional full annual employment	-	142	421	1239	1322
Additional Oxen pair needed	-	63	143	491	495
Total investment (m.Tk.)					
Economic	-	-	180.6	217.9	228.9
Financial	-	-	230.2	280.6	297.6
Investment/ha(Tk.)					
Economic	-	-	14980	18071	18988
Financial	-	-	19095	23269	24680
Net present value (m.Tk.)					
Economic	-	-	-73.4	57.0	52.0
Financial	-	-	-115.0	-25.0	0
Benefit/Cost Ratio					
Economic	-	-	0.69	1.18	1.15
Financial	-	-	0.62	1.05	1.00
EIRR					
Economic	-	-	5.9	15.7	15.2
Financial	-	-	4.3	13.2	12.0

Source: project Computation

Table 6.22 : Incremental Benefit (agricultural) (base situation)

Crops	Additional Production			Additional Labour			Add. animal traction		
	tons	Value added Tk/ha	million Tk	addit. area ha	m/d/ha	total year man/d	addit. area ha	Oxen/ day/ha	total year pair/d
- Boro									
* HYV	0	25,112	0.00	0	233	0	0	35	0
* local	0	0	0.00	0	0	0	0	0	0
- T. Aman									
* HYV	0	12,669	0.00	0	173	0	0	25	0
* local	0	8,829	0.00	0	139	0	0	25	0
- DW. Aman									
* broadcasted	0	0	0.00	0	0	0	0	0	0
* transplanted	0	0	0.00	0	0	0	0	0	0
- Aus									
* HYV	0	0	0.00	0	0	0	0	0	0
* local	0	11,566	0.00	0	147	0	0	20	0
Total rice 1)	0	17,956	0.00	0	193	0	0	30	0
- Jute	0	15,929	0.00	0	224	0	0	23	0
- Potato	0	42,548	0.00	0	185	0	0	22	0
- Sugarcane	0	42,659	0.00	0	270	0	0	25	0
- Wheat	0	17,823	0.00	0	90	0	0	21	0
- Mustard	0	11,831	0.00	0	70	0	0	15	0
- Pulses	0	16,940	0.00	0	48	0	0	16	0
- Vegetables	0	19,190	0.00	0	288	0	0	24	0
- Other crops	0	29,780	0.00	0	128	0	0	18	0
Total			0.00	0		0	0		0
$US (000)	38		0.00		addition. empl. No.	0		addition. pairs	0

Source: Project computations

1) value added, man/day/ha and oxen/pair/ha are average values for rice

Table 6.23 : Incremental Benefit (agricultural) (future situation without project)

Crops	Additional Production			Additional Labour			Add. animal traction		
	tons	Value added Tk/ha	million Tk	addit. area ha	m/d/ha	total year man/d	addit. area ha	Oxen/ day/ha	total year pair/d
- Boro									
* HYV	1,451	27,372	0.00	0	233	0	0	35	0
* local	0	0	0.00	0	0	0	0	0	0
- T. Aman									
* HYV	92	13,216	0.00	0	173	0	0	25	0
* local	125	8,966	0.75	84	139	11,672	84	25	2,096
- DW. Aman									
* broadcasted	0	0	0.00	0	0	0	0	0	0
* transplanted	0	0	0.00	0	0	0	0	0	0
- Aus									
* HYV	0	0	0.00	0	0	0	0	0	0
* local	-2	11,824	-0.03	-3	147	-383	-3	20	-52
Total rice 1)	1,666	19,171	0.72	81	193	11,289	81	30	2,044
- Jute	-27	15,929	-0.31	-19	224	-4,340	-19	23	-445
- Potato	356	44,162	0.35	8	185	1,452	8	22	173
- Sugarcane	7,420	43,665	3.23	74	270	19,948	74	25	1,847
- Wheat	34	18,261	-0.17	-10	90	-862	-10	21	-201
- Mustard	47	12,179	0.29	24	70	1,659	24	15	353
- Pulses	53	17,775	0.00	0	48	0	0	16	0
- Vegetables	121	20,206	0.14	7	288	2,010	7	24	168
- Other crops	502	30,680	2.76	90	128	11,542	90	18	1,612
Total			7.00	255		42,697	255		5,552
$US (000)	38		184.16		addition empl. No	142		addition pairs	63

Source: Project computations

1) value added, man/day/ha and oxen/pair/ha are average values for rice

Table 6.24 : Incremental Benefit (agricultural) Option 1

Crops	Additional Production			Additional Labour			Add. animal traction		
	tons	Value added Tk/ha	million Tk	addit. area ha	m/d/ha	total year man/d	addit. area ha	Oxen/ day/ha	total year pair/d
- Boro									
* HYV	2,189	28,215	0.08	3	233	699	3	35	105
* local	0	0	0.00	0	0	0	0	0	0
- T. Aman									
* HYV	5,867	29,075	23.26	800	173	138,240	800	25	20,000
* local	1,623	17,123	-12.14	-709	139	-98,693	-709	25	-17,725
- DW. Aman									
* broadcasted	0	0	0.00	0	0	0	0	0	0
* transplanted	0	0	0.00	0	0	0	0	0	0
- Aus									
* HYV	0	0	0.00	0	0	0	0	0	0
* local	-12	11,566	-0.12	-10	147	-1,473	-10	20	-200
Total rice 1)	9,668	25,709	11.09	84	196	38,774	84	30	2,180
- Jute	141	18,975	-2.18	-115	224	-25,806	-115	23	-2,645
- Potato	2,269	46,456	6.83	147	185	27,195	147	22	3,234
- Sugarcane	14,541	45,004	4.68	104	270	28,080	104	25	2,600
- Wheat	-14	20,805	-3.14	-151	90	-13,620	-151	21	-3,171
- Mustard	239	12,627	2.50	198	70	13,939	198	15	2,970
- Pulses	251	18,400	2.61	142	48	6,816	142	16	2,272
- Vegetables	670	19,851	2.44	123	288	35,424	123	24	2,952
- Other crops	769	33,087	3.99	121	128	15,471	121	18	2,161
Total			28.82	653		126,273	653		12,553
$US (000)	38		758.36		addition. empl. No.	421		addition. pairs	143

Source: Project computations

1) value added, man/day/ha and oxen/pair/ha are average values for rice

Table 6.25 : Incremental Benefit (agricultural) (future situation with project) Option 2 A

Crops	Additional Production			Additional Labour			Add. animal traction		
	tons	Value added Tk/ha	million Tk	addit. area ha	m/d/ha	total year man/d	addit. area ha	Oxen/ day/ha	total year pair/d
- Boro									
* HYV	3,262	28,215	6.49	230	233	53,613	230	35	8,050
* local	0	0	0.00	0	0	0	0	0	0
- T. Aman									
* HYV	8,464	29,075	43.21	1,486	173	256,788	1,486	25	37,151
* local	691	17,123	-20.26	-1,183	139	-164,691	-1,183	25	-29,578
- DW. Aman									
* broadcasted	0	0	0.00	0	0	0	0	0	0
* transplanted	0	0	0.00	0	0	0	0	0	0
- Aus									
* HYV	0	0	0.00	0	0	0	0	0	0
* local	-30	0	0.00	-26	147	-3,829	-26	20	-520
Total nce 1)	12,387	26,501	29.44	507	198	141,882	507	30	15,103
- Jute	15	18,975	-3.53	-186	224	-41,728	-186	23	-4,277
- Potato	4,661	46,456	17.23	371	185	68,633	371	22	8,162
- Sugarcane	19,770	45,004	9.23	205	270	55,355	205	25	5,125
- Wheat	-246	20,805	-4.83	-232	90	-20,928	-232	21	-4,872
- Mustard	440	12,627	5.49	435	70	30,626	435	15	6,526
- Pulses	511	18,400	6.88	374	48	17,954	374	16	5,985
- Vegetables	1,747	20,243	6.64	328	288	94,461	328	24	7,872
- Other crops	1,196	32,652	6.46	198	128	25,382	198	18	3,546
Total			73.02	2000		371,637	2,000		43,168
$US (000)	38		1,921.47		addition empl. No	1,239		addition pairs	491

Source: Project computations

1) value added, man/day/ha and oxen/pair/ha are average values for nce

Table 6.26 : Incremental Benefit (agricultural) (future situation with project) Option 2 B

Crops	Additional Production			Additional Labour			Add. animal traction		
	tons	Value added Tk/ha	million Tk	addit. area ha	m/d/ha	total year man/d	addit. area ha	Oxen/ day/ha	total year pair/d
- Boro									
* HYV	2,600	28,215	2.54	90	233	20,984	90	35	3,151
* local	0	0	0.00	0	0	0	0	0	0
- T. Aman									
* HYV	10,068	29,075	55.52	1,910	173	329,982	1,910	25	47,741
* local	-89	17,123	-27.05	-1,580	139	-219,899	-1,580	25	-39,493
- DW. Aman									
* broadcasted	0	0	0.00	0	0	0	0	0	0
* transplanted	0	0	0.00	0	0	0	0	0	0
- Aus									
* HYV	0	0	0.00	0	0	0	0	0	0
* local	-30	0	0.00	-26	147	-3,829	-26	20	-520
Total nce 1)	12,549	27,011	31.01	394	199	127,239	394	30	10,878
- Jute	121	18,975	-2.39	-126	224	-28,274	-126	23	-2,898
- Potato	3,336	46,456	11.47	247	185	45,688	247	22	5,433
- Sugarcane	24,646	45,004	13.43	298	270	80,588	298	25	7,462
- Wheat	-80	20,805	-3.62	-174	90	-15,694	-174	21	-3,654
- Mustard	383	12,627	4.63	367	70	25,833	367	15	5,504
- Pulses	633	18,400	8.88	483	48	23,169	483	16	7,723
- Vegetables	2,019	20,243	7.73	382	288	110,020	382	24	9,168
- Other crops	1,317	32,652	7.16	219	128	28,126	219	18	3,929
Total			78.31	2090		396,694	2,090		43,545
$US (000)	38		2,060.81		addition. empl. No.	1,322		addition. pairs	495

