World Bank
Government of the People's Republic of Bangladesh

Gumti Phase II Sub-Project Feasibility Study

FAP-5

FINAL REPORT

ANNEX E

AGRICULTURE

September, 1993

Mott MacDonald Limited
in association with
Nippon Koei Company Limited
House of Consultants Limited
Desh Upodesh Limited

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GUMTI PHASE II SUB-PROJECT FEASIBILITY STUDY
FINAL REPORT

ANNEX E - AGRICULTURE

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Glossary and Acronyms

Aman	-	Rice planted before or during the monsoon and harvested in November or December
AST	-	Agricultural Sector Team (funded by CIDA)
Aus	-	Rice planted during March to April and harvested during June and July
B aman	-	Broadcast Aman
BBS	-	Bangladesh Bureau of Statistics
BIWTA	-	Bangladesh Inland Water Transport Authority
Boro	-	Rice transplanted in December or January and harvested in April to May
BUET	-	Bangladesh University of Engineering Technology
BWDB	-	Bangladesh Water Development Board
CIDA	-	Canadian International Development Agency
DAE	-	Department of Agricultural Extension
DHI	-	Danish Hydraulics Institute
DOF	-	Department of Fisheries
DTW	-	Deep Tube Well
ECNEC	-	Executive Committee of the National Economic Council
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
EMP	-	Environmental Management Plan
FAP	-	Flood Action Plan - also projects under the FAP eg FAP1, FAP2 etc
FCD	-	Flood Control and Drainage
FCDI	-	Flood Control Drainage and Irrigation
FCD+I	-	FCD initially, then converted to include Irrigation
FFW	-	Food For Work
FMTW	-	Forced Mode Tubewell
FPCO	-	Flood Plan Coordination Organization
FRSS	-	Fishery Resources Survey System
GM	-	General Model
GPA	-	Guidelines for Project Assessment (from FPCO)
HTW	-	Hand Tubewell
HYV	-	High Yield Variety
JICA	-	Japanese International Cooperation Agency
JRC	-	Joint Rivers Commission
KSS	-	Krishni Sambaya Samity
LGED	-	Local Government Engineering Department
LIV	-	Locally Improved Variety
LLP	-	Low Lift Pump
MIKE11	-	Surface water computer model developed by Danish Hydraulics Institute
MLGRD	-	Ministry of Local Government Rural Development
MOFL	-	Ministry of Fisheries and Livestock
MOIWDFC	-	Ministry of Irrigation, Water Development and Flood Control
MPO	-	Master Plan Organization
NAM	-	Computer model which derives run-off and groundwater recharge from rainfall
NCA	-	Net Cultivable Area
NCS	-	National Conservation Strategy
NEMAP	-	National Environmental Management Action Plan
NFC	-	National Flood Council
NPV	-	Net Present Value
NPVR	-	Net Present Value Ratio
NWC	-	National Water Council
NWP	-	National Water Plan
ODA	-	Overseas Development Administration (UK)
Paddy	-	Unhusked rice
RRI	-	Rivers Research Institute
SCF	-	Standard Conversion Factor
SERM	-	South East Regional Model - a computer hydraulic model of the south-east region of Bangladesh

SERS	South East Regional Study - also known as FAP5
SIA	Social Impact Assessment
SPARRSO	Space Research and Remote Sensing Organization
SRDI	Soil Research Development Institute
STW	Shallow Tubewell
SWMC	Surface Water Modelling Centre - the MPO office responsible for the computerized modelling of flows, levels and groundwater
SWSMP	Surface Water Simulation Modelling Project
SSFCDIP	Small Scale Flood Control Drainage and Irrigation Project
T Aman	Transplanted Aman
TCCA	Thana Central Cooperative Association
Thana	Small administrative unit (formerly termed upazila)
TNO	Thana Nirbahi Officer
UNDP	United Nations Development Programme
Union	Division of a thana
[W]	With project - economic evaluation of the future situation with the proposed project
[WO]	Without project - economic assessment of the probable future value of production if no project is implemented
WRPO	Water Resources Planning Organization

E.1 Introduction

E.1.1 Objective

Annex E presents the present condition on agriculture in the Gumti Phase II Sub-project area as well as the future agricultural development proposals based on the possible interventions for flood control and drainage improvement together with irrigation development.

E.1.2 Methodology

The principal sources of data used by the study were field investigations and Government statistics. The structure of the field surveys was designed to incorporate the division of the study area into four agro-ecological zones on the premise of different flooding regimes and access to irrigation within each zone. Consequently much of the output from the surveys is presented by zone. The majority of surveys were based on questionnaires administered to a statistical sample of 12 randomly selected mouzas within each zone. Respondents were selected at random from lists of village inhabitants provided they fulfilled the requirements of the survey. Thus for example the farmer survey interviewed eight farmers in each mouza, picked at random until the predetermined quota for each farm size was fulfilled. The following surveys were completed :

1. A large-scale questionnaire survey of 384 farmers, with more detailed case studies of 51 of these farmers.
2. A survey of 240 fields in the four 2 km square topo/hydrological survey areas (60 fields x 4 squares).
3. A questionnaire survey of 96 fish pond operators.
4. A questionnaire survey of 160 professional fishermen.
5. A questionnaire survey of 96 landless people.
6. A questionnaire survey of 96 irrigation pump operators.
7. A questionnaire survey of 96 women.
8. Environmental fieldwork.
9. Health and Nutrition fieldwork.
10. An inventory of infrastructure.
11. Topographical survey of 4 sample squares.

Government statistics were collected from both District and Thana level offices, most notably from the Department of Agricultural Extension and the Bangladesh Bureau of Statistics. Other sources of information included banks, NGOs, parastatals and other consultants.

E.2 Soils and Land Capabilities

E.2.1 Introduction

This chapter describes physiographic units, Agro-Ecological Zones, soils and land capability in the Gumti Phase II Sub-Project area through review of the existing data and previous studies. These studies include (1) Land Resources Appraisal of Bangladesh for Agricultural Development (FAO 1988), (2) Feasibility Study on Gumti Phase II Sub-Project (the 1990 Report, Annex D Soils, Volume 2, 1990), and (3) Draft Regional Plan Report of SERS (Annex I, 1992). A more detailed discussion of the soils in the area is presented in Appendix E.I.

E.2.2 Agro-Ecological Region

The major part of the Gumti Phase II Sub-Project area is located on the floodplains of the Meghna River and its tributaries with a small portion of piedmont plains, terraces and small hills situated in the north eastern to eastern edge of the area. The area, shown in Figure E.2.1, is classified into 5 physiographic units, namely (1) Middle Meghna River Floodplain, (2) Old Meghna Estuarine Floodplain, (3) Northern and Eastern Piedmont Plains, (4) Northern and Eastern Hills and (5) Akhaura Terrace. These physiographic units correspond to 5 Agro-Ecological Regions which show different agricultural potentials, mainly due to the different features and characteristics of the physiography, topography, soil associations, soil moisture regime and climatic condition, according to the Agro-Ecological Zone (AEZs). The Agro-Ecological Regions in the area are briefly explained below.

AEZ-16: Middle Meghna River Floodplain exists along the Meghna River and consist of a complex, rather irregular landscape of floodplain ridges and inter-ridge depressions, cut-offs, ox-bow lakes and old channels as well as higher sandy ridges. This region is seasonally flooded by the Meghna in the monsoon season.

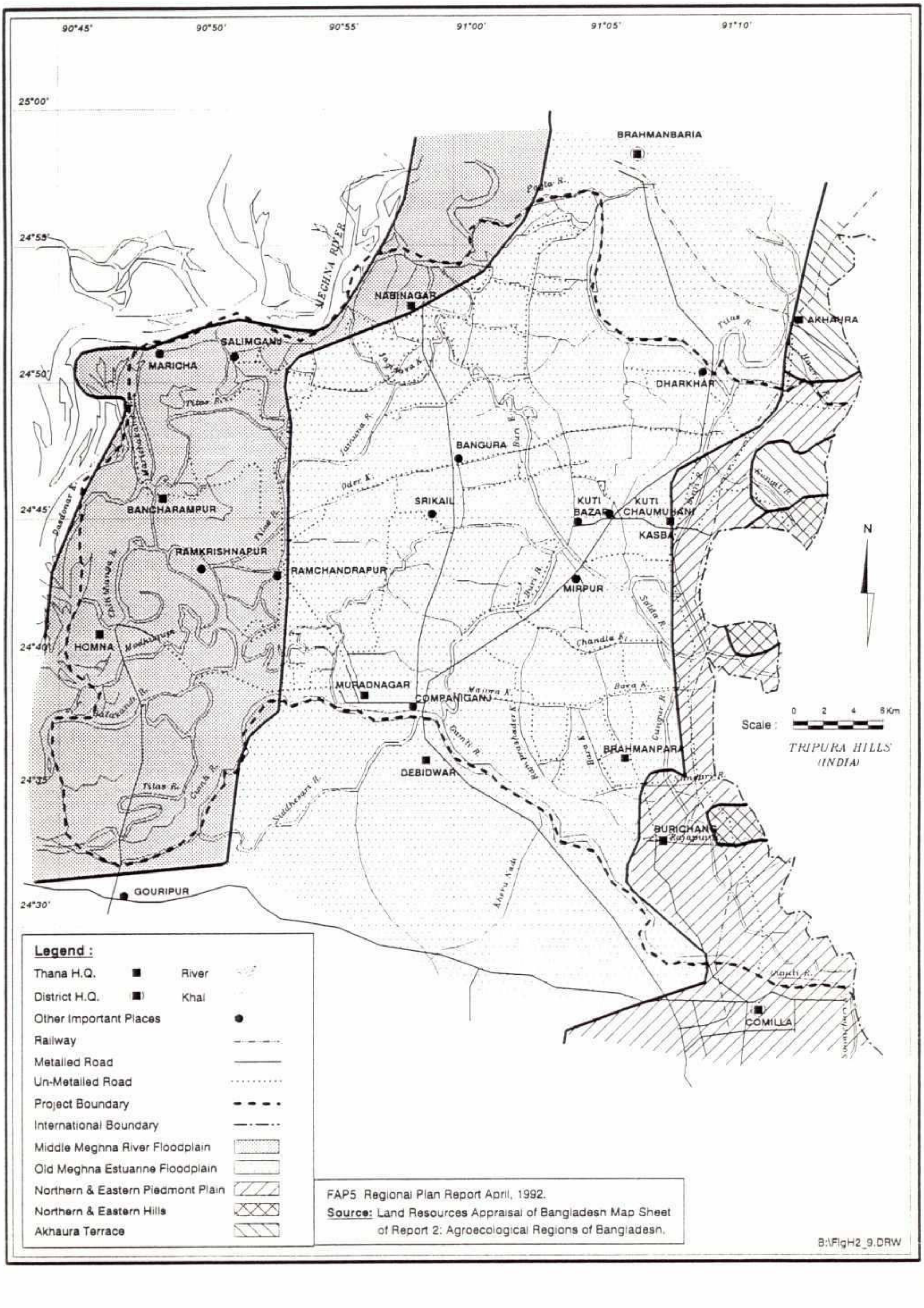
AEZ-19: Old Meghna Estuarine Floodplain covers the major part of the Sub-Project area. The landscape consists of smoothed out plains of very low relief with broad ridges and extensive shallow basins. This region is sub-divided into 4 sub-regions of 1) AEZ-19a: high land, 2) AEZ-19b: medium low land, 3) AEZ-19d: low land of Daudkandi-Hajiganji and part of Burichang-Debidwar and 4) AEZ-19i: lowland of the River Titas floodplain. This is based on differences in flooding, soil and geographical separation.

AEZ-22: Northern and Eastern Piedmont Plains occurs in a narrow discontinuous strip at the foot of the eastern hills in India. The physiography comprises merging alluvial fans and low-lying basins. This region has 3 sub-regions of 1) AEZ-22b: Northern & Eastern Plains and Basins, 2) AEZ-22c: South Sylhet Piedmont Plains and 3) AEZ-22d: Northern and Eastern Basins.

AEZ-29: Northern and Eastern Hills consists of 1 sub-region of AEZ-29c: Low Hills and Piedmont Plains and occupies minor area situated sporadically in the eastern edge along the eastern boundary of the Sub-Project. This region is the transitional zone between hills and floodplain. The relief varies from very steeply dissected to gently rolling, with 10 to 30% of floodplain landscape.

Figure E.2.1

Agroecological Regions in Project Area



FAP5 Regional Plan Report April, 1992.

Source: Land Resources Appraisal of Bangladesn Map Sheet of Report 2: Agroecological Regions of Bangladesh.

AEZ-30: Akhaura Terrace is located at the north eastern part in a minor area of the Sub-Project area. The area is broad, level terrace dissected by deep, broad valleys used for paddy cultivation. The extents of AEZs in the Gumti Phase II Sub-Project area are shown in Table E.2.1.

TABLE E.2.1

Agro-Ecological Region in the Gumti Phase II Sub-Project Area

Agro-Ecological Region/Sub-Region		Area (ha)	
AEZ-16	Middle Meghna River Floodplain	31,200	22.1%
AEZ-19	Old Meghna Estuarine Floodplain	68,800	48.9%
	19a: High Land	(300	0.2%)
	19b: Medium Low Land	(47,300	33.7%)
	19d: Low Land, Daudkandi-Hajiganji and part Burichang-Debidwar	(14,000	9.9%)
	19i: Low Land, Titas Floodplain	(7,200	5.1%)
AEZ-22	Northern and Eastern Piedmont Plains	14,100	10.0%
	22b: Northern & Eastern Plains and Basins	(3,800	2.7%)
	22c: South Sylhet Piedmont Plains	(4,400	3.1%)
	22d: Northern & Eastern Basins	(5,900	4.2%)
AEZ-29	Northern and Eastern Hills	2,500	1.8%
	29c: Low Hills and Piedmont Plains	(2,500	1.8%)
AEZ-30	Akhaura Terrace	1,400	1.0%
	Sub-total	118,000	83.8%
Others	Water bodies, infrastructure and settlement	22,900	16.2%
	Grand total	140,900	100.0%

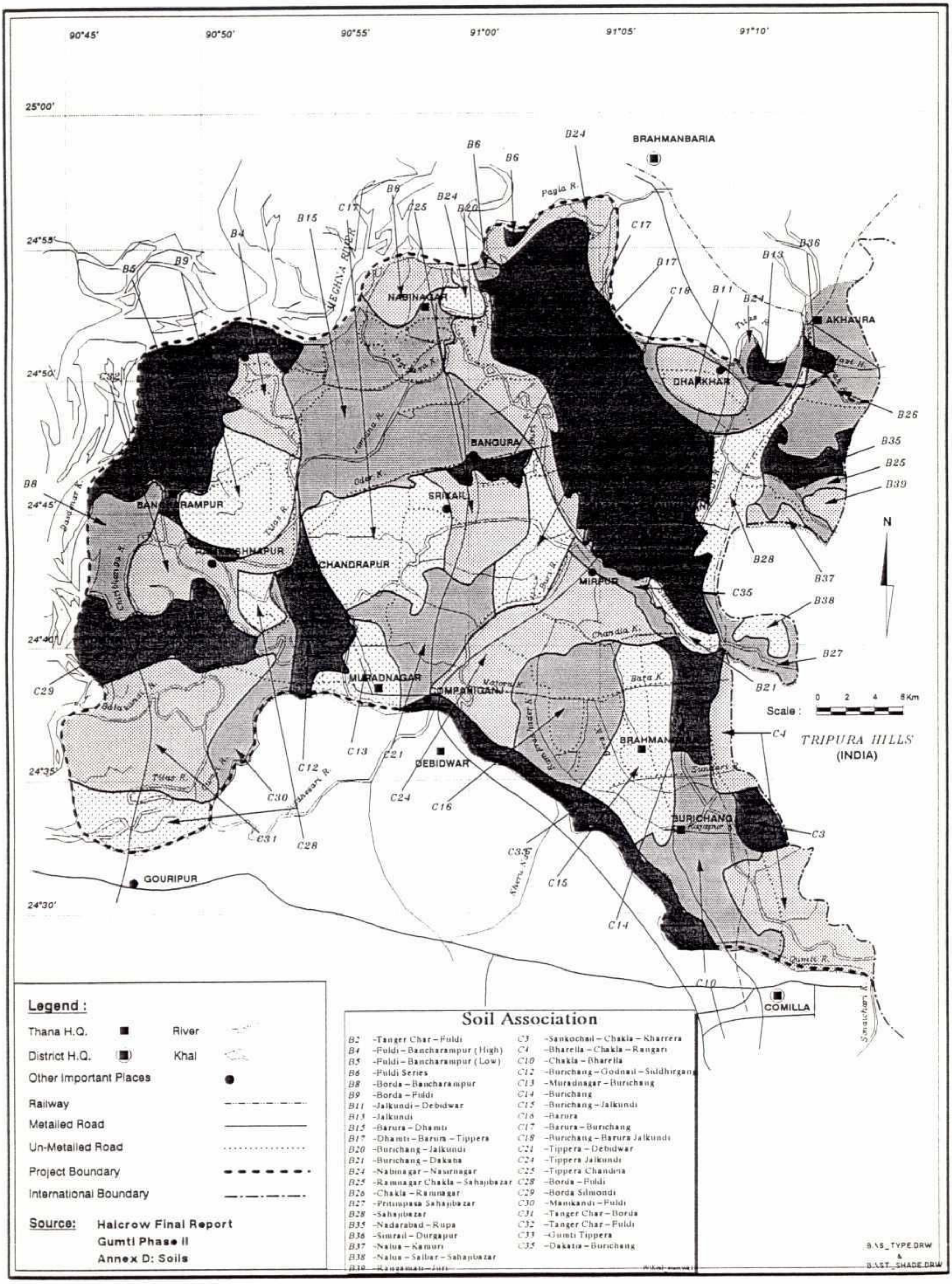
Note; Nos. of AEZs refer to the list of AEZs described in the Land Resources Appraisal of Bangladesh for Agricultural Development (FAO, 1988).

E.2.3 Soil Associations and Land Capability

Soils in the Gumti Phase II Sub-Project area are mostly fine to medium texture of Silty Clay, Silty Clay Loam and Silty Loam except coarser texture soils extending in a limited area along the Meghna. Figure E.2.2 shows the 42 soil associations identified in the area, according to the feasibility study carried out during 1988 to 1991, 39 of which are within the project boundary. The principal determinants of agricultural development are the flooding regime and availability of irrigation, rather than any intrinsic soil properties. According to the crop suitability classification of the 1990 Report, most of the soil associations are rated as suitable for crops under the condition of flood control, drainage improvement and irrigation. According to the AEZs, land capability

Figure E.2.2

Soil Types



is classified into 8 classes and sub-divided into 24 capability associations which express the main factors of limitation on agriculture. Most of the land capability in the Gumti Phase II Sub-Project area is classified into good to moderate agricultural land, as summarized in Table E.2.2. Table E.2.3 shows the soil associations by AEZs together with land capability classes. Land capability classes and capability associations are listed in Table E.2.4. The five broad classifications of land capability in the project area are presented in Figure E.2.3.

TABLE E.2.2

Land Capability in the Gumti Phase II Sub-Project Area

Agro-Ecological Region/Sub-Region	Capability Class*
AEZ-16 Middle Meghna River Floodplain	II to IV, mainly III
AEZ-19 Old Meghna Estuarine Floodplain	
19a: High Land (negligible)	II
19b: Medium Low Land	I to IV, mainly II & III
19d: Low Land, Daudkandi-Hajiganji and part Burichang-Debidwar	II & III
19i: Low Land, Titas Floodplain	III to IV
AEZ-22 Northern and Eastern Piedmont Plains	
22b: Northern & Eastern Plains and Basins	II
22c: South Sylhet Piedmont Plains	II
22d: Northern & Eastern Basins	II to IV
AEZ-29 Northern and Eastern Hills	
29c: Low Hills and Piedmont Plains	II to V, mainly III & IV
AEZ-30 Akhaura Terrace	II & III

Remarks;*: Class I:very good agricultural land, Class II:good agricultural land, Class III:moderate agricultural land, Class IV:poor agricultural land, Class V:non-agricultural land.

Figure E.2.3

Land Capability

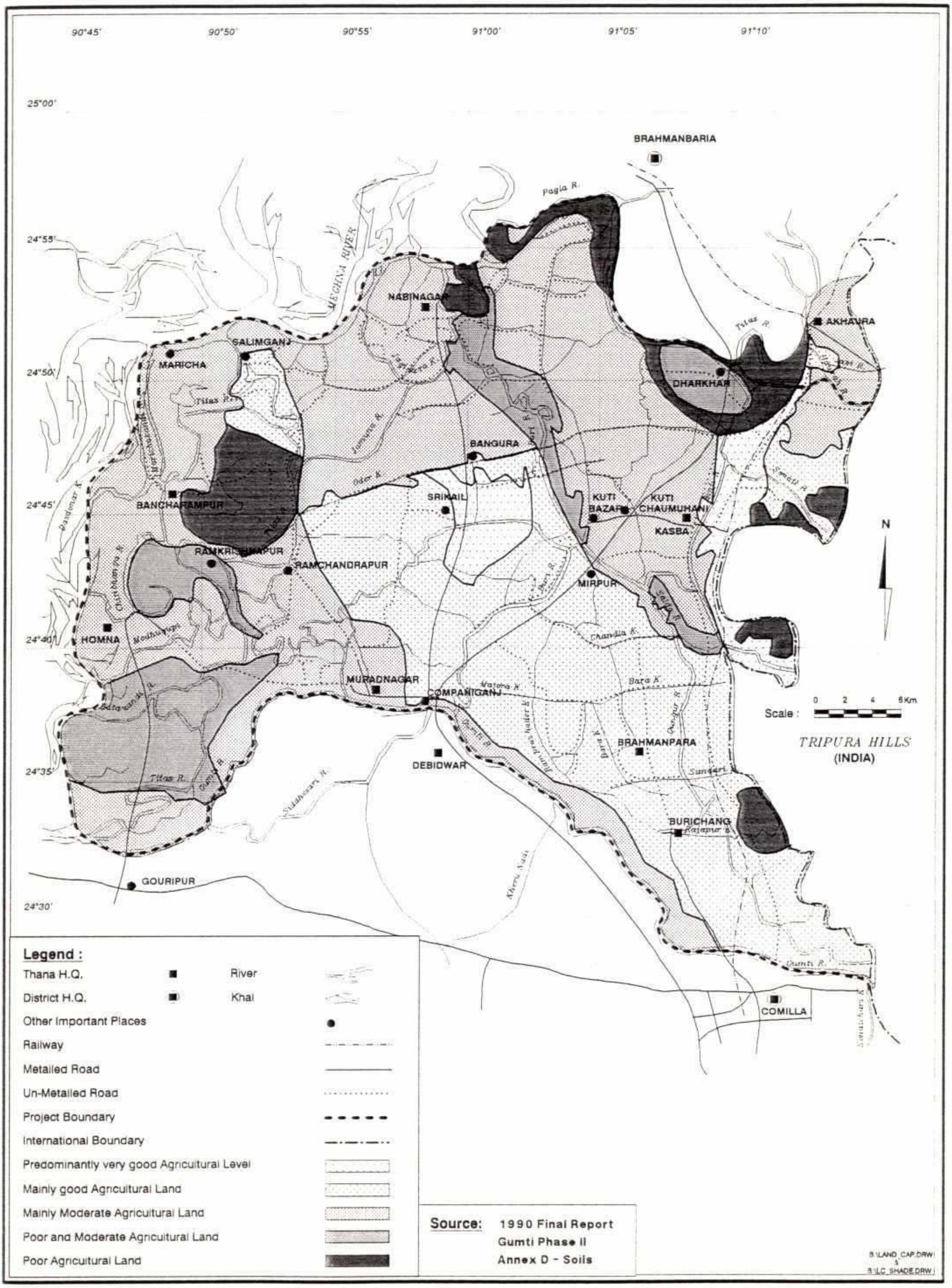


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TABLE E.2.3
Soil Association and Land Capability Class in the AEZs

Agro-Ecological Region/ Sub Region		Soil Association in AEZs*	Capability Association	Capability Class**	Area ha
AEZ-16	Middle Meghna River Floodplain	2 Tangerchar Fuldi	18,36	III&IV	3587
		4 Fuldi-Bancharampur (MH)	6	II&III	2050
		5 Fuldi-Bancharampur (ML)	11	III&IV	7134
		6 Fuldi Series	12	III&IV	1763
		8 Borda - Bancharampur	10	III	2050
		9 Borda-Fuldi	20,34	III&IV	7995
		69 Borda-Silmondi	33	III	4202
		70 Manikandi-Fuldi-Borda	33	III	2398
		71 Tangerchar-Borda	36	III&IV	7277
AEZ - 19	Old Meghna Estuarine Floodplain				
	19a High Land (negligible)	72 Gumti - Tippera	32	III	3157
		15 Barura-Dhamti	9	II&III	11398
	19b Medium Low Land	17 Dhamati-Barura-Tippera	9	II&III	16871
		20 Burichang-Jalkundi	18	III&IV	1589
		21 Burichang-Dakatia	17	III	758
		58 Burichang-Barura-Jalkundi	29	II	2767
		61 Tippera-Debidwar	28	II	3997
		64 Tippera-Jalkundi	28	II	6129
		65 Tippera-Chandina	26	I	2911
		74 Dakatia-Burchang	17	III	1045
	19d Low Land, Daudkandi-Hajiganj and part Burichang-Debidwar	20 Burichang-Jalkundi	29	II	1589
		53 Burichang-Godnail-Siddirganj	34	III	2706
		54 Muradnagar-Burichang	34	III	1865
		55 Burichang Series	29	II	2337
		56 Barura Series	29	II	11152
	19i Low Land, Daudkandi-Hajiganj and part Burichang-Debidwar	6 Fuldi Series	12	III&IV	430
		11 Jalkundi-Debiwar (L & LL)	17	III	1619
		20 Burichang - Jalkundi	18	III&IV	5145
		24 Nabinagar-Nasirnagar	21	IV	4489
AEZ - 22	Northern and Eastern Piedmont Plains				
	22b Northern & Eastern Plains and Basins	45 Bharella-Chakla-Rangali	31	II	5104
	22c South Sylhet Piedmont Plains	27 Pritimpasa-Sahazibazar	1	II	1332
		28 Sahazibazar Series	1,2	II	3095
	22d Northern & Eastern Basins	26 Chakta-Ramnagar	9	II&IV	1804
		36 Simrail-Durgapur	9	II&IV	3895
		51 Chakla-Bharella	31	II	
AEZ - 29	Northern and Eastern Hills				
	29c Low Hills and Piedmont Plains	25 Ramnagar - Chakla - Sahabazibazar	7	II&III	1025
		37 Nalua-Kamuri	22	IV&V	656
		38 Nalua-Salban-Sahazibazar	22	IV&V	779
		39 Rangamati-Juri	24	V	553
		44 Sonkochail-Chakla-Kharrera	37	III&IV	1004
AEZ - 30	Akhaura Terrace	35 Nidarabad-Rupa	4	II&III	1189

Remarks: *: Numbers of soil association correspond the numbers in Annex I Soils of the Draft Region Plan Report FAP 5, April 1992

** Numbers of capability association corresponds the numbers in Annex I Soils of the Draft Region Plan Report, FAP-5, April 1992. Capability classes indicate:

Class I: very good agricultural land, Class II : good agricultural land, Class III: moderate agricultural land, Class IV: poor agricultural land, Class V: non-agricultural land.

Source: (I) Annex I Soils of the Draft Region Plan Report, FAP-5, April 1992 (2) Album of Drawing of the Draft Region Plan Report, FAP-5, March 1992 (3) Feasibility Study on Gumti Phase II Sub Project (Annex D Soils, Volume 2), 1991.

TABLE E.2.4

Land Capability Class and Land Capability Associations

	Land Capability Class		Land Capability Association*
I	Very good agricultural land	26	Predominantly very good agricultural land, shallowly flooded
II	Good agricultural land	1	Imperfectly drained highland
		2	Seasonally shallowly flooded land and imperfectly drained highland
		28	Mainly good with some very good agricultural land, mainly moderately deeply flooded
		29	Predominantly good agricultural land, mainly moderately deeply flooded
		31	Mainly good with some poor agricultural land, mainly shallowly flooded, part moderately deeply flooded and slow draining in the dry season
II & III	Good & moderate agricultural land	4	Moderately well drained terrace with some imperfect drained valleys
		6	Seasonally shallowly flooded land with some moderately deeply flooded land
		7	Seasonally shallowly to deeply flooded land
		9	Seasonally shallowly and moderately deeply flooded land
III	Moderate agricultural land	10	Seasonally shallowly to deeply flooded land
		17	Seasonally moderately deeply to deeply flooded basins, part with flood hazard
		32	Mainly moderate with some very good agricultural land, mainly shallowly flooded, mainly with flood hazard
		33	Predominantly moderate agricultural land, droughty in dry season, moderately deeply to very deeply flooded
		34	Predominantly moderate agricultural land, deeply flooded, part slow draining in the dry season
III & IV	Moderate & poor agricultural land	11	Seasonally moderately deeply to very deeply flooded land
		12	Seasonally moderately deeply to very deeply flooded land, part sandy, part with flood hazard
		18	Seasonally moderately deeply to very deeply flooded land, part with flood hazard
		36	Poor and moderate agricultural land, deeply to very deeply flooded, partly very droughty in the dry season
		37	Predominantly poor agricultural land, high land, mainly with severe erosion hazard
IV	Poor agricultural land	20	Seasonally deeply to very deeply flooded land, part with flood hazard
		21	Seasonally deeply to very deeply flooded land, part with flood hazard, part slow draining in the dry season
IV & V	Poor & non-agricultural land	22	Very steep hills with some imperfectly drained valleys
		23	Seasonally deeply flooded charland with hazards of flood and river erosion
V	Non-agricultural land and with low bearing capacity	24	Steep hills and very deeply flooded valleys, perennially wet

Remarks; *: Numbers of capability association corresponds the numbers in Annex I Soils of the Draft Region Plan Report, FAP-5, April 1992. Capability classes indicate;

Class I:very good agricultural land, Class II:good agricultural land, Class III:moderate agricultural land, Class IV:poor agricultural land, Class V:non-agricultural land.

Source: (1) Annex I Soils of the Draft Region Plan Report, FAP-5, April 1992. (2) Album of Drawing of the Draft Region Plan Report, FAP-5, March 1992. (3) Feasibility Study on Gumti Phase II Sub-Project (Annex D Soils, Volume 2), 1991

E.3 Present Situation of Agriculture

E.3.1 Structure of Farming

The demographic data shows that the total number of households in the area is estimated at about 320,400 (5.85 person per household) with a population density of 1,300 persons per square km in 1993, of which 92% is farm households whose livelihood relies mainly on agriculture. The average farm size of 0.78 ha in the area is smaller than the national average, however the structure of farm households shows a wide variation of farm size, land ownership and tenancy, as mentioned below. Most of the data are collected from the current farmer surveys compiled in Appendix E.II of this Annex and supplemented by secondary data.

According to the farm size distribution estimation based on the tax-lists of sample mouzas, the area is characterized by a large portion of small and marginal farmers which accounts for 78% of the total households. Land ownership is unequally distributed with 60% of land owned by 22% of the households who are categorized in large and medium farms, as shown in Table E.3.1.

TABLE E.3.1

Farm Size Distribution

Farm Size Category and Operated Area

	Marginal 0.02 to 0.2 ha	Small 0.21 to 1.0 ha	Medium 1.01 to 3.0 ha	Large over 3.01 ha	Total
No. of farmers	25%	53%	18%	4%	100%
Areal distribution	6%	34%	38%	22%	100%

According to the 1981 census data, about 30% of the total households were "landless" farmers who owned less than 0.02 ha of farm land. The ratio of landless farmers may increase due to the high growth rate of population. Tenancy of cultivated land is categorized by owned land or rented land, in the form of share-cropping and mortgage. According to the farmer survey, about 80% of cultivable land is cultivated by the land owner, however, 20% is cultivated by tenants, in most cases on a share-cropping basis. The result shows that land rented-out is far more than rented-in, and this indicates that landless farmers may cultivate nearly 14% of the total cultivable land, which is balanced from rented-out (19.6%) to rented-in (5.6%). The tenure arrangement of farm land is shown in detail in Table E.3.4 and is summarised in Table E.3.2.

