THE PEOPLE'S REPUBLIC OF BANGLADESH

BANGLADESH WATER DEVELOPMENT BOARD

FEASIBILITY STUDY ON THE NORTH RAJSHAHI IRRIGATION PROJECT

VOLUME 1 MAIN REPORT

AUGUST 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF REPORTS

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PREFACE

In response to the request of the Government of the People's Republic of Bangladesh, the Government of Japan decided to conduct a feasibility study on the North Rajshahi Irrigation Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Bangladesh a study team headed by Mr. Ikuzo IWAMOTO, Sanyu Consultants Inc., two times in the period from July, 1987 to June, 1988.

The team exchanged views with the officials concerned of the Government of the People's Republic of Bangladesh and conducted field survey in the Rajshahi and Naogaon Districts.
After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between the two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the People's Republic of Bangladesh for their close cooperation extended to the team.

August, 1988

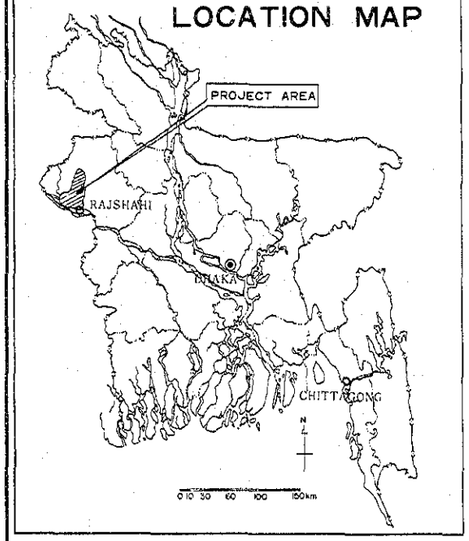
Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

NORTH RAJSHAHI IRRIGATION PROJECT

PROJECT MAP

LOCATION MAP



LEGEND

	Boundary of Study Area
	Boundary of Project Area
	Boundary of Upazila
○	Upazila Head Quarter
	Project Area (Barind Area)
	Project Area (Paba Flood Plain Area)
Ⓟ	Pumping Station
	Delivery Pipe & Pond
	Main Irrigation Canal
	Secondary Irrigation Canal
	River and Water Body
○	Regulator
	Proposed Drainage Improvement Works

NIAMATPUR
MANDAI
ATRAI RIVER
NACHOLE
SIB RIVER
BARIND AREA
POLDER (D)
CHALAN BEEL PROJECT (POLDER (D) AREA)
EMBANKMENT
TANOR
ANNUR
CHAPAI NAWABGANJ
MAHANANDA RIVER
MOHADEVPUR
SULTANGANJ
GODAGARI
BARAIPARA PUMPING STATION
PABA FLOOD PLAIN AREA
NAWHATA
BARNAI PROJECT AREA
PABA
RAJSHAHI
GANGES RIVER
KASBA PUMPING STATION

0 5 10km
SCALE 1 : 200,000

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GLOSSARY

Aman	-	The main rice crop, generally sown or transplanted before or during the monsoon season. Broadcast aman (B. aman) is direct-seeded, normally in March-April and harvested in November-December. Transplanted aman (T.aman) is transplanted from mid-July to early September and harvested in November-December.
Aus	-	Pre-monsoon rice, generally sown or transplanted in March-May and harvested in June-August. In many areas, aus and broadcast aman are sown in the same field at the same time.
Boro	-	Winter rice crop, generally transplanted in December-February and harvested in April-June.
Command Area	-	Cultivated area served by a particular irrigation system.
Deep Tubewell (DTW)	-	Wells with turbine pumps set below the groundwater level. Normal capacity of a deep tubewell with a surface-mounted 25-3-hp diesel engine or 15-kw electric motor is generally 2 cusec sufficient to provide irrigation to 20 to 40 ha, depending on conditions.
Shallow Tubewell (STW)	-	Wells with centrifugal pumps set on the ground surface. Normal capacity of a STW with 5-6-hp diesel engine is generally 0.5 cusec sufficient to provide irrigation to 4-5 ha.
Hand Tubewell	-	Simple single-action piston pump with a small diameter well (3.5 cm), operated manually to irrigate about 0.13 to 0.2 hectares.
Low-Lift Pump (LLP)	-	Portable centrifugal pumps coupled with a 7-8-hp to 16-18-hp diesel engine to pump 1 to 2 cusec of surface water about 6 to 12 meters. One LLP can irrigate from 8 to 18 ha.
Minor Irrigation	-	Mechanical lift-irrigation from deep tubewells, shallow tubewells, hand pumps and low-lift pumps.
Upazila	-	Basic administrative unit in Bangladesh. The country has four administrative tiers consisting of division (4), Zila (64), Upazila (460) and Union (about 4400). Each Union consists of about 20 villages.