Source: Project computations

1) value added, man/day/ha and oxen/pair/ha are average values for nce

Table 6.27 : Economic evaluation of cropping patterns

Cropping patterns	Gross return TK/Ha	Total labour requirement md/ha	Total variable cost TK/Ha	Gross margin TK/Ha	Value added TK/Ha
BASE SITUATION					
Sugarcane	50,317	270	21,158	29,159	42,659
Boro HYV	29,746	233	16,289	13,457	25,112
S.cane + Pulses	67,023	318	23,324	43,699	59,599
S.cane + Potato	95,155	455	32,698	62,456	85,206
S.cane + Mustard	61,903	340	24,433	37,470	54,490
Boro,(HYV)-T.Aman,(HYV)	40,673	406	23,187	17,486	37,781
Boro,(HYV)-T.Aman,local	36,610	372	21,285	15,326	33,941
Boro,HYV-Mustard	41,332	304	19,564	21,768	36,943
Wheat-Jute	30,293	315	12,271	18,022	33,752
WITH PROJECT (Options 2A, 2B)					
Boro,(HYV)-T.Aman,(HYV)	60,913	406	23,918	36,995	57,290
Boro,(HYV)-T.Aman,local	48,353	372	21,631	26,723	45,338
T.Aman,(HYV)-Jute	43,778	397	15,588	28,190	48,050
S.cane + Pulses	70,969	318	23,464	47,505	63,405
S.cane + Potato	101,716	455	33,006	68,710	91,460
S.cane + Mustard	65,268	340	24,657	40,611	57,631
Wheat-Jute	36,666	315	12,616	24,050	39,780
Boro,(HYV)-T.Aman,(HYV)-Mustard	73,379	476	45,216	68,499	102,294
Boro,(HYV)-T.Aman,(HYV)-Pulses	79,080	454	26,084	52,995	75,690
Wheat-Jute-T.Aman,(HYV)	64,446	487	19,961	44,485	68,855
Wheat-Jute-T.Aman,local	51,886	454	17,673	34,213	56,903
Jute-T.Aman,(HYV)-Pulses	61,944	445	17,754	44,190	66,450

Source: Project computations, CPP, expressed in financial prices

7 INSTITUTIONALIZATION

7.1 Strategy

The options in compartment development have been described in Chapter 4, agricultural development potentials within a compartment are described in Chapter 5 and agro-economics of those potentials have been analysed in Chapter 6. To achieve the target set in compartment development and subsequent analysis, a definite implementation strategy is needed. Structural measures proposed is easy to implement within the scope of available resources but implementation of non-structural measures are difficult, complex and need active participation of people of all levels. Participation of people of the field level (bottom up approach) is designed in water user groups (Section 7.5). Here we outline involvement of offices related to agriculture (Appendix A) in the "Integrated Agricultural Development in the CPP (Figure 7.1). Technology is related to research organizations, DAE, BADC and others provide input and extension whereas the CPP is related to water, water users (WUGs) and water management committees (SCWMC and CWMC). Active participation of all these will lead to total agricultural development of the area under the compartmentalization of the area.

7.2 Extended Project Team

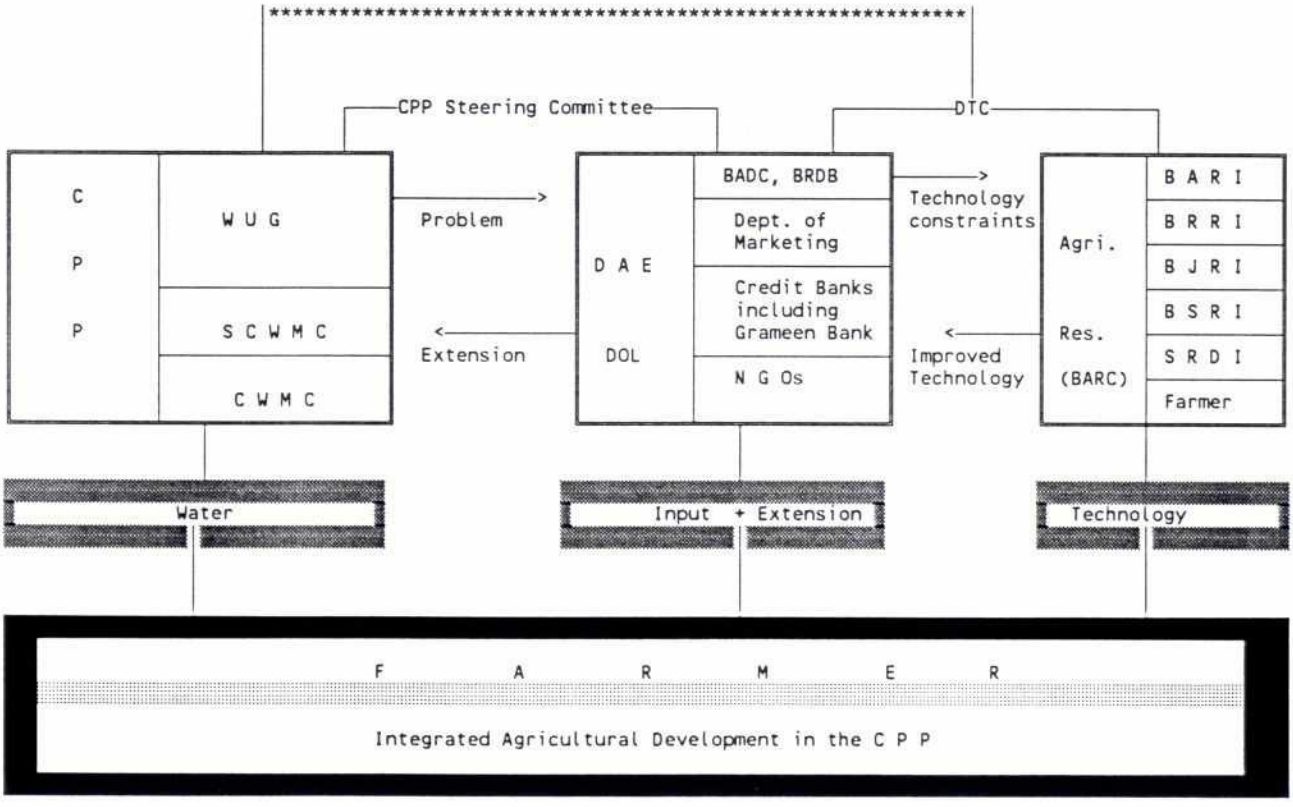
Govt. of Bangladesh has constituted an Extended Project Team for the CPP involving five outside GOB personnel including Deputy Director, DAE, Sirajganj and Executive Engineer (Irrigation), BADC, Sirajganj. So far, they have met twice formally and informal discussion are held very often. A monthly once meeting is planned as the project activities are geared up. Deputy Director, Dept. of Agriculture Extension, in his capacity as member of the CPP extended project team, actively participates in the work of the CPP alongwith his Thana Office of Sirajganj Sadar. The DAE, has recently participated in conducting a Census on irrigation of Sirajganj Sadar Thana.

7.3 DTC (District Technical Committee, Agriculture)

The DTC, with representatives of 'who is who in agriculture' of Sirajganj, meets once a month to discuss progress, problems and future activities related to a particular month. An active participation of the CPP in this committee is vital to integrate CPPs agricultural programme. This has already proved a success in Tangail. The Agronomist of the CPP is now in the process of being co-opted as member of the DTC.

7.4 Dept. of agricultural extension (DAE); Activities & role identification

This department of GOB is under the Ministry of Agriculture, and represented by Deputy Director (D/D) in Sirajganj district with a office at Khamarbari, Sirajganj having 3 Subject Matter Specialists (SMS), one Training Specialist and other Junior Officers and staff. Under the district office there are Thana Agriculture Offices in each Thana represented by Thana Agricultural Extension Officer (TAEO), Thana Additional Agricultural Officer (TAAO) and having Subject Matter Officers (SMO) and Junior Officers and staff. Under the Thana Agriculture Office there are Blocks averaging about three in each union having Block Supervisors (BS).



Legend:

CPP	Compartmentalization Pilot Project
WUG	Water Users Group
SCWMC	Sub- compartmental Water Management Committee
CWMC	Compartmental Water Management Committee
DAE	Department of Agricultural Extension
BADC	Bangladesh Agriculture Development Corporation
NGO	Non- Government Organization
BARI	Bangladesh Agril. Research Institute
BRRI	Bangladesh Rice Research Institute
BJRI	Bangladesh Jute Research Institute
BSRI	Bangladesh Sugarcane Research Institute
SRDI	Soil Resources Development Institute
DTC	District Technical Committee(Agriculture)
DOL	Department of Livestock
BRDB	Bangladesh Rural Development Board

Since Sirajganj CPP area falls within the Sirajganj District and covers areas of Sirajganj Sadar thana the following personnels of DAE would be involved in the project activities:

Deputy Director, Sirajganj District, who is a member of the Extended Project Team, CPP.

Thana Agriculture Extension Officer, Sirajganj Sadar

Thana Additional Agricultural Officer, Sirajganj Sadar

Block Supervisors

(Moreover, services of SMSs and SMOs may also be needed at times)

Activities and roles mentioned below is yet to be discussed and agreed upon.

7.4.1 Activities

1. Data and Information Process:

* Data on area, yield, production etc. of crops
* Data of crop damages
* Data on irrigation modes, coverages, needs, constraints etc.
* Information on input supply and uses including seeds, fertilizers, pesticides
* Information on pests and diseases of crops, and control managements
* Information on on-going field research, demonstrations, farming systems etc.
* Data and information on farm machinery - power tillers, sprayers, harrows etc.
* Data and information on homestead plantations and agro-forestry
* Feedback to and from DTC, RTC, CDP, ASSP etc.

2. Needs Assessment and Surveys:

* Identification and classification of chawks of each sub-compartment.
* Assist in inventorization of each chawk for soils, crops, infrastructures, plots, water management constraints, irrigation facilities, land tenure etc.
* Survey of chawkwise farmer's land and resources.
* Irrigation survey in dry season and landuse survey in monsoon season
* Survey of needs and constraints related to flood, drainage congestion, drought etc.

3. Consultation Process and Group Formation:

* Orientation in the CPP interventions, water management plans, implementations etc.
* Scheduling, participating, arranging and ensuring attendance of farmers in consultation process meetings.

* Organizing and mobilizing formation of WUGs (Water User Groups) on chawk basis.
* Possible participation in O&M activities.