TABLE E.3.2

Tenure Arrangement of Farm Land

	Owned Cultivated Land (A)	Area Rented-Out (B)	Area Rented-In (C)	Total Cultivated Area (A) - (B) + (C)
Area	371.4 ha	72.7 ha	20.9 ha	319.6 ha
Ratio	100.0%	19.6%	5.6%	86.1%

Average farm size of sample farm households is estimated at 0.83 ha per household consisting of 0.14 ha for marginal, 0.55 ha for small, 1.63 ha for medium and 4.03 ha for large farm size, as shown below;

TABLE E.3.3

Average Farm Size

(Unit:ha)

Planning Zone	Farm Size Category and Operated Area				
	Marginal 0.02 to 0.2 ha	Small 0.2 to 1.0 ha	Medium 1.0 to 3.0 ha	Large over 3.0 ha	Average
Zone A	0.13	0.50	1.57	3.64	0.73
Zone B	0.15	0.59	1.54	3.91	0.84
Zone C	0.13	0.58	1.64	3.99	0.85
Zone D	0.14	0.53	1.72	4.79	0.90
Whole Area	0.14	0.55	1.63	4.03	0.83

TABLE E.3.4

Tenure Arrangement and Average Farm Size

Planning Zone	Farm Size Category	Total Area Owned (ha)	Area not Cultivated (ha)	Owned Cultivable Area (ha)	Total Rented out (ha)	Total Rented in (ha)	Total Cultivated Area (ha)	No. of Farms (Nos.)	Average Farm Size (ha)
Zone A	Marginal	4.26	0.52	3.75	0.61	0.12	3.26	25	0.13
	Small	32.64	3.13	29.51	7.86	3.83	25.48	51	0.50
	Medium	32.07	3.27	28.80	5.62	0.39	23.57	15	1.57
	Large	20.36	1.46	18.91	0.72	0.00	18.18	5	3.64
	Total	89.33	8.37	80.96	14.81	4.34	70.49	96	0.73
Zone B	Marginal	5.68	1.67	4.01	0.12	0.06	3.95	27	0.15
	Small	36.61	5.33	31.28	7.02	4.06	28.32	48	0.59
	Medium	29.49	4.45	25.04	4.49	0.95	21.50	14	1.54
	Large	36.07	3.77	32.30	4.95	0.00	27.35	7	3.91
	Total	107.85	15.23	92.63	16.59	5.08	81.11	96	0.84
	18%	31%							
Zone C	Marginal	4.03	0.90	3.14	0.06	0.19	3.27	25	0.13
	Small	36.52	4.28	32.24	7.64	3.98	28.58	49	0.58
	Medium	41.29	3.95	37.34	11.66	0.49	26.17	16	1.64
	Large	29.35	1.85	27.50	3.58	0.00	23.92	6	3.99
	Total	111.19	10.96	100.22	22.95	4.66	81.94	96	0.85
Zone D	Marginal	5.07	0.95	4.12	0.87	0.15	3.40	24	0.14
	Small	27.64	2.65	24.99	4.75	3.65	23.89	45	0.53
	Medium	51.19	3.01	48.18	11.56	2.98	39.59	23	1.72
	Large	20.83	0.52	20.32	1.17	0.00	19.14	4	4.79
	Total	104.73	7.13	97.60	18.36	6.78	86.02	96	0.90
Total	Marginal	19.04	4.03	15.01	1.66	0.53	13.88	101	0.14
	Small	133.40	15.39	118.01	27.27	15.53	106.26	193	0.55
	Medium	154.03	14.68	139.36	33.34	4.81	110.83	68	1.63
	Large	106.62	7.59	99.03	10.43	0.00	88.59	22	4.03
	Total	413.09	41.69	371.41	72.70	20.86	319.56	384	0.83

E.3.2 Land Use

The Gumti Phase II Sub-Project area, consisting of four planning zones, covers a gross area of approximately 140,900 ha and covers four Thanas in Brahmanbaria District (65,900 ha or 47% of the total area) and seven Thanas in Comilla (75,000 ha or 53%). Figure E.3.1 shows the boundaries of the four zones. The gross area by Thana is shown in Table E.3.5.

Figure E.3.1

Planning Zones (A, B, C & D)

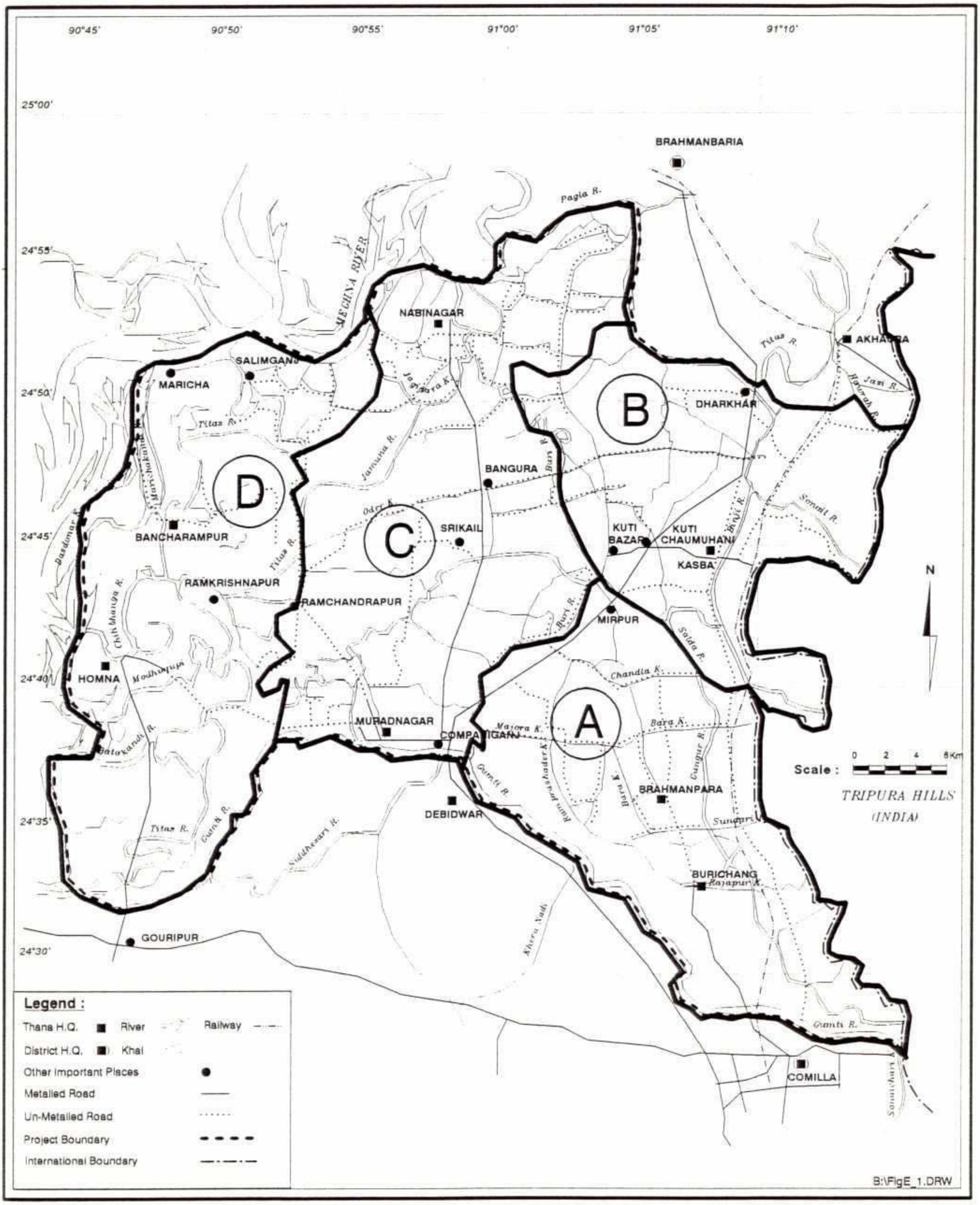

TABLE E.3.5

Gross Area by Thana

(Unit:ha)

Name of Thana	Planning Zone A	B	C	D	Total
Comilla Sadar*	3,541	-	-	-	3,541
Burichang*	9,558	-	-	-	9,558
Brahmanpara*	11,982	-	-	-	11,982
Debidwar*	6,895	-	-	-	6,895
Kasba**	-	20,987	-	-	20,987
Akhaura**	-	2,524	-	-	2,524
Nabinagar**	-	3,271	20,400	4,400	28,071
Muradnagar*	-	-	21,000	2,512	23,512
Bancharampur**	-	-	-	14,305	14,305
Homna*	-	-	-	11,856	11,856
Daudkandi*	-	-	-	7,623	7,623
Total	31,976	26,782	41,400	40,696	140,854
Ration	23%	19%	29%	29%	100%

Remarks; *:Comilla District, **:Brahmanbaria District

The gross area includes 22,800 ha (16% of the total area) of non-cultivable land of perennial water bodies, infrastructure and settlement area. The net cultivable area (NCA) is estimated at about 118,000 ha which corresponds to 84% of the gross area. Table E.3.6 shows distribution of the area by four planning zones.

TABLE E.3.6

NCA by Planning Zones

(Unit:ha)

Item	Planning Zone A	B	C	D	Total
	(23%)	(19%)	(29%)	(29%)	(100%)
Gross Area	31,976	26,782	41,400	40,696	140,854
	(21%)	(19%)	(30%)	(31%)	(100%)
NCA	24,506	22,412	35,040	36,080	118,038
Ratio to Gross	77%	84%	85%	89%	84%

In terms of the flood phase, 14% of the area is highland: F0 (flood depth of 0 to 30 cm), 23% medium highland: F1 (30 to 90 cm), and 63% medium lowland and lowland: F2&F3 (over 90 cm) as shown in Table E.3.7. Main flooding is caused by flash floods from the eastern Tripura Hills in the pre-monsoon season and the monsoon flood due to poor drainage and spillage from the Meghna and its tributaries. The four planning zones show very different flooding and inundation conditions according to the flood phase characteristics.

In Zone A, located in south-eastern part bounded by the Buri Nadi in the north-west, more than 81% of NCA is F0 and F1. Zone A is affected by flash flooding from the eastern Tripura Hills in the pre-monsoon season and the monsoon flood with longer duration due to poor drainage of rainfall. Zone B extends in the north-eastern portion of the area, and almost half of the land is situated in F2&F3 (56%). Zone B is affected by flash flooding from the Tripura Hills in the same way as Zone A. However, floods caused by poor drainage is related to the water level of the Meghna. In Zone C, which occupies the central part, 74% of the area is over 90 cm of flood depth (F2&F3). This zone is subjected to flooding during the monsoon season. Zone D is located in the western part of the area and 87% of the land is situated in F2&F3. This zone is mainly affected by the monsoon flooding. The area by flood phase in the planning zones is summarized in Table E.3.7.

TABLE E.3.7

Area by Flood Phase

(Unit:ha)

Flood Phase	NCA in Planning Zone A	B	C	D	Total
F0	9,312	4,482	1,752	1,082	16,629
	(38%)	(20%)	(5%)	(3%)	(14%)
F1	10,538	5,379	7,358	3,608	26,883
	(43%)	(24%)	(21%)	(10%)	(23%)
F2&F3	4,656	12,551	25,930	31,390	74,526
	(19%)	(56%)	(74%)	(87%)	(63%)
Total	24,506	22,412	35,040	36,080	118,038
	(100%)	(100%)	(100%)	(100%)	(100%)

Source: Estimation by Farmers Survey and AST data.

The situation with regard to irrigation has been changing every year depending on the rainfall and flooding, as well as distribution of equipment. It is considered that irrigation coverage has expanded recently through development of STWs, DTWs and LLPs. The degree of irrigation in the area is estimated using data obtained through farm survey and AST data. Irrigation water is applied mainly for boro crops, and supplemental irrigation is given for rabi, aus and aman crops. Application of the irrigation is high with approximately 63,200 ha or 53% of the total NCA. Irrigation condition varies depending on the planning zones and flood phases. Zones A, B and D are irrigated to more than 50%, however, Zone C is about 40%. Table E.3.8 shows that irrigation condition by flood phase generally indicates that the irrigation rate is higher in the lower flood phase.

TABLE E.3.8

Irrigated Area by Flood Phase

(Unit:ha)

Condition	Land Type F0	F1	F2 & F3	Total
	(41%)	(50%)	(57%)	(53%)
Irrigated	6,876	13,368	42,531	62,775
	(59%)	(50%)	(43%)	(47%)
Rainfed	9,753	13,515	31,995	55,263
	(100%)	(100%)	(100%)	(100%)
Total	16,629	26,883	74,526	118,038

Source: Estimation by Farmers Survey and AST data.

Zones A and B have different characteristics from Zones C and D in irrigation condition by flood phase. Medium lowland and lowland (F2&F3) in Zones A and B is irrigated at around 70%, and even higher land (F1 and F2) is about 50% under irrigation. This may reflect that the irrigation water source in Zone A and B is both groundwater and surface water. In Zones C and D, on the other hand, higher ground of F0 and F1 is mainly cultivated under rainfed condition, and half of F2&F3 land is covered by irrigation. The source in Zones C and D consist mainly of surface water (beels and khals) using LLP. Irrigated area by planning zone and flood phase is shown in Table E.3.10 and summarized in Table E.3.9.

TABLE E.3.9

Irrigated Area by Planning Zones

(Unit:ha)

Condition	Planning Zone				Total
	A	B	C	D	
Irrigated	(62%) 15,194	(68%) 15,240	(40%) 14,121	(50%) 18,220	(53%) 62,775
Rainfed	(38%) 9,312	(32%) 7,172	(60%) 20,919	(50%) 17,860	(47) 55,263
Total	(100%) 24,506	(100%) 22,412	(100%) 35,040	(100%) 36,080	(100%) 118,038

Source: Estimation by Farmers Survey and AST data.

E.3.3 Cropping Systems and Cultural Practices

E.3.3.1 Crop Management

(1) Cropping season

There are three cropping seasons in a year: two summer rainy seasons (kharif-1 from March to June, kharif-2 from July to October) and the winter dry season (rabi from November to February). More than 80% of annual rainfall (2,000 to 2,300 mm) is distributed in the summer season. Crop production can be constrained by waterlogged soils, flooding, low solar radiation, high humidity and infestation by pests and diseases. Paddy is the predominant crop in summer season, when two rice crops are generally grown, aus in kharif-1 (pre-monsoon) followed by aman in kharif-2 (monsoon). Deepwater rice requires a longer growth period throughout kharif-1 and 2. Jute is another important crop during the kharif-1 season. Such upland crops as pulses and vegetables are grown in a limited area.

The Rabi season is characterized by scanty rainfall, lower temperatures, high solar radiation, low humidity, and lower infection of insect pests and diseases. A wide range of crops are grown in this season. They include both tropical and temperate crops such as boro paddy, wheat, potatoes, mustard, chilies and winter vegetables. Although low soil moisture content may limit cropped area and yield, irrigation is highly effective to increase production. Lower temperatures in the winter season permits preparation of nurseries for boro paddy in December. This is transplanted in January to February and harvested in April to May.

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(2) Crop sequences

A wide range of cropping patterns can be found in the area, and farmers apply various modifications of pattern to their lands. Among the various factors to determine the cropping patterns are inundation depth of flood as well as availability of irrigation water. Cropping sequence is therefore broadly categorized according to land type of flood phase and availability of irrigation water to minimize flood damage and maximize the advantages of irrigation. Schematic Cropping Patterns for the area are presented in Figure E.3.2.

TABLE E.3.10

Area by Flood Phase under Present Condition

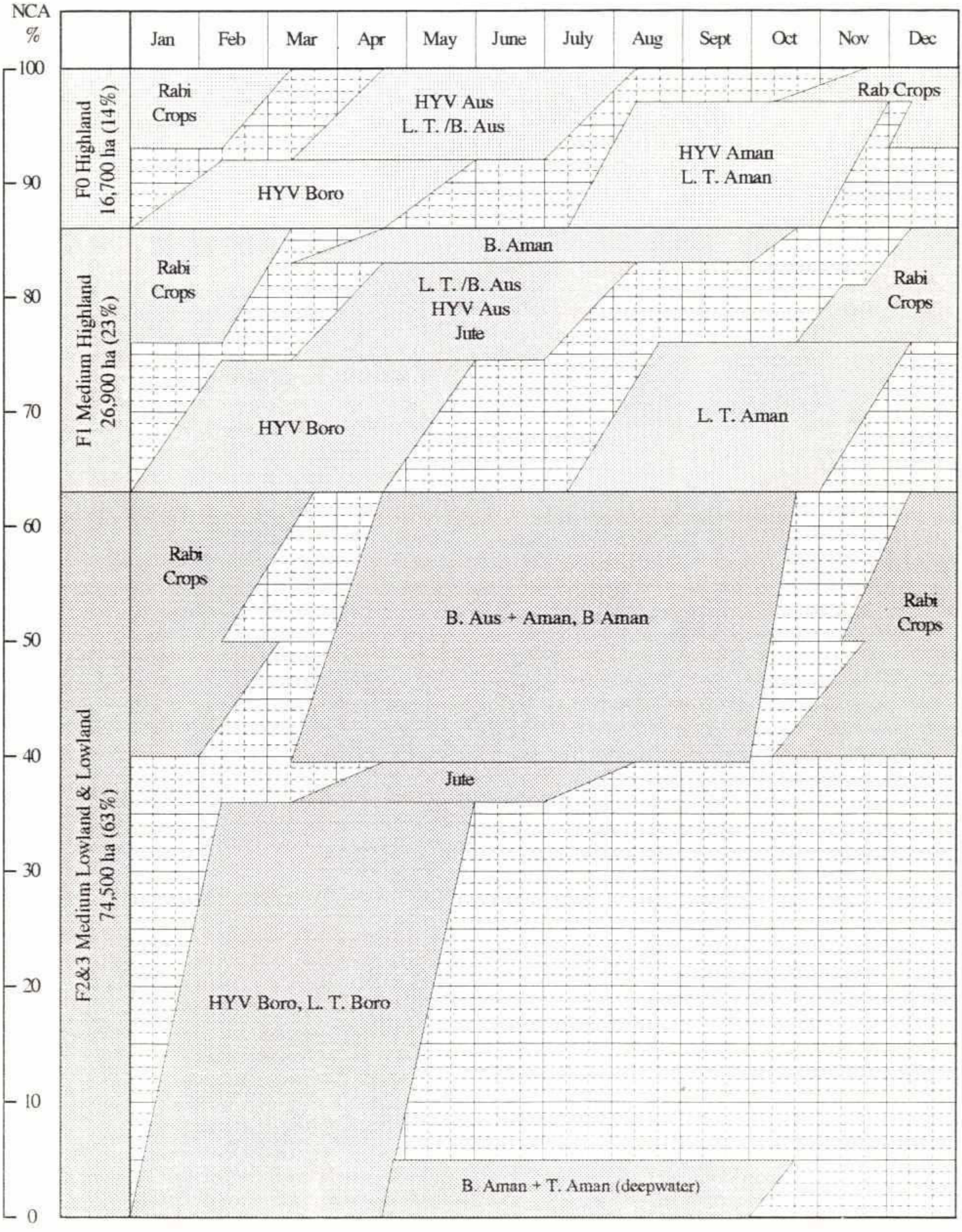
(Unit:ha)

				Flood Phase					
Zone	Condition	NCA		F0		F1		F2&F3	
		Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Zone A	Irrigated	15,194	62.0%	4,411	47.4%	7,352	69.8%	3,431	73.7%
	Rainfed	9,312	38.0%	4,901	52.6%	3,186	30.2%	1,225	26.3%
	Sub-total	24,506	100.0%	9,312	100.0%	10,538	100.0%	4,656	100.0%
		100.0%		38.0%		43.0%		19.0%	
Zone B	Irrigated	15,240	68.0%	2,465	55.0%	3,362	62.5%	9,413	75.0%
	Rainfed	7,172	32.0%	2,017	45.0%	2,017	37.5%	3,138	25.0%
	Sub-total	22,412	100.0%	4,482	100.0%	5,379	100.0%	12,551	100.0%
		100.0%		20.0%		24.0%		56.0%	
Zone C	Irrigated	14,121	40.3%	0	0.0%	1,752	23.8%	12,369	47.7%
	Rainfed	20,919	59.7%	1,752	100.0%	5,606	76.2%	13,560	52.3%
	Sub-total	35,040	100.0%	1,752	100.0%	7,358	100.0%	25,930	100.0%
		100.0%		5.0%		21.0%		74.0%	
Zone D	Irrigated	18,220	50.5%	0	0.0%	902	25.0%	17,318	55.2%
	Rainfed	17,860	49.5%	1,082	100.0%	2,706	75.0%	14,071	44.8%
	Sub-total	36,080	100.0%	1,082	100.0%	3,608	100.0%	31,390	100.0%
		100.0%		3.0%		10.0%		87.0%	
Total	Irrigated	62,775	53.2%	6,876	41.4%	13,368	49.7%	42,531	57.1%
	Rainfed	55,263	46.8%	9,753	58.6%	13,515	50.3%	31,995	42.9%
	Total	118,038	100.0%	16,629	100.0%	26,883	100.0%	74,526	100.0%
		100.0%		14.1%		22.8%		63.1%	

Source : Estimation based on farm survey results and AST data.
Remarks ; F0: highland, flood depth less than 0.3 m, F1 : medium highland, flood depth between 0.3 to 0.9 m, F2&F3 :medium lowland and lowland, flood depth between more than 0.9 m.

Figure E.3.2

Schematic Cropping Pattern under Present Condition



If the land is not affected by flood and poor drainage in two rainy seasons, a basic cropping pattern under irrigated condition can be assumed to be HYV boro in the winter season followed by HYV aman in the summer season. Other basic cropping patterns under rainfed conditions, which can be attempted, include HYV aus and HYV aman in the summer season followed by upland short term crops in the winter dry season. In practice, however, flood depth in various land types and irrigation, brings broad variations of those basic cropping patterns to avoid serious damage which cannot be predicted before planting. The present cropping pattern is shown in Fig. E.3.2.

(a) F0 (highland, flood depth less than 30 cm)

On the high ground where floods rarely affect the aus and aman crops, the basic cropping pattern can be slightly modified. HYV boro in the rabi season and HYV aman in the summer season is the typical cropping pattern under irrigation. Under rainfed conditions, aus paddy is followed by aman paddy, this is then followed by rabi upland crops using residual soil moisture. High yielding varieties are dominant in aus and aman paddy. Typical rabi crops are mainly wheat, pulses, oilseeds (mustard), potato, winter vegetables (tomato, cauliflower, cabbage, brinjal) and spices (chili, onion). Wheat and potatoes may be irrigated.

(b) F1 (medium highland, flood depth 30 to 90 cm)

As the flood depth increases, longer strawed local varieties become more popular. In areas where flooding starts later, kharif-1 crops such as aus and jute are grown, while where floods come earlier, kharif-1 crop is not cultivated, but broadcast aman is sown one month before the floods start. It may be considered unusual for B aman to be grown on F1 land but the small amount determined by our farmers surveys is likely to be on the periphery of F1, next to F2 land. Farmers attempt to assure the minimum production through keeping limited areas under mixed broadcast aman and broadcast aus. Irrigation is practised for HYV boro and rabi crops are cultivated under rainfed condition.

(c) F2&F3 (medium lowland and lowland, flood depth more than 90 cm)

Flooding usually comes early, and this prevents the growth of normal aus, bringing about broadcast deepwater aman as the main kharif paddy. Under irrigated condition, HYV boro is widely grown. However, rabi or wheat followed by broadcast aman is dominant in the rainfed land. In the area where flooding is deeper and longer lasting, farmers are limited to only single crop of HYV boro or local boro.

E.3.3.2 Crop Area and Intensities

The previous feasibility study described that cropping intensity was 188% under the present condition in the Gumti Phase II Sub-Project area. Out of the total crop area, 70% was rice and the remaining rabi crops. As irrigation has been expanding over the past few years, the crop area and intensity has changed. Crop area is mainly estimated on the basis of the farmer survey with supplement of the secondary data such as BBS, DAE and AST. Crop area by land type in each planning zone is shown in Tables E.3.14 to E.3.18 and is summarized in Tables E.3.11 to E.3.13.

(1) Crop Area

The total cropped area is estimated at approximately 201,000 ha, which is 171% of the cropping intensity in the whole area. Rice is the main crop, which accounts for 114,700 ha or 72% of the total cropped area, followed by 47,100 ha (23%) of rabi crop, 9,100 ha (5%) of jute and 400 ha (below 1%) of summer vegetables. The main rabi crop is wheat (32% of rabi crop area), oilseeds (mostly mustard, 27%) and pulses (19%) and potato, spices and vegetables are planted in small areas. The cropped area by land type is summarised in Table E.3.11.

TABLE E.3.11

Crop Area

(Unit:ha)

Crop	Total		F0		F1		F2 & F3	
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Rice	144,690	72%	29,199	77%	37,923	70%	77,567	71%
Rabi crop	47,089	23%	8,387	22%	11,239	21%	27,464	25%
Jute	9,118	5%	-	-	4,894	9%	4,224	4%
Summer vegetables	394	0%	394	1%	-	-	-	-
Total	201,291	100%	37,980	100%	54,056	100%	109,255	100%

Area under rice by land type is given in Table E.3.12. Rice crops consists of 32% aus, 25% aman and 43% of boro. 67% of the rice crop is high yielding variety (HYV), particularly HYV prevails in boro rice. The area under aus and aman decreases in lower land due to higher flood depths.

TABLE E.3.12

Rice Crop Area

(Unit:ha)

	Total		F0		F1		F2 & F3	
Crop	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
HYV aus	6,746	5%	4,224	15%	2,522	7%	-	-
B./L.T. aus	39,005	27%	5,135	18%	6,100	16%	27,771	36%
HYV aman	14,011	10%	11,591	39%	2,420	6%	-	-
B./L.T. aman	22,152	15%	1,373	5%	13,514	36%	7,265	9%
HYV boro	61,252	42%	6,876	23%	13,368	35%	41,008	53%
L.T. boro	1,524	1%	-	-	-	-	1,524	2%
Total of rice	144,690	100%	29,199	100%	37,923	100%	77,567	100%
NCA	118,038		16,629		26,883		74,526	

(2) Cropping Intensity

Cropping intensity is estimated at 171% in the whole area, ranging from the lowest intensity of 152% in Zone D to the highest of 201% in Zone A. The wide variation of cropping is mainly explained by the difference in composition of flood phase and extent of irrigation.

TABLE E.3.13

Cropping Intensity

Unit:ha

Planning Zone	Total		F0		F1		F2&F3	
	NCA	C. I.	NCA	C. I.	NCA	C. I.	NCA	C. I.
Zone A	24,506	201%	9,312	237%	10,538	184%	4,656	164%
Zone B	22,412	171%	4,482	203%	5,379	195%	12,551	149%
Zone C	35,040	168%	1,752	250%	7,358	243%	25,930	142%
Zone D	36,080	152%	1,082	223%	3,608	175%	31,390	147%
Total Area	118,038	171%	16,628	228%	26,883	201%	74,527	147%

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TABLE E.3.14

Crop Area by Land Type in the Total Project Area

(Unit:ha)

Crop	Total		F0		F1		F2 & F3	
			Land Type by Flood Phase					
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Area by Flood Phase	118,038	100%	16,629	14%	26,883	23%	74,526	63%
Cropped Area & Intensity	201,291	171%	37,980	228%	54,056	201%	109,255	147%
Kharif-1 Season								
B .Aus:LV	4,219	4%	2,817	17%	1,402	5%	-	-
B. Aus:HYV	1,066	1%	716	4%	350	1%	-	-
T. Aus :LV	2,589	2%	1,423	9%	1,166	4%	-	-
T. Aus :HYV	5,679	5%	3,508	21%	2,171	8%	-	-
B. Aus+Aman	5,932	5%	-	-	-	-	5,932	8%
B/LT. Aman:LV	26,265	22%	895	5%	3,532	13%	21,838	29%
Jute	9,118	8%	-	-	4,894	18%	4,224	6%
Summer Vegetables	394	0%	394	2%	-	-	-	-
Sub-total	55,263	47%	9,753	59%	13,515	50%	31,995	43%
Kharif-2 Season								
T. Aus :HYV	1,720	2%	-	-	1,720	6%	-	-
B. Aman:LV	3,427	3%	-	-	-	-	3,427	5%
T. Aman:LV (deep water)	3,839	3%	-	-	-	-	3,839	5%
T. Aman:LV	14,887	13%	1,373	8%	13,514	50%	-	-
T. Aman:HYV	12,292	10%	11,591	70%	701	3%	-	-
Sub-total	36,163	31%	12,964	78%	15,934	59%	7,265	10%
Rabi Season								
Boro:LV	1,184	1%	-	-	-	-	1,184	2%
Boro:LIV	340	0%	-	-	-	-	340	1%
Boro:HYV	61,252	52%	6,876	41%	13,368	50%	41,008	55%
Wheat	15,257	13%	1,745	11%	2,852	11%	10,660	14%
Pulses	8,843	8%	1,449	9%	1,123	4%	6,271	8%
Oilseeds	12,817	11%	1,263	8%	3,438	13%	8,117	11%
Potato	3,824	3%	1,335	8%	2,490	9%	-	-
Winter Vegetables	3,161	3%	1,898	11%	-	-	1,263	2%
Spices	3,187	3%	697	4%	1,335	5%	1,155	2%
Sub-total	109,865	93%	15,263	92%	24,606	92%	69,996	94%
Summary of Rice Cropped Area								
HYV aus	6,746	5%	4,224	15%	2,522	7%	-	-
B./L.T. aus	39,005	27%	5,135	18%	6,100	16%	27,771	36%
HYV aman	14,011	10%	11,591	40%	2,420	6%	-	-
B./L.T. aman	22,152	15%	1,373	5%	13,514	36%	7,265	9%
HYV boro	61,252	42%	6,876	24%	13,368	35%	41,008	53%
L.T. boro	1,524	1%	-	-	-	-	1,524	2%
Sub-total of rice	144,690	100%	29,199	100%	37,923	100%	77,567	100%
Summary of Total Cropped Area								
Rice	144,690	72%	29,199	77%	37,923	70%	77,567	71%
Jute	9,118	5%	-	-	4,894	9%	4,224	4%
Rabi crops	47,089	23%	8,387	22%	11,239	21%	27,464	25%
Summer Vegetable	394	0%	394	1%	-	-	-	-
Total	201,291	100%	37,980	100%	54,056	100%	109,255	100%

TABLE E.3.15

Crop Area by Land Type in Planning Zone A

(Unit:ha)

Crop	Total		Land Type by Flood Phase F0		F1		F2 & F3	
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Area by Flood Phase	24,506	100%	9,312	38%	10,538	43%	4,656	19%
Cropped Area & Intensity	49,134	201%	22,083	237%	19,405	184%	7,646	164%
Kharif-1 Season								
B .Aus:LV	1,250	5%	1,250	13%	-	-	-	-
B. Aus:HYV	245	1%	245	3%	-	-	-	-
T. Aus :LV	931	4%	466	5%	466	4%	-	-
T. Aus :HYV	4,411	18%	2,941	32%	1,470	14%	-	-
B. Aus+Aman	196	1%	-	-	-	-	196	4%
B. Aman:LV	1,568	6%	-	-	539	5%	1,029	22%
Jute	711	3%	-	-	711	7%	-	-
Summer Vegetables	0	0%	-	-	-	-	-	-
Sub-total	9,312	38%	4,901	53%	3,186	30%	1,225	26%
Kharif-2 Season								
T. Aus :HYV	1,054	4%	-	-	1,054	10%	-	-
B. Aman:LV	466	2%	-	-	-	-	466	10%
T. Aman:LV (deep water)	1,544	6%	-	-	-	-	1,544	33%
T. Aman:LV	5,608	23%	-	-	5,608	53%	-	-
T. Aman:HYV	8,360	34%	8,360	90%	-	-	-	-
Sub-total	17,031	70%	8,360	90%	6,662	63%	2,009	43%
Rabi Season								
Boro:LV	0	0%	-	-	-	-	-	-
Boro:LIV	0	0%	-	-	-	-	-	-
Boro:HYV	15,194	62%	4,411	47%	7,352	70%	3,431	74%
Wheat	2,255	9%	1,274	14%	980	9%	-	-
Pulses	490	2%	490	5%	-	-	-	-
Oilseeds	2,083	9%	613	7%	490	5%	980	21%
Potato	1,666	7%	931	10%	735	7%	-	-
Winter Vegetables	833	3%	833	9%	-	-	-	-
Spices	270	1%	270	3%	-	-	-	-
Sub-total	22,791	93%	8,822	95%	9,557	91%	4,411	95%
Summary of Rice Cropped Area								
HYV aus	4,656	11%	3,186	18%	1,470	9%	-	-
B./L.T. aus	3,945	10%	1,715	10%	1,005	6%	1,225	18%
HYV aman	9,414	23%	8,360	47%	1,054	6%	-	-
B./L.T. aman	7,617	19%	-	-	5,608	34%	2,009	30%
HYV boro	15,194	37%	4,411	25%	7,352	45%	3,431	52%
L.T. boro	0	0%	-	-	-	-	-	-
Sub-total of rice	40,826	100%	17,672	100%	16,489	100%	6,666	100%
Summary of Total Cropped Area								
Rice	40,826	83%	17,672	80%	16,489	85%	6,666	87%
Jute	711	1%	-	-	711	4%	-	-
Rabi crops	7,597	16%	4,411	20%	2,206	11%	980	13%
Summer Vegetable	0	0%	-	-	-	-	-	-
Total	49,134	100%	22,083	100%	19,405	100%	7,646	100%