ABBREVIATIONS

ATI	-	Agricultural Training Institute
BADC	-	Bangladesh Agricultural Development Corporation
BARC	-	Bangladesh Agricultural Research Council
BARI	-	The Bangladesh Agricultural Research Institute
BB	-	Bangladesh Bank
BBS	-	Bangladesh Bureau of Statistics
BFDC	-	Bangladesh Fisheries Development Corporation
BIADP	-	Barind Integrated Agricultural Development Project
BJRI	-	Bangladesh Jute Research Institute
BKB	-	Bangladesh Krishi Bank
BRDB	-	Bangladesh Rural Development Board
BRRI	-	Bangladesh Rice Research Institute
BS	-	Block Supervisor
BSBL	-	Bangladesh Samabaya Bank Ltd. (Bangladesh Cooperative Bank Ltd.)
BSCIC	-	Bangladesh Small and Cottage Industries Corporation
BSRDI	-	Bangladesh Soil Resources and Development Institute
BSS	-	Bhumiheen-Bityaheen Samabaya Samity (Landless/Assetless Cooperative Society).
CERDI	-	Central Extension Resources Development Institute
DAE	-	Department of Agriculture Extension
DAMI	-	Department of Agriculture Marketing & Information
DAMO	-	District Agricultural Marketing Office
DOF	-	Department of Food
DLS	-	Directorate of Livestock Services
DOF	-	Directorate of Fisheries
DSS	-	Department of Soil Survey
DTW	-	Deep Tube-Well
FAO	-	The Food and Agricultural Organization of the United Nations
FSMF	-	Fish Seed Multiplication Farm

FY	-	Fiscal Year
HYV	-	High-Yielding Variety
IFAD	-	International Fund for Agricultural Development
IMP	-	Irrigation Management Program
IRDP	-	Integrated Rural Development Program
JICA	-	Japan International Cooperation Agency
KSS	-	Krishak Samabaya Samity (Farmer's Cooperative Society)
LLP	-	Low-Lift Pump
MOA	-	Ministry of Agriculture
MOF	-	Ministry of Food
MEMR	-	Ministry of Energy and Mineral Resources
MFL	-	Ministry of Fisheries and Livestock
MLGRDC	-	Ministry of Local Government Rural Development and Cooperatives
MSS	-	Mahila Samabaya Samity (Women's Cooperative Society)
MTFPP	-	Medium Term Foodgrain Production Plan (FY 1981-1985)
NCB	-	Nationalized Commercial Bank
NCMRD	-	National Committee for Multi-Sectoral Rural Development
NRDP	-	North-West Rural Development Project
PDB	-	Power Development Board
PIU	-	Project Implementation Unit
R & H	-	Road and Highway Board
RID	-	Rural Industry Department
SB	-	Sonali Bank
SMO	-	Subject Matter Officer
SRDI	-	The Soil Resources Development Institute
SRTI	-	The Soil Resources Development Institute
STW	-	Shallow Tube-Well
UAO	-	Upazila Agricultural Officer
UCCA	-	Upazila Central Cooperative Association
UNDP	-	The United Nations Development Programme

UNIT OF MEASUREMENT

1. Length

mm	cm	m	km	in	ft	yd	mile
1	0.1	0.001	.....	0.03937	0.00328	0.00109	....
10	1	0.01	0.00001	0.39370	0.03281	0.01094	0.00001
1000	100	1	0.001	39.3701	3.28084	1.09361	0.00062
....	100000	1000	1	39370.1	3280.84	1093.61	0.62137
25.4	2.54	0.0254	0.00003	1	0.08333	0.02778	0.00002
304.8	30.48	0.3048	0.00030	12	1	0.33333	0.00019
914.4	91.44	0.9144	0.00091	36	3	1	0.00057
20116.8	2011.68	20.1168	0.02012	792	66	22	0.01250
.....	160934	1609.34	1.60934	63360	5280	1760	1
3.03030	0.30303	.003030	.....	0.11930	0.00994	0.00331	.....
30.3030	3.03030	0.03030	0.00003	1.19303	0.09942	0.0331	0.00002
303.030	30.3030	0.30303	0.00030	11.9303	0.99419	0.33140	0.00019
1818.18	181.818	1.81818	0.00182	71.5820	5.96516	1.98839	0.00113
109091	10909.1	109.091	0.10909	4294.92	357.910	119.303	0.06779
....	392727	3927.27	3.92727	154617	12884.8	4294.92	2.44029