4. Compartment Development and Implementation Schedule:

* Participate in planning discussions and implementation scheduling
* Offer comments and suggestions on compartment development.
* Arrange discussions of draft plans and implementation procedures in DTC, RTC etc.
* Representation and active participation in O&M procedures and committees.

5. Agricultural Development Activities:

* Participation in making out production plans of each chawk (WUGs)
* Introduction/extension of HYVs of rice and other crops.
* Extension service, motivation and mobilizing farmers for smooth and effective water management in each chawk/WUGs - field turn-outs and farm delivery
* Participation in training and demonstrate water delivery, retention and use in each plots according to crop requirements and plans - water management systems.
* Encourage input (seeds, fertilizers, practices etc.)
* Ensure integrated pest management procedures in the CPP area
* Accelerate homestead vegetable production programme, horticulture and agro-forestry
* Help and assist in tree plantation programme on embankments, road sides, canal banks etc. including procurement of saplings, plantations.

6. Training:

* Train farmers and WUGs in scientific crop production and water management
* Supply of training materials, logistics and technical expertise in training programs

7. Crop Demonstration:

* Scheduling crop demonstration programme and strategy
* Selection of sites and farmers for crop demonstration; contracts with farmers
* Selection of crop varieties, procurement of seeds (certified)
* Procurement of other inputs
* Regular monitoring, crop husbandary and pest control
* Water management proceduring and monitoring
* Public information, demonstrations and field-day
* Report.

8. Monitoring, Institutionalization and Documentation:

* Keep specific track and data on set agricultural indicators
* Participate in weekly/fortnightly meetings of WUGs and lead decision making

* Evaluate changes in agricultural patterns and productions
* Record and report constraints and success in agricultural and water management objectives
* Use formats and procedures developed by the CPP and feedback
* Foster formal institulization of sustainable WUGs and other committees
* Documentation of events, meetings, workshops, results and performances

7.4.2 Roles in Cooperation

The following roles in cooperation have been suggested for the following personnels. This is yet to be finalized through agreements and approval.

1. Deputy Director, Sirajganj District

- to act as a member of the Steering Committee and other subsequent committees.
- attend regular meetings and participate in decision making
- participate in planning, designing, and implementation of project features specially on agricultural and O&M aspects
- supply of data and information on agricultural aspects
- participate in agricultural activities and deploy TAEOs and BSs for related works including Need Assessments and surveys, crop demonstrations, consultation processes, organizing and training farmers, monitoring, documentation etc.
- arranging discussion on the CPP matters in DTC and RTC meetings
- design, and supervise the CPP crop demonstrations
- organise and arrange training of farmers and field trainers
- depute SMSs and SMOs in special technical activities of the CPP
- facilitate and liase input availability, credit and technology through the DTC
- undertake integrated pest management and disease control of crops in CPP area
- advise and assist in formation of WUGs and related committees
- corelate CPP with activities of CDP, ASSP and liase with BARI, BRRI, BARC etc.

2. Thana Agriculture Extension Officer, Sirajganj Sadar

- schedule and supervise need assessments, surveys, crop demonstrations etc.
- schedule and organise consultation process meetings through BSs
- collect, compile and supply field data on agriculture; maintain documents
- organise and train farmers groups/WUGs
- ensure and undertake input availability, credit and pest management
- represent in committees and participate in O&M
- participate in identifying chawks and production planning under water managed cropping patterns with HYV crops
- help and assist in formation of WUGs and committee representations

3. Block Supervisors

- undertake inventorisation of farmers
- participate in needs assessments, chawk surveys, consultation processes

- accomplish irrigation and crop survey including survey of homestead vegetation, horticulture and agro-forestry
- undertake crop demonstrations in farmers' plots emphasizing water management objectives and procedures, contracting farmers (selected)
- development of water management systems and water use procedures in each chawk, and practically demonstrating and training the farmers in rational water use
- undertake integrated pest management and disease control of crops
- organize farmers for formation of WUGs and representation in committees
- monitor the farmers activities and agri-indicators

7.5 Water User Groups and Committees

As it is virtually impossible to seperate water management and agriculture, farmers are, logically, key players in decision making and implementation of any effective water management system. The CPP has proposed a three-tier institutional setting (Table 7.1).

Table 7.1: Institution participation matrix

Level	Organization	Participation
Beneficiaries	Water User Groups (WUG) - Farmer	Individuals (Farmer)
Sub-Compartment	Sub-Compartmental Water Management Committees (SCWMC)	Representatives of WUG
Compartment	Compartmental Water Management Committee (CWMC)	Representatives of SCWMC

Source: CPP Institutional Report, 1993.

Water management had so far been an individual's responsibility, *per se*, with the exception of managing DTW irrigation. The idea of forming groups to manage freely available monsoon water has never been thought of. CPP's water user groups will be involved in year round water management including both monsoon and dry season water. It has been observed that farmers are the largest most interest group but they are loosely organized often through DAE's contact farmer system or through BRDB's, KSS system. Both of these group failed to stimulate, involve and cover all the farmers of a locality. The DAE is presently reformulating its approach for agricultural extension. They are thinking more or less a technology based group formation following different approaches at different places. The planned implementation of forming WUGs by the CPP simply fits well with the DAE's policy. A principle consensus has been established between the CPP and the Director of Field Services of the DAE, Dhaka on possible involvement of the DAE in the programme for organization of WUGs. The DAEs Block Supervisors will be utilized for the organization of WUGs in the field. The approach to be followed:

a) The most suitable criterion for the demarcation of WUGs (farmer) will be one chawk - one group. A chawk is a field block usually bordered by embankments,

roads, villages or other recognizable physical entities.

b) Each chawk is, then, characterized for hydrology, agriculture, problems and prospects.
c) Land operators of each chawk is identified and block supervisors are trained to organize group formation of land operators (WUG) in each chawk.
d) These WUG then, as an organized body, decide on production plan, water management plan with the technical know-how and training provided by the CPP directly or indirectly through the DAE.
e) Any development plan of a channel or a structure involving many chawks (and as such many WUGs) is discussed in sub-compartmental water committees comprising representatives of WUGs.
f) Compartmental water committee decides on issues related to any structural intervention providing flood protection, peripheral control and any other issues involving several sub-compartments.

The approach described above, as to be implemented, is detailed in the next section implementation.

8. IMPLEMENTATION ACTIVITIES

In line with the proposed construction programme, agricultural activities will be implemented in close collaboration with the offices related to agriculture located within the CPP area, Sirajganj, specially the Dept. of Agricultural Extension.

8.1 Field level water management

One of the main targets of the structural interventions is the water management for agriculture. Flood protection, peripheral control and breach management measures as described above will lead to prevention of crop damage. This security of the crop environment can further be utilized to develop an effective field level water management system utilizing the compartment and sub-compartments.

The aim is to develop field (or chawk) level water management. Each field block has water inlets or outlets through bridges, culverts, roads breaches etc. By sealing road breaches, placing minor structures, pipe culverts, water retention devices, an effective water management at the field level will be established. Three of the important components of water management are:

- Drainage Improvement: The actual impedance of drainage water in pre-monsoon and post-monsoon within the context of the existing infrastructure is a constraint in further developing the area with an improved water resources control. Re-excavation of existing khals is proposed.

- Water Retention: Water retention is the physical withholding of water on the field or in a depression (or beel) in order to evenly distribute water specially rain water on different levels of land contours. Water retention can be implemented by the construction of bunds or by actual construction of water retention structures.

- Irrigation: Supplemented irrigation is an important component in water management. In Sirajganj area, use of STW for supplemental irrigation is common using the underground water. Use of surface water irrigation is very limited in areas near mainly to Ichamati khal. With re-excavation of khals and water retention measures, water can be stored and managed for supplemental irrigation.

Specific features

- Excavation of existing canals and drains
- Development of secondary drains
- Sealing of road breaches and placing of pipe or box culverts or bridges at selected places for controlled flow of water
- Improvement of earthen road
- Small retention and regulatory structures.

The plan of SC6 is presented, as an example (Appendix F).

8.2 Identification of chawks

In order to initiate a field level water management, field blocks or chawks need to be identified and characterized. Individual sub-compartment is composed of several field blocks or chawks bounded by village roads or settlement areas. These chawks are distinct physical entities and easily recognized by village people. Each chawk has water inlets or outlets through bridges, culverts, roads breaches etc. Field level water management is to be established by mechanisms such as sealing of road breaches, constructing minor structures, pipe culverts or water retention devices. This is yet to be detailed out. However, SC-6 has been characterised, mapped in detail and chawks identified (details in Appendix F).

8.3 Inventorisation of farmer/land operators of a chawk

In order to establish water user groups in each chawk, an inventorisation of land operators is planned. In this activity, each land operator will be characterized basically to know his identity, land resources and importantly his farm operation activities. Data will be entered on-farm card. With all these data, it will be possible to form WUG.

Block Supervisors of the DAE will be used to perform inventorisation of land operators.

8.4 Production plan

Production plan of crops will be produced by Water User Groups in each chawk. WUGs will be trained on water management activities, preparation of management plan and about deciding on production plan. WUGs will produce definite production plan of crops seasonwise. In that plan, input and credit requirement will be estimated. These requirement, channelled through SCWMC and CWMC, will be directed to the DTC and it's members.

8.5 Crop Demonstration Plots

This crop demonstration in farmer's plots will be executed in cooperation with the Department of Agricultural Extension. The main thrust in this programme will be to suggest and test varietywise cropping patterns suitable in improved water managed condition. Depending on the acceptability of introduced variety, modification will be made on the suggested cropping pattern. This programme will also help in speedy extension of introduced high yielding varieties of rice and other crops in the region. and possible diversification.

Objective : Pattern based crop demonstrations: sustainable, vehicle for HYV transfer. Acceptability status among farmers of a pattern, redesign pattern.

Executor : Department of Agricultural Extension, Sirajganj.

Specific : a) site selection
b) variety based cropping pattern selection through District Technical Committee, Sirajganj
c) suggest & test variety based cropping pattern in improved water management
d) determine farmer's acceptability
e) direct liasion with research station specially - BRRI, BARI, SRDI, BJRI to introduce newly released varieties
f) feedback of farmer's reaction on new cultivars to research stations.

Reporting : Seasonal.