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TABLE E.3.16

Cropped Area by Land Type in Planning Zone B

(Unit:ha)

Crop	Total		Land Type by Flood Phase					
	Total		F0		F1		F2 & F3	
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Area by Flood Phase	22,412	100%	4,482	20%	5,379	24%	12,551	56%
Cropped Area & Intensity	38,235	171%	9,099	203%	10,466	195%	18,669	149%
Kharif-1 Season								
B .Aus:LV	717	3%	717	16%	-	-	-	-
B. Aus:HYV	471	2%	471	11%	-	-	-	-
T. Aus :LV	291	1%	291	7%	-	-	-	-
T. Aus :HYV	112	1%	112	3%	-	-	-	-
B. Aus+Aman	583	3%	-	-	-	-	583	5%
B. Aman:LV	3,989	18%	426	10%	1,009	19%	2,555	20%
Jute	1,009	5%	-	-	1,009	19%	-	-
Summer Vegetables	0	0%	-	-	-	-	-	-
Sub-total	7,172	32%	2,017	45%	2,017	38%	3,138	25%
Kharif-2 Season								
T. Aus :HYV	0	0%	-	-	-	-	-	-
B. Aman:LV	1,255	6%	-	-	-	-	1,255	10%
T. Aman:LV (deep water)	1,726	8%	-	-	-	-	1,726	14%
T. Aman:LV	4,191	19%	1,121	25%	3,070	57%	-	-
T. Aman:HYV	1,479	7%	1,479	33%	-	-	-	-
Sub-total	8,651	39%	2,600	58%	3,070	57%	2,981	24%
Rabi Season								
Boro:LV	247	1%	-	-	-	-	247	2%
Boro:LIV	90	0%	-	-	-	-	90	1%
Boro:HYV	14,904	67%	2,465	55%	3,362	63%	9,077	72%
Wheat	2,286	10%	471	11%	471	9%	1,345	11%
Pulses	1,210	5%	314	7%	-	-	896	7%
Oilseeds	3,093	14%	650	15%	1,546	29%	896	7%
Potato	403	2%	403	9%	-	-	-	-
Winter Vegetables	67	0%	67	2%	-	-	-	-
Spices	112	1%	112	3%	-	-	-	-
Sub-total	22,412	100%	4,482	100%	5,379	100%	12,551	100%
Summary of Rice Cropped Area								
HYV aus	583	2%	583	8%	-	-	-	-
B./L.T. aus	5,581	19%	1,434	20%	1,009	14%	3,138	20%
HYV aman	1,479	5%	1,479	21%	-	-	-	-
B./L.T. aman	7,172	24%	1,121	16%	3,070	41%	2,981	19%
HYV boro	14,904	50%	2,465	35%	3,362	45%	9,077	58%
L.T. boro	336	1%	-	-	-	-	336	2%
Sub-total of rice	30,054	100%	7,082	100%	7,441	100%	15,532	100%
Summary of Total Cropped Area								
Rice	30,054	79%	7,082	78%	7,441	71%	15,532	83%
Jute	1,009	3%	-	-	1,009	10%	-	-
Rabi crops	7,172	19%	2,017	22%	2,017	19%	3,138	17%
Summer Vegetable	0	0%	-	-	-	-	-	-
Total	38,235	100%	9,099	100%	10,466	100%	18,669	100%

TABLE E.3.17

Cropped Area by Land Type in Planning Zone C

(Unit:ha)

Crop	Total		Land Type by Flood Phase: F0		F1		F2 & F3	
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Area by Flood Phase	35,040	100%	1,752	5%	7,358	21%	25,930	74%
Cropped Area & Intensity	58,972	168%	4,380	250%	17,870	243%	36,722	142%
Kharif-1 Season								
B .Aus:LV	1,927	6%	526	30%	1,402	19%	-	-
B. Aus:HYV	350	1%	-	-	350	5%	-	-
T. Aus :LV	1,367	4%	666	38%	701	10%	-	-
T. Aus :HYV	1,156	3%	456	26%	701	10%	-	-
B. Aus+Aman	3,854	11%	-	-	-	-	3,854	15%
B. Aman:LV	8,585	25%	-	-	-	-	8,585	33%
Jute	3,574	10%	-	-	2,453	33%	1,121	4%
Summer Vegetables	105	0%	105	6%	-	-	-	-
Sub-total	20,919	60%	1,752	100%	5,606	76%	13,560	52%
Kharif-2 Season								
T. Aus :HYV	666	2%	-	-	666	9%	-	-
B. Aman:LV	876	3%	-	-	-	-	876	3%
T. Aman:LV (deep water)	280	1%	-	-	-	-	280	1%
T. Aman:LV	4,836	14%	-	-	4,836	66%	-	-
T. Aman:HYV	2,453	7%	1,752	100%	701	10%	-	-
Sub-total	9,110	26%	1,752	100%	6,202	84%	1,156	5%
Rabi Season								
Boro:LV	35	0%	-	-	-	-	35	0%
Boro:LIV	70	0%	-	-	-	-	70	0%
Boro:HYV	14,016	40%	-	-	1,752	24%	12,264	47%
Wheat	4,836	14%	-	-	1,402	19%	3,434	13%
Pulses	3,679	11%	140	8%	1,051	14%	2,488	10%
Oilseeds	5,116	15%	-	-	1,402	19%	3,714	14%
Potato	456	1%	-	-	456	6%	-	-
Winter Vegetables	420	1%	420	24%	-	-	-	-
Spices	315	1%	315	18%	-	-	-	-
Sub-total	28,943	83%	876	50%	6,062	82%	22,005	85%
Summary of Rice Cropped Area								
HYV aus	1,507	4%	456	13%	1,051	10%	-	-
B./L.T. aus	15,733	39%	1,191	35%	2,102	19%	12,439	48%
HYV aman	3,119	8%	1,752	52%	1,367	12%	-	-
B./L.T. aman	5,992	15%	-	-	4,836	44%	1,156	5%
HYV boro	14,016	35%	-	-	1,752	16%	12,264	47%
L.T. boro	105	0%	-	-	-	-	105	0%
Sub-total of rice	40,471	100%	3,399	100%	11,108	100%	25,965	100%
Summary of Total Cropped Area								
Rice	40,471	69%	3,399	78%	11,108	62%	25,965	71%
Jute	3,574	6%	-	-	2,453	14%	1,121	3%
Rabi crops	14,822	25%	876	20%	4,310	24%	9,636	26%
Summer Vegetable	105	0%	105	2%	-	-	-	-
Total	58,972	100%	4,380	100%	17,870	100%	36,722	100%

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TABLE E.3.18

Cropped Area by Land Type in Planning Zone D

(Unit:ha)

Crop	Total		F0		F1		F2 & F3	
			Land Type by Flood Phase					
	Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio
Area	Ratio	Area	Ratio	Area	Ratio	Area	Ratio	
Area by Flood Phase	36,080	100%	1,082	3%	3,608	10%	31,390	87%
Cropped Area & Intensity	54,950	152%	2,417	223%	6,314	175%	46,218	147%
Kharif-1 Season								
B .Aus:LV	325	1%	325	30%	-	-	-	-
B. Aus:HYV	0	0%	-	-	-	-	-	-
T. Aus :LV	0	0%	-	-	-	-	-	-
T. Aus :HYV	0	0%	-	-	-	-	-	-
B. Aus+Aman	1,299	4%	-	-	-	-	1,299	4%
B. Aman:LV	12,123	34%	469	43%	1,984	55%	9,669	31%
Jute	3,824	11%	-	-	722	20%	3,103	10%
Summer Vegetables	289	1%	289	27%	-	-	-	-
Sub-total	17,860	50%	1,082	100%	2,706	75%	14,071	45%
Kharif-2 Season								
T. Aus :HYV	0	0%	-	-	-	-	-	-
B. Aman:LV	830	2%	-	-	-	-	830	3%
T. Aman:LV (deep water)	289	1%	-	-	-	-	289	1%
T. Aman:LV	253	1%	253	23%	-	-	-	-
T. Aman:HYV	0	0%	-	-	-	-	-	-
Sub-total	1,371	4%	253	23%	0	0%	1,118	4%
Rabi Season								
Boro:LV	902	3%	-	-	-	-	902	3%
Boro:LIV	180	1%	-	-	-	-	180	1%
Boro:HYV	17,138	48%	-	-	902	25%	16,236	52%
Wheat	5,881	16%	-	-	-	-	5,881	19%
Pulses	3,464	10%	505	47%	72	2%	2,886	9%
Oilseeds	2,526	7%	-	-	-	-	2,526	8%
Potato	1,299	4%	-	-	1,299	36%	-	-
Winter Vegetables	1,840	5%	577	53%	-	-	1,263	4%
Spices	2,490	7%	-	-	1,335	37%	1,155	4%
Sub-total	35,719	49%	1,082	100%	3,608	100%	31,029	99%
Summary of Rice Cropped Area								
HYV aus	0	0%	-	-	-	-	-	-
B./L.T. aus	13,746	41%	794	76%	1,984	69%	10,968	37%
HYV aman	0	0%	-	-	-	-	-	-
B./L.T. aman	1,371	4%	253	24%	-	-	1,118	4%
HYV boro	17,138	51%	-	-	902	31%	16,236	55%
L.T. boro	1,082	3%	-	-	-	-	1,082	4%
Sub-total of rice	33,338	100%	1,046	100%	2,886	100%	29,405	100%
Summary of Total Cropped Area								
Rice	33,338	61%	1,046	43%	2,886	46%	29,405	64%
Jute	3,824	7%	-	-	722	11%	3,103	7%
Rabi crops	17,499	32%	1,082	45%	2,706	43%	13,710	30%
Summer Vegetable	289	1%	289	12%	-	-	-	-
Total	54,950	100%	2,417	100%	6,314	100%	46,218	100%

E.3.4 Crop Husbandry and Input Use

E.3.4.1 General Description of Farming Practices

Most farmers use part of the harvest as seed for the following season. Some farmers buy seed from their neighbours or in local markets. This way of self-multiplication without roguing, purification and cleaning causes deterioration of genetic characteristics and mixture of varieties, particularly for HYV. High seed rate results in a low germination rate due to improper storage. Vegetable seeds are usually purchased in markets.

Land preparation is made through ploughing, laddering, puddling and levelling using local equipment mainly drawn by a pair of draft animals. Several ploughings, to a depth of 7.5 to 15 cm, are followed by laddering to break the clods. After soils are saturated by irrigation water or rainfall, paddy fields are puddled and levelled. In part of the area, power tillers are operated to rotovate and puddle the paddy field.

Most aus, mixed aus/aman, deepwater aman rice are sown by broadcasting in the lower land. Jute and upland crops are sowed directly. Some spices such as chili and onion are transplanted in some areas. Some pulses and oilseeds are grown as a relay crop by broadcasting seed into a standing aman crop 15 to 20 days before harvesting. Paddy seedlings are raised in dry nurseries for aus and aman in order to prevent flood damage and also enable them to be kept for longer periods. Nurseries for boro are usually established in wet conditions. Generally 2 to 3 seedlings per hill are transplanted, however, more seedlings are used for delayed transplanting in kharif season to compensate for low tillering.

Urea, MP, TSP, zinc, gypsum are applied as basal at the time of land preparation. During crop growth, a top dressing of urea is made three to four times, when available. Farmers also apply animal manure as basal by mixing surface soils in land preparation. To prevent pests and diseases, use of agro-chemicals is increasing. Rotation of varieties and integrated pest management is not conducted. Weeding by raking with a wooden harrow is common practice in aus and jute at early stage. Hand-weeding is widely carried out for major crops.

All crops are harvested by hand. The aus crop is harvested in deep water using a boat for transportation. Threshing through beating by hand, or trampling by cattle are common practices. Treadle threshers are used in some areas. Threshed rice is dried on the road, mat or drying floor, and then winnowed before storing or selling. Farmers face problems in drying the aus crop during monsoon season.

E.3.4.2 Input Use

Typical rates of input use of fertilizers, pesticides and seeds for major crops are shown in Table E.3.19. These are estimated on the basis of the farmer and case study surveys carried out in this study. Input use shows a wide variation depending on crops, varieties, irrigation condition, farming practices as well as supply condition and availability of operation funds. Generally, broadcast rice crops of aus, aman and mixed aus/aman show lower rates of inputs than transplanted rice. Input dosage for local varieties is smaller than that required for HYV rice. Crops under irrigation are cultivated using more inputs than crops grown in rainfed land.

Although most work is carried out by the farmer and his family, it is necessary to hire labourers for transplanting, weeding and harvesting. Since each operation starts at almost the same time, it is considered that availability of labour in those periods is one of the constraints to increased cropping intensity, according to the farmer survey.

Draught animals play an important role for farming practices such as land preparation, weed control, transportation and threshing. About 60% of the farmers own their own draught animals, however, 50% hire animals due to shortage of draught power. 12% of the farmers are using power tillers at present. It is considered that the farmers using power tillers will increase in order to solve the shortage of draught power.

Use of chemical fertilizers has increased over recent years, and they are applied to most crops at present, according to farmer surveys. Traditionally animal manure was the main fertilizer, however, availability of manure is limited due to decreasing the number of animals and intensive use of cow dung as fuel.

Irrigation is primarily used for boro. Wheat, potatoes and vegetables are also irrigated. In the kharif season, supplemental irrigation is provided to HYV aus and aman. LLP is the dominant mode of irrigation.

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TABLE E.3.19

Unit Input Quantity and Unit Yield

Crop	Farm Labour man-days	Draft Animals pair-days	Seed kg	Fertilizer Urea kg	TSP kg	MP kg	Animal Manure kg	Agro-chemicals kg	Products main ton/ha	by to/ha
B. aus, LV	142	45	85	100	50	0	1,000	0.25	2.00	4.00
B. aus, HYV	145	45	85	100	50	0	1,000	0.25	2.50	2.50
T. aus, LV	154	47	30	80	40	0	1,000	0.25	2.60	4.80
T. aus, HYV, irrig.	181	47	30	140	110	35	1,000	0.50	3.60	3.60
T. aus, HYV, unirrig.	177	47	30	140	110	35	1,000	0.50	3.20	3.20
Mixed aus/aman	165	44	83	80	40	0	0	0.13	2.30	2.30
B. aman, deepwater	111	44	83	50	0	0	0	0.13	1.88	1.88
T. aman, deepwater	134	40	44	90	25	0	0	0.13	2.40	2.40
T. aman, LV	146	40	44	100	50	20	0	0.25	2.60	5.20
T. aman, HYV, irrig.	171	43	30	133	95	38	700	1.16	3.85	3.85
T. aman, HYV, unirrig.	167	43	30	133	95	38	700	1.16	3.65	3.65
Boro, LV	120	25	40	128	0	0	0	0.00	3.00	6.00
Boro, HYV, irrig.	214	45	30	193	160	45	1,000	1.00	5.40	5.40
Boro, HYV, unirrig.	160	45	30	193	160	45	1,000	1.00	0.00	0.00
Wheat, irrig.	127	45	130	115	80	30	0	0.30	2.25	2.25
Wheat, unirrig.	102	45	130	80	50	24	0	0.30	1.80	1.80
Potato, irrig.	194	44	1,000	277	290	102	1,500	3.00	15.00	0.00
Potato, unirrig.	175	44	1,000	277	290	102	1,500	2.00	10.00	0.00
Jute	215	45	9	89	67	9	2,000	0.00	1.90	3.80
Pulses, average	50	30	31	0	0	0	0	0.00	0.64	0.64
Mustard	58	37	10	192	144	40	750	0.40	0.75	0.75
Spices (chili)	157	30	1	100	180	90	2,500	0.00	4.00	0.00
Vegetables (Brinjal)	270	44	1	100	60	40	2,500	0.30	8.00	0.00

Source: Project farmer Survey

E.3.4.3 Management of Major Crops

(a) Aus Paddy

Broadcast aus, mainly local varieties with a small portion of HYV, is sown on dry land at the onset of the monsoon season in medium to high land. Application of inputs is at a limited level, due to low yields. Inadequate rainfall in March and April causes delayed seeding, and this increases the risk of damage by flood. Other forms of broadcast aus are sown at this time on slightly lower land, mixed with the seed of deepwater aman. The whole crop is harvested when aus matures before the land is deeply flooded. The aman then grows from ratoon to give a harvest in November to December. In this way, the farmers try to ensure their harvest by spreading the risk of floods.

Transplanted aus is also grown on higher and better drained ground in a limited area, and it may sometimes be irrigated at the initial stage.

(b) Aman Paddy

Broadcast deepwater aman is sown in March and April in small areas, mainly on low ground. Transplanted aman is sown after harvesting a boro crop, when the floods start. On the higher ground, aman is transplanted with supplemental irrigation supply.

(c) Boro Paddy

High irrigation rates of farm land in the area enable high yielding varieties predominant in boro paddy on the medium to highland in the dry and winter season. Nurseries are established in December to January, and seedlings are transplanted in January to February. Flash floods in April to May and low temperatures between December and February are the major problems for the boro paddy.

(d) Jute

There are two species of *C. capsularis* (desi or mesta) and *C. olitorius* (tossa) grown in the area. *C. capsularis* is dominant due to its resistance to deep water. Jute is sown in early kharif (March to May) on lower ground and harvested in June to August when flowering starts. The plants are cut and left in the field until leaves are shed. The plants are then bundled and submerged in water for 2 to 3 weeks for retting. After the plants rot, fibres and sticks are separated. The fibres are washed and dried before sale. The jute sticks are also dried before use as fuel or fencing. Farming practices require a large amount of labour for thinning, weeding and harvesting.

(e) Rabi Crops

Wheat, Potatoes and pulses are the main upland crops in the rabi season. Wheat is cropped from November to December and harvested in February to March by utilizing residual soil moisture. Potatoes are planted in late October to November and harvested in February and March. Pulses generally include several kind of legumes, and khesari, masur (lentil) and mash kali (black gram) are common in the area. Spices and vegetables are grown in a limited area. Chilies are an important spice in the area. Winter vegetables are supplied to Dhaka. Summer vegetables including beans, brinjal and squash are also grown in the area, however, their area is very limited on the higher ground.

E.3.5 Crop Yields

The current level of crop yields is estimated primarily on the data obtained by the farmer surveys. However, secondary data survey such as BBS and AST were also considered. Where specific yields for some crops from nearby locations or projects were available, then they too were considered. Having assimilated as much primary and secondary data as possible, the yield for each individual crop was subjectively determined. It should also be noted that the yields in Comilla District are considered to be higher then the national average. For example HYV, boro yields nearby were reported us being as high as 6 Tons/ha. The yields, determined in this way, are presented in Table E.3.19.

The total annual cereal production is about 567 thousand tonnes of rice and wheat which amounts to 302 kg of per capita. This is more than per capita consumption. Although the per capita production of grains is relatively low in Zone D, production of cash crops such spices and vegetables both in winter and summer is higher. This is normally transported outside the area. The present agricultural production is given on Table E.3.20.

TABLE E.3.20

Present Agricultural Production

(Unit:ton)

Crop	Planning Zone				Total
	A	B	C	D	
Rice (Paddy)	158,100	116,900	139,000	125,100	539,100
Wheat	4,100	4,100	8,700	10,600	27,500
Sub-total	162,200	121,000	147,400	135,700	566,600
per capita*	384 kg	385 kg	278 kg	224 kg	302 kg
Pulses	300	800	2,400	2,200	5,700
Oilseeds	900	2,300	3,800	1,900	9,600
Potato	16,700	4,000	4,600	13,000	38,300
Winter Vegetable	6,700	500	3,400	14,700	25,300
Spices	1,100	400	1,300	10,000	12,800
Jute	1,400	1,900	6,800	7,300	17,400
Summer vegetable	0	0	800	2,300	3,100

Remark; *: Population in 1993 is estimated at 422,800 for Zone A, 314,500 for Zone B, 530,800 for Zone C, 605,400 for Zone D, and 1,873,500 for the whole area.

E.3.6 Agricultural Support Services

E.3.6.1 Agricultural Extension and Research

Agricultural extension services are provided by the Department of Agricultural Extension (DAE) of the Ministry of Agriculture. Under DAE, the Deputy Director of Agriculture controls extension activities at district level with the support of Special Matter Specialists in crop production, pest control and training. The Thana Agriculture Officer (TAO) manages extension work at Thana level, and is supported by the Subject Matter Officer, Assistant Agricultural Extension Officer and Junior Agriculture Officer. Block Supervisors are grass roots extension agents under TAO. Thanas are divided into Blocks which cover 900 to 1,000 households. Blocks are sub-divided into 8 Sub-Blocks in which 10 contact farmers are designated. Block Supervisors provide farmers with extension services through contact farmers under T&V system. This system is now being improved under the Agricultural Support Services Programme assisted by World Bank, ODA and USAID in minor irrigation operation and on-farm water management.

There is a Regional Research Station of the Bangladesh Rice Research Institute at Comilla around the area, for research into rice, providing comprehensive applied research. Most inputs are available in the local markets in and around the area. The supply channel of farm inputs and irrigation equipment, such as fertilizer, chemicals, LLP and shallow tubewells has been changed to the private sector from Bangladesh Agricultural Development Corporation (BADC) by the national policy of privatization of reduction of subsidy on farm inputs. Certified seeds of major crops are currently supplied by BADC.

E.3.6.2 Agricultural Credit

Credit Requirements and Sources

Farmers may require short-term credit to finance agricultural inputs such as fertiliser, seeds, irrigation charges, and hired bullocks and labour. They may also need longer term loans to cover purchase of livestock, irrigation equipment or power tillers. All households may also need credit to meet social obligations (such as weddings) and emergencies, while some, particularly the poorest group, may also need credit to buy food and other necessities during periods of hardship prior to harvests, or if they suffer losses in floods or other disasters.

Credit is available from institutional sources (banks, cooperatives and NGOs) and from a range of informal sources such as money-lenders, input suppliers, relatives and neighbours. The surveys conducted for the Gumti II feasibility study suggest that farmers make surprisingly little use of credit, funding most of their requirements from crop sales or other sources of income (see Table E.3.21). Although this low level of borrowing suggests that farmers have little need for credit, it could also mean that they are unable to get credit, either because it is not available, or because they are unable to get access.

TABLE E.3.21

Sources of Finance for Farm Inputs

	% of farmers
Retrained funds (previous crops)	56.5
Retained funds (other enterprises)	28.4
Asset sales	2.0
Relatives, friends	7.8
Commercial banks	2.9
Input suppliers	0
Money lenders	2.4
Total	**100.0**

Bank Lending

The main source of institutional credit for agriculture are the Sonali, Rupali, Janata, Krishi and Agrani whose lending activities are coordinated in what is known as the lead bank system. In Comilla and Brahmanbaria, the lead bank is the Sonali which is responsible for disseminating information on lending targets to the other banks as well as collecting data on performance.

Two sorts of loans are made, one to finance crop production which is short term, usually six months and another to finance the purchase of irrigation equipment which has a term of 9 years. Total amounts lent by the lead bank system are presented in Table E.3.22, where it can be seen that relative to the number of farmers in the eleven thanas the sums are minute.

Nationally bank lending to agriculture nearly halved between 1987/88 and 1990/91, after a rapid rise between 1985/86 to 1987/88 when it nearly doubled. Figures for 1991/92 presented in Table E.3.22 suggest that it may now be increasing again.

Rapid expansion in agricultural credit and rural bank branches overstretched the management capacities of the banks involved. Loan recovery rates are low, and a study into agricultural credit[1] estimated that the recovery rate declined from 44% in 1980 to 19% in 1989. As a result of poor recovery many borrowers have become defaulters and are disqualified from future borrowing.

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[1]. Institutional Credit in Bangladesh Agriculture, R. Nevin USAID 1988.

TABLE E.3.22

	Crop Production Loans (Tk 000) Target	Amount Lent	No of Loans	Av Size of Loan	% not fully repaid	Loans for the Purchase of Irrigation Equipment Target	Amount Lent	No of Loans	Av Size of Loan
1989/90									
Homna	9225	6295	231	27.3	95	1695	1635	10	163.5
Debidwar	13735	4496	769	5.8	69	1140	1023	8	127.9
Muradnagar	21622	11922	1914	6.2	32	660	1128	8	141.0
Brahmanpara	8492	5501	1158	4.8	87	579	1874	12	156.2
Burichang	10661	5028	1090	4.6	93	976	362	5	72.4
Comilla Sadar	17189	4795	1156	4.1	87	1300	1200	15	80.0
Daudkandi	20149	12120	1989	6.1	94	3010	2910	70	41.6
Nabinagar	18465	9559	1521	6.3	29	na	108	3	36.0
Kasba	6360	3530	628	5.6	50	na	165	1	165.0
Akhaura	3425	975	220	4.4	22	na	667	5	133.4
Bancharampur	6924	2594	619	4.2	40				
	136247	66815	11295	5.9			11072	137	80.8
1990/91									
Homna	11265	8564	343	25.0	87	1135	776	6	129.3
Debidwar	14325	5419	790	6.9	70	1399	1033	8	129.1
Muradnagar	22802	7771	1277	6.1	73	1018	789	5	157.8
Brahmanpara	10332	5118	764	6.7	86	8400	400	3	133.3
Burichang	12935	4156	870	4.8	94	418	163	4	40.8
Comilla Sadar	20489	6813	833	8.2	72	1629	1200	10	120.0
Daudkandi	24600	10210	1440	7.1	92	6710	2520	50	50.4
Nabinagar	11185	5115	785	6.5	40	na	2713	19	142.8
Kasba	6820	2898	424	6.8	75	na	3920	24	163.3
Akhaura	4425	456	51	8.9	80	na	356	3	118.7
Bancharampur	7548	2193	405	5.4	60	na	2349	17	138.2
	146726	58713	7982	7.4			16219	149	108.9
1991/92									
Homna	13245	10728	1034	10.4	96	459	200	2	100.0
Debidwar	16385	9258	1423	6.5	96	2069	300	2	150.0
Muradnagar	22852	14741	3850	3.8	40	780	700	5	140.0
Brahmanpara	11007	9468	1649	5.7	74	1700	675	6	112.5
Burichang	12449	9566	1831	5.2	92	280	200	3	66.7
Comilla Sadar	22088	11632	2361	4.9	78	300	300	3	100.0
Daudkandi	26440	14694	2858	5.1	89	2000	1500	10	150.0
Nabinagar	24540	9571	2288	4.2	14	na	2864	17	168.5
Kasba	10060	4315	1147	3.8	4	na	169	1	169.0
Akhaura	5530	872	234	3.7	5	na	169	1	169.0
Bancharampur	9672	5204	1446	3.6	8	na	684	4	171.0
	174268	100049	20121	5.0			7761	54	143.7
Average per Thana	19052	9399	1642	6			1461	14	103.1

Poor performance of the banking sector is attributed to a weak management capability and inadequate operating procedures, together with a shortage of qualified staff. The banks have been subject to political and social pressures to increase lending volumes, but lack field level contact with farmers. Where they have attempted to utilise local organisations to approve loan applications, the vetting procedures involved have resulted in access to credit becoming a form of political patronage.

Although banks may insist on the mortgaging of land as collateral (many small farmers find it difficult and expensive to establish proper title to their land), enforcement of such recovery instruments is almost non-existent: there are no records of banks obtaining possession and selling land belonging to a defaulter.

The government, through the Financial Sector Reform Project (FSRP), is attempting to improve the banks' accounting, management information systems, and credit delivery/recovery systems. This project, which is supported by the World Bank and USAID, started in 1990. It is attempting to classify outstanding loans and get the NCBs to make provision against profits for loans of dubious quality, and generally improve loan discipline. However these attempts suffered a setback in 1991 when a general waiver was announced on agricultural loans under Tk 5000. Many borrowers with larger loans have ceased repayments in the hope that their loans will be forgiven. Despite this write off, overdue agricultural loans still amount to over Tk 32,000 million.

Greater attention to the viability of lending, with branch officers being made more accountable appears to be making banks extremely reluctant to lend in all sectors of the economy. Although they have a large supply of liquid funds, and continue to allocate substantial amounts to the agricultural sector, only a small proportion of this is actually disbursed.

Leading by NGOs for Agriculture

A number of NGOs have credit programmes which have been strikingly successful in reaching the rural poor, and in achieving rates of loan repayment in excess of 95 percent. Although the volume of this lending is large (Gramin bank disbursed Tk. 6.2 million in 1990), the bulk of it is for non-agricultural purposes, as most NGOs exclude people owing over 0.2 ha of land, so its effect on agricultural productivity is limited.

A number of NGOs have developed specific irrigation credit programmes. BRAC and Proshika support the formation groups of landless people who buy and operate irrigation pumps and generate income via water sales. Although these programmes have been successful their scope is limited to landless groups. Gramin Bank has had a less happy experience in taking over responsibility for over 1000 DTW formerly operated by a government project in the north-west.

E.4 Future Development Proposals

E.4.1 Strategy for Development

The basic objective of any proposed development in the area is one for economic improvements. This encompasses the maximisation of the net present value of aggregate consumption benefits and employment generation. With current Government policy of attempting to reduce public sector expenditure, the encouragement of investment by the private sector is important. Other factors which must be accounted for in the formulation of interventions are the need to avoid as far as possible improving the flooding regime in a benefited area at the expense of significantly worsening flooding in another. Experience elsewhere in Bangladesh has demonstrated that the likely outcome of such a strategy is that the dis-benefited populace may well take matters into their own hands and cut the embankment, with obvious and disastrous consequences. Apart from increasing the risks of failure (through public cuts), the social impacts of such interventions are divisive and clearly inequitable. Where minor adverse affects are precipitated, mitigation measures to redress the balance must be considered.

In general, interventions are evaluated on the basis of current levels of Government activity in agricultural support through the Extension Service (DAE) and the Bangladesh Agriculture Development Corporation (BADC) which is responsible for seed production and distribution. Programmes to assist and develop these services are inevitably country-wide and cannot easily incorporate local programmes which are only likely to be funded by a project for a short time. The inference is that improvements in agricultural support services are expected to benefit areas both within and without the project area equally and that it is unrealistic to anticipate substantially increased extension inputs on which future yield increases can be justified.

One aspect of development which is expected to occur irrespective of any project interventions is the continuing and expanding exploitation of groundwater with which the project areas is richly endowed. Given the favourable recharge conditions in the monsoon, it is most unlikely that groundwater exploitation will be limited by the availability of water (Annex C- Groundwater Investigations). The rate of development is far more likely to be determined by the cost and ease of development. Where possible, farmers prefer to use low lift pumps (lifting water from khals) as these are the cheapest form of irrigation available. Elsewhere the use of shallow tubewells is widespread, with deepset pumpsets being common in areas of lower water tables. Deep tubewells are more expensive and practically all those within the project area were installed by BADC at highly subsidised prices.

E.4.2 Development Proposals

E.4.2.1 Introduction

Development proposals designed to increase agricultural production are based on a variety of strategies, covering a range of options which include quite simple proposals such as khal deepening in Zone D, designed to increase access to irrigation water for lifting with low lift pumps at one end of the spectrum through to full area FCDI schemes at the other.

E.4.2.2 Zones A and B: Controlled Flooding

Zones A and B have been combined because proposals for their development share common costs of river excavation which are essential for the implementation of projects in either zone but which, if undertaken independently, would seriously reduce returns. Proposals for Zones A and B are illustrated in Figure E.4.1, where it can be seen that three polders (shaded areas 1B, 2 and 5) were initially considered. Output from the hydro-dynamic model showed very little agricultural benefit was achieved in the smaller northern scheme (no 5 in Figure E.4.1) because the topography of the area is relatively low and it would not drain rainfall adequately under gravity. As a result this proposal was abandoned.

Design of the remaining two embankments was based on making maximum use of existing road embankments.

Zone A Design Considerations

The initial model run showed that the peak water level in the unprotected area, to the east of Gunghur River, rose by approximately 0.8 m when the Ghungur right embankment was in place. Further runs showed that if controlled discharge (40% of peak flow) was allowed into the protected area then this would reduce the additional rise but would also adversely affect the agricultural benefits caused by the embankment.