1 Imp. yd = 0.9143992 m 1m = 1.0936143 Imp.yd 1 Imp.in = 2.539998cm
1 knot = 1852 m
1 U.S.yd = 0.91440183m 1m = 1.0936111 U.S.yd 1 U.S.in = 2.540005cm

2. Area

cm^2	m^2	km^2	a	in^2	ft^2	yd^2	$mile^2$	acre
1	0.0001	.....	.....	0.15500	0.00108	0.00012	.....	.....
10000	1	0.000001	0.01	1550.00	10.7639	1.19599	.....	0.00025
.....	1000000	1	10000	.....	.....	.....	0.38610	247.105
.....	100	0.0001	1	155000	1076.39	119.599	0.00004	0.02471
6.4516	0.00065	.....	.....	1	0.00694	0.00077	.....	.....
929.030	0.09290	.....	0.00093	144	1	0.11111	.....	0.00002
8361.27	0.83613	.....	0.00836	1296	9	1	.....	0.00021
.....	.....	2.58999	25899.9	.....	.....	.....	1	640
.....	4046.86	0.00405	40.4686	.....	43560	4840	0.00156	1
918.274	0.09183	.....	0.00092	142.333	0.98842	0.10982	.....	0.00002
33057.9	3.30579	.....	0.03306	5123.98	35.5832	3.95369	.....	0.00082
991736	99.1736	0.00010	0.99174	153719	1067.50	118.611	.....	0.02451
.....	991.736	0.00099	9.91736	.....	10675.0	1186.11	0.00038	0.24506
.....	9917.36	0.00992	99.1736	.....	106750	11861.1	0.00383	2.45063
.....	.....	15.4235	154235	.....	.....	.....	5.95504	3811.22

3. Volume

cm^3	m^3	l	gallon	in^3	ft^3	yd^3	British gallon
1	.000001	0.001	0.00026	0.06102	0.00004	.....	0.00022
1000000	1	1000	264.171	61023.7	35.3147	1.30795	219.975
1000	0.001	1	0.26418	61.0255	0.03532	0.00131	0.21998
3785.43	0.00379	3.78532	1	231.001	0.13368	0.00495	0.83270
16.3871	0.00002	0.01639	0.00433	1	0.00058	0.00002	0.00360
28316.8	0.02832	28.3161	7.48048	1728	1	0.03704	6.22883
764555	0.76455	764.533	201.973	46656	27	1	168.179
4546.09	0.00455	4.54596	1.20095	227.42	0.16054	0.00595	1
27.8265	0.00003	0.02783	0.00735	1.69808	0.00098	0.00004	0.00612
27826.5	0.02783	27.8257	7.35094	1698.08	0.98268	0.03640	6.12097
.....	6.01052	6010.35	1587.80	366784	212.259	7.86154	1322.13
180.391	0.00018	0.18039	0.04765	11.0081	0.00637	0.00024	0.03968
1803.91	0.00180	1.80386	0.47654	110.081	0.06370	0.00236	0.39680
18039.1	0.01804	18.0386	4.76539	1100.81	0.63704	0.02359	3.96804
180391	0.18039	180.386	47.6539	11008.1	6.37044	0.23594	39.6804

1l=1.000028dm^3 1 gal = 3.7853240 1 U.S GAL = 3.785329 1 Imp.gal = 4.545963
1 gal = 1/8bu = 8 pint = 128 fluid ounce
1 shipping ton = 1000/353m^3 1 Imp. shipping ton = 42ft^3 = 1.05 U.S shipping ton
1 U.S bbl = 31.5 U.S gal 1 Imp.bbl = 36 Imp.gal