8.6 Tree plantation and embankments homestead vegetation programme

Objective: Boundaries of compartment, sub-compartment and even chawks offer great potentials for tree plantations. These are currently under used or used in an unplanned way. Apart from economic value, tree plantation on embankments reduce soil erosion. The BWDB has following recommendation for plantation embankments (Table 8.1).

Table 8.1: Recommended trees and species for raising on embankments

Fuel wood species	Fast growing species such as Minjiri, Bakain, Australia, acacia, Eucalyptus, Babul, Ipil-ipil, Colliendra species etc.
Fruit trees	Jack fruit, Date palm, Black berry etc.
Timber species	Mehogini, Boroi, Sissoo, Teak, Babul, Albezia, Richardiana

Source: Dept. of Forest and BWDB Agreement, 1981

Homestead vegetation provide room for crop diversity and much needed emergency food in case of crop damages. A number of NGOs are active in both tree plantation and homestead vegetation programme.

Cooperator:
a) Dept. of Forestry
b) Dept. of Agricultural Extension
c) Proshika, a NGO
d) BRAC, a NGO

Specific activiities:
a) Analyse the present programme of cooperators
b) Identify the areas covered by cooperators and room for improvement
c) Proportionate distribution of area between cooperators and each area covered with specific tree plantation and homestead vegetation programme

d) Distribution of low cost irrigation equipment such as treadle pumps to interested WUGs in field level water management. This, as well, be used for homestead vegetation and can provide additional employment opportunity to women interest group
e) A coordinated approach among cooperators in developing the programme
f) Tree plantation programme will proceed embankment and road construction or improvement programme of the project.

Reporting: Cooperator-wise, seasonal.

8.7 Training

An effective implementation of a project plan depends on the skill and knowledge of its planners, executors and users. CPPs training programme in detail is presented in Annex-7. However, sections dealing with farmer as beneficiaries, and personnel involved in the DAE are mentioned in brief.

8.7.1 Training Needs

8.7.1.1 Department of Agricultural Extension

The highest officer of DAE in Sirajganj district (Deputy Director DAE) is a member of the extended project team, and of the proposed Steering Committee. It is also proposed to have the agricultural officers at Thana level in the Steering Committee. Training needs are tailored accordingly. There is an inseparable relation between land and water management for agriculture, and water management has a profound impact on cropping pattern, planting schedule, choice of varieties etc (and the other way round), DAE officers should be involved in implementing about water management systems in CPP.

Consequently some officers at District level, a number of officers at Thana level (Thana Agriculture Extension Officer and Additional Agricultural Officer), as well as the Subject Matter Officers), and DAE field extension workers or block supervisors, should receive training and information on the following topics:

- general information on CPP
- technical aspects of water management in CPP
- non-technical aspects of water management in CPP
- tasks and responsibilities for water management
- on-farm water management, and water requirements of particular crops
- water pollution: notably effects on fish of agrochemicals

Training should preferably be coordinated with the DAE district training officer.

8.7.1.2 Beneficiaries

That FAP 20 has a training task towards the project's beneficiaries that is to educate them as to their responsibilities in respect of operation and maintenance.

At beneficiary level there appears a training need for a multitude of facets, but keeping in mind the overall objective of FAP 20, i.e. water management, the following items appear the most relevant:

- water management, specifically planning, maintenance, and operation at field and plot level;
- general introduction of the CPP;
- record keeping;
- leadership;
- communication/discussion techniques;
- resource planning;
- responsibilities/tasks of the different actors in the system for water management (government and non-government);
- water quality and water pollution;
- other aspects as come up through feed back from e.g. group organizers;
- beneficiary contributions to construction, operation and maintenance of the physical infrastructure;

It should be noted that once an effective team of group organizers has been fielded, it will not be difficult to add additional topics through the regular training as envisaged to group organizers. In this sense the training to beneficiaries can be flexible and in accordance with anticipated and unforeseen needs.

8.7.2 Outline of training programme

Training of members of the Executive Committee

Initially training would focus on the Steering Committee. For these Steering Committee, a 2-3 day training course will be organized focusing on general introductions of CPP in all its aspects, and subsequently concentrating on the Steering Committees' responsibilities and roles in this, and the need for coordination.

A tentative programme for training of Steering Committee members for this course would include: inauguration and general introduction of the CPP, including its technical aspects and organizational aspects, tasks and responsibilities for water management, a field visit to the project area, and training on the need and requirements for effective inter-agency coordination and participation. The last items could use e.g. a technique called joint resource management assessment, in which participants are asked to identify the problems in the field of water management, and subsequently to state which agencies/actors could possibly resolve the problems. This has proved to be an

effective way to create an awareness of the need for coordination and for an integrated approach. It could be followed by a more theoretical expose on different forms of coordination.

Training of project and related officers and staff

A short course on project management would be beneficial to the project as a whole.

For the Subject Matter Specialists, Agricultural Extension Officer, Thana Additional Agricultural Officer, Subject Matter Officers. Thana Rural Development Officer, Assistant Fisheries Officer and the Thana Engineer of LGED a joint course should be provided introducing them to the major aspects of CPP, both technical and non-technical. A 3 day course could be organized by VERC/TARD with assistance mainly for the technical aspects from personnel from the different departments involved, notably BWDB and the team of consultants. The course should be held once in Sirajganj.

A similar course, but at a somewhat lower level, involving staff members of these agencies at the field level (DAE block supervisors, BRDB block inspectors, and also BWDB's work assistants, and field workers of NGO's presently active in the project area) should be organized. The course would also be organized by VERC/TARD to avoid differences in course contents. A 4 day course should be held several times due to the number of trainees involved.

Training of beneficiaries : farmers, as member of Water User Groups

Training of beneficiaries is planned in two ways:

1. Indirectly: Most of the training of beneficiaries will be done as on-the-job-training by group organizers. This is much more effective than special, short term courses, provided group organizers sufficiently master the subject matters.

2. Training courses to selected representatives of beneficiaries (selection of trainees preferably done by beneficiaries) on specific subjects, e.g.:

- training for managing committees of water users' groups;
- special courses on agricultural techniques
- new possibilities and techniques due to changes in water management
- cropping patterns
- on-farm water management

Workshops

Workshops, involving representatives from all groups having an interest in the CPP project should be organized at regular intervals, initially twice a year, possibly coinciding with the start of a new cropping season. A suitable location will have to be

found preferably in or around Sirajganj so as to facilitate a combination with field visits and the optimum involvement of representatives of the beneficiaries.

Study tours within Bangladesh

Study tours are expected to have a positive effect in the sense that they can lead to a broader understanding of problems. At the same time they can lead to the forging of better work relations. It is proposed that participants in studytours actively engage in some preparatory work, and that study tours are concluded by some general debriefing in order to force participants to draw conclusions with regards to their own situation.

Study tour abroad

A study tour abroad might serve as an eye-opener and stimulus for discussion on possible relevant practices for CPP. Several locations in Indonesia can be visited showing methods of farmers' involvement in water management, of cost recovery for routine operation and maintenance (both in irrigated and non-irrigated areas, and of flood and drainage protection in low-lying swampy areas). An inter-departmental team involving e.g. the project director and executive engineers of BWDB, and the highest officials at district level of DAE and BRDB, accompanied by one of the consultants, is thus advised to make such a trip within the near future in order to have the maximum benefit to the project.

9. STUDIES

Compartmentalization is a new concept and is therefore likely to produce new questions. The ToR allow for these issues to be looked in-depth through special studies. These studies will be executed in consultation, cooperation and active collaboration with organizations of related fields.

9.1 Production System Analysis (PSA)

MPO (1986) provides a comprehensive production system analyses for regions of Bangladesh. With the gradual development of water market, release of sale and distribution of irrigation equipment, fertilizer etc. to private sector and development of demand-driven input prices, a reanalyses of production system is needed. Farmer, with his number of limitations and resources constraints, operates his land in a way to derive maximum benefit i.e. he has his own production system on farm level. His knowledge, economic vulnerability, available opportunities etc. determines his farm operation. The main objective of PSA is a good understanding of the farmer's way to cope with the risks and benefit of the floods for better understanding of the bottlenecks. Impacts of improved water management on the total production system will be identified i.e. ... *"monitoring the results of water control operations, with particular attention to agricultural activities..."* [ToR, page 13). More acceptable and realistic production system alternatives will be constructed.

Objective	:	Effect of improved water management on production system activities. Identify production system alternatives.
Main Cooperators	:	a) On-Farm Research Division, Bangladesh Agricultural Research Institute b) Dept. of Marketting, Sirajganj c) Dept. of Agricultural Extension, Sirajganj
Specific Activities	:	a) site selection, farmer selection b) data on present production system c) monitoring of farm operation for at least 2 calendar years d) impact assessment e) design and redesign a production system alternatives
Work Schedule	:	Phased out with construction programme. For 1993-94, 2 sites: at SC 1 and 3. Each site with 3 farmers (test cases for next years).
Reporting	:	Annual

9.2 Study on Opportunities for Livestock and Poultry

Increased production target of 'with project' situation demand additional draft animal available in the area. Farm mechanisation is an alternative but yet to gain popularity within the scope of production cost. Possible impact of improved water management on livestock & poultry is not defined. This study will define specific opportunities for livestock and poultry development activities in the area. It is assumed that with flood control and drainage systems development the livestock will have a fair scope to develop in well drained catchment for grazing, forage crops development in the cropping pattern and additional feed availability from the by-products and residues of intensive crop productions. Similarly poultry will also be developed. This opportunity might largely contribute to the protein needs of the area and would supplement to a fair extent to the negative impact of fisheries. A specific development plan for the CPP area is expected.

Objective : Rehabilation & development effort for livestock & poultry in improved water management system.

Main Cooperator : Dept. of Livestock, Sirajganj
Bangladesh Agricultural University, Mymensingh

Specifics :
a) Identify effects of improved water management on livestock and poultry
b) Define opportunities for livestock and poultry development
c) Draw specific development plan for the CPP area.

Work Schedule : 1 year in 1993-94.

Reporting : Preliminary and final reports

10 MONITORING AND EVALUATION

10.1 General

FAP 20, as a pilot project, is specifically designed to test all aspects of compartmentalization and provides guidelines for the future. For this reason, comprehensive monitoring and evaluation (M&E) at every stage is particularly important. Four basic principles have, therefore, been adopted:

- that all significant aspects are monitored effectively
- that the simplest possible approach is taken
- that priority should be given to early-warning indicators, those that will quickly show up where action to solve problems is needed
- that all aspects will be monitored on simple standard formats which will be as easy as possible both to prepare and for the users to read and interpret.