However, excavation of the Salda and Buri Nadi showed a considerable mitigation. With no discharge entering the protected area of Zone A, the peak (1987 and 1988) water levels showed an increase of only 30 cm. If a very severe flood did occur and the villages in the unprotected were being threatened, then opening Ghungur embankment gates would further reduce the water level by 10 cm. As the villages in the area are not particularly flood prone at the moment, it is unlikely that the additional rise will cause significant problems.

The model also showed that the flood phasing in the unprotected area is a little worse, affecting about 8% of the area of aman. However, because the additional excavation has such a significant effect on pre-monsoon flows, flash flooding in the unprotected area in the pre-monsoon should be reduced because of better drainage.

In addition to the Ghungur right bank, the proposal for Zone A included a left bank along the Salda River, up to the Comilla-Sylhet road. In order to protect the whole zone from monsoon floods, it was also proposed to seal the Comilla-Sylhet road to form the north-west boundary. Four regulators will replace road structures so that the area may be effectively drained. Also, the khals within the protected area leading to the regulators are to be re-excavated.

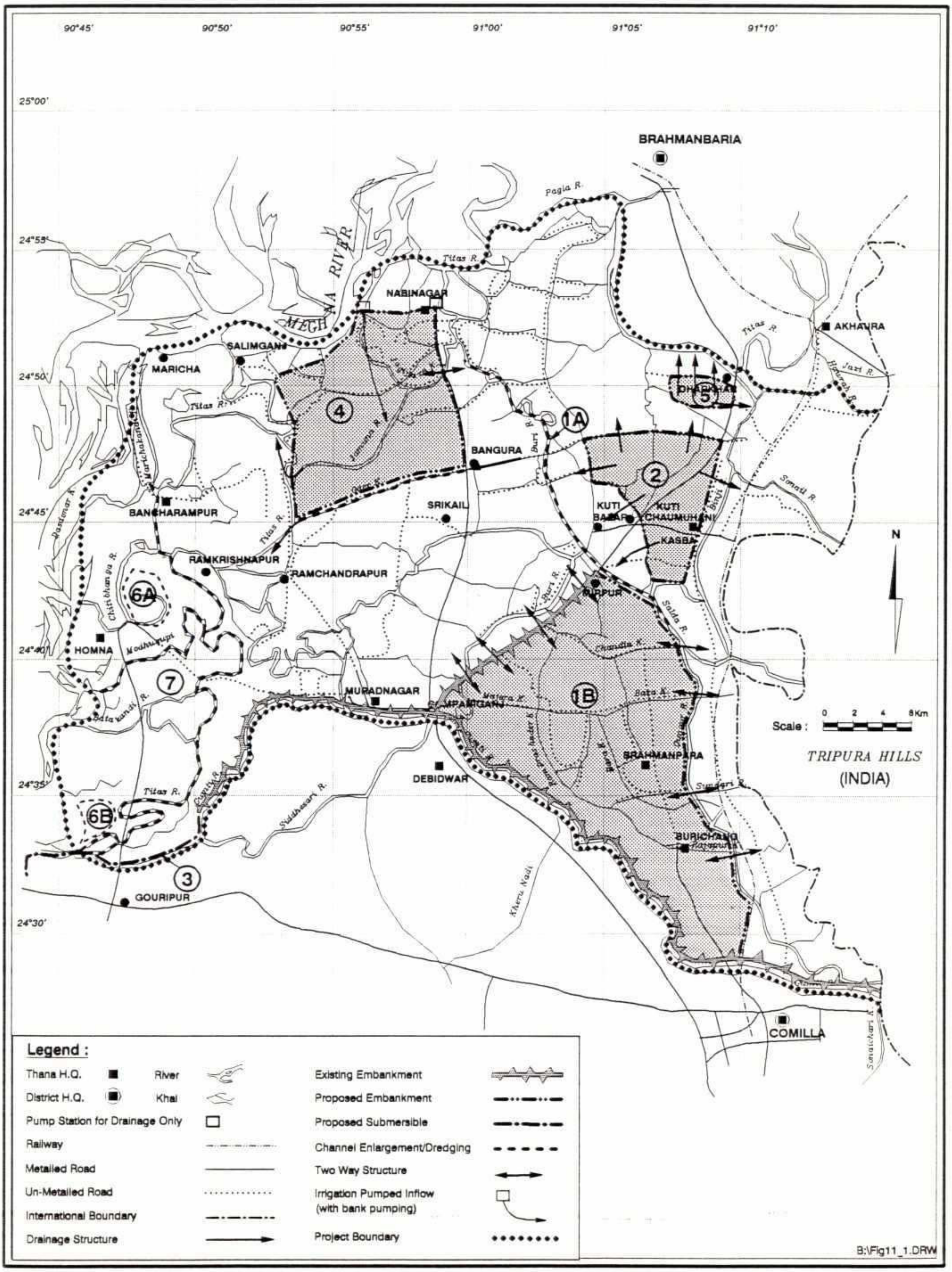
In order to minimise khal and floodplain fisheries losses, the regulators under the Comilla-Sylhet road will be fish friendly.

Zone B Design Considerations

Model runs showed large improvements in the poldered area of Zone B. The main reason for this is that the polder encircles an area of relatively high ground which facilitates gravity drainage of rainfall and which is much improved by the excavation of the Buri Nadi River. The excavation of the Buri Nadi will also provide

Figure E.4.1

Layout of Interventions



an additional benefit. At present, in a 1 in 5 dry year LLP irrigation can take place in the river up to 5 km south of Nabinagar. With the proposed excavation, an additional 12 km of river will support irrigation in a 1 in 5 dry year, serving an additional 2400 ha of LLP irrigation.

E.4.2.3 Zone C Proposals

The initial proposal for Zone C was to have two embanked schemes either side of the Oder Khal, each with pumped irrigation supply to the khal and river network. A distribution canal, along the line of borrow pits for the Muradnagar-Nabinagar road, was to be excavated. Also, re-excavation was required in the existing khals.

The hydraulic model runs showed that in the present situation, pre-monsoon flow generated in the Tripura hills flowed into the Buri Nadi, which conveyed it north into the Titas River, by Nabinagar. When the monsoon arrived, water levels in the Titas backed up, with the rise of the Meghna levels. Instead of going north, the direction of flow changed to the west, passing through the khal and floodplain system north of Muradnagar to discharge into the Meghna between Homna and Daudkandi.

By effectively blocking this route with the southern embankment scheme, the water was restricted to flowing through the Oder khal. This caused congestion which had an adverse effect on the area to the east of the Muradnagar-Nabinagar road, including drainage from the schemes in Zones A and B.

These adverse effects meant that the southern embankment had to be abandoned. Model runs without the southern embankment, but with the khal excavation, brought the water levels back to the without project situation.

The proposed intervention for Zone C therefore consists of an embankment for the northern area with 8 cumecs of pumped irrigation to the northern area and 14 cumecs for the southern area. Both of the pump stations will be reversible and both pump stations will be used for pumped drainage of the northern embankment. Because the full 22 cumec capacity will be used for the 8800 ha protected area, the percentage of FO land will increase from 7% to 73%, which will give a large rise in the amount of T aman which could be grown. The disadvantage will be the impact on floodplain fisheries in the area.

E.4.2.4 **Zone D Proposals**

Khal Re-excavation

The most effective intervention for the Gumti Phase II area is re-excavation of khals in Zone D. This intervention can be carried out with no negative effect. This is because fisheries will incur no floodplain losses but will achieve some gains. Also, drainage of the area will be improved. Maintenance costs will not be so high because of the sediment content of the Meghna is relatively low.

The proposed location for khal excavation is given in Figure E.4.1. At present, about 4000 ha can be irrigated by LLP during a 1 in 5 dry year. This value will increase to 14000 ha with the recommended re-excavation. It should be noted that farmers are generally willing to invest in LLPs even if the guaranteed availability is less than a 1 in 5 year return period. The present and future areas are therefore likely to be greater than 4000 and 14000 ha, respectively, with a greater element of risk involved.

At present, JICA is carrying out khal excavation in the area, however, the scale of their proposed work is small compared to the proposed requirements.

Extension to Gumti North Embankment

Figure E.4.1 shows a small embankment is to be constructed between the existing embankment on the north side of Gumti River and Gouripur. The purpose of this embankment is to prevent flash floods from affecting the boro crops of the area between the Gouripur-Homna road and the River Gumti. A small (submersible) embankment has been selected as it is not considered worthwhile to protect the area against monsoon floods, when high monsoon water levels will come from the Meghna River anyway. After the month of June, the Meghna related water levels will rise in the Gumti and Titas Rivers, so the embankment will be submerged.

In addition to protecting the area from flash flooding in the boro season the embankment will also prevent sand from coming into the area, thereby reducing the required maintenance cost for re-excavation the lower titas river in the area. The model is not sophisticated or accurate enough to predict the effect downstream of Gouripur. It is expected that flooding which occurs now will not be significantly worse than at present. It will be very difficult to justify extending the embankment from Gouripur to the River Meghna as this would have to include a large structure at the Lower Titas outfall to the River Gumti, which would be extremely expensive.

Submersible Embankment Schemes

Two submersible embankment schemes were initially proposed. The effect of these embankment schemes are analysed in detail in Annex I, Appendix I.V.

It was concluded that it was not possible to include a fish gate in the design because any viable fish gate would let an unacceptable amount of water into the protected area before the boro crop could be harvested. As a result, submersible embankments are expected to cause fish losses of up to 50% of present production because access to both fish and spawn would be derived in the months of April and May (evidence of such large losses were obtained from the existing Satdona beel scheme).

A further disadvantage of the concept was that when water is allowed into the protected area, the rate of rise of water level is much higher (10 cm per day) than the normal Meghna level rise (5 cm per day). This means that only extra fast growing but inferior yielding varieties of deepwater aman can be grown.

Field visits to the proposed sites confirmed that submersible embankments were unlikely to be cost effective, mainly because farmers are already aware of the threat to their boro crop and endeavour to plant as early as possible, which in most years allows them to harvest before the flood. They also expressed little interest in planting deepwater rice after boro, arguing that the time available for land preparation and seeding would be insufficient and that any delay in planting would not give the plants enough time to establish themselves sufficiently well to withstand the rapid rise in water levels which the plants would experience when the embankment started to fill.

E.4.2.5 Full Area FCD Proposal

The FCD proposal is illustrated in Figure E.4.2. It was designed during the 1990 feasibility study from which the following description is quoted.

The emphasis has been on the minimum cost solution to the problem of flooding from the major rivers in Bangladesh and the minor rivers crossing the border from India. With the exception of the Salda/Buri Nadi channel and the side drains to east and west of the Buri embankments, no attempt has been made to improve the internal drainage of the area, it being considered that such actions would merely transfer the flooding from one area to another, with little or no overall benefit. However, large drainage channels to convey the runoff from the Tripura Hills in India to the Homna regulator have been included, as there would otherwise be unacceptable waterlogging in the Burichang and Brahmanpara areas.

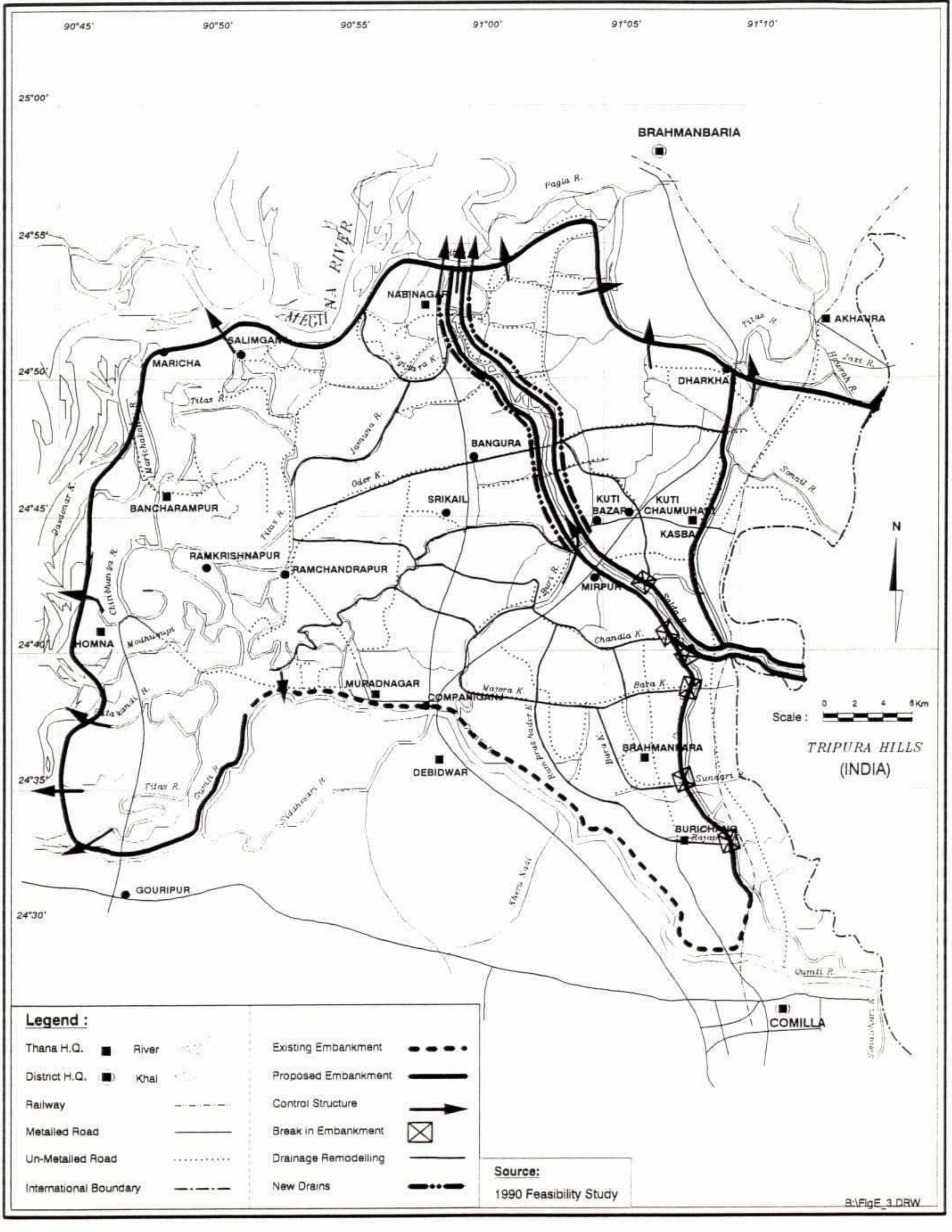
The peripheral embankment, from its junction with the Gumti river embankment at Paniatan in the south west to the Indian border in the north east, follows the alignment originally selected for the FCDI proposals. There is no reason to change this line, which was chosen on the basis of enclosing the maximum practicable area without making the embankments excessively high; the exclusion of the Hawrah River area from the polder was agreed with the BWDB, as there are severe problems of flooding on the Indian side of the border which would be exacerbated by empolderment - the area is also covered by a small schemes project.

As in the case of the FCDI scheme, the Salda and Buri channel is embanked from the high ground to the east of the railway line to the junction with the Pagla (Titas) River immediately to the north of Nabinagar town. Two further embankments, on the left (western) banks of Ghungur and Bijni Rivers, complete the major earthworks proposed in this scheme. In the case of the Ghungur embankment, the intention is to control the flood waters of the cross border rivers and thus reduce the flood peaks and water levels in the areas to the west. The Bijni embankment, which follows the road alignment from the Salda to the peripheral embankment, directs all the water crossing the border to the large regulator at the junction of the Bijni with the Titas.

There are a number of regulators in the peripheral embankment, many of which are designed as flushing sluices; that is, they will admit water for irrigation in the dry season, as well as draining the area in the post monsoon period. Especially large regulators are provided on the Chitibhanga river at Homna, to both polders and the Buri Nadi at Nabinagar, and on the Bijni river.

Figure E.4.2

FCD Proposal



There are three further structures; a navigation lock at Homna, to provide access for the existing river traffic, and two regulators/flushing sluices linking the southern arm of the Buri to the embanked Salda/ Buri channel and in the Ghungur to the Salda.

A metalled road will be built from Homna via Nabinagar to Batmatha along the crest of the embankment. At Batmatha it will join the Comilla-Sylhet road. No other metalled roads are proposed, but it is anticipated that the embankments will be used as unmetalled tracks - and may eventually be improved, if traffic warrants it.

E.4.2.6 The Full Area FCDI Proposal

The FCDI alternative is illustrated in Figure E.4.3. This proposal is for a comprehensive development of the area for both irrigation and drainage. The intention is to provide irrigation to all the irrigable land from either the surface water supplies, using LLP's, or from tubewells. Drainage pumping by the pumps installed for irrigation produces further benefits attributable to the project.

The main differences between this proposal and that for FCD are the installation of the four primary and five secondary pump stations, improved internal drainage, numerous controls on the channels to retain water levels in the dry season and additional roads, mainly to provide better access to the major structures.

The primary pump stations will be:

(a) Mohanpur, serving a low lying area of about 5,000 ha in the south west corner of the project.

(b) Homna, irrigating an area of about 53,500 ha in the west of the project and, with Nabinagar West, draining 103,000 ha.

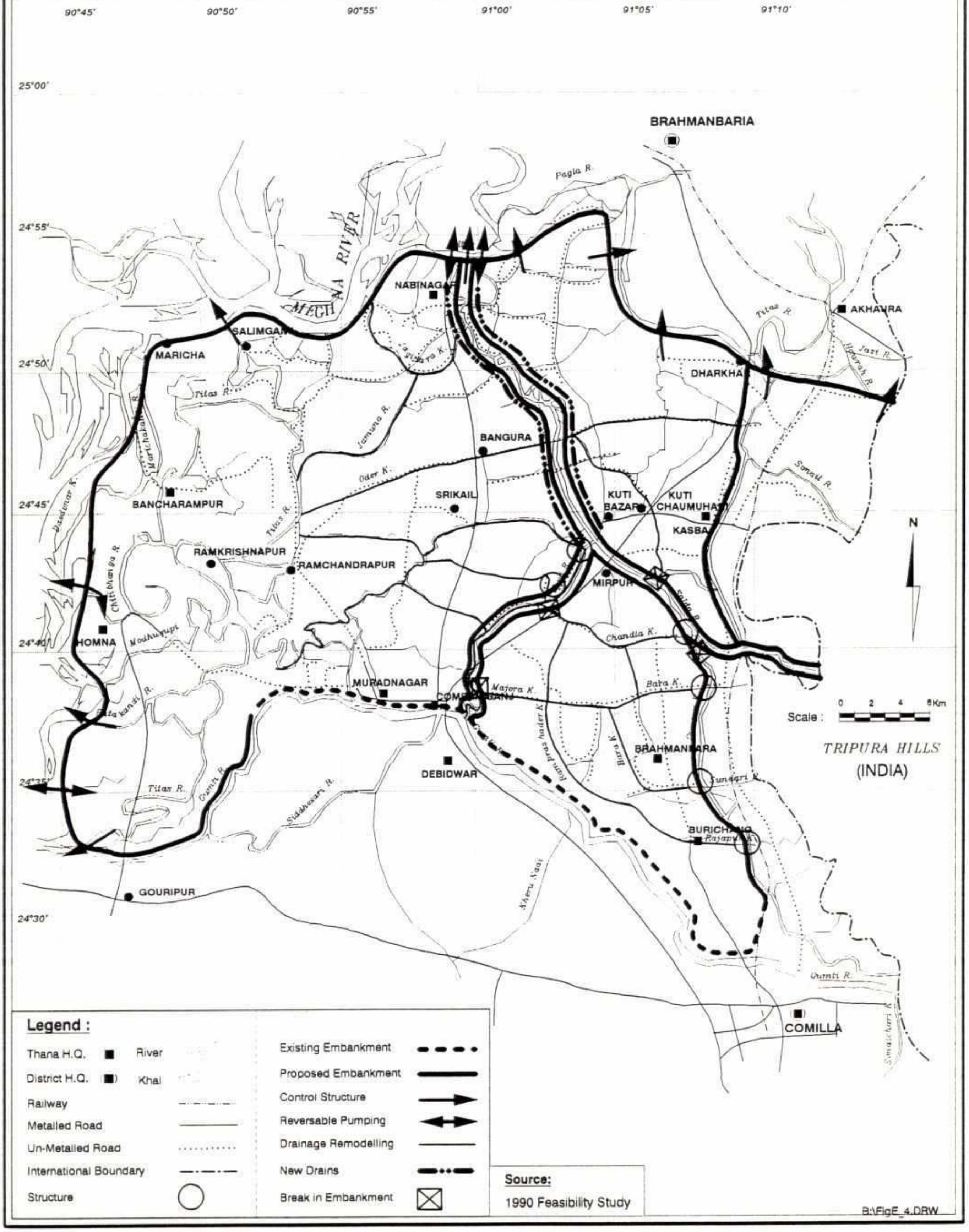
(c) Nabinagar West, providing irrigation water, with Nabinagar East, to the remainder of the project and, with Homna, draining the West and South areas totalling about 103,000 ha.

(d) Nabinagar East, irrigating with Nabinagar West and draining about 23,500 ha in the North West block of the project area.

Three of the five re-lift pump stations raise water pumped into the area by the Homna pump station from a nominal 2.9 m PWD to 3.8 m, PWD to irrigate higher lands. The two remaining stations raise water from the Salda to supply the Ghungur and the Bijni area with irrigation.

Figure E.4.3

FCDI Proposal



Three options for the size of the pumping plant at the primary pump stations have been studied. In two of the options the pump capacity at the Bijni and Ghungur re-lift stations is also reduced. The options are listed below:

Pump Station	**Option 1**		**Option 2**		**Option 3**	
	Pump Size Cumec	**No. of Pumps (Operating + Standby)**	**Pump Size Cumec**	**No. of Pumps (Operating + Standby)**	**Pump Size Cumec**	**No. of Pumps (Operating + Standby)**
Main Pumping Station:						
Nabinagar East	6.25	3+1	6.25	2+1	6.25	3+1
Nabinagar West	6.25	5+1	6.25	4+1	6.25	4+1
Homna	6.25	8+1	6.25	8+1	6.25	6+1
Mohanpur	2.25	2+1	2.25	2+1	1.9	2+1
Total Capacity (cumec)	104.5	92.0			85.05	
Relief Pumping Stations						
Bijni	3	4+1	3	3+1	3	2+1
Ghungur	3	3+1	3	3+1	3	3+1

The results of a preliminary study with the Surface Water Simulation Modelling Programme showed that areas to the east of the Buri Nadi and south of the Salda were not well drained. Since it had also been decided to drain the cross border flows into the Ghungur through this area and down to the Homna pumping station, a considerable increase in the drainage capacity was needed. This has been provided by enlarging the existing main channels running westwards through the area.

In order to control level and supply of water during the dry season, it is necessary to place numerous checks and irrigation control structures in the internal channel network. Some of these, on the main drainage channels, are necessarily large, but the majority are small structures.

Additional metalled roads are to be provided, along the embankments where possible, to the re-lift pump stations. These will link to the existing road system in the area and provide improved access for the farmers as well.

For the purposes of comparing this option with alternative proposals, Option 2 (i.e. 92 cumec pumping capacity) has been selected.

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E.4.3 Future Agricultural Development

E.4.3.1 Methodology

Present cropping patterns are based on information obtained from the farmer survey in which the crops grown during one year were recorded for each plot operated by the farmer respondent. Future cropping patterns depend on assumptions relating to future irrigation development in the dry season and project interventions which improve flooding regimes in the wet season.

The use of the Hydrodynamic Model

The evaluation of flood mitigation projects in Bangladesh has for some time been based on classifications of flood depth known as flood phases. These are categorised as follows:

- F0 - flood depths of 0.3 M
- F1 - flood depths of 0.3 - 0.9 M
- F2 - flood depths of 0.9 - 1.8 M
- F3 - flood depths of 1.8 M (for less than nine months per year)
- F4 - flood depths of 1.8 M (for more than nine months per year)

This classification system has been in use for some time and is retained by the Regional Plan for broad level planning purposes. Both crop statistics and cropping distributions (with the exception of the 9 month concept) have been developed by the Master Planning Organisation for flood phases by planning unit which enable flood mitigation programmes to be evaluated on the basis of changes in flood phasing which result from proposed interventions. A drawback of the present classification, for other than broad level planning is that it relates neither to the duration of flooding nor to the frequency with which the inundation occurs. Thus, for example, an intervention which reduced the duration of flooding while at the same time had little impact on its peak depth might well enable an aman crop to be transplanted on the receding flood for which no benefit under the depth of flooding rules can be claimed. As a result, FPCO have produced (but not yet officially published) a new set of guidelines which specify the maximum depths of flooding which various types of rice can withstand throughout their life cycle. These are presented in Table E.4.1.

TABLE E.4.1.

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	30 cm	May
B Aus	Seeding	Field Capacity	March - April
	Vegetative	50 - 70 cm	May
	Reproductive	30 - 50 cm	June
	Maturity	50 cm	July
HYV Aus	Transplanting	10 -20 cm	March - April
	Vegetative	30 - 50 cm	May - June
	Reproductive	20 - 30 cm	July
	Maturity	30 cm	August
LT Aus	Transplanting	20 - 30 cm	March - April
	Vegetative	50 - 70 cm	May - June
	Reproductive	30 - 50 cm	July
	Maturity	50 cm	August
LT Aman	Transplanting	20 - 30 cm	July - September
	Vegetative	50 - 70 cm	September - October
	Reproductive	30 - 50 cm	November
	Maturity	50 cm	November - December
HYV Aman	Transplanting	10 - 20 cm	July - August
	Vegetative	30 - 50 cm	September - October
	Reproductive	20 - 30 cm	October - November
	Maturity	30 cm	November - December
DWR	Seeding	Field Capacity	March - April
	Transplanting	30 - 50 cm	April - May
	Vegetative	50 - 400 cm*	June - September
	Reproductive	50 - 90 cm	October - November
	Maturity	Field Capacity	November - December

* Rise in water level has to be gradual so that the plants can keep pace.

The rules have been incorporated within the processing package of the Mike II hydro-dynamic model as follows:

- depths of flooding tolerances, as presented in Table E.4.1 are transformed into histograms of maximum allowable flooding depths by 10 day periods to accord with the 10 day analysis used by the model for a range of planting/sowing dates.

- in each decad (with three decads per calendar month) crop failure occurs on the fourth day on which the level exceeds the critical value. Hence each decad should be represented as a maximum of a four day minimum level, starting by looking three days backwards into the previous decad. Water levels were analysed at each representative river level node in terms of four day exceedances over the whole year for the 25 year run which enabled them to be expressed in terms of probabilities.

- water levels are translated into areas of land flooded to various depths by comparison with area elevation curves for each minute square (311 hectares) which are calculated by reference to the land level data base. The data base itself is simply a large number of entries of topographic heights for each minute square which is based on the 1989 1 to 16000 FINNMAP mapping, where each point represents approximately three hectares.

- areas on which crops can be safely grown are calculated by application of FPCO submergence rules over a range of conditions, which include the extreme, average and one in 3, 4, 5 8 and 10 wet years.

The output from the model is consequently a list of the percentages of an area on which crops can be safely grown at specified probability levels. For many crops the list is academic as the area actually grown is determined by other factor such as access to irrigation. The model only produces areas on which crops can be theoretically grown, other things being equal. In addition, because the model is unable to represent flash floods satisfactorily, it cannot be used to assess either their impact or frequency.

Cropping Patterns

Cropping patterns are determined by a large variety of factors but among the more important are :

- access to irrigation in the dry season which to a very large extent decides whether or not a boro crop is grown.

- the flooding regime in the monsoon season which determines whether or not a farmer can grow transplanted high yielding aman, transplanted local varieties of aman, deep water aman or nothing.

- attitudes to risk which are generally determined by farmers' expectations of likely costs and returns but which are also a function of farmers' ability to bear losses should they arise. These are not clear cut for some farmers are in a position where crop failure is not much worse an outcome than not planting because either strategy is catastrophic in terms of providing food for their families. Other farmers are in a more fortunate position where they are able to grow sufficient food for consumption with relatively low risk crops and are unwilling to gamble this security on the chance of either higher returns or the possibility of jeopardising their holdings through incurring losses. Larger farmers are generally in a position to decide for themselves what strategy to adopt although evidence from the farmer survey suggests that the very large farmers tend to farm at lower intensities than either medium or small farmers, and invariably have other sources of income to rely on.

Changes in cropping patterns which can be anticipated are expected to result from both increased access to irrigation and changed flooding regimes. Increased irrigation invariably results in increased boro cultivation, as the crop produces high yields, good returns and is generally perceived as being less risky than most other crops except in areas prone to flash floods. Any increase in boro cultivation has widespread implications for many other crops in both the rabi and aus seasons. Some short duration crops such as pulses and oilseeds may precede a boro crop but only if they are planted on the receding flood. Wheat, potatoes and most winter vegetables are not generally harvested in time for a boro crop to be planted. The same is true of aus, mixed aus and aman and jute crops which are seeded in March, April (and May to some extent) and thus compete with the boro crop which is harvested in (late) April, May and early June. Transplanted aus and deepwater aman crops may follow boro but require an early boro harvest as well as a fast turnround in land preparation and transplanting. Consequently this sequence of crops cannot be expected to cover a very high proportion of the area. Broadcast deep water aman is another crop which can follow boro but it is more safely sowed in March or April when it is unlikely to be damaged by severe early rains (the crop cannot be broadcast into standing water) and has plenty of time to establish itself well enough to elongate with the arrival of floods (a period of about two months). Thus broadcasting aman after the middle of April becomes increasingly more risky the later it is sowed, and consequently has been restricted in the development of cropping patterns to maximum of ten per cent of the area in question.

Transplanted aman crops (HYV varieties are transplanted July and August, local varieties in July, August and September) may follow aus crops but it is more common for them to follow the boro crop as this gives farmers plenty of time to prepare the land and tend their nurseries. In general transplanted aman crops do not compete for land with any other seasonal crops except deepwater varieties which are by definition generally grown elsewhere.

They do conflict with early sown rabi crops as transplanted aman is generally harvested in November and December, by which time the residual moisture has evaporated sufficiently to hinder germination of unirrigated rabi crops. Some farmers overcome this problem by broadcasting seed into the standing aman crop, but in general it may be concluded that increased areas of transplanted aman crops are likely to restrict the ability of farmers to grow crops in the time between the harvest of aman and the transplanting of boro.

From the above it can be seen that future cropping patterns will be mainly determined by assumptions concerning both access to irrigation and projected flooding regimes.

All existing irrigation within the project area comes under the category of minor irrigation; that is to say that there are no schemes involving major pump stations and/or extensive gravity distribution. Estimates of irrigated area in each of the project area zones have been based on the following sources:

- the farmer survey which asked whether (and how) a crop grown on each of the farmers' plots is irrigated.

- data collected by the Bangladesh - Canada Agriculture Sector Team (AST) on numbers of and areas commanded by minor irrigation equipment by extension block and thana.

- thana statistics from the Department of Agricultural Extension (DAE) and the Bangladesh Bureau of Statics (BBS) on irrigation areas and modes.

A discussion of the development trends of all modes of minor irrigation based upon AST and other data sources is presented in Chapter 5 of Annex C (Groundwater Investigations), together with the 1991 irrigated areas by mode according to AST, tabulated by extension block.

In general it was found that the farmer survey produced higher irrigation coverage than either AST figures or DAE/BBS statistics. In the case of Zone C, it was clear that this resulted from an unrepresentative sample which happened to include too high a provision of low lift pumps which was clearly not representative of the whole zone. In Zones A and B, it was also concluded after comparison with AST data that the survey was overstating the irrigation area and that a compromise between the two would be more realistic. As a result the following irrigation rates were adopted:

	Adopted	Survey	AST
Zone A	62%	68%	50 - 60%
Zone B	68%	78%	60 - 70%
Zone C	40%	51%	30 - 40%
Zone D	50%	50%	40 - 50%

This is not as drastic as it might seem because in the "future with" and "without" project projections it is assumed that irrigation rates would increase irrespective of whether the project is undertaken, to 75% in Zones A, B and C (although Zone C is a special case and is discussed in more detail in Chapter J.4 of Annex J) and 60% in Zone D where irrigation development will be restricted, not by any shortages of suitable groundwater resources but by some very low lying land which suffers from poor drainage. One of the conclusions of Annex C is that there are no technical restrictions to the development of groundwater anywhere in the project area although the exploitation of the resource in Zone C will require the use of both shallow force mode technology which is as yet unproven and deep tubewells which are expensive. The maximum expected rate of irrigation coverage is set at 75% (Zone D = 60%) for the purposes of analysis in the "future with" and "without" project and situations irrespective of how it is provided. For the 1990 study FCDI options, areas without access to surface water are assumed to develop groundwater resources up to the level of 75% coverage in Zones A, B and C and up to 60% in Zone D. 75% coverage was selected as a likely possible maximum because it is slightly below irrigation rates already achieved in Akhaura (over 80% but which is exceptional as it enjoys artesian flows in some areas) and allows for expected growth in the future. As this maximum is applied to both the without and with project cropping patterns its selection is neutral in terms of the analysis in all respects except flood damage losses.