4. Weight

mg	g	kg	ton	oz.	lb.
200	0.2	0.0002	.....	0.00705	0.00044
1	0.001	.....	.....	0.00004	.....
1000	1	0.001	.....	0.03527	0.00220
.....	1000	1	0.001	35.2740	2.20462
.....	.....	1000	1	35274.0	2204.62
64.8	0.06480	0.00006	.....	0.00229	0.00014
28349.5	28.3495	0.02835	0.00003	1	0.0625
453592	453.592	0.45359	0.00045	16	1
.....	.....	1016.05	1.01605	35840	2240
.....	.....	907.185	0.90718	32000	2000
375	0.375	0.00038	.....	0.01323	0.00083
3750	3.75	0.00375	.....	0.13228	0.00827
.....	3750	3.75	0.00375	132.277	8.26733
600000	600	0.6	0.0006	21.1644	1.32277

1 lb = 0.45359243 kg 1 kg = 2.2046223 lb
1 Imp. lb = 0.45359245 kg 1 U.S lb = 0.4535924277 kg
1 mound = 37.3261 kg

I. PROJECT SUMMARY

1. Project Components

The North Rajshahi Irrigation Project (hereinafter referred to as "the Project") consists of the following three tangible components:

(1) Agricultural development plan (major component) on the basis of irrigation and drainage facilities development;

(2) Rural road network plan to improve rural communication and transportation facilities utilizing operation and maintenance road linking the existing road;

(3) Inland fisheries development plan in the existing ponds and tanks in the Project area and in the beels along the Sib river utilizing the irrigation water and the return-flow.

Also, the environmental impact of the Project implementation has been briefly studied taking into account the natural, ecological and socio-economic conditions.

2. Development Concepts

The Project area has been divided into two areas; namely, the Barind Area and Paba Flood Plain Area. The Barind area forms high elevated and undulating topography (EL. 15-46 m), while the Paba flood plain area is a low-lying flat area (EL. 14 to 15 m). The development concepts for the Project have been determined as follows taking into consideration the natural, physical features and availability of the water resources.

(1) Provision of stable and year-round irrigation water supply.

(2) The size and capacity of pumps and irrigation facilities should be decided on the basis of the supplemental irrigation during the wet season. In order to utilize the facilities effectively throughout the year, the dry season irrigable area should be reduced have the same capacity of pumps during the wet season.

(3) The irrigation water should be pumped from the Ganges river to attain year-round irrigation on the basis of surface water resources development.

(4) Considering the topography, soil and agricultural farming system in the Project area, the irrigation system for Barind area and Paba flood plain area should be separated.

(5) The Project aims to increase the unit yield of crops and crop intensity and overall production through the introduction of irrigated farming technology.

(6) Introduction of irrigated farming technology and strengthening of supporting and extension services.

(7) Introduction of vegetable and other diversified crops and increasing of the crop intensity.

(8) Strengthening and expansion of existing agricultural supporting system, especially in the Barind area.

(9) Introduction of post-harvest technology and improvement of existing facilities.

(10) Establishment and improvement of systematic drainage networks in the Paba flood plain area and the Sib river for Barind area.

(11) Establishment of a road network system to ensure effective functioning of irrigation facilities, water management, farm production, marketing activities and accessibility during the wet season.

(12) Establishment and reinforcement of farmers' organization for supplying farm inputs, credit, appropriate water management and irrigation facility maintenance.

(13) Economic and technical optimization of the Project size on the basis of alternative studies, and,

(14) Study on the stage-development of the Project implementation.

3. Study Area and Project Area

The Study area has been selected in the western side of the Sib river within the area of 151,800 ha as mentioned in the Scope of Works taking into account the topography, availability of river water, potentiality of the area for agriculture and irrigation development. As a result of the study, the optimal scale of the project development has been decided on the basis of alternative studies in the Barind area. Accordingly, the Project area has been decided for 72,270 hectares in which the net irrigation area is 51,200 hectares (Barind area, 42,200 hectares, and Paba flood plain area, 9,000 hectares).