10.2 Agricultural Monitoring

Agricultural monitoring is part of Economic Impact Assessment of the project. An FPCO (1993) draft paper entitled 'Soil and Agricultural Data Collection and Analysis' lists changes in cropping pattern, crop type, crop damage, input supply and use, yield level, input and output prices, agricultural extension, integrated pest management, changes in soil phase, soil fertility and contamination of surface and ground water as suggested indicators. A number of these will be monitored in different frequencies under different programme such as repeat landuse surveys, production system studies, case studies, environmental programmes, repeat household surveys, etc.

As a general rule, if is expected that better results are obtained from focused studies covering more limited topics than from a comprehensive multi-aspect survey. The gain in depth of understanding more than compensates for some loss of integration in the overall picture.

For this, a regular crop monitoring programme is to be initiated on set sample plots to measure four parameters:

- cropped area and cropping patterns
- yields
- intensity of input use
- farmgate costs of inputs and farmgate prices of outputs.

Cropped Area and Cropping Patterns: It is almost certain that the economic value of the CPP will depend predominantly on increases in agricultural production. The major benefit of water control is expected to come from a change towards a more intensive cropping pattern and, within that cropping pattern, from a shift to higher yielding crops.

Yields: Accurate estimates of yields are often difficult to obtain. Crop cutting is time consuming and difficult to organise without inconvenience to the farmer, which leads to mistakes. In interview surveys yields can only be calculated using farmers estimates of area as well as production; leaving room for two errors rather than one and for a squared error if they are both wrong. Yields are especially vulnerable to the snapshot problem; an abnormally good or an abnormally bad season at the time of the baseline or the ex-post survey can make the comparison between the two near enough meaningless. It is asking a lot to expect a 'normal' season both times.

The best compromise has often been to measure field areas of set sample plots and rely on farmers' reports of production. This exercise would also allow levels of flood damage to be estimated with a good level of accuracy; measuring not just a rather arbitrary percentage damaged by area but also an estimate of the direct effect on yields.

Intensity of Input Use and Farmgate Prices: So far limited data has been collected on levels of input use, of costs of production including wage rate. Input use - seed, fertilizer, labour, ploughing etc. - is a key indicator. Increasing crop intensities show agricultural sector making progress and unchanging input use show the opposite. Together with the farmgate prices, the quantities used also provide the costs of production which are essential for monitoring.

Monitoring Plan

The most practical way to do an effective agricultural monitoring is to carry out a sample survey of selected individual fields.

Selection of Individual Fields

- Distribute the cropped area by both land type and soil type.
- Sample of fields is selected with a stratum for each land type/soil combination. Stratification has two advantages. One is that the same degree of statistical precision can be obtained with a smaller sample. The other is that it makes it possible to analyse the way project impact varies according to different land types. It would for example, allow a direct analysis of the inter-relation between crop, flooding depth and soil.
- The sample fields can be selected by direct identification off Finnmaps at 1:10,000 scale and utilizing available mouza map.
- Sample size is partly a matter of judgement and compromise. A good estimate for some variables can be achieved with a small sample. For others a much larger one may be necessary. A sample from each 25-40 ha of cropped area is planned.
- Each sample plot will be measured accurately, once for all.

Data Collection

- Record crop in the field of each sample plot 3-6 times a year
- The field areas will be measured and farmers reports of production will be used. This exercise would allow levels of crop damage due to flood or others to be estimated with a good level of accuracy.

- Input use and farmgate price information is gathered by interviewing the operator of the sampled fields. Estimates of per hectare input application would also be much more accurate because the field would have been measured.

Work Schedule

This is in line with overall M&E plan for Sirajganj compartment of the CPP. Agricultural monitoring plan, selection of sample plots, identification: October - December, 1993. Start of agricultural monitoring survey: January, 1994. However, execution of this monitoring plan requires provision of additional manpower as Survey Associates.

10.3 Groundwater Availability Monitoring

Bangladesh is endowed with an ample supply of groundwater resources. These resources are increasingly under streses from irrigation developments. It is therefore essential to monitor the trend of development in groundwater availability.

Monitoring Plan

Data Source: Collation of groundwater level data from relevant institutions such as the Groundwater Circle of the BWDB, DPHE and BADC, Sirajganj.

Data Collection: Collection of basic data to run a simple numerical model of groundwater recharge, based on the water balance at selected well sites at CPP Sirajganj. Therefore, the following data will be collected:

1) flood extent, depth and length; area extent of beels and rivers at various seasons to determine the gross infiltration area over time.
2) basic meteorological data to calculate the open water evaporation (using the modified Penman formula) and the evapotanspiration losses of cultivated fields (for typical cropping patterns).
3) basic soil data on infiltration to determine the actual rate of percolation down to the aquifer.
4) basic data on water abstraction by irrigation and rural/urban water supply in the vicinity of selected groundwater observation wells.
5) determine the average deep percolation rates of irrigated fields to assess the actual groundwater recharge.

It is aimed to assist in general groundwater management and project impact assessment, i.e. to identify situations when the groundwater drawdown accelerates and reaches a critical level for rural water and irrigation supply and further actions would be required.

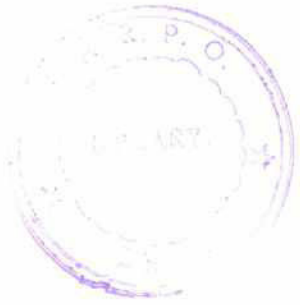
10.4 Soil Fertility Monitoring

Soil fertility changes induced by flood control are a widespread matter of speculations. Unfortunately, analyses are rare and virtually absent on the CPP areas.

The objective is to identify and evaluate specific soil fertility impacts of compartmentalization and to develop a management plan to maintain and enhance the long term soil fertility.

Monitoring Plan

- Re-evaluate the major inherent soil fertility constraints to agricultural development.
- Evaluate current impairements to maintain the long term soil fertility caused by the existing cropping pattern system and use of agricultural inputs (e.g. agro-chemicals, mechanisation).
- Identify and assess the likely extra impacts of water management on soils; the analysis should concentrate on the effects of flood control on the supply and availability of nutrients in croplands and on changes of the soil-water dynamic in various land types (F1-F3 lands), especially related to soil moisture availability for crops and trees during various seasons.
- Assess long term effect of crop intensification or diversification which are anticipated in future cropping pattern systems and increased use of inputs.
- The analysis should concentrate on changes in soil phases (such as, soil-water dynamics, pH and redox-potentials) and bio-chemical poperties related to nutrient supply and availability.



APPENDICES

Appendix A: Names of personnel in offices related to agriculture & livestock in Sirajganj

I. THANA LEVEL (SIRAJGNJ SADAR THANA)

Department of Agricultural Extension
Mr. Shamim Hossain, TAEO
Mr. Badruzzaman Haider, TAAO

Bangladesh Agricultural Development Corporation

Fertilizer: Mr. Md. Mizanur Rahman, Asstt. Manager

Seed: Mr. Khaza Ahmed, Thana Inspector

Jute Seed:Mr. Md. Nasiruddin, Thana Inspector (Centre 1)
Mr. Kazi Golam Mostafa, Thana Inspector (Centre 2)

Irrigation: Mr. Abdul Quddus, S SAE

Department of Relief
Mr. Ruhul Huq, Project Implementation Officer (Sadar)
Mr. Sheikh Serajul Islam, Project Implementation Officer (Sadar)

Department of Livestock
Mr. Mohd. Shahidul Islam, Thana Livestock Officer (Sadar)
Dr. Sheikh Azizur Rahman, Vet. Asstt. Surgeon

Bangladesh Rural Development Board
Mr. Abdus Salam Mondal, Rural Dev. Officer
Mr. Aslam Parvez, Asstt. Rural Dev. Officer
Ms. Mazeda Khatun, Asstt. Rural Dev. Officer
Mr. Abul Hossain, Project Officer

Dept. of Forests
Mr. Md. Ishaque, Forest Ranger

II. DISTRICT LEVEL OFFICES

Department of Agricultural Extension

* Mr. T.I.M. Khorshed Alam Chowdhury, Deputy Director
Mr. Azizur Rahman, SMS (Crops)
Mr. Nurul Haque, SMS (Water Management)
Mr. Sharafat Ali, SMS (Plant Protection)
Mr. Abdur Rashid, Training Officer

Bangladesh Agricultural Development Corporation

Irrigation
* Mr. Abdus Sabur, Executive Engineer
Mr. Khan Mohd. Abdur Rahman, SE

Bangladesh Rural Development Board
* Mr. Abdul Khaleque, Deputy Director
Mr. Sahabuddin Ahmed, Senior Asstt. Director

Department of Marketting
Mr. Mirza Saiful Islam, District Marketting Officer

Department of Relief
Mr. Abu Jafar Khan, District Relief and Rehabilitation Officer

Department of Livestock
Dr. Haridas Basak, District Livestock Officer
Dr. Ranjit Kumar, Additional District Livestock Officer

Department of Food
Mr. Shamsul Haque Mollah, District Controller of Food

Ministry of Jute
Office of the Chief Inspector of Jute
Mr. Md. Sirajul Maula, Chief Inspector of Jute

Bangladesh Jute Mills Corporation
Mr. Md. Nurul Haque Mian, Senior Jute Purchase Officer

* Members, Extended Project Team, CPP, Sirajganj

III. REGIONAL

Cotton Development Board
Mr. Shanti Ranjan Mondol, Cotton Development Officer
Mr. Abdus Salam, Cotton Unit Officer

Field Disease Investigation Laboratory (Livestock)
Dr. Abdur Razzak, Principal Scientific Officer

Silk Board
Mr. Md. Nurul Islam Khan, Manager

Jute Seed Circle, BADC [8 centres including 2 of Sirajganj Sadar Thana]
Mr. Md. Sahidur Rahman, Circle Jute Seed Officer

Horticultural Centre
Mr. Md. Haider Ali, Inspector-in-charge

Dept. of Forests
Mr. Md. Mahmudullah Chowdhury, Asstt. Forest Conservator

IV. COMMITTEES

District Technical Committee (Agriculture)

Chairman	-	Mr. T.I.M. Khorshed Alam Chowdhury, DD, DAE, Sirajganj
Member-Secretary	-	Mr. Azizur Rahman, SMS (Crops), DAE
Members	-	24

District Agricultural Credit Committee

Chairman	-	Mr. A.Z.M. Shafiqul Islam, DC
Secretary	-	Mr. Md. Belayet Hossain, DGM, Janata Bank, Sirajganj
Members	-	15

District Agricultural Rehabilitation Committee

Chairman	-	Mr. A.Z.M. Shafiqul Islam, DC
Member-Secretary	-	Mr. T.I.M. Khorshed Alam Chowdhury, DD, DAE, Sirajganj
Members	-	3

District Development Coordination Committee

Chairman	-	Mr. A.Z.M. Shafiqul Islam, DC
Members	-	58 - includes Executive Engineer, CPP.