Flooding Regimes

Output from the hydro-dynamic model post processing runs provides maximum areas of crops which can be safely grown at various levels of risk in both the "present" and "future with" project situations. While these give a useful indication of the potential improvements which an intervention might achieve, it is necessary to establish how well the model predicts present cropped areas of transplanted aman before it can be used to predict future cropped areas. As far as the model results are concerned transplanted amans are the key crops (both HYV and LY) because these are directly controlled by the flooding regime and can be increased with little adverse affect on other crops other than the deepwater amans which they might replace.

A comparison is presented in Table E.4.2 where it can be seen that the overall fit between the project area as predicted by the model and the farmer survey is extraordinarily good (note that HYV and LV aman areas produced by the model are mutually exclusive). The results are less impressive when considered by zones. Overall, the errors when expressed as a percentage of NCA appear reasonable. It is only when they are calculated as a ratio of each other that they look rather poor. One feature of the model is that in both Gumti and Noakhali it proved to be considerably more reliable in predicting large areas of T aman (over 30%) than very small. Where only small areas of T aman can be grown at present it may be that farmers have different attitudes to risk being prepared to take either smaller or greater chances depending on their circumstances. It may also be the case that because the crop can only be grown on isolated areas of high ground, farmers on these grounds are either unaware of the opportunity or have never received sufficient encouragement or advice to motivate them.

In these circumstances, it has been decided that in Zone A, 100% of the model predictions can be included in future cropping patterns whereas only 80% of predicted should be included elsewhere. It should be noted that great care has been taken to account for present practice and where existing practices differs from model predictions, a conservative estimate has been incorporated.

TABLE E.4.2

Model Analysis of Present Cropping Patterns

		Zone A ha	Zone B ha	Zone C ha	Zone D ha	Total ha
NCA		24506	22413	35040	36080	118039
Model Results	Risk Factor					
Max HYV Aman	1:5	8708	3711	1408	510	14337
Max LT Aman	1:5	12778	7388	5115	3996	29277
Survey Predictions						
(Farmer Survey)						
HYV Aman		8332	1479	2453	0	12264
LT Aman		5612	4191	4836	2526	17164
Total T Aman		13944	5670	7288	2526	29428
Ratio		1.09	0.77	1.42	0.63	1.01
Error		4.8	7.7	6.2	4.1	0.1
BBS T.Aman		11988.00	2567	6213.00	2158	22926
DAE T.Aman		13100.00	5936	2348.00	776	22160
MPO figure based on planning area 31(pro rata)						33928

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Yields

Results of the farm survey for Gumti Phase II are given in Table E.4.3 DAE and BBS figures are averages for the eleven thanas over the period 1989-90 to 1991/92. Rice yields are in tonnes of paddy per hectare.

TABLE E.4.3

Crop Yield Data

	Gumti II			
	Farmer survey	DAE	BBS	used in budgets
B Aus, local	2.30	1.87	1.43	2.00
B Aus, HYV	2.95		1.53	2.50
T Aus, local	2.51		2.81	2.6
T Aus, HYV irri				3.6
T Aus, HYV n-ir	3.58	3.27	2.69	3.20
Mixed aus/aman	3.13		2.30	
B Aman local dw	1.8	1.73	2.19	1.88
T Aman local dw	2.62			2.40
T Aman, local	2.70	2.25	2.48	2.60
T Aman HYV irri			3.85	
T aman HYV n-ir	3.79	3.83	3.02	3.65
Boro, local	3.71	2.65	2.34	3.00
Boro, HYV irrig	5.60	4.79	4.19	5.40
Boro HYV p-irr				0.00
Wheat irrig.	2.30	1.70	1.65	2.25
Wheat unirrig.	1.99			1.80
Potato irrig.	11.86	15.07	12.61(1)	15.00
Potato unirrig.	11.42	6.63	7.65(1)	10.00
Jute	1.94	1.61	1.72	1.90
Pulses: keshari	0.89		0.66	0.70
mung			0.60	
masur	0.45		0.61	0.50
mash	0.75		0.70	
Mustard	0.75	0.90	0.84	0.75
Sugarcane	38.41	0.90	0.84	0.75
Spices (onion)	1.85		4.35	0.00
Spices (chili)	2.62		2.76	4.00
Veg. (brinjal)	10.59		7.19	4.00
Veg. (tomatoes)	0.84		8.95	0.00

Note (1) BBS and DAE potato yields are for HYV and local and not by irrigation status.

In general the farmer survey yields are higher than both DAE and BBS yields although DAE yield estimates are generally higher than BBS's. As discussed in Section E.3.5, the higher yield rates used in the crop budgets reflect the farmer survey as these yields are to some extent confirmed by the survey done by FAP 12 in the Meghna Dhonaghoda Irrigation Project and by the Deep Tubewell Monitoring Project which covers part of the northern area and which gave a yield of 5.5 tonnes per hectare for boro.

Yields of chili, which is the most commonly grown spice, were increased to 4.0 tonnes per hectare because the crop budgets in financial prices produced very poor returns for what was supposed to be a relatively high value spice crop with yields of only three tonnes. As no increase in the production of chili is allowed in the future cropping patterns, on the grounds that crop production is governed by demand, the yield increase assumed has no impact on the economics.

A comparison of yield data from different sources is presented in Table E.4.4.

Future Yields

Previous appraisals of FCDI projects have commonly assumed that substantial input supply and agricultural extension programmes would accompany projects, and that farmers would use recommended doses of inputs and achieve yields appropriate to these levels of inputs. In reality, while FCDI projects and irrigation have generally been found to lead to changes in cropping patterns (due to altered flood phasing), it is not immediately apparent that they have resulted in an increase in input application or yields received for a given crop type grown under the same land and water conditions as before.

In one of the most detailed recent evaluations of a major FCDI project (Thompson 1989), no differences were found in yields for winter crops (mainly boro) and aus between Chandpur Irrigation Project (CIP) and adjacent 'control' areas outside the project boundaries. In summarising the yield impacts of FCDI the following extract from Thompson is particularly relevant:

> "Flood protection appears to be successful in maintaining yields closer to 'normal' in unusual flood years, compared with unprotected areas, but otherwise CIP has not provided an additional benefit over the switch in cropping pattern. That is, yields in a normal year are not higher compared to outside when the same type of paddy is considered. In general this probably reflects levels of input use... fertiliser use for a given crop type is not higher inside CIP compared to outside areas. Thus CIP does not appear to have provided more effective extension services relative to non-project areas, nor has any supposed increase in wealth due to more productive agriculture been reinvested as working capital in an attempt to further increase yields."

This finding is supported by detailed analysis of farmer survey results which did not identify any improvement in yield or associated change in input use for the same crop grown on higher, and therefore less flood-prone, land. Although evaluations of completed projects by FAP 12 has in some cases identified yield improvements inside FCD project areas (see Table E.4.4), it concluded that:

> "in most projects the major impact on weighted mean paddy yields is from farmers switching to more productive types of paddy when hydrological conditions change sufficiently to permit this".

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TABLE E.4.4

Comparison of Yield Data From different Sources

Tonnes per hectare (rice as paddy)	Farmer survey	FAP 12 (MDIP)		BBS avg. 1989-91	Used in crop budgets
		project	outside		
B Aus, local	2.30	2.08	2.04	1.43	2.00
B Aus, HYB	2.95	3.59		1.53	2.5
T Aus, local	2.51	2.99		2.81	2.6
T Aus, HYV	3.58	4.22		2.69	3.2
Mixed aus/aman	3.13	1.71	1.14		2.3
B Aman local d.w.	1.80	1.87	2.04	2.19	1.88
T Aman, local d.w.	2.62				2.40
T Aman, local	2.70	3.31	1.29	2.48	2.6
T Aman, HYV	3.79	4.66	2.8	3.02	3.65
Boro, local	3.71	3.15		2.34	3.0
Boro, HYV	5.60	5.04	4.47	4.19	5.4
Wheat irrigated	2.30	1.92	1.98	1.65	2.25
Wheat unirrigated	1.99	1.96	1.98	1.65	1.80
Potato irrigated	11.86	9.52	17.38	11.45	15.00
Potato unirrigated	11.42	9.52	17.38	11.45	11.00
Jute	1.94	1.26	1.02	1.72	1.90
Pulses: keshari	0.89		0.9	0.66	0.70
mung			0.9		0.60
musur	0.45		0.9	0.61	0.50
mash	0.72		0.9	0.00	0.70
Mustard	0.75	0.74	0.49	0.77	0.75
Sugarcane	38.41	32.8		32.64	na
Spices (chili)	2.05	1.21	0.58	2.31	4.00
Veg. (brinjal)	8.01			7.18	8.00

For the purposes of the economic analysis, it has been assumed that for a given crop a single yield value (and level of inputs) is applicable in both the without and with project conditions. The yield figures used have been assumed to allow for normal levels of crop damage due to flooding. Differences in yields between the with and without project cases have been assumed only in cases where flood protection would cause a reduction in the average annual level of crop damage and which are accounted for separately.

Similarly no difference is assumed between present and future yields (with and without the project). There is no evidence that there is an upward trend in the yields of individual crops. Analysis of BBS statistics by IFDC[1] indicate that although HYV boro yields rose by 0.3% per year from 1973 to 1979, they then declined by 0.4% per year up to 1989, despite increased use of fertiliser. This is attributed to an increasing proportion of the expanding area being grown under less suitable conditions. Boro yields best on heavy soils and these areas were the first to be cultivated with the crop. As boro expands it has in turn pushed wheat, pulses and oilseeds on to more marginal land so their yields have also suffered. Analysis of data on HYV aman paddy IFDC[2] shows an annual yield decline from 1972 to 1988 of 0.5%. Analysis of yields reported by BBS for the region shows a pattern of static yields for major crops over the last six years. Static and declining yields are also attributed to increasing cropping intensity, reduced flooding (which may add silt and organic matter to the soil, reduced production of pulses and use of animal manure) both of which improve soil structure and fertility.

This approach, both for with and without project, and present and future yields, is consistent with the FPCO Guidelines for Project Appraisal.

E.4.3.2 Future without Project Development

Future "without project" development is based on the further development of groundwater and increased planting of boro. In total, irrigation coverage has been assumed to reach 75 per cent of NCA in Zones A, B and C and 60 per cent in Zone D.

E.4.3.3 Future with Project Development

Future "with project" development is based on

(i) the further development of irrigation as in the "without project" case, except that in some of the options considered irrigation supplies will be increased through the excavation of Khals and/or pumping into Khals from the River Meghna.

(ii) improved flooding regimes which should facilitate the cultivation of additional areas of HYV or LT aman.

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1 Farm Level Fertilizer Use Survey, 1990/1 Rabi/Boro Season, I Jahan, K Sanyal, IFDC, 1993

2 Farm Level Fertilizer Use Survey, 1989 Aman Season, Sidhu and Ahan, IFDC 1991

E.4.3.4 Cropping Patterns and Areas

Cropping patterns for each of the options, prepared on the bases discussed above are presented in Tables E.4.5 and E.4.6. They are also presented according to flood phase and zone in Appendix E.III.

A number of alternative cropping patterns have been prepared for Zone C, see Tables E.4.6(i), (ii) and (iii). They are based on three different assumptions regarding "future without project" development of irrigation (See Annex J).

There are :

1) no further groundwater exploitation

2) complete (i.e. 75% coverage of NCA) development of groundwater resources in 10 years

3) slow development of groundwater exploitation which takes 15 years with an increase of only 12% in the first ten years.

Cropping patterns for Khal excavation and the Gumti submersible embankment in Zone D are not required as Khal excavation is evaluated in Annex J as a comparison between the costs of providing irrigation, and the embankment only provides flood protection against flash floods.

FCD and FCDI Projects

Cropping patterns for these options are presented in Tables E.4.7 and E.4.8. They are also presented according to fflood phase and zone in Appendix E.III.

Areas of All Development Proposals

Areas in net cultivable hectares of each of the development options are presented in Table E.4.9

TABLE E.4.5

Cropping Patterns For Zones A and B Controlled Flooding Project:

(% of NCA)

	Year 1	Future w'out(1)	Future with (1)
B Aus, local	4.2%	2.6%	2.6%
B Aus, HYV	1.5%	1.5%	1.5%
T Aus, local	2.6%	1.1%	1.1%
T Aus, HYV irri	3.0%	2.7%	3.4%
T Aus, HYV n-ir	8.9%	8.1%	9.2%
Mixed aus/aman	1.7%	1.7%	2.0%
B Aman local dw	15.5%	9.5%	6.3%
T Aman local dw	7.0%	7.0%	8.0%
T Aman, local	20.9%	20.9%	13.6%
Aman HYV irri	3.2%	3.2%	4.4%
T Aman HYV n-ir	17.8%	17.8%	30.2%
Boro, local	0.7%	0.7%	0.7%
Boro, HYV irrig	64.1%	74.3%	74.3%
Boro HYV p-irr.	0.0%	0.0%	0.0%
Wheat irrig.	1.7%	1.5%	1.5%
Wheat unirrig.	7.9%	6.4%	6.4%
Potato irrig.	2.3%	2.3%	2.3%
Potato unirrig.	2.1%	2.1%	2.1%
Jute	3.7%	3.7%	3.7%
Pulses: ave.	3.6%	2.7%	2.7%
Mustard	11.0%	9.2%	10.3%
Spices (chili)	0.8%	0.8%	0.8%
Veg. (brinjal)	1.9%	1.9%	1.9%
Total	186.2%	181.6%	188.8%

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TABLE E.4.6 (i)

Summary of Cropping Pattern Changes : Zone C
(No further groundwater development)

(% of NCA)

	Year 1	Future w'out(1)	Future with(1)
B Aus, local	5.5%	5.5%	5.5%
B Aus, HYV	1.0%	1.0%	1.0%
T Aus, local	3.9%	3.9%	4.0%
T Aus, HYV irri	0.9%	0.9%	1.2%
T Aus, HYV n-ir	4.3%	4.3%	6.0%
Mixed aus/aman	11.0%	11.0%	8.0%
B Aman local dw	27.0%	27.0%	10.3%
T Aman local dw	0.8%	0.8%	0.6%
T Aman, local	13.8%	13.8%	16.0%
T Aman HYV irri	0.4%	0.4%	1.3%
T Aman HYV n-ir	6.6%	6.6%	19.7%
Boro, local	0.3%	0.3%	0.3%
Boro, HYV irrig	40.0%	40.0%	60.7%
Boro HYV p-irr.	0.0%	0.0%	0.0%
Wheat irrig.	1.0%	1.0%	0.8%
Wheat unirrig.	12.8%	12.8%	11.2%
Potato irrig.	0.1%	0.1%	0.1%
Potato unirrig.	1.2%	1.2%	1.2%
Jute	10.2%	10.2%	10.2%
Pulses: ave.	10.5%	10.5%	9.0%
Mustard	14.6%	14.6%	12.0%
Spices (chili)	0.9%	0.9%	0.9%
Veg. (brinjal)	1.5%	1.5%	1.5%
Total	168.3%	168.3%	181.5%

TABLE E.4.6 (ii)

Summary of Cropping Pattern Changes : Zone C
(FWO 10 year groundwater development)

(% of NCA)

	Year 1	Future w'out(1)	Future with(1)
B Aus, local	5.5%	2.5%	2.5%
B Aus, HYV	1.0%	0.0%	0.0%
T Aus, local	3.9%	1.4%	1.4%
T Aus, HYV irri	0.9%	0.5%	1.2%
Aus, HYV n-ir	4.3%	2.2%	5.9%
Mixed aus/aman	11.0%	4.0%	3.2%
B Aman local dw	27.0%	12.0%	8.0%
T Aman local dw	0.8%	0.8%	0.6%
T Aman, local	13.8%	13.8%	16.0%
T Aman HYV irri	0.4%	0.4%	1.3%
T Aman HYV n-ir	6.6%	6.6%	19.7%
Boro, local	0.3%	0.3%	0.3%
Boro, HYV irrig	40.0%	74.7%	74.7%
Boro HYV p-irr.	0.0%	0.0%	0.0%
Wheat irrig.	1.0%	0.6%	0.6%
Wheat unirrig.	12.8%	7.9%	7.9%
Potato irrig.	0.1%	0.1%	0.1%
Potato unirrig.	1.2%	1.2%	1.2%
Jute	10.2%	6.5%	6.4%
Pulses: ave.	10.5%	6.4%	6.4%
Mustard	14.6%	13.6%	13.6%
Spices (chili)	0.9%	0.9%	0.9%
Veg. (brinjal)	1.5%	1.5%	1.5%
Total	168.3%	157.9%	173.4%

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TABLE E.4.6 (iii)

Summary of Cropping Pattern Changes : Zone C
(FWO : 15 year groundwater development)

(% of NCA)

	Year 1	Future w'out(1)	Future with(1)
B Aus, local	5.5%	4.4%	2.5%
B Aus, HYV	1.0%	0.6%	0.0%
T Aus, local	3.9%	3.0%	1.4%
T Aus, HYV irri	0.9%	0.7%	1.2%
T Aus, HYV n-ir	4.3%	3.5%	5.9%
Mixed aus/aman	11.0%	8.4%	3.2%
B Aman local dw	27.0%	21.5%	8.0%
T Aman local dw	0.8%	0.8%	0.6%
T Aman, local	13.8%	13.8%	16.0%
T Aman HYV irri	0.4%	0.4%	1.3%
T Aman HYV n-ir	6.6%	6.6%	19.7%
Boro, local	0.3%	0.3%	0.3%
Boro, HYV irrig	40.0%	52.8%	74.7%
Boro HYV p-irr.	0.0%	0.0%	0.0%
Wheat irrig.	1.0%	1.8%	0.6%
Wheat unirrig.	12.8%	11.0%	7.9%
Potato irrig.	0.1%	0.1%	0.1%
Potato unirrig.	1.2%	1.2%	1.2%
Jute	10.2%	8.8%	6.4%
Pulses: ave.	10.5%	9.0%	6.4%
Mustard	14.6%	14.2%	13.6%
Spices (chili)	0.9%	0.9%	0.9%
Veg. (brinjal)	1.5%	1.5%	1.5%
Total	168.3%	164.5%	173.4% 173.4%

TABLE E.4.7

Summary of Cropping Pattern Changes
FCD : Full Area

(% of NCA)

	Year 1	Future w'out(1)	Future with(1)
B Aus, local	3.6%	2.0%	2.0%
B Aus, HYV	0.6%	0.6%	0.6%
T Aus, local	1.6%	0.9%	0.9%
T Aus, HYV irri	1.3%	1.2%	1.8%
T Aus, HYV n-ir	4.1%	3.9%	5.4%
Mixed aus/aman	5.0%	2.9%	2.8%
B Aman local dw	23.8%	15.4%	15.0%
T Aman local dw	3.3%	3.3%	2.3%
T Aman, local	12.6%	12.6%	9.4%
T Aman HYV irri	1.4%	1.4%	2.2%
T Aman HYV n-ir	9.0%	9.0%	17.8%
Boro, local	1.3%	1.3%	1.3%
Boro, HYV irrig	55.0%	69.1%	69.1%
Boro HYV p-irr.	0.0%	0.0%	0.0%
Wheat irrig.	1.2%	0.9%	0.9%
Wheat unirrig.	11.7%	8.3%	8.3%
Potato irrig.	1.0%	1.0%	1.0%
Potato unirrig.	2.3%	2.3%	2.3%
Jute	7.7%	6.6%	6.2%
Pulses: ave.	7.0%	5.2%	5.2%
Mustard	11.1%	10.2%	11.8%
Spices (chili)	2.7%	2.7%	2.7%
Veg. (brinjal)	3.4%	3.4%	3.4%
Total	170.7%	164.3%	172.6%

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TABLE E.4.8

Summary of Cropping Pattern Changes
FCDI : Full Area

(% of NCA)

	Year 1	Future w'out(1)	Future with(1)
B Aus, local	3.6%	2.0%	2.0%
B Aus, HYV	0.9%	0.6%	0.6%
T Aus, local	2.2%	0.9%	0.7%
T Aus, HYV irri	1.7%	1.5%	2.3%
T Aus, HYV n-ir	4.5%	3.6%	6.2%
Mixed aus/aman	5.0%	2.9%	2.3%
B Aman local dw	25.2%	15.4%	13.3%
T Aman local dw	3.3%	3.3%	4.0%
T Aman, local	12.6%	12.6%	9.1%
T Aman HYV irri	1.4%	1.4%	2.9%
T Aman HYV n-ir	9.0%	9.0%	25.8%
Boro, local	1.3%	1.3%	1.3%
Boro, HYV irrig	51.9%	69.1%	69.1%
Boro HYV p-irr.	0.0%	0.0%	0.0%
Wheat irrig.	1.2%	0.9%	0.9%
Wheat unirrig.	11.7%	8.3%	8.3%
Potato irrig.	1.0%	1.0%	1.0%
Potato unirrig.	2.3%	2.3%	2.3%
Jute	7.7%	6.6%	6.5%
Pulses: ave.	7.0%	5.2%	5.2%
Mustard	11.1%	10.2%	10.9%
Spices (chili)	2.7%	2.7%	2.7%
Veg. (brinjal)	3.4%	3.4%	3.4%
Total	170.7%	164.3%	181.0%

Figure E.4.4

Schematic Cropping Pattern under Future Without Project Condition

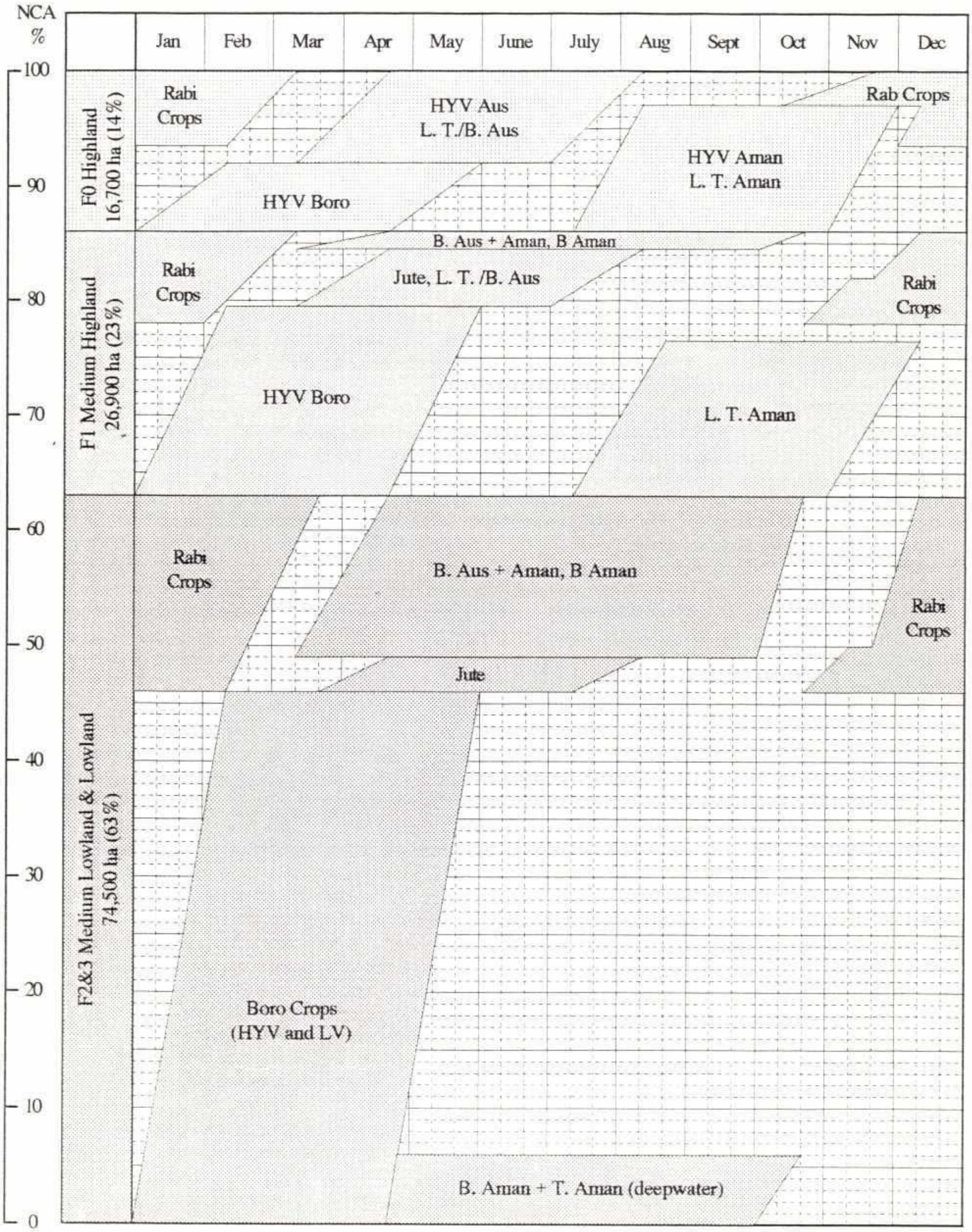

Figure E.4.5

Schematic Cropping Pattern under Future With Project Condition

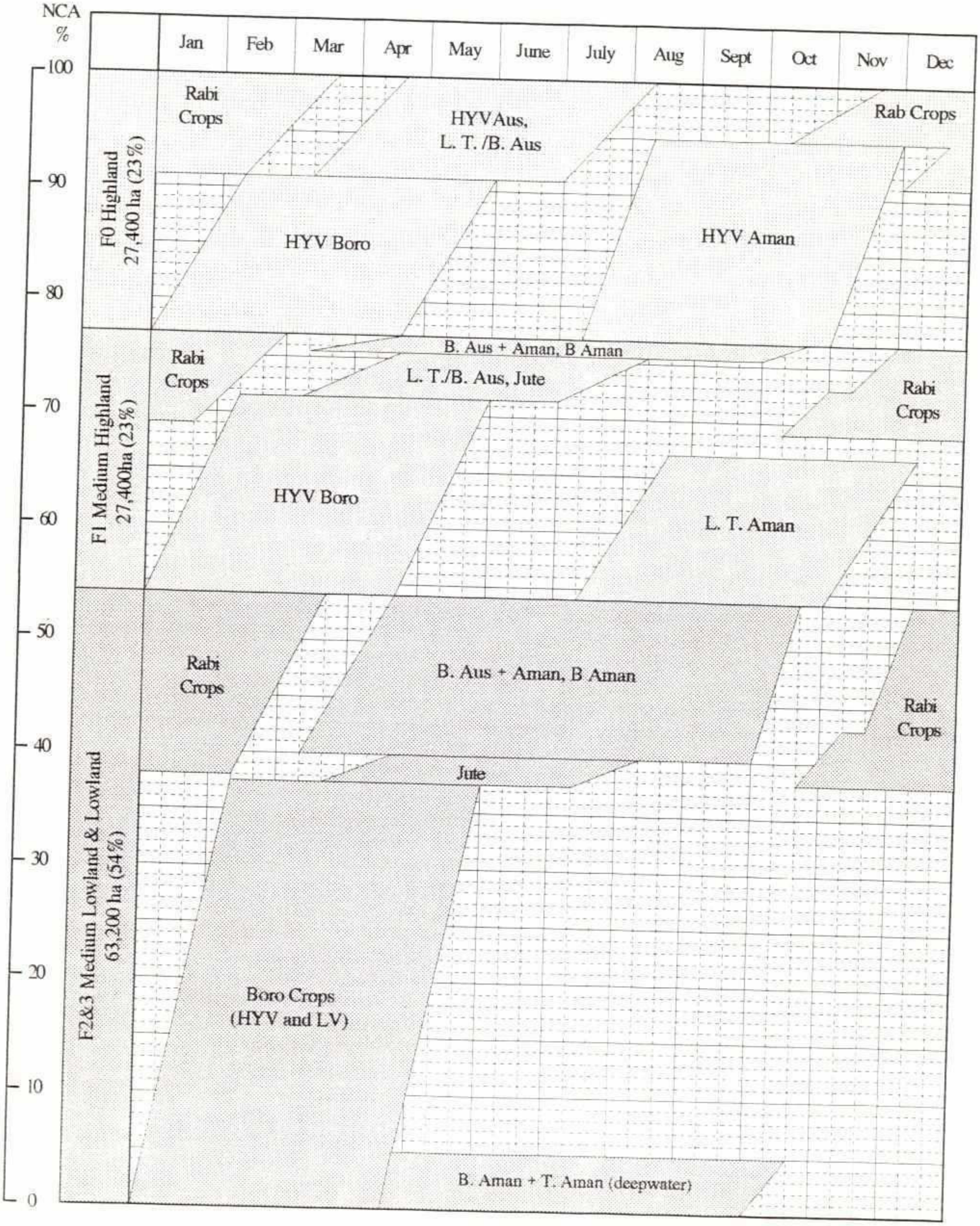

TABLE E.4.9

Areas (NCA) of Development Proposals:

Area (Ha)	NCA	Embanked	Not Embanked
Zone A	24506	17933	6573
Zone B	22412	4184	18228
Zone C	35040	8852	26188
Zone D	36080		36080
FCD	108487	108487	
FCDI	107100	107100	

E.4.3.5 Future Agricultural Production

Future agricultural production is estimated on the basis of the future proposed cropping pattern and unit yield. The total production will be increase under both future without-project [FWO] and with-project[FW] conditions particularly in paddy production. Although population growth will reduce the present level of per capita production in the future, per capita production in 2023 would maintain the surplus from self-consumption in the project area, as given in Table E.4.10. Schematic cropping patterns for the "Future Without Project" and "Future With Project" are presented in Figures E.4.4 and E.4.5 respectively.

TABLE E.4.10

Per Capita Production under Present and Future Condition in the Gumti Sub-Project Area

Crop	Zone A Total (ton)	Zone A capita (kg)	Zone B Total (ton)	Zone B capita (kg)	Zone C Total (ton)	Zone C capita (kg)	Zone D Total (ton)	Zone D capita (kg)	Whole Area Total (ton)	Whole Area capita (kg)
Present Condition [P]										
Rice	158,100	373.9	116,900	371.7	139,000	261.9	125,100	206.6	539,100	287.8
Wheat	4,100	9.7	4,100	13.0	8,700	16.4	10,600	17.5	27,500	14.7
Total	162,200	383.6	121,000	384.7	147,700	278.3	135,700	224.1	566,600	302.4
Pulses	300	0.7	800	2.5	2,400	4.5	2,200	3.6	5,700	3.0
Oilseeds	1,600	3.8	2,300	7.3	3,800	7.2	1,900	3.1	9,600	5.1
Potato	16,700	39.5	4,000	12.7	4,600	8.7	13,000	21.5	38,300	20.4
Winter Vegetables	6,700	15.8	500	1.6	3,400	6.4	14,700	24.3	25,300	13.5
Spices	1,100	2.6	400	1.3	1,300	2.4	10,000	16.5	12,800	6.8
Jute	1,400	3.3	1,900	6.0	6,800	12.8	7,300	12.1	17,400	9.3
Summer Vegetable	-	-	-	-	800	1.5	2,300	3.8	3,100	1.7
Population* ('000)		422.8		314.5		530.8		605.4		1,873.5
Future without Project [WO]										
Rice	167,800	232.4	122,600	228.3	181,000	199.7	137,200	132.7	608,600	190.2
Wheat	3,800	5.3	2,800	5.2	5,400	6.0	7,700	7.4	19,700	6.2
Total	171,600	237.6	125,400	233.5	186,400	205.6	144,900	140.1	628,300	196.4
Pulses	300	0.4	500	0.9	1,400	1.5	1,700	1.6	3,900	1.2
Oilseeds	600	0.8	2,700	5.0	3,600	4.0	2,600	2.5	9,500	3.0
Potato	16,700	23.1	4,000	7.4	4,600	5.1	13,000	12.6	38,300	12.0
Winter Vegetables	6,700	9.3	500	0.9	3,400	3.8	14,700	14.2	25,300	7.9
Spices	1,100	1.5	400	0.7	1,300	1.4	10,000	9.7	12,800	4.0
Jute	1,400	1.9	1,900	3.5	4,300	4.7	7,300	7.1	14,900	4.7
Summer Vegetable	-	-	-	-	800	0.9	2,300	2.2	3,100	1.0
Population** ('000)		722.1		537.1		906.5		1,033.9		3,199.6
Future with Project [FW]										
Rice	174,700	241.9	131,400	244.6	202,400	223.3	137,200	132.7	645,700	201.8
Wheat (rainfed)	3,800	5.3	2,800	5.2	5,400	6.0	7,700	7.4	19,700	6.2
Total	178,500	247.2	134,200	249.9	207,800	229.2	144,900	140.1	665,400	208.0
Pulses	300	0.4	500	0.9	1,400	1.5	1,700	1.6	3,900	1.2
Oilseeds	900	1.2	2,700	5.0	3,600	4.0	2,600	2.5	9,800	3.1
Potato	16,700	23.1	4,000	7.4	4,600	5.1	13,000	12.6	38,300	12.0
Winter Vegetables	6,700	9.3	500	0.9	3,400	3.8	14,700	14.2	25,300	7.9
Spices	1,100	1.5	400	0.7	1,300	1.4	10,000	9.7	12,800	4.0
Jute	1,400	1.9	1,900	3.5	4,300	4.7	7,300	7.1	14,900	4.7
Summer Vegetable	-	-	-	-	800	0.9	2,300	2.2	3,100	1.0
Population** ('000)		722.1		537.1		906.5		1,033.9		3,199.6

Remarks, *:population in 1993, **:population in 2023, as projected in Annex G Socio-Economy

E.5 Possible Constraints to Future Developments

E.5.1 Availability of Labour Force and Draught Animal

It is the practice for labourers to be drawn from the farmer's family members wherever possible, otherwise labourers are hired from other households. Draught animals are also often owned by the farmer or a member of his family. However, according to the farmers survey, the majority of farmers reported that delay of cropping was caused by shortage of labour and draught animals, particularly for land preparation. Consequently, crops might not be harvested at the proper time and this results in lower yields than normal. This shortage is also corroborated by the fact that power tillers are utilized for land preparation by about 12% of farmers in the project area (this including 25% of the farmers in Zone A). In the future, requirement of labour force and draught animals will further increase under both without-project and with-project conditions. Therefore, the proposed cropping patterns are examined in terms of requirement and availability of labour force and draught animals in the following sub-sections. An outline of the estimation of requirement and availability is presented in Tables E.5.1 to E.5.3 for both labour force and draught animals.