4. Main Features of North Rajshahi Irrigation Project

1) Irrigation Acreage

Project Area	:	72,270 ha
Gross Area	:	61,630 ha
Net Irrigable Area: Total Area	:	51,200 ha
(Paba Flood Plain Area	:	9,000 ha)
(Barind Area	:	42,200 ha)

2) Related Upazila and District

Rajshahi District: Godagari, Tanore, Paba Upazilas

Naogaon District : Niamatpur Upazila

3) Population and Household in the Project Area

a) Total Population : 338,000

b) Total Household : 58,000

4) Production

a) Paba Flood Plain Area

	Present	With Project	Increment
Rice			
Area (ha)	7,790	10,080	2,290
Yield (t/ha)	1.18	4.05	2.87
Production (ton)	9,237	40,860	31,623 (3.42 times)
Cropping Intensity	158%	196%	38%

b) Barind Area

	Present	With Project	Increment
Rice			
Area (ha)	50,470	80,180	29,710
Yield (t/ha)	1.35	4.24	2.89
Production (ton)	67,920	339,710	271,790 (4.0 times)
Cropping Intensity	132%	213%	81%

5) Irrigation

Unit Water Requirement (in terms of weighted average, i.e, not peak)

Pump & Main Canal: 1.0484 l/sec/ha

Secondary Canal : 1.2345 l/sec/ha

Tertiary Canal : 1.5456 l/sec/ha

6) Facilities

a) Pumping Stations

	Baraipara		Kasba	
Type of Pumping Station	Fixed		Fixed	
° Water Demand (cum/sec)	44.24		9.44	
° Design Capacity (cum/sec)	42.588		8.247	
° Design W.L (PWD) Intake	8.686		7.860	
° Delivery Pond W.L	30.50		19.80	
° Total Head (meter)	27.0		13.0	
° Pump Type	Vertical Fixed Flow		Vertical Mixed Flow	
° Number of Units	4	4	1	2
° Diameter (mm)	1,650	1,350	1,350	1,000
° Unit Pump Capacity (cum/s)	6.65	4.0	4.12	2.06
° Unit Motor Power (kw)	2,390	1,450	720	370
° Total Power Requirement(kw)	15,400		1,460	

b) Irrigation Canal

	Barind	Paba
° Main Canal Length (km)	48.77	13.9
° Secondary Canal (km)	159.66	62.8
° Sub-secondary (km)	285.47	18.79
° Tertiary Canal (km)	775.80	288.0

c) Appurtenant Structures

	Barind	Paba
° Diversion Structure (Number)	149	17
° Syphon (")	5	3
° Turn-out (")	1,217	391
° Main Bridge (")	4	4
° Farm Bridge (")	15	-

(cont'd.)	Barind		Paba
d) Link Road (km)	10		5
e) Land Acquisition (ha)			
a) Pumping Station	5.7		3.1
b) Irrigation Canal (Main, Secondary & Tertiary)	1,281		278
c) Total	1,286.7	1,567.8 ha	281.1

7) Total Construction Cost

a) Financial Cost	:	4,983 Million TK
b) Construction Cost	:	97,324 TK/ha (2,949 US$/ha)
c) Economic Cost	:	3,164 Million TK
d) Construction Cost	:	61,796 TK/ha (1,873 US$/ha)

8) Total Net Production Value (Economic): 1,366 Million TK.

9) Total Incremental Benefit (Economic): 962 Million TK.

10) Economic Internal Rate of Return : 18.4%

II. PROJECT AREA

5. Socio-economic Conditions

The Project area belongs to two Zilas (districts) of Rajshahi and Naogaon in the Rajshahi Region, and the Upazilas of Godagari, Tanore, and Paba are in Rajshahi District while Niamatpur Upazila is in Naogaon District.

Total population of the Project area was estimated at about 338,000 in 1981 which is about 47% of the total population in the four Upazilas. The annual average population growth rate is 3.8% between 1974 to 1981. The total number of households in the Project area is 58,000 and 73% of working population are engaged in agriculture. The owner-farmers account to 53%, owner-tenant are 30% and tenant-farmers are 17%.

The landless-farmers (less than 0.2 ha farmland) in the Study area is 47%. The GDP per capita in the Study area is approximately 3,400 TK (1984/85) which is about 85% of the national average of 4,000 TK.

6. Soil

The characteristics of the soil in the Barind area is different from that of the Paba flood plain area.

The Barind Tract is an elevated landscape, with marine deposits of Mio-pliocene age. It comprises level mainly in the eastern part, to undulating and locally rolling topography. In the undulating and rolling area, the summits are usually almost level while the slopes are teraced. In the west, the tract is hilly and dissected by narrow valley; there is relatively high and slopes downwards to the east.

The soils in the level to rolling Barind tract are mainly imperfectly drained, mixed yellowish brown and grey, loamy with moderate to strong, medium and fine blocky structure in the subsoils. The clayey substratum,

known as the Madhupur clay, exists at a depth of about 1 meter. The reactions are usually acidic in nature.