V. ASSOCIATIONS

Sirajganj District Electricity-powered DTW & STW Owners Association.

Address: New Dhaka Road, Sirajganj

Executives: Mr. Khondakar Ruhul Amin, Mr. S.M. Liaquat Ali.

Appendix B: Agronomic characteristics of recommended high yielding varieties of rice

Variety	Recommended Season	Optimum Planting Time	Seedling age (Days)	Seedling Height (cm)	Plant Height (cm)	Duration (Days)	Yield ton/ha (Paddy)	Year of recommendation	Remarks
BR 1(Chandina)	T. Aus Boro	15.04-15.05 01.01-15.02	20-25 40-45	20-24 14-16	80-90 75-85	115-120 145-150	4.0-4.5 4.5-5.5	1970	Most disease tolerant variety
BR 2 (Mala)	Boro	01.01-15.02	40-45	17-18	100-150	150-160	5.0-5.5	1971	-
BR 3 (Biplab)	T. Aus	15.04-15.05	25-30	18-20	95-100	125-130	4.0-5.0	1973	-
BR 4 (Brrisail)	T. Aman	15.07-31.07	30-35	30-32	120-125	140-145	5.0-5.5	1975	Photoperiod insensitive, most disease tolerant, not suitable for late planting
BR 5(Dulhabhog)	T. Aman	15.07-15.08	30-35	20-25	110-130	145-150	2.5-3.0	1976	Strongly photoperiod sensitive, fine quality rice
BR 6	Boro	01.01-15.02	40-45	13-14	95-100	135-140	3.5-4.5	1977	-
BR 7(Brribalam)	Boro	01.01-15.02	40-45	14-15	100-125	135-155	4.0-4.5	1977	-
BR 8 (Asha)	Boro	01.01-15.02	40-45	15-16	110-125	155-160	5.0-5.5	1978	-
BR 9 (Sufala)	T. Aus Boro	15.04-15.05 01.01-15.02	20-25 40-45	30-35 13-15	115-130 110-120	115-120 150-155	4.0-4.5 5.0-5.5	1978	-
BR 10(Progoti)	T. Aman	15.07-15.08	30-35	35-40	120-125	145-150	5.0-6.0	1980	Photoperiod insensitive, can be planted upto August 30 with 40-45 days old seedlings
BR 11(Mukta)	T. Aman	15.07-15.08	30-35	30-35	120-125	140-145	5.5-6.0	1980	Most popular T. Aman variety, submergence tolerant upto 7 days in clear water, photo-period insensitive. Grown also as Boro.
BR 12 (Moyna)	Boro	01.01-15.02	40-45	11-12	80-85	160-165	4.5-5.5	1983	Photoperiod insensitive, most disease tolerant
BR 14 (Gazi)	T. Aus Boro	15.04-15.05 01.01-15.02	20-25 40-45	30-35 18-20	115-120 100-105	120-125 155-160	4.0-5.0 5.0-6.0	1983	Most disease tolerant, often grown as T. Aman by farmers.
BR 15 (Mohini)	T. Aus Boro	15.04-15.05 01.01-15.02	20-25 40-45	20-25 13-14	80-85 95-100	120-125 150-160	4.0-5.0 5.0-5.5	1983	Disease tolerant
BR 16 (Shahi Balam)	T. Aus Boro	15.04-15.05 01.01-15.02	20-25 40-45	20-25 13-14	100-105 85-90	125-130 160-165	5.0-5.0 5.0-6.0	1983	Most disease tolerant, duration too long
BR 17 (Hashi)	Boro	15.12-15.01	40-45	25-30	110-130	150-155	5.0-5.5	1985	Special for Haor areas and river basins
BR 18(Shahjalal)	Boro	15.12-15.01	40-45	20-25	100-115	165-170	5.0-5.5	1985	Special for Haor areas and river basins

BR 19 (Mangol)	Boro	15.12-15.01	40-45	20-25	105-115	160-165	5.0-5.5	1985	Special for Haor areas and river basins
BR 20 (Nizami)	B. Aus	25.03-30.04			110-120	110-115	3.0-3.5	1986	Recommended for rainfed upland cultivation, may also be sown in line
BR 21 (Niamat)	B. Aus				90-100	95-105	2.5-3.0	1986	Recommended for rainfed upland cultivation, also can be sown in line
BR 22 (Kiron)	T. Aman	15.07-30.08	30-35	30-35	110-115	155-160	4.5-5.5	1988	Strongly photoperiod sensitive, can be used for late planting upto Sept.30 with higher aged seedlings
BR 23 (Dishari)	T. Aman	15.07-30.08	30-35	35-40	115-120	155-160	4.5-5.5	1988	Strongly photoperiod sensitive, can be used for late planting upto Sept.30 with higher aged seedlings
BR 24	B. Aus	25.03-30.04			100-110	100-107	2.5-3.0	1990	Earlier than BR20, can also be sown in line
BR 25	T. Aman	15.07-30.08				130-135		1990	Improved Pajam. Suitable for early planting tolerant to blast, natures earlier than Pajam and BR11
BR 26 (Srabani)	T.Aus Boro				100-110	105-107	4.0	1992	Similar to Chandia

Source: Plant Breeding Division, Bangladesh Rice Research Institute, Joydevpur, Gazipur

Appendix C: Improved varieties of jute, sugarcane, wheat and mustard

JUTE

White Jute (*C. Capsularis*)

CC-45 : Photoinsensitive, height 4 meter, yield potential 5.2 tons/ha.
CVE-3 : Duration 105-110 days, height 4 meter, yield potential 4.5 tons/ha.
CVL-1 : Duration 125-135 days, height 4 meter, yield potential 5.2 tons/ha.
D-154 : Duration 120-125 days, height 3.5 meter, yield potential 4.9 tons/ha.

Tossa Jute (*C.Olitorius*)

0-4 : Suitable for high lands. Duration 130-135 days, height 4-4.2 meter, yield potential 4.5 tons/ha.
0-9897 : Photoinsensitive, height 4.5 meter, yield potential 4.6 tons/ha.

SUGARCANE

ISD-1/53 : Growing period 14 months. Tolerant to water logging. Resistant to red rot, smut, red stripe and wilt. Sugar recovery 9.75%. Yield 60-80 tons/ha.

ISD-2/54 : Duration 15 months. Good tillering habit, resistant to red not, smut, and wilt. Sugar recovery percens 9.44. Yield 62-90 tons/ha.

ISD-16 : Duration 14 months. Good for molasses. Tolerant to mosaic and white leaf disease and stem borer. Sugar recovery percent 10-20. Yield potential 82-119 tons/ha.

ISD-17 : Duration 14 months. Good germination capacity. Tolerant to white leaf, red rot, mosaic and stem borer. Sugar recovery 10%. Yield potential 80-115 tons/ha.

ISD-20 : Duration 12-13 months. Tolerant to white lef,red rot, smut etc. Sugar recovery is higher than ISD-16.

ISD-21 : Duration 12 months. Not disease tolerant. Yield potential 60-90 t/ha. Sugar recovery 10-12%.

I-112/67 : Duration 15.5 months. Resistant to red rot, smut, red stripe and wilt. Sugar recovery 11.73%.

L-Java-C : Duration 15 months. Resistant to red rot, red stripe and wilt. Sugar recovery 9.70%. Yield 60-90 tons/ha.

WHEAT

Sonalika : Approved in 1973. Duration 100-104 days. Yield with irrigation 3.2-3.4 t/ha; without irrigation 2.2-2.7 t/ha.

Pavan : Approved in 1979. Duration 112-117 days. Yield with irrigation 3.7-4.2 t/ha. Suitable for early planting.

Kanchan : Released in 1983. Duration 106-112 days. Yield potential with irrigation 3.5-4.4 t/ha; without irrigation 2.2-2.8 t/ha.

Akbar : Released in 1983. Duration 103-108 days. Yield with irrigation 3.5-4.2 t/ha, without irrigation 2.1-2.8 t/ha.

Barkat : Released in 1983. Duration 105-113 days. Yield with irrigation 3.4-3.8 t/ha; without irrigation 2.1-2.8 t/ha.

Ananda : Released in 1983. Duration 103-108 days. Yield with irrigation 3.4-3.8 t/ha; without irrigation 2.1-2.7 t/ha.

Aghrani : Released in 1987. Duration 103-107 days. Suitable variety for late planting. Yield with irrigation 3.4-3.8 t/ha; without irrigation 2.1-2.6 t/ha.

MUSTARD

Sonali Sarisha
SS-75 : Height 90-105cm. Duration 90-100 days. Yield potential 1.8-2.2 t/ha. Oil content 44%.

Kalyania-TS
-72 : Height 75-90cm. Duration 75-85 days. Yield potential 1.4-1.6 t/ha. Oil content 41-42%.

Tori-7 : Height 60-75cm. Duration 70-80 days. Yield potential 1.0-1.1 t/ha. Oil content 40-41%.

Rai-5 : Height 120-135cm. Duration 90-100 days. Yield potential 1.0-1.2 t/ha. Oil content 40%.

Source: BARI, BJRI, BSRI.