E.5.1.1 Labour

The annual total requirement of labour in the project area is calculated at 34.3 million man-days on the basis of the crop area of the proposed cropping pattern and unit labour requirement for each crop. The annual total labour force available for agriculture in the project area is estimated at 115.7 million man-days in 1993 and 198.0 million in 2023, assuming that (1) 33% of the population is available as labour, (2) 75% of the available labour force are engaged in agriculture, (3) there are 250 working days in a year, (4) projected population figures between 1993 and 2023 described in Annex G are applied. Farming practices of the proposed cropping pattern requires 30% of the annual labour force available for agriculture in 1993. The proportion of requirement to availability will be reduced to 17% in 2023, owing to the population increase.

In addition to the annual balance in the above, the peak requirement period, for the HYV boro crop, was examined. This will occupy the largest crop area in the proposed cropping pattern. Peak requirement reaches 212,200 man-days in early January, according to calculated requirements for each practice on a 10-day basis. The daily total labour force available for agriculture is also estimated at 374,700 man-days at present and 538,600 in 2023, applying the same assumptions as before. At the peak requirement period in which the practices for nursery preparation, land preparation and transplanting overlap, cultivation of HYV boro in 81,600 ha requires 60% of the present available labour force in 1993. Even in the case of the peak requirement, duplicating the practices of HYV boro crops with those of such crops as rabi crops and aus paddy, labour requirements will not exceed 75% of availability. This proportion will also be reduced to approximately 40% in 2023.

These results indicate that the trends of population in the project area could sustain the future labour availability enough for the proposed cropping pattern, and no particular measures would be necessary to supplement the labour force.

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E.5.1.2 Draught Animals

The requirement of draught animals for the proposed cropping pattern is examined through balancing the availability in the project area used in the 1990 Report, since no data is available to estimate the present and future availability of draught animals. The requirement of draught animals has been calculated at 8.72 million pair-days per annum. The availability of draught animals for agriculture in the project area is estimated at 22.5 million pair-days per annum. The ratio of requirement to availability is 39% on an annual basis. In term of the peak requirement which occurs in late December to early January, the available draught animals of 61,000 pairs/day would not be enough to supply the peak requirement of 71,400 pairs/day for HYV boro over 81,600 ha. This shortage in availability will continue up to the end of January.

The results show that some measures would be necessary to supplement the shortage of draught animals in the future cropping pattern. It is considered that draught animals could not increase due to the shortage of feed supply and limited grazing land. In this regards, diversification of draft power from the single main source of draught animals will be required through the expansion of power tillers.

E.5.2 Crop Inputs

Crop input supply is unlikely to be a constraint in the future. Distribution of inputs is now the responsibility of the private sector and there is evidence that the cost of distribution has fallen since deregulation which has helped offset the price increases in fertiliser. Input use by farmers is also not expected to restrict production unless commodity prices fall. In late 1992, there was a dramatic collapse in rice prices (which are not included in this study) caused by an exceptionally good aman harvest. Should prices fail to recover then input use may decline until such time as shortages increase prices once again. Despite increases in fertiliser prices, fertiliser use has increased, despite the lack of formal credit. There is no evidence from the surveys that farmers lack resources. In fact they use the same, if not more, fertiliser than other farmers and get similar yields.

E.5.3 Future Credit Availability and Requirements

Future development of force-mode tubewells is being supported by the National Minor Irrigation Project (NMIDP). However this project does not have a credit component beyond the funding of equipment importers and dealers/contractors. There was provision for lending to farmers for irrigation equipment in the proposed Agricultural and Rural Credit Project II (IDA/ADB/USAID), but this project has been indefinitely postponed pending a reforms of the institutions involved. However the problem in lending is not the availability of funds (banks have sufficient supplies of cash), but rather in the delivery and recovery systems, which is dependant on major institutional reforms of the banking system and on changing the attitudes of borrowers towards loan repayment.

Investment by farmers in LLP to utilise improved surface water supplies developed by projects in the region need not be dependant on improvements in the availability of institutional credit. Rapid development in LLP and STW has already taken place without a major recourse to bank credit. In fact the problems that farmers perceive in getting access to bank credit suggests they would prefer to fund this investment from their savings.

TABLE E.5.1

Annual Requirement of Labour Force and Draught Animal under Future With Project Condition [FW] in the Gumti Phase-II Project Area

Crops	Total Cropped Area (ha)	Labour Requirement Unit Rate (man-day/ha)	Labour Requirement Total (man-day)	Draught Animal Requirement Unit Rate (pair-day/ha)	Draught Animal Requirement Total (pair-day)
Kharif-1 Season					
B. Aus:LV	2,420	142	343,600	45	108,900
B. Aus:HYV	720	145	104,400	45	32,400
T. Aus :LV	1,030	154	158,600	47	48,400
T. Aus :HYV (rainfed)	6,620	177	1,171,700	47	311,100
B. Aus+Aman	3,370	165	556,100	44	148,300
B. Aman:LV	12,560	111	1,394,200	44	552,600
Jute	7,790	215	1,674,900	45	350,600
Summer Vegetables	390	270	105,300	44	17,200
Sub-total	34,900		5,508,800		1,569,500
Kharif-2 Season					
T. Aus :HYV (rainfed)	1,750	177	309,800	47	82,300
B. Aman:LV	2,700	111	299,700	44	118,800
T. Aman:LV (deep water)	4,240	134	568,200	40	169,600
T. Aman:LV	12,220	146	1,784,100	40	488,800
T. Aman:HYV (rainfed)	23,580	167	3,937,900	43	1,013,900
Sub-total	44,490		6,899,700		1,873,400
Rabi Crops					
Boro:LV	1,180	120	141,600	25	29,500
Boro:LIV	340	214	72,800	45	15,300
Boro:HYV (irrigated)	81,590	214	17,460,300	45	3,671,600
Wheat (rainfed)	10,940	102	1,115,900	45	492,300
Pulses	6,160	50	308,000	30	184,800
Oilseeds	13,000	58	754,000	37	481,000
Potato (rainfed)	3,820	175	668,500	44	168,100
Winter Vegetables	3,160	270	853,200	44	139,000
Spices	3,190	157	500,800	30	95,700
Sub-total	123,380		21,875,100		5,277,300
Grand Total	202,770		34,283,600		8,720,200
Ratio to availability			17%		39%
Availability		(2023)	197,969,000	(1986-88)	22,474,000

Availability of Labours

1. Population	in 1993	1,873,500	persons
	in 2023	3,199,500	persons
2. Labour availability		33%	(F/S in 1990, the BWDB report)
3. Availability for agriculture		75%	(F/S in 1990, the BWDB report)
4. Available number for agriculture	in 1993	463,691	adult equivalent
	in 2023	791,876	adult equivalent
5. Annual working days		250	days (F/S in 1990, the BWDB report)
6. Annual available number	in 1993	115,923,000	man-days
	in 2023	197,969,000	man-days

Availability of Draught Animals

1. Population	264,320	heads
	132,200	pairs approximately
2. Work efficiency due to age structure	68%	
3. Availability for agriculture	100%	
4. Available number for agriculture	89,896	adult pair equivalent
5. Annual working days	250	days (F/S in 1990, the BWDB report)
6. Annual available number	22,474,000	pair days

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TABLE E.5.2

Balance of Labour Force in the Gumti Phase-II Project Area

1. ANNUAL BALANCE

1.1 **Annual Requirement**

-Total requirement under future with project condition [FW] : 34,280,000 man-days

1.2 **Annual Availability**

- Total population in the area : 1991 1,870,000
  2023 3,200,000

- Condition of Calculation
  Population availability for labour : 33% of total population (F/S in 1990, the 1990 report)
  Labour availability for agriculture : 75% of total available labour (F/S in 1990, the 1990 report)
  Working days : 250 days/year (F/S report in 1990)

- draught power availability : 1993 1,870,000 x 33% x 75% x 250 days = 115,710,000 man-day
  2023 3,200,000 x 33% x 75% x 250 days = 198,000,000 man-day

1.3 **Balance of Requirement and Available Labour**

- in 1993 Availability (115,710,000) - Requirement (34,280,000) = 81,430,000 man-days of surplus, (70% of total labour is surplus)
- in 2023 Availability (198,000,000) - Requirement (34,280,000) = 163,720,000 man-days of surplus, (83% of total labour is surplus)

2 BALANCE AT PEAK REQUIREMENT (HYV boro, largest crop area in 69% of the project area)

2.1 **Peak Requirement of Labour Force**

- HYV boro in 81,600 ha under future with project condition [FW]
- Peak unit labour requirement : 2.600 man-day/ha/day in 1st decade of January
- Total requirement in the project area : 81,600 ha x 2.600 man-days/ha/day = 212,200 man-days

2.2 **Availability of Labour Force**

- Total population in the area : 1993 1,870,000
  2023 3,200,000

- Condition of calculation
  Population availability for labour : 33% of total population (F/S in 1990, the 1990 report)
  Labour availability for agriculture : 75% of total available labour (F/S in 1990, the 1990 report)
  Working days : 250 days/year = 68% (F/S report in 1990)

- Total labour available per day in 1993 1,870,000 x 33% x 75% x 68% = 374,700 man-days/ha
  2023 3,200,000 x 33% x 75% x 68% = 538,600 man-days/ha

2.3 **Balance of Requirement and Available Labour for HYV Boro**

- Balance (1993) in 1st peak : Availability (374,700) - Requirement (212,200) = 162,500 of surplus
- Balance (2023) in 1st peak : Availability (538,600) - Requirement (212,200) = 326,400 of surplus

TABLE E.5.3

Balance of Draught Animal in the Gumti Phase-II Project Area

1. ANNUAL BALANCE

1.1 Annual Requirement

-Total requirement under future with project condition [FW] : 8,720,000 pair-days

1.2 Annual Availability

- Total number of draught animal available in the area :
  264,320 heads (draught animal) = 132,200 pairs (F/S in 1990, the 1990 report)

- Condition of calculation
  Work efficiency : 68%* of a adult pair equivalent on average,
  *: Working life span of 20 years, idle in age 1 - 2 years, 50% ability in age 3 years, 75% ability in 4 years, 100% ability in 4 - 10 years, 75% ability in 11 to 15 years, 50% ability in 16 - 20 years.
  Working days :250 days/year (F/S report in 1990)

- draught power availability : 132,200 pairs x 68% x 250 days = 22,474,000 pairs/day

1.3 Balance of Draught Animal

- Availability (22,474,000) - Requirement (8,720,000) = 13,754,000 pairs/days (61%) of surplus,

2 BALANCE AT PEAK REQUIREMENT (HYV boro, largest crop area in 69% of the area)

2.1 Requirement of Draught Animal

- HYV boro in 81,600 ha under future with project condition [FW]

- Unit requirement :	1st peak	0.875 pair/day/ha in 3rd decade of Dec. to 1st decade of January.
based on cropping pattern	2nd peak	0.750 pair/day/ha in 2nd and 3rd decade of January.
- Total requirement :	1st peak	81,600 ha x 0.875 pair/day/ha = 71,400 pairs/day
in the area	2nd peak	81,600 ha x 0.750 pair/day/ha = 61,200 pairs/day

2.2 Availability of Draught

- Total number of draught animal available in the area :
  264,320 heads (draught animal) = 132,200 pairs (F/S in 1990, the 1990 report)

- Condition for calculation
  Work efficiency : 68% of a adult pair equivalent on average (refer to section 1.2 on the above)
  Working days :250 days/year = 68% (F/S report in 1990)

- draught power availability : 132,200 pairs x 68% x 68% = 61,100 pairs/day

2.3 Balance of Draught Animal for HYV Boro

- Balance
  1st peak : Availability (61,100) - Requirement (71,400) = 10,300 pairs/day of shortage
  2nd peak : Availability (61,100) - Requirement (61,200) = 100 pairs/day of shortage

- Shortage of draught animal
  1st peak : (10,300 of adults pair equivalent) ÷ 68% ÷ 68% = 22,300 pairs or 44,600 heads
  2nd peak : (100 of adults pair equivalent) ÷ 68% ÷ 68% = 200 pairs or 400 heads

Investment in FMTWs, that may provide an alternative to surface water in areas where conditions preclude STWs, is more problematic. Although their overall cost per hectare irrigated is competitive with STW, because relatively high capital costs are offset by greater operating efficiency, they do demand a larger investment. This means they are less easily affordable and the investment will be seen as a considerable risk, especially as they are a relatively untried technology. This may mean that uptake of this technology is relatively slow. However in a survey of 92 STW operators,[1] over half said they were interested in purchasing FMTW. Almost half of the potential investors said they would use their own savings rather needing an bank loan.

1 1) DTW Final Report Credit Study.

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1. Inception Report, South East Region Water Development Programme (FAP-5), February, 1991

2. Interum Report (Draft), South East Region Water Development Programme (FAP-5), September 1991 Main Report, Annexes I Crop Input Statistics, II Estimate of Cost of Minor Irrigation, III Average Financial Returns by Land Category, IV Non-agricultural Flood Damage, V Water Modelling, VI.1 Noakhali North Planning Unit, VI.2 Dakatia Planning Unit, VI.3 Dhonagoda Planning Unit, VI.4 Gumti Phase I Planning Unit, VII Engineering Costing

3. Regional Plan Report (Draft), South East Region Water Development Programme (FAP-5), April 1992
   Volume I Part 1 - Existing Situation
   Volume II Part 2 - The Regional Water Plan
   Volume III Annexes I Soils, II Agriculture, III Sociology, IV Environment
   Volume IV Annexes V Hydrogeology, VI Fisheries
   Volume V Annexes VII Project Evaluations-Additional Economic Analysis Tables, VIII Crop Input Statistics, IX Estimate of Costs of Minor Irrigation, X Average Financial Returns by Land Category, XI Non-Agricultural Flood Damage, XII Hydrology and Water Modelling, XIII Engineering Costing
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6. First Progress Report, Gumti Phase II Sub-Project Feasibility Study, December 1992

7. Second Progress Report, Gumti Phase II Sub-Project Feasibility Study, March 1993

Basic Report Related to the Study

1. Final Report of Feasibility Study on Gumti Phase II Sub-Project, March 1991

   Bureau of Consulting Engineer LTD of Bangladesh in association with Sir William Halcrow and Partners LTD of United Kingdom

2.

3.

Soil/Land Use/Agriculture

1. Soil-Crop Suitability Classification for Bangladesh, FAO/UNDP Agriculture Development Adviser Project, 1985

2. Reconnaissance Soil Survey Report of Comilla, SRDI, 1965-1966.

3. Reconnaissance Soil Survey Report of Brahmanbaria, SRDI, 1973.

4. Album of Drawings, Regional Plan, South East Region Water Development Programm (FAP-5), March 1992.

APPENDIX E.I

SOILS IN THE GUMTI PHASE II PROJECT AREA

Appendix E.I

Soils in the Gumti Phase II Project Area

The original Gumti Phase II Sub-Project Feasibility Study was carried out by the Bureau of Consulting Engineers Ltd. in association with Sir. William Halcrow and Partners Ltd. and is referred here as the 1990 Report. Annex-D contains the relevant section on soils. The studies were conducted between January 1988 and the March, 1990.

A more recent study which has covered the Gumti Phase Sub-Project Area has been the South East Regional Study. However the former was a detailed feasibility study and consequently studied the area to different levels of detail.

The other notable studies regarding Soils and Agriculture those of importance in the Gumti Phase II Sub-Project Area includes the Land Resources Appraisal of Bangladesh for Agricultural Development (FAO 1988).

In addition, for soils the Gumti Phase II Sub-Project Area has been covered by part of two reconnaissance Soil Survey during the mid sixties and early seventies, as part of the programme of SRDI for systematic soil survey of the country.

The information on soils furnished including the soil and land capability maps in the BWDB report essentially forms those of the SRDI, except 10 blocks distributed over the Gumti Phase II Sub-Project Area, where detail soil surveys were carried out and constitute 5% of the area.

However, no chemical data of the representative soil units that have been surveyed in Blocks, could be found in the report. Efforts were made to collect chemical data of the Blocks from DPS-I as suggested in the report, but in vain. Additionally efforts were also made to collect chemical data for Gumti Phase II Sub-Project Area from SRDI but only data for Daudkandi thana was available.

Existing Situation

Soils and Agriculture

The Land Resources Appraisal of Bangladesh for Agricultural Development (FAO 1988) has described 30 agro-ecological regions with 88 subregions throughout the country. These are essentially based on important differences in physiography, soils and flooding characteristics. Although a number of units have been recognised, those of importance in the Gumti Phase II Sub-Project Area are the Middle Meghna River Floodplain in the west; the Old Meghna Estuarine Floodplain in the centre; and the Northern and Eastern Piedmont Plain. The three floodplain regions account for bulk of the area and together constitute about 84%.

Most of the soils are developed by river alluvium. Silt loams to silty clay loams predominate on floodplain ridges and silty clay and clay in basins and depressions. Ridge soils are gently sloping while basin soils generally occupy level sites. Depression soils generally occupy more undulating sites and upper soil layers have been levelled to make the land fit for cultivation of irrigated boro rice. Soils are more heavy textured (silty clay or clay and well structured than soils of other basin areas. In some areas localized well decomposed, humified organic layer exists.

The piedmont soils occupy a complex landscape of valleys, ridges, terraces, plains or level basins and basin depressions. As such it is difficult to generalize on characteristics of the soils. Piedmont soils are generally silty clay loam to clay with a relatively strong structure.

Although 39 soil associations have been shown in the map on Figure F.2.2, only 21 major soil series were identified. Most soils on the area have been provisionally put in the order of Inceptisols and Entisols of Sub-Order Aquents (USDA system).

However, except from some substantial sandy areas occurring in the Middle Meghna River Floodplain, the principal determinants of agricultural development are the flooding regime and availability of irrigation rather than any intrinsic soil properties. Primarily on the basis of flooding, most of the area falls mainly into land capability classes II and III with the east into class III and IV. In the centre, between Muradnagar and Nabinagar, lies a small area of class I land. The natural fertility of most of the floodplain soils is relatively high and the land capability classification indicates the relative suitability of the land for sustained production of common agricultural crops. Surveys of the sample blocks indicate that some 78% of the project area may be rated as good to moderate agricultural land and expanded crop production may be obtained from the area.

Present Constraints

At present the main limitations for intensive land use and optimum crop production on most of the land are seasonal flooding and lack of irrigation and drainage facilities. Most of the land on ridges and basin margins produces winter crops during the dry season, however, some limited areas yields are often poor because of dry season water availability. Drought affects the production of winter crops during the later part of the dry season and also of monsoon crops during the intermittent dry spells in the late monsoon as well as early dry season. It also delays sowing of monsoon crops. However, lands in basin bottoms which used to remain fallow in dry season for remaining wet even in December presently with irrigation by low-lift pumps or from deep tube-well/shallow tube-well, transplanted winter rice crops are being grown in many areas throughout the Gumti Phase II Sub-Project Area.

As in other parts of the country, flood and drought are two main constraints on agricultural development in the area. The intensity and extent of crop damage due to these causes, however, varies from year to year depending on climatic conditions. Some crops sometimes face production constraints during pre-monsoon period due to drought and again in the monsoon period due to flooding. Sometimes, either of the two major constraints becomes the main problem for present agricultural development.

The depth of flooding, where the major part of the project area remains under 0.6 m flooding between April and November, limits the cultivation of modern aman varieties. This makes farmers grow either deep water aman mixed with aus or single DW aman on medium low and low land resulting in low productivity of paddy. A longer spell of drought in October or a cold spell in late November (15.5°C or below) can damage flowering plants severely affecting the yield potential. Of the three paddies, boro rice has the least probability of natural constraints as long as there is no dearth of irrigation water. The water regime at the transplanting time in low-lying areas may limit the growing of modern boro varieties. Early floods in May occasionally damage HYV boro, Rain may also interfere in sun-drying of late local boro and HYV boro.

Yield reduction due to winter drought and insect attack are considered as normal features of the present agricultural development resulting in low yields in general for all crops except for some irrigated and well fertilized rice.

Longer term effect of the interventions

Flood protection and drainage

In most of the deeply flooded basin areas (medium lowland and lowland) that constitute 70% of the area (DPS 1), BWDB 1986-1988), complete or partial protection of land seems to be rather difficult and expensive/uneconomic to provide. Because measures would involve embanking the rivers and damming the small channels that often link basin depressions through which parts of the basin are flooded early in the rainy season and drained early in the dry season depending on the level of rivers joining them. Water control would also require pumping out water from the extensive basin areas. This would be extremely difficult because of the enormous amount of water from the local rainfall and from eastern hills at times when river levels are already at their highest.

Moreover, production of high yielding dry-land crops would not be encouraging in those areas during the dry season. This is because of slow internal drainage and heavy nature of most soils in deeper basin sites. Instead, dry season irrigation development seems to be more economic and an easier way. With dry-season irrigation, high yielding boro paddy could be grown throughout most of such areas. Limited flood protection including pump drainage might be needed in some areas to prevent early floods damaging the crops.

However, preventing the flooding or reducing the flood levels by flood protection and pump drainage or shallowly to moderately deeply flooded ridges and basin margins could be more reasonable. Almost the entire area is suitable for irrigation development.

There is popular belief among the farmers that the fertility of floodplain soils are maintained by the annual deposit of alluvium from the seasonal floods very little factual information is available at present on relative contributions of biological and alluvial materials to short term and long term fertility.

Research therefore needs to be carried out as part of the environmental impact studies which should be designed into any major projects which might alter local environments.

However, the reduction of depth of flooding might have some impact on nitrogen fertility of the floodplain area in the way they modify the depth of water and time available for algal growth and the amount of organic matter provided by short-stemmed deep water and other plant remains. Yet, the nature and extent of any such changes would depend on the flood protection method used.

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However, it seems the construction of embankments will not cut off lands from water related sources of plant nutrition at least on lands where wetland rice continues to be grown.

Now it needs to be realised that on flood protected land where transplanted aus or boro and transplanted aman are substituted for deep water aman (more or less aus), much greater quantities of nutrients are being removed from the soils by annual grain yield. This may account for 5 times or more higher than previous where larger amounts of straw are also being removed from the land. Without additional nutrients, such high yields could never be sustained either with or without natural flooding.

Irrigated Agriculture

Irrigated agriculture using pumps and tube-wells is becoming very common throughout the area and it seems about 50% of the area is now being irrigated.

However, rational use of irrigation water is of vital importance. Transplanted HYV Boro/Aus is mostly grown followed by transplanted Aman in highlands and in place of broadcast Aman in basins. In both cases, the land remains water-logged round the year. This environmental change on the land causes adverse affect on soils by way of continued absence of oxygen in the subsoils, chemical changes of soil material by forming toxic compound for plants, constant percolation loss of essential nutrient elements including micro nutrients and organic matter.

Again, the expansion of irrigation and continuous wetland are rice culture are not only depriving the soil of some plant nutrients but also contribute to the greenhouse effect and ground water contamination. Continued water-logging in addition to lowering down the inherent soil fertility, also adversely affect land by way of:

- Spread of hydrophillic soil borne pests and diseases which become difficult to combat or eradicate as fields continue to remain water-logged continuously season after season.
- Disease of bearing capacity of soils, particularly in some deep silty clay loam soils rendering them difficult to work.

Good Management

There is no scientific evidence that continuous cropping under good management is harmful. Soil environment is changed by flood protection and drainage works, or by substitution of irrigated crop production for rainfed production. The changes which management must aim to avoid are those which would lead to a loss of productivity.

However, there is no reason such deteriorations should lead to permanent damage to soils. The monitoring and research system should be strengthened, as was done previously for zinc and sulphur deficiencies which were first recognized, then identified and finally removed by appropriate treatments. However, treatments may not necessarily be chemical. Even in the case soils nutrient problems as zinc and sulphur deficiencies, crop rotations which allow the soil to dry out for a period during the dry season may solve the problem on some soils. For plough pans, the problem may have to be tackled through both cropping systems and farming system research.

Agro-Chemicals

In the past, quick returns encouraged rapid increase in the application of agro-chemicals which, recent research has shown, are harmful to the environment in the long run. Indiscriminate use of chemicals eliminate useful insects, herbs and fungi that use to keep harmful in balance.

Nitrogen fertilizer, which is used most, poses the greatest threat to the environment and human health. Nitrate formed in the soil, seeps down the aquifer. Although this hazard is still of negligible level in the country, to be taken up in research and planning for crop production. According to BRRI, the nutrient supplying capacity of Bangladesh soils has declined over the last three decades because the use of fertilizer had not been balanced. The soil should in future be enriched with the addition of nutrients in a balanced fertilisation programme.

Pesticides are toxic substances, they kill fish, destroy valuable parasites, predators and a vast number of other beneficial insects as well as induce risk of insect pest outbreaks.

However, in Bangladesh it is estimated that at present 3.5 million kilograms of pesticides is used. This is not very high but the pesticides are not used rationally. Therefore, an integrated pest management practice - a combination of measures including biological, cultural and physical measures in which pesticides are recommended only as the last resort.

Here, it seems relevant to mention that crop rotations involving cereals, legumes, shallow rooted and deep rooted crops help maintain soil fertility at a stable level. Crop rotation also serves as a natural pest control method through destabilisation of pest population due to frequent changes in hosts.

Summary

A review of all the available soil information for the project area suggests that seasonal flooding and the lack of irrigation facilities as well as low dry season rainfall are the main constraints holding back more intensive land use and optimum crop production rather than those of soil quality. No major soil constraints were observed, however, after centuries of cultivation the natural fertility of most of the lands seem to be rather moderate. The balanced use of suitable fertilizers on almost all the soils would seem to be very important in order to maintain high yields, particularly from new varieties. After fertilizers application, irrigation would seem to be the most economic method of increasing overall crop production. By adopting irrigation, most of the lands could be made to produce good dry land or rice crops during the dry season. Wetland monsoon crops, such as aus and jute, could be sown earlier and yields of transplanted aman would be more certain on some lands. Overall the soils could benefit more if agricultural production in most of the lands encompass at a greater diversity of crops.

Sufficient surface water exists in the Meghna River system to irrigate the western part of the project area through khal deepening. Ground water is readily available, if needed, to supplement surface water but there are identified constraints.

In the eastern parts ground water development has been proposed and is apparently readily available for use by tubewells. However, salt water has been encountered locally in some of the eastern parts in Brahmanbaria and Comilla Districts and is likely to occur near the southern boundary of the region.

Although, the possibility of saline upconing has been considered in relation to geological conditions groundwater quality needs to monitored to check whether increased use of groundwater for irrigation in these areas or in the adjoining areas causes saline water to be drawn into aquifers that presently are sweet. This has importance considerations for likely salinity development in surface soils as a result of groundwater irrigation development. In general, the provision of large-scale water control projects in the western parts of the region is made difficult due to a number of reasons, for example significant disruption to fisheries production. Instead, small-scale irrigation/drainage schemes are therefore recommended. These could include the expansion of command areas of existing irrigation facilities by appropriate measures, providing additional pumps/tube wells, excavation of khals and local schemes for providing protection against dry early flooding boro paddy areas.

Moreover, rainfed agriculture could be strengthened by appropriate measures. These could include (i) expansion and intensification of cultivation of rabi crops on loamy ridge soils (especially wheat, chili, potato, ground nut, mustard, pulses, (ii) Improvement of soil and crop management that include increased use of fertilizers and organic matters and more efficient way of using them as well as making field drains or raised beds on basin margin soils so that dry land rabi crops can be planted on time.

Most of the eastern part of the region (within AEZ-19) seems from a point of view suitable for polder development on the pattern of CIP and DND. Polder siting has been planned bearing in mind the existing embankment location and the drainage/irrigation canal network.

However, large-scale water control project in the region should take note of the following factors:

(i) The silty nature of most soils causing low infiltration, slow permeability, easy plough pan formations and low aeration when soils are wet. Such soils have a high capillary potential which keeps them moist for most if not all of the dry season (except higher soils puddled for transplanted aman cultivation). For this reason drainage is considered more necessary than irrigation for dry land rabi crop cultivation and irrigation is only necessary for boro paddy cultivation.

(ii) The heavy monsoon rainfall in the eastern parts and the amount of flood flow which enter from the other regions. This brings in large quantities of silt from the Indian border hills. The risk of early floods and flash floods in depressions.

(iii) Flood protection embankments along the rivers entering from the eastern hills could aggravate flood hazards by increasing the flow (and sediments reaching the downstream areas) and the severity of crop losses when embankments are breached.

Finally, a regular system of monitoring needs to be provided as an essential component of the projects for soil fertility, use of fertilizers and other issues under irrigated conditions.

A Research and Extension system must constantly be on alert to recognize and identify symptoms of declining soil productivity, ecological hazards and changes in soil physical and chemical properties may need to be recommended practical solutions to remove the constraint identified. The recommendations may need to be addressed to policy planners as well as to farmers and on institutional structure to deal with these issues is required.

APPENDIX E.II

BASELINE SURVEY RESULTS

GUMTI PHASE II SUB-PROJECT

E. Baseline Survey Results

E.1 Agro-Economic Survey

E.1.1 General

The surveys conducted in each of the agro-ecological Zones A,B,C and D are as follows:

Surveys		Respondents (number)				Total Respondents
		A	B	C	D	
1)	Farmers	96	96	96	96	384
2)	Farmers Case Study	12	13	12	14	51
3)	Landless	24	24	24	24	96
4)	Capture Fishery	25	37	42	65	165
5)	Culture Fishermen	24	24	24	24	96
6)	Women	28	24	24	24	100
7)	Plot	60	60	60	60	240
8)	Irrigation Pump	24	24	24	24	96

The objective and methodology of the surveys were illustrated in the Inception Report. In most respects the surveys have brought out results which appear to be reasonable in the sense that they are not far apart from those obtained from secondary data sources. It should, however, be mentioned about the survey results that answers to yes/no, what crops are grown types of questions are more reliable than those requiring a quantity such as a yield. The problem gets worse in the case of such quantification as for small farm plots. Because the results, reported in smaller units like production in kilogram/maund per decimal/acre, on conversion into bigger units like tonnes and hectares gets extolled if there is any error of under on over estimation. In theory, these errors should balance each other out in the calculation of averages but where sample sizes are small the results may be seriously affected by extreme events. Cross tabulation where analysis is carried out by desegregation of data is particularly vulnerable in this respect. Following the standard practices, we have classified the farmers in the following groups for our analysis:

Farm-groups	Owning farmland (hectares)
Large	3+
Medium	1.0 to 3.0
Small	0.2 to 1.0
Marginal	0.02 to 0.2

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E.1.2 Ownership, Fragmentation and Land-tenure

The pattern of land ownership cannot be derived from the farmer survey because the sample was not drawn randomly; the number of farms in each farm-size (marginal, small, medium and large) was predetermined. As such, the distribution of farmers by farm-size was assessed from an analysis of entries on the tax-lists from which the sample of the farmer survey was drawn and the results verified with secondary data. These results have been applied to the average holding sizes obtained from the farmer survey to arrive at the land ownership pattern which is presented in the table below.