The major constraint of crop production is the severe drought during the dry season in the Barind tract.

The Ganges Flood Plain comprises of level ridges, inter-ridge depressions with shallow small and deep broad basins. The soils forming in the upper layers comprise imperfectly drained, pale brown, loamy, firable to slightly firm, with weak to moderate blocky structure. The basins are usually occupied by poorly drained, dark grey to dark greyish brown, clayey soils, etc. They are calcareous either from the top or below the subsoil.

The major constraints of crop production are the relatively deep seasonal flooding and wetness during the early dry season.

The Tista Flood Plain is an area of slightly irregular, low relief with a complex pattern of low, narrow ridges, small basins and infilled channels. The ridges are mainly covered by olive grey to grey, friable, and loamy soils. They are acidic in reaction. The basin margins and low ridges are occupied by grey to dark grey, clayey friable soils.

The relatively deep seasonal flooding and wetness during the early dry season are the major constraints of crop production.

7. Present Land Use

Land utilization of the Upazilas of the Study area in 1986 is classified into four categories: net cropped area, current fallow, cultivable waste, and not available for cultivation. The cultivable area in the Barind tract corresponds to about 82% of the gross area, and in the floodplain is about 70%. Land not available for cultivation which includes homesteads, water bodies and roads, is about 20% to 30% in the Study area.

Paddy is the most important crop in the Project area, both in terms of acreage and crop yield. Aus and both transplanted and broadcast aman are grown, however, there is relatively little boro. Jute and sugarcane

8. Agriculture

In the Barind area, within the total cropped area, rice occupies 91% and the other crops 9%, while in Paba flood plain 50% and 50%, respectively. Cropping intensity of the Barind area is lower (132%) than that of Paba flood plain (158%). Area of transplanted aman (T.aman) is 71% in Barind and only 16% in Paba area where sugarcane and jute are predominant.

The present yield of crops in the both areas are quite low. The average yield of paddy is 1.18 ton/ha to 1.35 ton/ha. Boro has the highest at 2.4 ton/ha and Aus has the lowest at 0.89 ton/ha. Yield of broadcast aman is in between T-aman and aus. The yield of paddy is generally low due to flood and drought. There is no substantial difference in paddy yield between the two areas. Yields of other crops, however, are higher in Paba flood plain area than in Barind area. Average yields of wheat and sugarcane are 2.0 ton/ha and 46 ton/ha, respectively.

In the Barind area, most of cropped area is occupied by rice in which T.aman is the main crop. Therefore, cropping patterns in Barind area are simple and may be mainly mono-cropping of T.aman with some T.aman combined with boro, aus and upland crop.

In the Paba flood plain, on the other hand, rice and upland crops occupy nearly equal area and T.aman is not main crop; moreover, many kinds of upland crops are grown. There may be many cropping patterns in Paba area.

9. Present Irrigation, Drainage and Flood Control

Irrigation facilities in the Project area are normally a small scale utilizing ground water by STW and DTW and surface water by LLP. There is no large scaled significant irrigation project in the area. As for the Barind Integrated Rural Development, however, implementing under the BADC,

2,000 of DTW have been planned to be installed in 14 Upazilas within 5 years from 1984. It has been planned to install 270 DTW in 3 Upazilas related to the Project by 1987, and about 50% of them may be located in the Project area.

Normally, the life time of these DTW is 10 to 12 years. The operating period would probably not overlap with the start of the Project operation taking into account the stage development scheme. The DTW in the Project area located in high land area should be maintained in future as well.

As for the flood control and drainage improvement projects, the implementation of Chalan Beel Project adjacent to the Project area will soon be completed. The polder dike for Polder D area forms as east boundary of the Project. The implementation of the Barnai project has started in 1987 and aimed at flood control of the Barnai river located downstream of the Sib river by construction of polder dike in the right bank of the Barnai river. The flood water level in the Sib river will increase due to the construction of polder dike at both sides of the Barnai river.

In the Paba flood plain area, Karnahar Barabila flood control project was constructed several years ago. Irrigation water supply facility should be facilitated by the Project.