Appendix-D: Submergence tolerance range of rice at different growth stages

Crop	Growth Stage	Submergence Range	Period
HYV Boro	Transplanting	10 - 20 cm	January-February
	Vegetative	30 - 50 cm	March
	Reproductive	20 - 30 cm	April
	Maturity	Field capacity	May
B Aus	Seeding	Field capacity	March - April
	Vegetative	50 - 70 cm	May
	Reproductive	30 - 50 cm	June
	Maturity	Field capacity	July
HYV Aus	Transplanting	10 - 20 cm	March - April
	Vegetative	30 - 50 cm	May - June
	Reproductive	20 - 30 cm	July
	Maturity	Field capacity	August
T.Aman(Local)	Transplanting	20 - 30 cm	July - September
	Vegetative	50 - 70 cm	September-October
	Reproductive	30 - 50 cm	November
	Maturity	Field capacity	November-December
T.Aman(HYV)	Transplanting	10 - 20 cm	July-August
	Vegetative	30 - 50 cm	September-October
	Reproductive	20 - 30 cm	October-November
	Maturity	Field capacity	November-December

Source: FPCO (1993). Soil and Agricultural Data Collection and Analysis.

Appendix E: Fertilizer recommendation for major crops grown in the Sirajganj region (AEZ-4)

Crops	Fertilizers (Kg/ha)*			
	Urea	TSP	MP	Gypsum
Irrigated				
Boro (HYV)	217	133	67	55
T. Aman (HYV)	152	44	33	55
Wheat	217	89	67	55
Rainfed				
T. Aman (Local)	109	44	33	-
T. Aman (HYV)	152	89	67	55
Wheat	130	89	50	-
Jute	65	-	17	-
Mustard	152	89	50	55
Vegetables	261	133	133	-

* Source: Fertilizer, Recommendation Guide, BARC, 1989

Appendix F: Field level water management

Introduction

One of the ultimate target of the structural interventions is the field level water management. Flood protection and breach management measures will lead to prevention of crop damage. This security of crop environment can be utilized to develop an effective water management system utilizing the compartment and sub-compartments.

The aim is to develop field block (or chawk) level water management. Individual sub-compartment is composed of several field blocks or chawks bounded by village roads or settlement areas. These chawks are physical entities and easily recognised by village people. Each field block has water inlets or outlets through bridges, culverts, roads breaches etc. By sealing road breaches, placing minor structures, pipe culverts, water retention devices, an effective water management at the field level will be established. The plan of SC 6 is presented here, as an example.

Physical Features of SC 6 (Figure 1)

Boundary: The area is bounded by Bahuli-Sahangacha earthen road in the east, Ichamati river in the west, Fulkocha-Garudaha earthen road in the north and old Bogra road between Bahuli and Hat Pangashi in the south.

Villages: *Ditpur Kanu, Sabbisa, Alokdia, Brahmangatipara, Alokdia Khandakarpara, Bagdumur, Alampur, Islampur, Khaga, Panchibari, Fulkocha, Chawk Fulkocha, Rangaligati, Basegati, Garudaha, Nandina, Char Nandina, Basargati, Ichamati.*

Number of chakwks: 15 (Table 1)

Roads: One paved road for Pachibari to Fulkocha. 18 different earthen roads.

Present Infrastructures (Figure 2)
Bridge/culvert = 14
Road breaches = 39
Water control structures = Nil

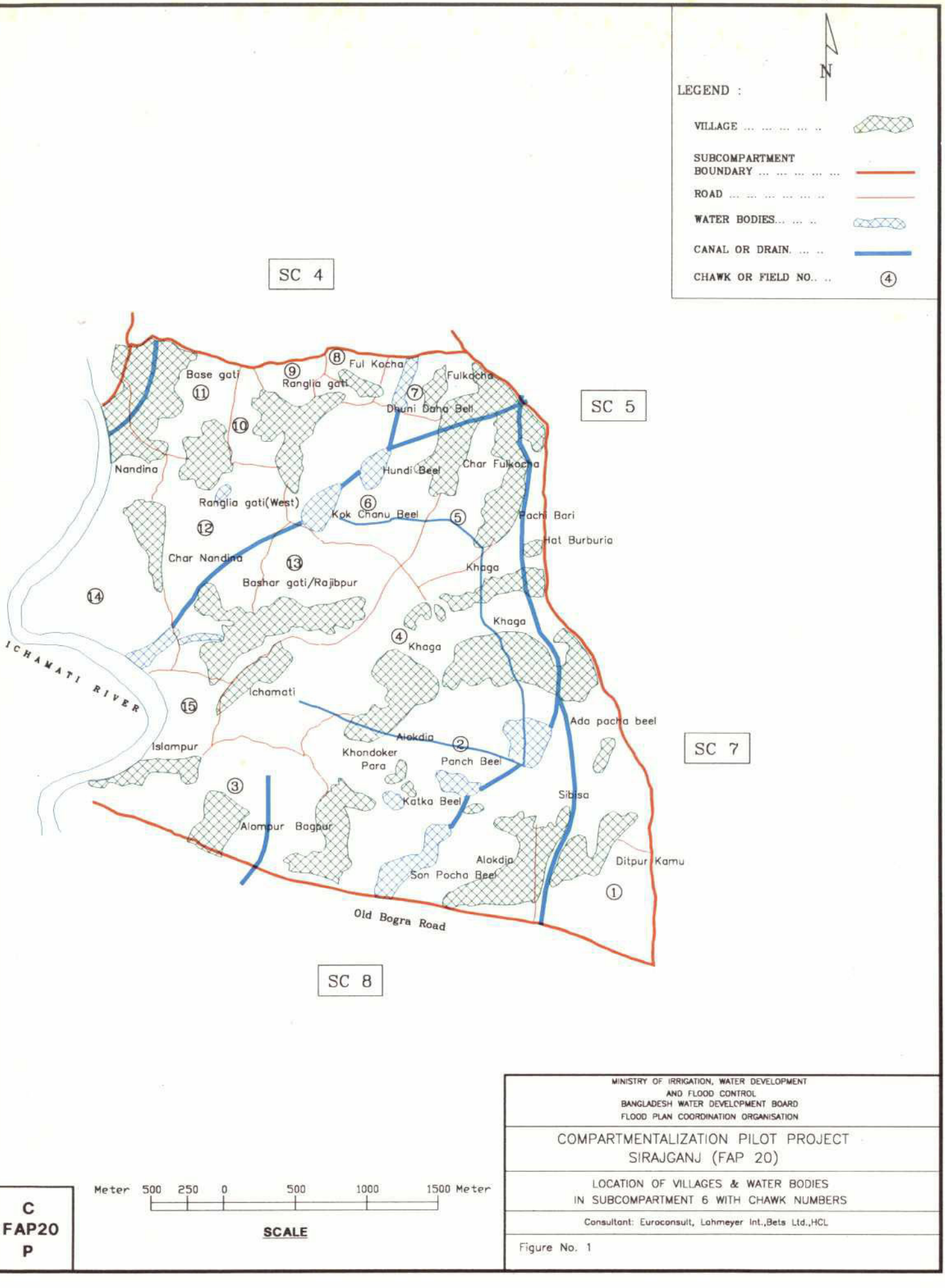
Waterbodies: Khaga khal, Basegati khal, Garudaha khal, Pachibari khal, Dumur khal, Basargati khal. The same canal has different names at different locality.

Depressions: Adapacha, Passbeel, Katha beel, Sonapacha beel, Dhunidaha beel, Hundi beel and Kokchara beel.

Table 1: Chawkwise distribution of area (ha) in SC-6 of CPP, Sirajganj

Chawk	Gross	Settlement	Waterbodies	NCA
1	102	26	1	75
2	360	55	5	300
3	93	30	1	62
4	170	18	1	151
5	104	30	3	71
6	124	15	3	106
7	30	4	2	24
8	17	4	0	13
9	16	0	0	16
10	39	8	0	31
11	65	25	0	40
12	79	7	1	71
13	129	16	1	112
14	93	0	2	91
15	34	0	1	33
Total	**1455**	**238**	**21**	**1196**

Source: Project computations.



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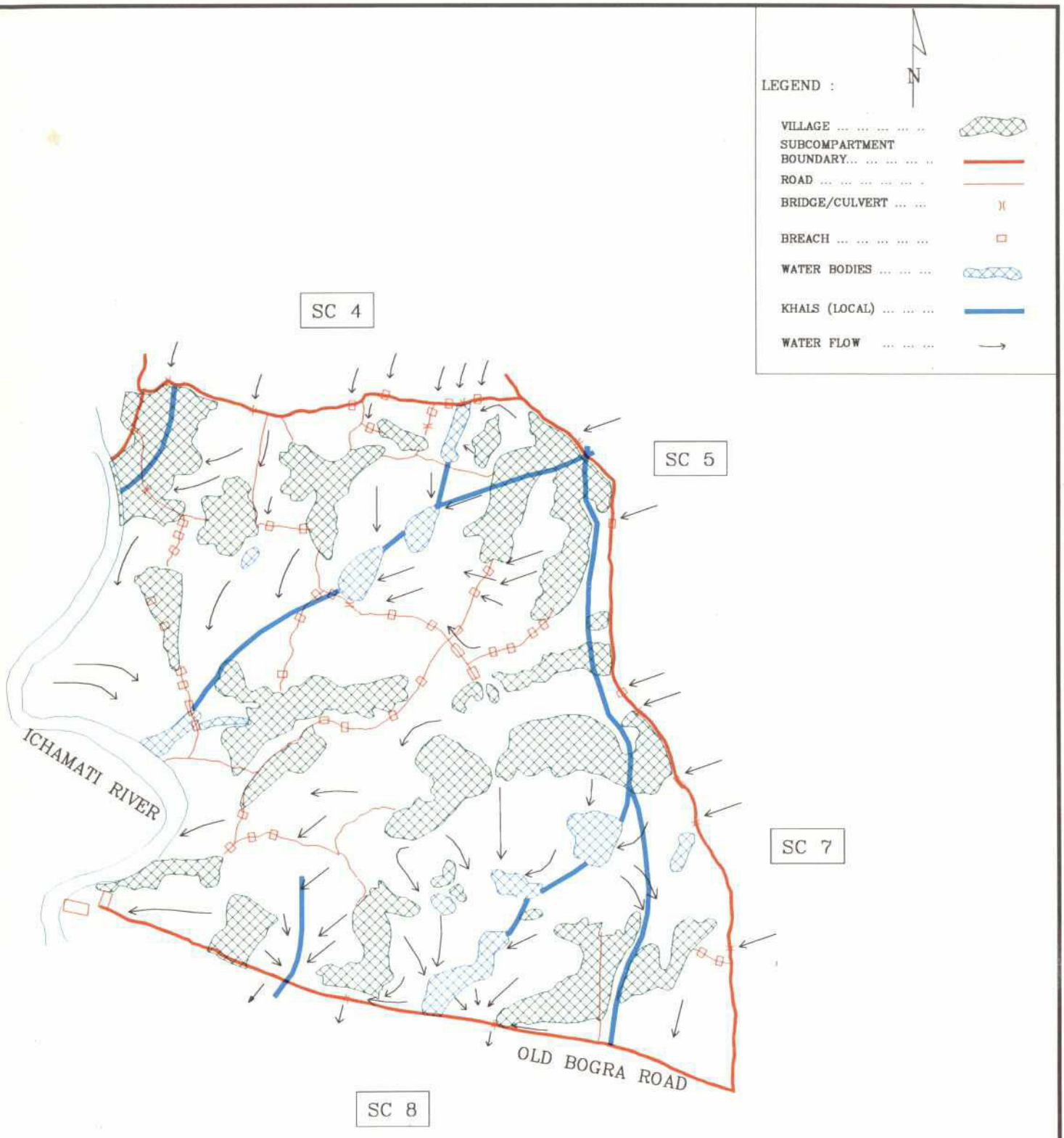
LOCATION OF VILLAGES & WATER BODIES IN SUBCOMPARTMENT 6 WITH CHAWK NUMBERS