Comilla is noted as a district dominated by smaller farmers. The survey reveals that nearly 80 percent of the farmers are small or marginal whereas only 4.0 percent are large farmers. This tiny proportion of large farmers

TABLE E.1.1

Pattern of Land Ownership

Farm-Size	Percentage of Farm Land Owned				Overall % by	
	A	B	C	D	Area	No. of farms
Large	15.0	22.7	22.1	29.3	21.9	4.0
Medium	35.5	36.6	39.1	32.6	38.1	17.6
Small	44.2	32.6	34.5	34.4	33.8	53.2
Marginal	5.3	8.1	4.3	5.7	6.2	25.2

Source: Estimated by applying average holding size obtained from survey to the farm household distribution obtained from tax-list.

own over one-fifth of the farmland whereas the vast majority group owns 40 percent. This pattern of land ownership appears to be consistent with the 1983-84 Agricultural census results for the erstwhile Comilla district. According to the census small or marginal farmers constitute 84 percent of farm households owning 53 percent of farmland whereas about 9 percent of the farmland is owned by large farmers who constitute a little over one percent of farm-households. The survey indicates an average farm-size holding of 0.78 hectares as against 0.92 hectares for Bangladesh recorded by the census. The survey result seems reasonable from the point view of the relative concentration of smaller farmers in the area.

Fragmentation of Landholding in the area is observed to be 6.5 fragments per hectare on the average against the national average of 6.6 fragments per hectare. The dispersion of land holding across different flood phases is rather low. Nearly one half of the farmers own land in one flood phase and most of the other half in two flood phases only. Therefore, the widely held view that farmers endeavour to farm land across a range of flood phases in order to spread the risk is not supported. Dispersion of land holding has a positive relationship to the farm-size.

TABLE E.1.2

Dispersion of Landholding

Farm-Size	Percentage of Farmers with Plots in Number of Flood Phases			
	1	2	3	4
Marginal	79.2	18.8	1.0	-
Small	44.0	46.1	9.9	-
Medium	19.1	60.3	17.7	2.9
Large	13.6	59.1	22.7	4.6
All	47.0	43.0	9.1	0.8

The Extent of Tenancy, measured as a ratio of area under tenanted-in arrangement to the total cultivated area, is quite low, about 7.4 percent against nearly 20 percent for Bangladesh. Given the relative concentration of smaller farmers in the area this result does not seem to be out of order. However, it should be noted that total area tenanted-out is much higher than that tenanted-in and perhaps a much bigger sample would be necessary to balance the transactions. Share-cropping, accounting about 65 percent of the tenanted-in area, is the predominant mode of tenancy. Share-cropping-out is a common practice for all groups of farmers including the marginal farmers.

TABLE E.1.3.

Land Use (Area in Hectare)

	Total owned Land	Area not cultivated	owned cultivable land	Area rented out	Area Sharecropped out	Area mortgaged out	Area rented in	Area Share cropped in	Area mortage ged	Total cultiva ted and
Zone : A										
Marginal	57.969	13.56	50.85		8.231		1.641			44.26
Small	467.200	67.16	422.67	20.855	83.707	7.958	2.433	49.296	3.063	364.94 2
Medium	399.806	67.881	359.04	5.049	45.441	19.523			4.837	293.86 4
Large	138.482	9.894	128.554		4.957					123.59 7
Total	1063.457	158.495	961.114	25.90	142.336	27.481	4.074	49.296	7.900	826.66 3
Zone B										
Marginal	19.95	5.89	14.155			.426		.215		13.944
Small	261.709	38.073	223.636		38.909	11.305		16.914	12.134	202.47
Medium	311.836	47.064	253.228		41.102	6.417		8.986	1.068	215.76 3
Large	185.508	19.404	166.104		24.84	.622				140.64 2
Total	779.003	110.431	657.123		104.851	18.77		26.115	13.202	572.81 9
Zone C										
Marginal	30.912	6.912	24.192			.468		14.515		38.239
Small	254.79	29.754	225.036		39.784	13.568	1.696	16.081	9.995	199.45 6
Medium	356.04	34.086	322.092		21.942	78.66		3.355	.871	225.71 6
Large	156.512	9.856	146.688		13.931	5.184				127.57 3
Total	798.254	80.608	718.008		75.657	97.88	1.696	33.951	10.866	590.98 4
Zone D										
Marginal	30.806	5.84	25.112	1.478	2.336	1.472		.937		20.763
Small	134.466	12.921	121.545	2.010	12.235	8.857	2.438	12.381	2.92	116.18 2
Medium	151.300	8.908	142.460	7.332	19.143	7.687	.358	8.444		117.10 0
Large	114.598	2.86	111.738		5.566	.891				105.28 1
Total	431.17	30.529	400.855	10.82	39.27	18.907	2.796	21.762	2.92	359.33 6

Source: Estimated by applying average holding/transction size obtained from survey to the farm household distribution obtained from tax-list.

E.1.3 Cropping Pattern and Cropping Intensity

A description of the cropping patterns by flood-phase, which is supposed to be a better barometer for under standing of the future cropping patterns with project than that by other characteristics, is presented in the table. This is followed by another table containing information on various crops grown in different zones. This table would provide an overview of the cropping pattern as also cropping intensity in the various zones.

TABLE E.1.4

Dominant Cropping Patterns

Cropping Pattern	F_0		F_1		F_2		F_3	
	Rank	% of cropped area	Rank	% of cropped area	Rank	% of cropped area	Rank	% of cropped area
- t aman (HYV) - boro	2	10.70	1	13.42				
b. aus (HYV-t.aman (L/I) - boro	9	2.73	7	2.25				
t. aus (HYV-t.aman (HYV) - boro	8	4.04	3	11.72				
- t. aman (L/I) - boro	1	16.30	2	13.19	3	6.22		
mixed aus/aman - oilseeds			5	4.35	13	2.20		
- - boro					5	4.89	1	44.70
d.w. b. aman - boro					1	13.94	2	10.06
d.w.b. aman - wheat					2	8.83	3	8.58
d.w.b. aman - pulses					4	5.07	6	2.91
d.w.b. aman - oilseeds					7	3.48	7	2.56
d.w.t. amn - boro					6	3.72	5	3.90
t. aus (L) - t. aman (L/I) - boro	6	4.97						
t. aus (HYV) - t. aman (HYV)	10	2.57						
t. aus (HYV) - t. aman (HYV) - wheat	7	4.36						
t. aus (HYV)-t.aman(HYV)-potato (HYV)-boro	5	5.45						
t. aus (HYV) - t. aman (HYV) - veg.	3	6.71						
Jute - t. aman (HYV) - wheat	4	5.77						
- t. aman - oilseed - boro			4	5.91				
b. aus (L) - t. aman (L/I) - oilseed			8	2.11				
b. aus (L) - t. aman (L/I) - wheat			9	2.09				
t. aus (HYV) - t. aman (HYV) - potato (HYV)			6	4.01				
t. aus (HYV) - t. aman (L/I) - boro					12	2.58		
mixed aus/aman - wheat					8	3.02		
d.w.b. aman - oilseed - boro					9	2.90		
d.w.b. aman - chilli					10	2.78		
Jute - potato (HYV)					11	2.62		
- - oilseed - boro							4	5.18
No. of cropping pattern & percent of cropped area	10	63.6	9	59.1	13	62.3	7	77.9

Note: L/1 means local/local improved variety.
Boro in all cropping patterns are HYV.

TABLE E.1.5

Farmer Survey Results: Cropping Patterns

Areas in Ha	Zone A		Zone B		Zone C		Zone D	
	70.49	Percent	81.11	percent	81.94	percent	86.02	percent
B. Aus: LV	3.63	5.1	2.58	3.2	4.47	5.5	0.78	0.9
B. Aus: HYV	0.71	1.0	1.71	2.1		0.0		0.0
T. Aus: LV	2.74	3.9	1.09	1.3	1.55	1.9		0.0
T. Aus: HYV	15.62	22.2	0.41	0.5	2.22	2.7		0.0
B. Aus + Aman	0.56	0.8	20.8	2.6	9.00	11.0	3.08	3.6
B. Aman: LV	7.96	11.3	20.54	25.3	18.01	22.0	30.85	35.9
T. Aman: LV (deep water)	4.41	6.3	6.26	7.7	0.69	0.8	0.68	0.8
T. Aman: LV	16.13	22.9	15.15	18.7	11.34	13.8	0.63	0.7
T. Aman: HYV	24.05	34.1	5.37	6.6	5.77	7.0		0.0
Boro: LV		0.0	0.88	1.1	0.06	0.1	2.13	2.5
Boro: LIV		0.0	0.34	0.4	0.20	0.2	0.46	0.5
Boro: HYV	48.28	68.5	63.73	78.6	41.38	50.5	40.89	47.5
Wheat	6.46	9.2	5.08	6.3	11.34	13.8	14.00	16.3
Jute	2.06	2.9	3.61	4.5	8.39	10.2	9.13	10.6
Pulses	0.78	1.1	1.12	1.4	8.26	10.1	6.90	8.0
Oilseeds	6.01	8.5	10.05	12.4	11.98	14.6	6.05	7.0
Potato	4.76	6.8	1.49	1.8	1.03	1.3	3.13	3.6
Taro	1.60	2.3	0.05	0.1	0.32	0.4	3.03	3.5
Winter Vegetables	0.76	1.1	0.19	0.2	0.69	0.8	1.40	1.6
Summer Vegetables		0.0		0.0	0.24	0.3	0.72	0.8
Spices	0.76	1.1	0.41	0.5	0.73	0.9	5.98	6.9
Other	0.63	0.9	0.00	0.0	0.36	0.4	1.38	1.6
All	147.90	210	142.15	175	138.03	168	131.22	153
Comparative Cropping Intensities								
1991/92 BBS		167		169		154		150
1991/92 DAE		175		160		148		142

Total number of cropping patterns in F_o, F_1, F_2 and F_3 are reported to be respectively 55, 132, 109 and 62. But only a few dominant cropping patterns account for the major share of the cropped area in all these lands. It should be borne in mind that a better understanding of the cropping patterns would warrant, examination of data for at least two years because some cropping patterns like b.aus-t.aman-boro or d.w.b.aman-oilseed-boro may not be repeatable in the successive years because of agronomic reasons: It may be rather preposterous to raise b.aus/d.w.b.aman following boro in the immediate next year. However, this small problem does not invalidate the observed overall cropping pattern.

It is important to note that save one, all the cropping patterns are based on rice and that vegetables show up in only one cropping pattern in F_o accounting an infinitesimal proportion of the cropped area. By far, boro is the most important crop-followed by aman which has, however, the largest acreage in Zone D only. Aus does not appear to be a popular cereal in Zones B and D. Among other crops, wheat and oilseeds are quite sizeable in all the zones. Jute and pulses seem to have some importance in zone C and D. Although Comilla district is known to be a centre for producing vegetables in Bangladesh, the project area contributes little to it. Vegetable acreage of the project area is only about 1.0 percent of the cropped area.

As expected, cropping intensities turn out in descending order from 210 in Zone A through 175 in B and 168 in C to 153 in zone D. Although the DAE and BBS cropping intensities are lower for all the zones, there exists a broad measure of agreement except in Zone A where the difference is quite high. A main reason of the differences is due to the fact that the survey data relates to the project area which constitute a portion of the area of the thanas under the project whereas DAE and BBS data refer to the overall area of the thanas involved. Thus DAE and BBS data are influenced by the conditions outside the project area. Table E.1.6 contains a more comprehensive account of cropping intensity.

TABLE E.1.6

Survey Cropping Intensities

	All	Zone A	Zone B	Zone C	Zone D
Overall	175	210	175	168	153
Marginal farmers	172	230	166	146	147
Small farmers	184	214	191	175	154
Medium farmers	176	211	172	168	154
Large farmers	169	200	163	164	149
Flood phase 0	207	211	264	254	100
1	209	239	200	230	168
2	192	184	191	195	199
3+	138	152	144	125	**131**

On the whole it can be said that cropping intensities behave as expected although little confidence can be attached to some of them as they are based on extremely small areas and few respondents (eg, Fo in D has only one respondent). Nevertheless it is reasonable to conclude that small (and to a lesser extent marginal) farmers do crop there lands more intensively than larger farmers and that less flood prone land is farmed more intensively than more deeply flooded land.

E.1.4 Irrigation

Data on irrigation, the critical input, is shown in Table E.1.7 which transpires that except in Zone D, boro land is wholly irrigated by all groups of farmers. Zone D which is a low lying area has nearly 10 percent of un-irrigated boro most of which is of local variety. The coverage of irrigated boro i.e. irrigated boro acreage as percentage of total area is highest for marginal farmers. Large farmers come next in this respect. The performances of small land medium farmers are somewhat similar on the whole. Rabi crops have sizeable irrigation followed respectively by Aus and Aman in Zone A. These crops have very little irrigation in Zone B and C and no irrigation at all in Zone D. Source-wise, LLP is the most important covering 65% of total irrigation, DTW is the second and sizeable with 22 percent coverage while STW and traditional methods provide respectively about 12 and 9.0 percent of total irrigation.

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TABLE E.1.7

Irrigation Coverage (%)

	A		B		C		D	
	Rabi	Boro	Rabi	Boro	Rabi	Boro	Rabi	Boro
Marginal	33	100	0	100	20	100	36	85
Small	45	100	24	100	4	99	22	87
Medium	43	100	8	100	7	100	14	84
Large	20	100	0	100	9	100	29	96

Per Cent Coverage of Irrigated Boro (1)

Marginal	80	88	61	41
Small	64	78	55	46
Medium	69	78	38	44
Large	72	82	58	54

Per Cent of Irrigation Coverage

Aus	20	5	2	-
Aman	11	1	3	-
Rabi	34	5	5	-
Boro	100	100	99	92

Per Cent Source of Irrigation

STW	3	29	8	7
LLP	48	21	77	75
DTW	30	37	10	9
Manual TW	-	1	-	-
Traditional	9	12	3	9
Overall (1)	68	80	51	47

(1) Calculated as % of Irrigation boro in total area.

E.1.5. Crop Yields

Yield data for sampled crops are presented in Table E.1.8 below. Yield data for those crops which are not adequately represented are also included keeping in mind the unrepresentativness of the sample in question. Most of the yields are characterised by high variations when disaggregated by the flood phase. Unlike cropping intensities which are not likely to change radically from year to year, yield data from a single year are less acceptable for their susceptibility to weather conditions, for predicting the basis for a 30 year average. Thus the survey data will be combined with other available data in formulating project yields.

TABLE E.1.8

Number of Cases and Yield (t/ha)

CROPS	YIELD								TOTAL	FERTI				TOTAL
	F0		F1		F2		F3		(t/ha)	F0	F1	F2	F3	(t/ha)
	#	(t/ha)	#	(t/ha)	#	(t/ha)	#	(t/ha)		(t/ha)	(t/ha)	(t/ha)	(t/ha)	
SEASON: AUS														
B.aus local	1	2.30	67	2.33	17	2.33	2	1.23	2.30	.07	.22	.14	.16	.20
B.aus HYV	6	2.87	10	3.00					2.95	.19	.27			.24
T.aus local	3	2.19	25	2.68	12	2.23			2.51	.17	.20	.18		.19
T.aus HYV	19	3.45	67	3.67	8	3.22			3.58	.42	.28	.22		.30
M. B.aus & B.aman			13	3.15	49	3.33	25	2.74	3.13		.22	.19	.26	.21
B.aman local (d_w.)			28	1.67	209	1.82	119	1.79	1.80		.13	.14	.12	.13
T.aman local (d.w.)			3	3.90	26	2.45	27	2.63	2.62		.11	.14	.10	.12
Barbati (cowpea)	1	2.30							2.30	.60				.60
Sesame					1	1.23	1	.46	.85				.12	.12
Jute desi/mesta	5	1.79	43	1.74	111	1.89	15	2.84	1.93	.15	.20	.18	.19	.19
Jute tosha			4	2.01	7	2.20			2.13		.16	.31		.26
Brinjal	1	1.73							1.73	.25				.25
Okra	1	.58	1	4.98	2	3.05			2.92			.41		.41
Other/mixed veg			1	3.84	1	3.55			3.69					
Dhaincha (sesbania)							4	15.59	15.59				.09	.09
TOTAL	37	2.84	262	2.63	443	2.11	193	2.39	2.34	.32	.22	.16	.14	.18
SEASON: AMAN														
T.aman local/LIV	24	3.33	122	2.72	66	2.46	1	.92	2.70	.26	.21	.16	.33	.20
T.aman HYV	45	3.92	144	3.79	17	3.42			3.79	.31	.26	.24		.27
Oth.tree crop/fruit	1	384.13							384.13	.31				.31
TOTAL	70	9.15	266	3.30	83	2.66	1	.92	4.14	.30	.24	.17	.33	.23
SEASON: RABI														
Wheat local	3	2.37	7	1.99	1	.66	3	1.28	1.82	.33	.32	.21	.25	.30
Wheat HYV	9	2.08	33	2.12	111	2.11	70	1.97	2.07	.29	.32	.35	.36	.34
Kaon (millet)	1	1.84	4	1.40	3	1.15	5	1.16	1.28	.25	.27	.12	.28	.24
Keshari (Lathyrus)	1	.92	5	.57	12	.96	7	.99	.89	.01	.08	.13	.09	.10
Masur (lentil)	1	.69	2	.31	13	.43	5	.51	.45	.06	.06	.12	.25	.14
Chola (chick pea)							1	.17	.17					
Mash kalai (b.gram)	1	.37	4	.61	8	.79	8	.76	.72		.08	.04	.07	.07
Barbati (cowpea)	1	3.69							3.69	.25				.25
Other pulses	1	1.38					1	.92	1.15	.12			.08	.10
Mustard	4	.64	36	.70	67	.81	39	.72	.75	.32	.40	.34	.42	.38
Sesame	6	.98					6	.50	.74	.15			.20	.17
Soyabean					1	2.15			2.15			.25		.25
Potato hyv	6	16.24	31	11.08	24	12.70	5	11.50	12.17	.66	.71	.59	.68	.66
Potato local	2	7.84	10	10.88	2	6.30	2	5.22	9.22	.43	.59	.41	.49	.51
Taro/eddoe	5	13.70	14	12.81	21	12.10	10	12.23	12.49	.28	.15	.21	.23	.21
Sweet potato					1	15.37			15.37			.49		.49
Brinjal	3	18.05	2	2.00	1	5.42			10.60	.22	.14			.19
Tomatoes	1	.84							.84	.22		.33		.28
Gourds/pumpkin/melon					2	23.53	3	26.87	25.53			.39	.25	.31
Other/mixed veg	9	9.67			3	17.13	2	5.19	10.63	.28		.27	.31	.29
Onion	2	1.04	2	.81	3	2.89	2	2.15	1.85	.04	.49	.22	.41	.33
Chilli	13	1.64	20	3.32	48	2.86	15	1.75	2.62	.46	.57	.51	.47	.51
Garlic	1	.46							.46	.25				.25
Coriander			1	1.77					1.77		.06			.06
Sugarcane			1	38.41					38.41		2.06			2.06
Tobbacco					1	.84			.84					
Oth.tree crop/fruit			1	9.22	1	2.63			5.93		.33			.33
TOTAL	70	5.58	173	5.05	323	3.59	184	2.75	3.91	.34	.45	.37	.36	.38
SEASON: BORO														
Boro local			1	6.15	2	5.17	27	3.51	3.71		.21	.31	.21	.22
Boro LIV (eg. Panjam)					4	4.19	3	5.33	4.68			.37	.25	.32
Boro HYV	38	4.75	233	5.02	278	5.18	541	6.13	5.60	.48	.42	.39	.38	.39
TOTAL	38	4.75	234	5.03	284	5.16	571	6.00	5.55	.48	.42	.39	.37	.39

E.1.6 Summary Farmer Survey Indicators

The salient points relating to any development proposals are concerned with those factors which might restrict or delay the achievement of expected future increases in agricultural production. These commonly include shortage of inputs, especially draft power and labour, fertiliser and pesticides, irrigation facilities, access to credit and market etc.

TABLE E.1.9

Summary Farmer Survey Indicators

% of Respondents who	Zone			
	A	B	C	D
Use animal for land preparation	74	85	93	93
Have their own draft animals	57	51	51	49
Record shortage of draft power	45	56	51	41
Make some use of power tillers	25	10	4	7
Employ non-family labour	75	79	76	70
Register delays of farm work for labour shortage	39	40	42	44
Register shortage of irrigation water every year	55	51	25	31
Sell most of the products	8	4	6	5
Buy the products	67	67	77	76
Use own source to finance fetilis 0 & pesticides	75	100	92	57
Use own source to finance tubewell/LLP hire	58	85	67	44
Has regulator contact with extension	17	15	8	21
Need more extension facilities	67	69	92	86
Happy with normal monsoon flood	40	41	42	44
Have sources of income other than farming	82	77	79	84
Have farming as the main source of income	59	60	56	66
Have farming as the second source of income	20	33	33	30

It appears from the survey results that just over half of the respondents own draft animals, and that nearly all the remainder complain of shortages of animals for land preparation which results in significant yield reduction. Any substantial increase in the area of a single crop such as HYV aman would obviously increase the shortage. Interviews with district livestock officers confirm that livestock numbers are static or even declining in some areas which suggests that any rapid increase in livestock numbers is unlikely. A more likely development is a continuation of existing trends towards mechanisation of at least some land preparation operations, such as ploughing coupled with the use of animals for puddling for example. The survey recorded that in Zone A, 25 percent of respondents made use of power tillers from which it is not unreasonable to conclude that serious shortages of draft power would be met by an increase in the supply of power tillers reasonably quickly. Other zones are less well served in this respect but it is likely that a rapid increase in the availability and use of power tillers can be anticipated.

Given the very high population densities in the project area it is surprising that so many respondents, over 40 percent, registered delays in their farming operations which they ascribe to labour shortages. The 1990 study anticipated no shortages. Most of the shortages in reported to occur during the planting of boro. Perhaps in the farmers' perception the shortage imply that they were unable to plant the crop as quickly as they wished and do not constitute a real constraint. Farmer case study survey indicate that a sizeable portion of farmers, about 20 percent employ women for particularly post harvest agricultural activities. This may be a pointer to the fact that should labour shortages increase in future more women will be drawn into the labour market to mitigate the problem.

Information on markets and purchased inputs suggest that marketing and the availability of fertiliser and chemicals are unlikely to be major problems. Access to credit has always been difficult particularly for many small farmers but evidence from the survey does not suggest that they use smaller quantities of purchased inputs at present. Informal sources of credit, particularly from private dealers in fertiliser, chemicals and seeds are likely to increase as competition between them develops.

Other noteworthy aspects of the survey are the high proportions of respondents who have additional sources of income and the relatively low numbers who cite farming as their main source of income.

E.1.7 Flood damage

Data on flood damage to crops is not easy to interpret and is in any case unreliable. Evidently the 1988 flood has assumed mythological proportions and very few farmers admitted to any other outcome than total loss of all the crops growing at the time. Besides which,apart from determining the proportion of farmers who suffered losses in various years it is not possible to generalise such information without also knowing what proportion of farmers did not suffer losses which cannot be estimated without knowing their cropping patterns for the years in question.The data is more useful in determining the pattern and distribution of damage rather than its overall extent.Data on damage to property is easier to interpret and is summarised below.Since 1988 no damage,other than to one house in 1989 is recorded.

TABLE E.1.10

Damage to Property in 1988 (per cent of sample)

		A	B	C	D
Housing	not damaged	43	21	28	18
	minor damage	23	31	24	35
	major damage	22	31	35	38
	destroyed	12	17	13	9
Livestock	no losses	64	42	44	41
	losses	36	58	56	59
of which	poultry (1)	28	54	55	56
	sheep/goats	9	15	11	7
	cattle	13	25	11	7

(1) where poultry,sheep and cattle are percentages of the sample in each zone who reported losses

E.2.1 Landless Survey

The main and secondary occupations of the landless respondents are summarised below, in Table E.2.1, where it can be seen that under half of those surveyed list casual work as their main occupation. The most common single occupational category following casual labouring is trading/shopkeeping. Surprisingly few respondents claimed to have secondary occupations.

Earnings per day are presented in Table E.2.2. Those for occupations other than casual farm work are much lower than expected and are probably distorted by unreported additional benefits. Fortunately the main purpose of the survey was to obtain current wage rates for casual farm work and in this instance the results agree with rates reported by both farmers and fish pond owners as well as other secondary sources. Other indicators are presented in Table E.2.3.

TABLE E.2.1

Occupational Analysis of Landless Survey Main Occupation

Occupation	Zone : A		Zone : B		Zone : C		Zone : D	
	#	#	#	#	#	#	#	#
Labourer/casual worker	11	45.8	9	37.5	10	41.7	8	33.3
Fishermen	1	4.2	1	4.2	2	8.3	2	8.3
Skilled artisan	0	.0	0	.0	1	4.2	1	4.2
Rickshaw driver	0	.0	3	12.5	2	8.3	0	.0
Shopkeeper/trader	5	20.8	4	16.7	5	20.8	7	29.2
Clerk	0	.0	0	.0	0	.0	1	4.2
Other	7	29.2	7	29.2	4	16.7	5	20.8
Total	24	100.0	24	100.0	24	100.0	24	100.0
Second Occupation								
Labourer/casual worker	2	50.0	4	40.0	4	33.3	3	60.0
Fishermen	0	.0	1	10.0	5	41.7	1	20.0
Skilled artisan	1	25.0	0	.0	0	.0	0	.0
Shopkeeper/trader	0	.0	0	.0	1	8.3	1	20.0
Other	1	25.0	5	50.0	2	16.7	0	.0
Total	4	100.0	10	100.0	12	100.0	5	100.0

TABLE E.2.2

Average Income in Taka per day

Zone : A	A/M	M/J	J/JL	JL/A	A/S	S/O	O/N	N/D	D/JA	JA/F	F/M	M/A	TOTAL
Farm work	47	45	39	43	43	38	39	49	47	45	43	45	44
Fishing	30	30	30	30	30	28	30	30	30	30			30
Livestock			20	20	20								20
Weaving						15	15						15
Carpentry	20	25	15	23	20	25	30	35	38	35	20	18	25
Large Industry	30	30	30	30	30	40	40	40	30	30	25	25	32
Shopkeeper	33	35	31	29	25	24	23	34	36	42	39	31	32
Government employee	40	40	40	40	40	40	40	40	40	40	40	40	40
Other	53	35	33	33	35	35	35	40	65	53	53	50	45
Zone : B													
Farm work	48	47	43	44	43	41	41	48	48	46	41	41	45
Fishing	50	50	45	40	40	25	28	25	20	20	20	20	31
Construction labour											40	40	40
Rice mill	25	25	25	25	25	25	25	25	25	25	25	25	25
Other cottage Industry			30	25	25	25	25						26
Rickshaw/van	40	35	33	33	33	33	28	43	33	33	33	33	34
Shopkeeper	45	48	50	48	44	48	61	50	59	55	50	45	50
Other	43	43	33	29	30	27	31	26	28	31	30	30	32
Zone : C													
Farm work	44	42	38	36	39	38	38	46	43	41	40	38	41
Fishing	20		28	26	24	23	29	27	28	25	28	25	26
Rickshaw/van	45	43	43	43	28	30	30	28	28	28	28	28	33
Shopkeeper	40	40	42	42	38	28	28	30	20	20	20	20	33
Doctor/other medical	50	50	70	70	60	60	70	50	50	50	60	60	58
Other	36	37	25	25	23	22	22	27	27	27	24	22	26
Zone : D													
Farm work	45	43	39	39	39	42	43	46	41	41	44	45	43
Fishing	40	33	31	29	29	31	30	33		30	30	30	31
Weaving	39	39	36	33	36	34	30	32	34	33	32	32	34
Shopkeeper	48	55	45	44	46	44	39	44	45	42	39	42	44
Other	40	20	25	25	25	25	25	40	40	40	40	40	32

Note: Months are based on Bangladesh equivalents.

TABLE E.2.3

Summary Landless Survey Indicators

Indicator	Zone A	Zone B	Zone C	Zone D
family size	5.5	6.5	7.2	6.8
men	1.6	1.7	1.5	2.0
women	1.7	1.5	1.9	2.0
children	2.3	3.3	3.8	2.8
labourers	5.3	6.4	7.0	6.6
fishermen	6.0	9.0	6.5	6.0
others	5.7	6.4	7.5	7.1
% katcha type house	100	100	92	96
% katcha type house labourers and fishermen	100	100	100	100
% labourers who own their house	100	100	100	100
% sample reporting declining work opportunities	25	38	71	75
% sample who fish	33	50	67	71
average monthly wet season catch per farm labouring family(kg)	5	12	11	9

The importance of fishing in the west of the project area, even to farm labourers, is evident from the number who go fishing in the wet season. In Zones B, C and D, farm labourers sold approximately 60%, 50%, and 20% of their catch respectively. In Zone A where catches are much lower, no sales of fish are made by farm labourers. It is noteworthy that 100 per cent of respondents claimed to own their own house and the land it occupied.

A much higher proportion of those surveyed reported declining work opportunities in the west of the project area(Zones C and D) which is perhaps a reflection of the poorer access in these parts. Improvements in general levels of economic activity may be expected to be generated by the completion of the bridge over the Meghna.

Flood losses reported by the respondents are presented in Table E.2.4

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TABLE E.2.4

Flood Losses Reported by Landless Respondents

Indicator	Zone A	Zone B	Zone C	Zone D
damage to housing: 1988 flood : % reporting no damage	30	5	5	0
: % reporting minor damage	4	0	13	8
: % reporting severe damage	21	8	21	42
: % reporting destruction	45	87	62	50
loss of livestock: % reporting losses	58	75	88	88
: of which cattle	8	17	4	0
: of which sheep/goats	13	4	4	8
: of which poultry	38	54	79	83

Since 1988 no cases of damage to either property or livestock by flooding are reported. It is not clear how reliable the damage estimates to housing may be. At first sight it seems unlikely that 87 per cent of houses were destroyed in Zone B although it is true that damage was particularly severe in the northern part of the area. Nevertheless, given that the 1988 flood lasted for more than four weeks and that nearly all the houses are 'katcha', it may well be that the corner posts and walls (woven split bamboo) would have become sufficiently waterlogged to be ruined. It is less likely that the roofing timbers and corrugated sheets would have been damaged.

E.3.1 Fish Pond Survey

A summary of culture pond data is presented in Tables E.3.1 and E.3.2. Table E.3.1 contains an areal analysis of the ponds included in the survey,whereas Table E.3.2 provides information on the origin, ownership pattern, stocking and water status of ponds.

TABLE E.3.1

Pond Holding Sizes - Fish Culture Survey

	Units	A	B	C	D
Number of respondents	No	24	24	24	24
Total no. of ponds	No	51	45	60	37
Average no. of ponds	No	2.13	1.88	2.50	1.54
Total area of ponds	Ha	21.39	14.56	31.35	11.55
Average size of holding	Ha	0.79	0.58	1.21	0.44
Average size of ponds	Ha	0.42	0.33	0.52	0.31
Area of ponds with water all year round	Ha	16.84	13.81	28.80	10.45
Average size of holding	Ha	0.89	0.69	1.25	0.52
Average of ponds	Ha	0.47	0.46	0.51	0.35
Area of pond without water all year round	Ha	4.55	0.75	2.55	1.09
Average size of holding	Ha	0.57	0.15	0.85	0.18
Average size of ponds	Ha	0.30	0.15	0.85	0.16

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TABLE E.3.2

Origin, Ownership and Status of Fish Ponds

	Zone : A		Zone : B		Zone : C		Zone : D	
		%		%		%		%
Origin								
Purpose built as a fish pond	20.27	94.7	10.45	71.7	28.31	90.3	8.93	77.3
Formerly a barrow pit					.12	.4	.13	1.1
Natural pond/take/river	.24	1.1					2.02	17.5
Do not know	.88	4.1	4.12	28.3	2.92	9.3	.47	4.0
Total	21.39	100.0	14.56	100.0	31.35	100.0	11.55	100.0
Ownership and Tenure of Ponds								
Sole owner and operator of the pond	2.62	12.2	4.49	30.9	6.19	19.7	3.02	26.1
Sole owner-rent out ponds to others	.66	3.1					.18	1.6
Shared/joint ownership with other	10.87	50.8	6.69	45.9	11.84	37.8	3.87	33.6
Rent in private pond for cash	7.26	33.9	3.11	21.4	12.21	38.9	2.45	21.2
Rent in government/khas pond for cash					.49	1.5	2.02	17.5
Rent in for share of fish			.27	1.9	.62	2.0		
Total	21.39	100.0	14.56	100.0	31.35	100.0	11.55	100.0
Status								
Pond not stocked - wild fish caught	.40	1.9					.73	6.3
Pond stocked with finger lings	20.99	98.1	14.56	100.0	31.35	100.0	10.82	93.7
Total	21.39	100.0	14.56	100.0	31.35	100.0	11.55	100.0
Ponds with all year round water	16.84	78.8	13.81	94.8	28.80	91.9	10.45	90.5
Ponds without year round water	4.55	21.02	0.75	5.2	2.55	8.1	2.55	9.5

It is noteworthy that such a high percentage of fish ponds are purpose built which suggests that, should conditions be favourable further expansion can be anticipated, in the sense that the construction of new ponds is already a well established venture. Joint or shared ownership is the most common form of ownership, closely followed on renting for cash which represents a simple solution to the problems of multiple ownership. The great majority of ponds are operational throughout the year(88 per cent) in the sense that normally they do not dry out. Nearly all permanently operational ponds are stocked with fingerlings; even 90 per cent of ponds which are generally expected to run dry are stocked with fingerlings although at a much reduced rate. Even in an exceptionally dry year, such as 1992, 62 per cent of pond operators did not anticipate any decline in production caused by water shortages. Additional water supplements from irrigation sources are generally not made;only 10 per cent of respondents reported using irrigation facilities to top up their ponds.

Yields and output from the various categories of fish pond are presented in Table E.3.3. Data for this table exclude those ponds which are operated as hatcheries as fingerlings are sold by number not weight and are in any case not comparable. Nearly all of the ponds farm either exotic or local varieties of carp, some in conjunction with other varieties which are however insignificant in comparison. Yield differences between zones are unexceptional except for Zone D where they are smaller, although in terms of output there is little difference.

Major costs include labour, feed, and stocking. Family labour is used for feeding and about half of the remaining work except for catching the fish which is either undertaken with the help of hired workers or contracted out. The cost per day of hired labour averaged Tk 42, ranging from Tk 46 in Zone B to Tk 38 in Zone C. Average stocking costs are given in Table E.3.4 (the high figure in Zone B, for ponds which dry out is caused by one high entry).

Sales of fish are made through three channels which are,in order of importance:

1) local market (45%)
2) local dealers buying at the pondside (40%)
3) local fishermen who purchase the right to catch and sell all the fish in the pond (7%)

About 8 per cent of output is consumed by the pond operator.

Advice on fish pond culture is obtained from the following sources:

1) no advice ever obtained (16%)
2) other fish farmers (43%)
3) fisheries officer (30%)
4) other (11%)

Most fish farmers are self financing in the sense that 87 per cent of units finance current operating expenses from sales of fish, or other sources of income. Very little finance is obtained from banks or moneylenders. Even when new ponds are constructed, these are usually financed out of retained earnings. In general fish farming is an additional enterprise within a farming system. Thus 44 per cent of respondents cited farming as their main source of income with only 27 per cent of respondents giving fish farming as their main source of income. In total 73 per cent of fish farmers had other sources of income.

Flood damage reported by respondents are presented in Table E.3.5, where it can be seen that losses were substantial in 1988(66 per cent) but very much lower thereafter.

TABLE E.3.3

Area (ha), Yield (kg/ha) and Output (tk/ha) of Fish ponds

Status	Zone: A			Zone : B			Zone : C			Zone : D		
	Area	Yield	Output	Area	Yield	Output	Area	Yield	Output	Area	Yield	Output
Pond stocked with fingerlings												
(1) water year round	16.84	1198.9	42815	11.41	1227.7	52992	28.45	1143.9	51168	9.25	853.32	48427
(2) dry for part of the year												
(Pond not stocked	4.15	1170.4	38714	.67	1648.3	60178	2.55	439.00	22348	1.09	1280.4	123500
(1) water year round												
(2) dry for part of the year	0.40											

TABLE E.3.4

Average cost in Tk/ha of Fingerlings

	Contains enough water	Dry for part of the year
	Tk/ha	Tk/ha
Zone : A	7472.67	5850.00
Zone : B	8147.54	12666.67
Zone : C	7579.05	705.71
Zone : D	9009.82	1417.96

TABLE E.3.5

Average Loss of Production Through Flooding of Fish Ponds (%)

Years	A	B	C	D	%
1988	41	62	87	73	66
1989	-	-	7	2	2.5
1990	-	-	3	-	0.8
1991	-	-	-	11	2.8
1992	-	-	-	-	-

E.4.1 Fishermen (Capture) Survey

Data relating to capture fishery is presented in Table E.4.1, where it can be seen that just under half of the sample have no other source of income than the sale of fish. Of the remainder, 84 per cent give fishing as their main source of income with farming cited as the major second source (53 per cent). Thus out of 169 fishermen interviewed 155 (92 per cent) are essentially dependent on fishing for their livelihood. This is also reflected in the number of days spent fishing which is presented in Table E.4.2.

As might be expected over half of the annual catch is made in the monsoon or aman season (ranging from 53 per cent in Zone D to 67 per cent in Zone B), about 30 per cent in the aus season and the remainder in the dry season. Gill nets are the most popular means of catching fish, with cast nets following. Gill net fishing is invariably done in groups and often at night.

Average catch per day in 1992 was approximately 2 Kg which was sold for between Tk 35-40 per Kg giving a gross daily return of between Tk 70-80. Catches in 1992 declined by about 30 per cent from nearly 3 Kg per day in 1991, presumably as a result of the very low flood. Declining catches are also reflected in the claims of 65 per cent of fishermen to use a smaller mesh than they did five years ago (as compared to 32 per cent who use the same size mesh). Further evidence of declining catches could be inferred from the survey which suggests that 93 per cent of fishermen spend more time fishing than they did five years although, of course there could be other reasons for the increase such as a higher cost of living. In spite of this, fishermen relegated the decline in fish catch to second place when asked to rank their problems. Access to capital was the most frequently mentioned, followed by falling fish catches, with the theft of fish (from reserved waters) third. Marketing of fish was only mentioned by 3 per cent of respondents as a major problem. Strategies proposed by fishermen to improve their incomes are presented below in order of preference:

1) improve credit facilities for the purchase of boats and gear
2) increase the depth and area of water
3) ban the use of mist nets
4) maintain existing water levels for longer
5) improve the control of fishing(better regulation).

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TABLE E.4.1

Distribution of Fishermen by Sources of Income

	Zone : A		Zone : B		Zone : C		Zone : D		Total	
Other Sources of Income	#	#	#	#	#	#	#	#	#	#
No	5	20.0	19	51.4	17	40.5	41	63.1	82	48.5
Yes	20	80.0	18	48.6	25	59.5	24	36.9	87	51.5
Total	25	100.0	37	100.0	42	100.0	65	100.0	169	100.0
Main Sources of Income	#	#	#	#	#	#	#	#	#	#
Fishing (capture)	17	85.0	17	94.4	20	80.0	19	79.2	73	83.9
Farming	2	10.0							2	2.3
Operator of fish ponds	1	5.0							1	1.1
Agriculture labour							2	8.3	2	2.3
Rural Industry							1	4.2	1	1.1
Rickshaw/other transport						4.0			1	1.1
Trader/shop					1	16.0	1	4.2	6	6.9
Government job			1	5.6	4		1	4.2	1	1.1
Total	20	100.0	18	100.0	25	100.0	24	100.0	87	100.0
Second Sources of Income										
Fishing (capture)	1	5.0	1	5.6	4	16.0	5	20.8	11	12.6
Farming	12	60.0	8	44.4	15	60.0	11	45.8	46	52.9
Operator of fish ponds	2	10.0							2	2.3
Agriculture labour	1	5.0			2	8.0	1	4.2	4	4.6
Other daily labour					1	4.0			1	1.1
Rickshaw/other transport	1	5.0							1	1.1
Trader/shop	2	10.0	9	50.0	3	12.0	5	20.8	19	21.8
Other							1	4.2	1	1.1
No second sources	1	5.0					1	4.2	2	2.3
Total	20	100.0	18	100.0	25	100.0	24	100.0	87	100.0

TABLE E.4.2

Number of Days Spent Fishing Per Year

	Zone : A	Zone : B	Zone : C	Zone : D
Minimum	125	150	180	162
Maximum	360	350	365	355
Average	245	262	286	292
Standard Deviation	59	61	47	51

TABLE E.4.3

Changes in Fish Catches Over Last 5 Years (Responses)

	Big Decrease				Small Decrease				Any Increase			
	A	B	C	D	A	B	C	D	A	B	C	D
Permanent beel	-	1	-	30	-	-	-	1	-	-	-	-
Seasonal beel	9	14	34	7	1	1	4	-	-	-	-	-
Khal	19	25	33	44	2	4	4	2	-	-	-	-
Major river	1	4	15	12	1	-	-	1	-	-	1	-
Flood plain	16	8	5	46	2	4	1	1	-	-	-	-

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TABLE E.4.4

Reasons Given for the Decline in Fish Catches (%)

	A	B	C	D
Over Fishing	2	6	26	27
Decline in Amount of Water	69	64	28	27
Obstruction of fish Migration	7	3	9	27
Pollution	-	13	3	4
Fish Diseases	20	14	34	11
Other	2	-	1	4
Total	100	100	100	100

SURVEY METHODOLOGY

SELECTION OF SAMPLE

A two stage random sample was drawn. The first stage consists in selecting a random sample of mouzas, and the second selecting farmers within the selected mouzas.

Unless a "large sample" (more than 10% of the population) can be selected, the statistical validity of a sample depends on its absolute size and not its proportion to the size of the population under investigation. Therefore, the following formula is used to determine sample size:

$$N = K^2V^2/D^2$$

where: N = sample size

K = required level of confidence

V = inherent variability of the subject under investigation

D = acceptable margin of error in results

If K = 1.28 - 85% confidence that our estimates will be correct

V = 0.5 - maximum value and, without other evidence, accepted as a norm in agricultural surveys.

D = 10% - our estimates will be accurate +/- 10%

Then the sample size can be calculated as N = 41

For a clustered sample (as used in this survey) the sample size was adjusted for the "cluster effect" - that is the members of the same cluster will tend to be more similar to each other than to members of other clusters. This depends on the size of the cluster (m) and the intra-cluster correlation coefficient (s): the relationship being $z = 1+s(m-1)$. If we take a typical value for s = 0.2 and m = 8 (as in this survey) then z = 2.8. The total sample size worked out to be 41 x 2.4 = 98. Further details of sample size calculation can be found in the Methodology Report. FAP 12 (HTS 1991).

The table below calculates sample size for a range of cluster sizes. The smaller the cluster the lower the value of z and the smaller the sample required. However a large number of clusters means that there is more work drawing up a sample frame (i.e. list of households) for each cluster. The optimum sample size is that which minimizes the total work in both drawing up sample frame and carrying out interviews.

Cluster size	12	11	10	9	8	7	6	5	4	3	2
Basic N	41	41	41	41	41	41	41	41	41	41	41
z	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2
Adjusted N	131	123	115	106	98	90	82	74	66	57	49
no clusters per zone	11	11	12	12	12	13	14	15	17	19	25
Rounded N*	132	121	120	108	96	91	84	75	68	57	50
No. zones	4	4	4	4	4	4	4	4	4	4	4
Total clusters	44	44	48	48	48	52	56	60	68	76	100
Total sample	528	484	480	432	384	364	336	300	272	228	200
Days to list frame	88	88	96	96	96	104	112	120	136	152	200
Days to interview	132	121	120	108	96	91	84	75	68	57	50
Total survey days	220	209	216	204	192	195	196	195	204	209	250

* divisable by number of clusters

The table assumes, based on previous experience, that it will take 2 man-days to draw up a sample frame and one enumerator can do 4 interviews per day.

In this case the optimal cluster size is 8 - that is 8 farmers will be interviewed in each Mouza. We therefore need a sample of 96 for each group about which we wish to make separate estimates. These groups may be defined in terms of farm size, tenancy, land type or other factors. What is not allowed for is accurate estimates within sub-groups - for instance, with a total sample size of 384 (4x96), we may be able to get accurate estimates for 4 different land types, and also for 4 different farm size groups, but not for different farm sizes with a particular land type.

Survey of Fields in 2 km Squares

Detailed topographic and hydrological investigations in 2km squares will generate detailed physical data which can be related to agronomic data. The survey in these squares will have a different approach to that in the 48 mouzas. Initial investigations will take the from of informal interviews with farmers which will aim to classify land types relative to flood depth, and understand farmer decision making in response to floods and given varying levels of resources. Informal interviews should be carried out, if possible by a multi-disciplinary team. This will be followed up by a formal questionnaire survey that will concentrate on individual fields where water levels and land heights can be measured. Fields will be selected from a range of land heights. The questionnaire for the formal survey will be based on the findings of the informal interviews.

Methodology for Sample Selection

1. Selection of first stage sample

The farmer survey would cover 8 farmers in each of 48 mouzas giving a total of 384 farmers. Selection of a statistically valid sample of farmers, using methods devised by FAP 12, involves the following steps:

(a) The area should be divided into 4 zones with different flooding and agro-ecological characteristics. In Gumti these zones are:
Zone A - high land to the south east
Zone B - relatively highland to the north east
Zone C - medium land in the central section
Zone D - low lying land to the west.

these zones were marked on a map with the exact boundary of zones aligned with mouza boundaries. All the mouzas in each zone are listed on a spreadsheet with their area and population.

(b) A random sample of 12 mouzas per zone, plus 3 spares is selected with probability of selection proportional to the population of the mouza. This is done by creating a list of the cumulative population of each mouza. A list of about 20 random numbers is then generated running between 1 and the cumulative total of all the mouzas in the zone. This can be done in Lotus with a the formula T*@RAND where T is the cumulative total. Copy this formula for 20 cells and then use the /RangeValue command to fix the numbers generated. Mouzas are selected if a random number falls within the range of their part of the cumulative total. If a mouza is selected twice, this was ignored and an additional random number was used to select another mouza. A sample example of this selection process is shown in the table below.

2. Selection of Second Stage Sample

(c) The Union Council HQ for each of the selected mouzas was visited by a survey supervisor to obtain from the Chairman or Secretary a tax list showing names of all the heads of households in that mouza. This list was copied, and the mouza visited. The list was then reviewed with a knowledgeable local person to up-date it and identify occupations of those on the list. Care was taken to include all landless people on the list. This in itself was a useful piece of information as it showed the relative importance of different occupations in the project area. The list itself identified land ownership, however the survey required a list of farm <u>operators</u> rather than <u>landowners</u>. From the list of farm operators, a random selection of sixteen was made (eight plus eight spares) using a list of pre-printed random numbers.

Landless people and fish pond operators were also identified on the list, and a sample of two landless people (plus 2 spares) and two fish pond operators (plus 2 spares) selected at random. The landless people included all people who are not farm operators - this may include people

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such as teachers and land owners who have rented their land out to tenants/sharecroppers, as well as labourers and destitute persons.

Fish pond operators may be either farmers or landless. So it was possible to select, by chance, the same man to interview as a farmer and as a fish pond operator.

Experience indicated that some mouzas were not in fact located as shown in the small areas atlas. Some no longer exist or have been washed away by rivers. Other close to towns may have become almost entirely urban. Three spare mouzas were therefore selected so the supervisor could make substitutions in the field.

(d) The enumerator then visited the mouza and interviewed the selected farmers. The selection of eight spare farmers enabled the enumerator to make a second choice if the selected farmer was not available.

Much time and effort could be avoided if the second stage sample selection procedures was omitted, and enumerators just turned up to the selected mouza and interviewed the first farmers they meet. However previous surveys have shown that enumerators are more likely to find, and talk to, the larger, richer and full time farmer, who will be selected by the villagers as their representative to talk to an outsider. The sample would therefore not be statically valid and would not give and accurate picture of the project area as a whole.

The case studies were selected from the completed questionnaires so more detailed information could obtained from example farmers with a range of resource levels and land types. This also acted as a useful check on the completion of the survey forms by the enumerators. The case studies were based on a questionnaire but also included a considerable element of informal interviews. They were carried out by agricultural economist or agronomist. This work was combined with overall survey supervision.

APPENDIX E.III

"FUTURE WITH" CROPPING PATTERNS

Zone A Strategy (c)

		Present			Future With Project		
NCA = 24506		F0	F1	F2&F3	F0	F1	F2&F3
B.Aus LV		1250	0	0	892	0	0
B.Aus HYV		245	0	0	0	0	0
T.Aus LV		466	466	0	0	245	0
T.Aus HYV irri		912	456	0	1091	160	0
T.Aus HYV n-ir		2029	2068	0	2918	1335	0
Mixed Aus/Aman		0	0	196	0	0	245
B.Aman(DW)		0	539	1495	0	0	172
T.Aman(DW)		0	0	1544	0	490	613
T.Aman LV		0	5608	0	0	4656	0
T.Aman HYV irri		1505	0	0	2161	0	0
T.Aman HYV n-ir		6855	0	0	9847	0	0
Boro LV		0	0	0	0	0	0
Boro HYV irri		4411	7352	3431	8577	8332	1470
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		331	255	0	299	255	0
Wheat n-ir		943	725	0	852	725	0
Potato irri		587	463	0	1050	0	0
Potato n-ir		345	272	0	617	0	0
Jute		0	711	0	0	711	0
Pulses		490	0	0	490	0	0
Mustard		613	490	980	0	490	245
Spices		270	0	0	270	0	0
Veg		833	0	0	833	0	0
		22083	19405	7646	29897	17399	2745
Crop Intensity		90%	79%	31%	122%	71%	11%
Total Crop Intensity			200%			204%	

Zone B Strategy (c)

		Present			Future With Project		
NCA = 22412		F0	F1	F2&F3	F0	F1	F2&F3
B.Aus LV		717	0	0	717	0	0
B.Aus HYV		471	0	0	471	0	0
T.Aus LV		291	0	0	291	0	0
T.Aus HYV irri		44	0	0	341	0	0
T.Aus HYV n-ir		68	0	0	533	0	0
Mixed Aus/Aman		0	0	583	0	0	583
B.Aman(DW)		426	1009	3810	0	560	2129
T.Aman(DW)		0	0	1726	0	381	1569
T.Aman LV		1121	3070	0	2017	2689	0
T.Aman HYV irri		0	0	0	0	0	0
T.Aman HYV n-ir		1479	0	0	2914	0	0
Boro LV		0	0	336	0	0	336
Boro HYV irri		2465	3362	9077	4146	4034	8292
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		47	47	134	45	45	67
Wheat n-ir		424	424	1210	403	403	605
Potato irri		20	0	0	20	0	0
Potato n-ir		383	0	0	383	0	0
Jute		0	1009	0	0	1009	0
Pulses		314	0	896	314	0	448
Mustard		650	1546	896	1345	1345	896
Spices		112	0	0	112	0	0
Veg		67	0	0	67	0	0
		9099	10466	18669	14120	10466	14926
Crop Intensity		41%	47%	83%	63%	47%	67%
Total Crop Intensity			171%			176%	

Zone C Strategy (c)

NCA =	35040	Present			Future With Project		
		F0	F1	F2&F3	F0	F1	F2&F3
B.Aus LV		526	1402	0	1016	631	0
B.Aus HYV		0	350	0	0	0	0
T.Aus LV		666	701	0	1261	0	0
T.Aus HYV irri		77	232	0	161	131	0
T.Aus HYV n-ir		378	1134	0	785	640	0
Mixed Aus/Aman		0	0	3854	0	0	1121
B.Aman(DW)		0	0	9461	0	0	2803
T.Aman(DW)		0	0	280	0	0	210
T.Aman LV		0	4836	0	0	5606	0
T.Aman HYV irri		105	42	0	442	0	0
T.Aman HYV n-ir		1647	659	0	6917	0	0
Boro LV		0	0	105	0	0	105
Boro HYV irri		0	1752	12264	4730	6307	15137
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		0	98	240	115	98	74
Wheat n-ir		0	1303	3194	1532	1303	978
Potato irri		0	27	0	27	0	0
Potato n-ir		0	428	0	428	0	0
Jute		0	2453	1121	0	1472	0
Pulses		140	1051	2488	491	701	1577
Mustard		0	1402	3714	1402	2102	2102
Spices		315	0	0	315	0	0
Veg		526	0	0	526	0	0
		4380	17870	36722	20148	18992	24108
Crop Intensity		13%	51%	105%	58%	54%	69%
Total Crop Intensity			168%			181%	

Note: No changes were made in the Computer Model for Zone D under Strategy (c),

Zone A Strategy (d) (FCD)

		Present			Future With Project		
NCA =	22523	F0	F1	F2&F3	F0	F1	F2&F3
B.Aus LV		1149	0	0	968	0	0
B.Aus HYV		225	0	0	0	0	0
T.Aus LV		428	428	0	0	248	0
T.Aus HYV irri		838	419	0	957	147	0
T.Aus HYV n-ir		1865	1901	0	2129	1227	0
Mixed Aus/Aman		0	0	180	0	0	225
B.Aman(DW)		0	496	1374	0	0	14
T.Aman(DW)		0	0	1419	0	0	450
T.Aman LV		0	5154	0	0	3829	0
T.Aman HYV irri		1383	0	0	2189	0	0
T.Aman HYV n-ir		6300	0	0	9973	0	0
Boro LV		0	0	0	0	0	0
Boro HYV irri		4054	6757	3153	8108	7658	1126
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		305	234	0	275	293	0
Wheat n-ir		867	667	0	783	833	0
Potato irri		539	426	0	965	0	0
Potato n-ir		317	250	0	567	0	0
Jute		0	653	0	0	653	0
Pulses		450	0	0	450	0	0
Mustard		563	450	1126	0	1126	338
Spices		248	0	0	248	0	0
Veg		766	0	0	766	0	0
		20296	17835	7252	28379	16014	2153
Crop Intensity		90%	79%	32%	126%	71%	10%
Total Crop Intensity			201%			207%	

Zone B Strategy (d) (FCD)

		Present			Future With Project		
NCA =	20598	F0	F1	F2&F3	F0	F1	F2&F3
B.Aus LV		659	0	0	659	0	0
B.Aus HYV		433	0	0	433	0	0
T.Aus LV		268	0	0	268	0	0
T.Aus HYV irri		0	0	0	353	0	0
T.Aus HYV n-ir		0	0	0	553	0	0
Mixed Aus/Aman		0	0	536	0	0	391
B.Aman(DW)		494	927	3502	0	1133	1112
T.Aman(DW)		0	0	1586	0	659	927
T.Aman LV		1030	2822	0	0	2472	0
T.Aman HYV irri		0	0	0	0	0	0
T.Aman HYV n-ir		1359	0	0	5973	0	0
Boro LV		0	0	309	0	0	309
Boro HYV irri		2266	3090	8342	4738	4738	5664
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		43	43	124	62	62	21
Wheat n-ir		389	389	1112	556	556	185
Potato irri		19	0	0	16	0	0
Potato n-ir		352	0	0	313	0	0
Jute		0	927	0	0	927	0
Pulses		288	0	824	288	0	0
Mustard		597	1421	824	1133	1442	1236
Spices		103	0	0	103	0	0
Veg		62	0	0	62	0	0
		8363	9619	17158	15510	11988	9846
Crop Intensity		41%	47%	83%	75%	58%	48%
Total Crop Intensity			171%			181%	

Zone C Strategy (d) (FCD)

NCA = 32205	Present F0	Present F1	Present F2&F3	Future With Project F0	Future With Project F1	Future With Project F2&F3
B.Aus LV	483	1288	0	483	902	0
B.Aus HYV	0	0	0	0	0	0
T.Aus LV	612	0	0	580	0	0
T.Aus HYV irri	44	104	0	159	137	0
T.Aus HYV n-ir	214	508	0	775	668	0
Mixed Aus/Aman	0	0	3543	0	0	1224
B.Aman(DW)	0	0	7085	0	870	4444
T.Aman(DW)	0	0	258	0	0	225
T.Aman LV	0	4444	0	0	1610	0
T.Aman HYV irri	97	39	0	213	0	0
T.Aman HYV n-ir	1514	605	0	3330	0	0
Boro LV	0	0	97	0	0	97
Boro HYV irri	161	3221	12882	1771	6441	15845
Boro HYV p-irri	0	0	0	0	0	0
Wheat irri	0	90	221	68	113	113
Wheat n-ir	0	1198	2935	899	1498	1498
Potato irri	0	25	0	25	0	0
Potato n-ir	0	394	0	394	0	0
Jute	0	2254	1031	0	1353	0
Pulses	129	966	2287	451	644	1449
Mustard	0	1288	3414	0	3221	3221
Spices	290	0	0	161	0	0
Veg	483	0	0	193	0	0
	4026	16425	33751	9500	17455	28115
Crop Intensity	13%	51%	105%	30%	54%	87%
Total Crop Intensity		168%			171%	

Zone D Strategy (d) (FCD)

NCA = 33161	Present F0	Present F1	Present F2&F3	Future With Project F0	Future With Project F1	Future With Project F2&F3
B.Aus LV	298	0	0	298	0	0
B.Aus HYV	0	0	0	0	0	0
T.Aus LV	0	0	0	0	0	0
T.Aus HYV irri	0	0	0	0	0	0
T.Aus HYV n-ir	0	0	0	0	0	0
Mixed Aus/Aman	0	0	1194	0	0	1194
B.Aman(DW)	431	1824	9650	99	1492	7130
T.Aman(DW)	0	0	265	0	0	265
T.Aman LV	232	0	0	995	1326	0
T.Aman HYV irri	0	0	0	0	0	0
T.Aman HYV n-ir	0	0	0	0	0	0
Boro LV	0	0	995	0	0	995
Boro HYV irri	0	829	14922	663	2321	15917
Boro HYV p-irri	0	0	0	0	0	0
Wheat irri	0	0	216	0	0	157
Wheat n-ir	0	0	5189	0	0	3756
Potato irri	0	24	0	0	8	24
Potato n-ir	0	1170	0	0	390	1170
Jute	0	663	2852	0	829	2686
Pulses	0	0	2653	133	0	1923
Mustard	0	0	2321	0	0	2719
Spices	0	1227	1061	0	763	1194
Veg	1260	0	1161	796	1161	0
	2222	5737	42479	2984	8290	39130
Crop Intensity	7%	17%	128%	9%	25%	118%
Total Crop Intensity		152%			152%	

Zone A Strategy (e) (FCDI)

NCA =	22235	Present F0	Present F1	Present F2&F3	Future With Project F0	Future With Project F1	Future With Project F2&F3
B.Aus LV		1134	0	0	956	0	0
B.Aus HYV		222	0	0	0	0	0
T.Aus LV		422	422	0	0	89	0
T.Aus HYV irri		827	710	0	1082	303	0
T.Aus HYV n-ir		1841	1580	0	2409	675	0
Mixed Aus/Aman		0	0	178	0	0	222
B.Aman(DW)		0	489	1356	0	0	0
T.Aman(DW)		0	0	1401	0	0	0
T.Aman LV		0	5087	0	0	2891	0
T.Aman HYV irri		1365	0	0	2722	0	0
T.Aman HYV n-ir		6219	0	0	12398	0	0
Boro LV		0	0	0	0	0	0
Boro HYV irri		4002	6671	3113	10895	5559	222
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		301	231	0	387	173	0
Wheat n-ir		856	658	0	1102	494	0
Potato irri		532	420	0	953	0	0
Potato n-ir		313	247	0	559	0	0
Jute		0	645	0	0	467	0
Pulses		445	0	0	445	0	0
Mustard		556	445	1112	311	889	267
Spices		245	0	0	245	0	0
Veg		756	0	0	756	0	0
		20036	17606	7160	35220	11540	712
Crop Intensity		90%	79%	32%	158%	52%	3%
Total Crop Intensity			201%			214%	

Zone B Strategy (e) (FCDI)

NCA =	20335	Present F0	Present F1	Present F2&F3	Future With Project F0	Future With Project F1	Future With Project F2&F3
B.Aus LV		651	0	0	651	0	0
B.Aus HYV		427	0	0	427	0	0
T.Aus LV		264	0	0	264	0	0
T.Aus HYV irri		0	0	0	508	0	0
T.Aus HYV n-ir		0	0	0	794	0	0
Mixed Aus/Aman		0	0	529	0	0	203
B.Aman(DW)		488	915	3457	0	1118	773
T.Aman(DW)		0	0	1566	0	773	773
T.Aman LV		1017	2786	0	0	2034	0
T.Aman HYV irri		0	0	0	0	0	0
T.Aman HYV n-ir		1342	0	0	7931	0	0
Boro LV		0	0	305	0	0	305
Boro HYV irri		2237	3050	8236	6711	3660	4575
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		43	43	122	61	61	20
Wheat n-ir		384	384	1098	549	549	183
Potato irri		18	0	0	18	0	0
Potato n-ir		348	0	0	348	0	0
Jute		0	915	0	0	915	0
Pulses		285	0	813	285	0	0
Mustard		590	1403	813	1525	1423	732
Spices		102	0	0	102	0	0
Veg		61	0	0	61	0	0
		8256	9496	16939	20233	10534	7565
Crop Intensity		41%	47%	83%	100%	52%	37%
Total Crop Intensity			171%			189%	

Zone C Strategy (e) (FCDI)

NCA =	31793	Present F0	Present F1	Present F2&F3	Future With Project F0	Future With Project F1	Future With Project F2&F3
B.Aus LV		477	1272	0	922	890	0
B.Aus HYV		0	318	0	0	0	0
T.Aus LV		604	636	0	1145	0	0
T.Aus HYV irri		70	211	0	146	141	0
T.Aus HYV n-ir		343	1029	0	712	686	0
Mixed Aus/Aman		0	0	3497	0	0	890
B.Aman(DW)		0	0	8584	0	922	3306
T.Aman(DW)		0	0	254	636	636	1272
T.Aman LV		0	4387	0	0	2226	0
T.Aman HYV irri		95	38	0	382	0	0
T.Aman HYV n-ir		1494	598	0	5977	0	0
Boro LV		0	0	95	0	0	95
Boro HYV irri		0	1590	11128	4610	6994	12145
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		0	89	218	134	89	67
Wheat n-ir		0	1183	2898	1774	1183	887
Potato irri		0	25	0	25	0	0
Potato n-ir		0	389	0	389	0	0
Jute		0	2226	1017	0	1335	0
Pulses		127	954	2257	445	954	1113
Mustard		0	1272	3370	954	2384	1717
Spices		286	0	0	159	0	0
Veg		477	0	0	191	0	0
		3974	16214	33319	18599	18440	21492
Crop Intensity		13%	51%	105%	59%	58%	68%
Total Crop Intensity			168%			184%	

Zone D Strategy (e) (FCDI)

NCA =	32737	Present F0	Present F1	Present F2&F3	Future With Project F0	Future With Project F1	Future With Project F2&F3
B.Aus LV		295	0	0	295	0	0
B.Aus HYV		0	0	0	0	0	0
T.Aus LV		0	0	0	0	0	0
T.Aus HYV irri		0	0	0	0	0	0
T.Aus HYV n-ir		0	0	0	426	0	0
Mixed Aus/Aman		0	0	1179	0	0	1179
B.Aman(DW)		426	1801	9526	0	2128	5958
T.Aman(DW)		0	0	262	0	0	229
T.Aman LV		229	0	0	0	2619	0
T.Aman HYV irri		0	0	0	0	0	0
T.Aman HYV n-ir		0	0	0	1309	0	0
Boro LV		0	0	982	0	0	982
Boro HYV irri		0	818	14732	1637	3274	13750
Boro HYV p-irri		0	0	0	0	0	0
Wheat irri		0	0	213	13	26	115
Wheat n-ir		0	0	5123	314	629	2766
Potato irri		0	24	0	0	0	24
Potato n-ir		0	1155	0	0	0	1155
Jute		0	655	2815	0	1146	2324
Pulses		0	0	2619	131	393	1899
Mustard		0	0	2292	982	0	1702
Spices		0	1211	1048	0	327	1931
Veg		1244	0	1146	786	1146	0
		2193	5664	41936	5893	11687	34014
Crop Intensity		7%	17%	128%	18%	36%	104%
Total Crop Intensity			152%			158%	