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 1



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WATER FLOW, INLETS AND OUTLETS OF
SUBCOMPARTMENT 6

Consultant: Euroconsult, Lahmeyer Int.,Bets Ltd.,HCL

Figure No. 2

Agricultural characterisation of chawks:

- Chawk 1 : Mainly sugarcane area. Rice near canal.
- Chawk 2 : Sugarcane around periphery of villages Khaga, Sibisa, Alokdia and Bagdumur. Rice area around 3-4 depressions such as Adapacha beel, Panch beel, Katka beel and Sonapacha beel. Boro is cultivated but Aman crop is normally damaged.
- Chawk 3 : Mainly rice is area between Islampur and Alampur.
- Chawk 4 : Mainly rice area in depressions in the middle of the chawk.
- Chawk 5 : High lands around Fulkocha and Char Fulkocha are planted to sugarcane. Otherwise rice is grown.
- Chawk 6 : Only rice growing area.
- Chawk 7 : Mainly sugarcane, rice is cultivated around Dhunidaha beel.
- Chawk 8 : Only rice is grown.
- Chawk 9 : Mainly sugarcane. A certain area is under wheat and jute.
- Chawk 10 : Mainly rice. Sugarcane only on high lands near Rangilagati village.
- Chawk 11 : Sugarcane on highlands near Basegati and Nandina villages. Certain area are also under wheat and jute.
- Chawk 12 : Mainly rice growing area.
- Chawk 13 : Mainly rice. Sugarcane around village Bashargati.
- Chawk 14 : Sugarcane area along Ichamati river bank. Rice area near Char Nandina village.
- Chawk 15 : Rice area near to Islampur village. Sugarcane along Ichamati river bank.

A total of 472 ha is planted to sugarcane, 590 ha to Boro and 525 to T.Aman.

Problems, Needs and People's Suggestions

Needs Assessment Survey (NAS):

All the villages surveyed experienced floods since 1984 (excluding 1992). Monsoon period water congestion due to floods resulted in T. Aman damage upto 100% and sugarcane damage to the extent of 25%. Sand deposits have not been reported in the sub-compartment. Drought causes insignificant damage. The farmers use STW to provide supplementary irrigation to the crops. To minimise the crop loss mustard, pulses, etc. cannot be grown after affected T.Aman crop since the recession of flood water is slow.

Specific Suggestions from NAS. Measures to be taken are shown in italics.

a) Improvement of road extending from Fulkocha to Old Bogra road.

Road breaches will be sealed.

b) Construction of one bridge at Rangaliagati.

Bridge cum retention structure to be made.

c) Re-excavation of existing khal from Dhunidaha beel to Sundi beel.

Re-excavation is planned.

d) Construction of one bridge on Fulkocha-Garudaha road near Dhunidaha beel.

Planned as sub-compartmental water control structure.

e) Construction of one culvert near Islampur village on Old Bogra road.

Proposal is under consideration.

Additional suggestion during the consultation process meetings.

f) Construction of one culvert on Fulkocha-Bashargati road.

Culvert cum retention structure is planned.

In addition, following specific measures are proposed for field level water management:

Specific measures for field level water management at SC 6 (Figure 3)

All of the specific proposals given during Needs Assessment Survey and Consultation Process Meetings have been accomodated. However, field level water management, as envisaged in the concept, and shown in Fig. 3, needs additional small scale control structures, improvement of boundaries for effective control. Proposals are:

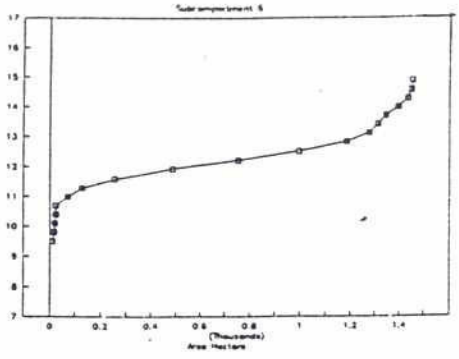
1) Construction of 4 small scale regulatory structure.
2) Construction of 7 small scale retention structure. Some of these structures will be constructed with bridge or culvert proposed.
3) Re-excavation of all main drains or canals.
4) Excavation of secondary drains.
5) Improvement of 8 village roads with sealing of road breaches.

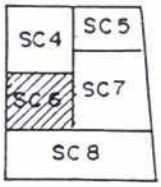
All these proposed development activities will result in improved water inlet and outlet control and thereby giving an effective management capabilities to water user groups of each chawk. A gradual drainage and spread/use of water will be operated from northern chawks to southern chawks.

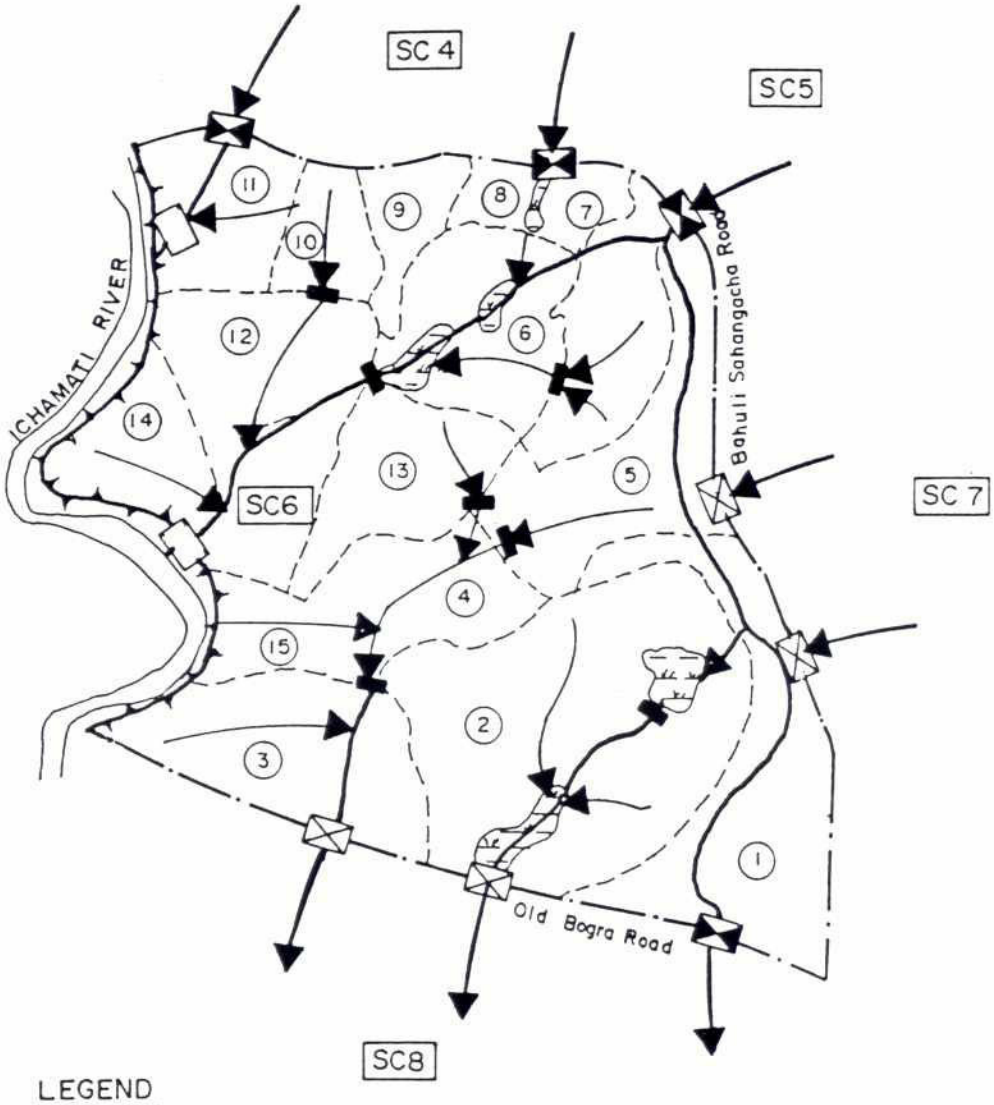
All proposed measures are local measures which will imply the operation of individual water control structures. The structures will be operated by Water Users Groups and, where applicable, by sub-compartmental water committees.

A considerable input is envisaged in discussing the use, operation and management of the system with ultimate users.

An extension and training programme is introduced for the WUG and operating personnel, with field demonstrations.







LEGEND

- Main drain .....
- Secondary drain .....
- Small Retention structure ....
- Regulatory structure ...
- Peripheral structure .....
- Subcompartment control structure .....
- Road .....
- Village road .....
- Embankment .....
- Chalk & beel ..... (10)

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FIELD LEVEL WATER MANAGEMENT
OF SC. 6

Consultant: Euroconsult, Lahmeyer Int.,Beta Ltd.,HCL

Figure/Drawing No.