10. Inland Fisheries

Depending on the 1983-84 survey, catch from inland waterbody in Rajshahi region is approximately 31,000 tons. Out of this catch, 34% is from rivers, 29% from beels, 25% from ponds and remaining 11% from flood area. The area of cultured ponds is 30% of total pond area (14,700 ha), but fish production is 65% of catch from the total ponds. Average fish yield in cultured pond is 1.17 ton/ha per year which is lower than that in the tropical area (2-5 ton/ha) due to water shortage in dry season. Fish species from rivers are carp (more than 80% of catch), catfish and live fish. Cultured fish is carp classified as rui, catla, mrigal, grass carp, silver crop and common carp.

DOF (Directorate of Fisheries) controls government-owned ponds and natural or cultured fishery and supplies fingerling through FSMF (FishSeed Multiplication Farm). There are five FSMF in Rajshahi Region which produce fingerling and distribute to the growers. Present production of the fingerling is sufficient to meet the demand in the region. NWRDP has the Aquaculture Development Program which is to improve government-owned derelict ponds for landless people's cooperative (BSS, WBSS) to enterprise fish culture.

III. THE PROJECT

11. Objectives of the Project

The proposed Project aims to expand agricultural production and thus increase income of residents in the area through the introduction of modern agricultural technology and stable year-round irrigation water supply from surface water. Furthermore, the Project is intended to improve the living standards of local residents by introducing rural development such as road network, fisheries and village water supply. The project will also increase employment opportunities not only during the implementation period of the project but also after the completion of the Project, by stimulating private sectors of post-harvest and marketing activities due to large amount of production increments.

In order to achieve the above objectives, the main component of the development plan is providing irrigation facilities in agricultural land for mainly rice. The water resources development to supply irrigation water will be necessary to lift up water from the Ganges or Mahananda rivers by pumps. In addition, supplementary components functionary related to the irrigation development, such as road network development and fish culture development are incorporated into the Project.

12. Selection of Proposed Pumping Stations

All of available maps, aerial photographs, information from the local peoples have been collected and compiled in order to find the most stable and reliable sites for the proposed pumping stations.

Furthermore, in order to determine the latest river conditions, river cross-section survey has been carried out during the Study period in December 1987 from the Sultanganj to Baraipara as well as in the Kasba area.

(1) Pump Station Site for Barind Area

The left bank of the Mahananda and Ganges rivers from Sultanganj to Godagari has largely changed. The Ganges river near Godagari and at the confluence with the Mahananda has shifted about 1.3 km during 1975 to 1983. According to the latest survey results (1987), the bank line again moved back to the river side since 1983 for about 600 m.

Accordingly, the Ganges is near Godagari and the mouth of the Mahananda river oscillating.

The banks of the Mahananda river at Sultanganj and 1.6 km downstream of Godagari at Baraipara are quite stable for a long period. Since the river bank is stable enough at Sultanganj, the site can be proposed for a pumping station operated during the wet season only.

At Baraipara near the Railway Bazar, the Ganges bank line is very stable for the last 50 years and channel is very deep near the bank. The deeper portion is located near the left bank in 1987 and also in 1974 as shown in the cross-section survey conducted by the JRC.

Accordingly, the Baraipara is selected as the most suitable site for the proposed pumping station for Barind Area for a year-round irrigation purpose considering the both points of river bank stability and quantity of the available river water during the dry season.

(2) Pump Station Site for Paba Flood Plain Area

The river bank line movement has been studied from the available Paba Upazila map surveyed in 1940, topographic map scale of 1:50,000 surveyed in 1968. The most accurate record of the river bank condition is the aerial photographs taken in 1975, however, the photographs taken in 1983 were not available.

The river bank was eroded in around 1940. However, since 1975, the river bank near the Kasba did not change for about 12 years.

The cross-section of the river in the Kasba shows that the deepest portion of the river course is located near the left bank and the depth of water is sufficient for the proposed intake site.

Accordingly, the Kasba site has been selected as the proposed pumping station for Paba flood plain area.

13. Alternative Plans

The layout of irrigation canals and irrigable area for the Barind area varies depending upon the elevation of the delivery point of the pumping station. The following four alternative plans have been studied to estimate the cost and benefit, and economic justification has been made to select the optimal plan among them.

Alternative Plan No.1: Delivery elevation of pump: EL 36.6 m (120')
Alternative Plan No.2: -ditto- : EL 30.5 m (100')

Alternative Plan No.3: Delivery elevation of pump: EL 24.4 m (80')

Alternative Plan No.4: Sib river reservoir plan, pumping at Kasba from the Ganges to the Sib river and boosting at Manda in the northern portion of the Sib river to EL 27.4 m (90').

According to the estimation of construction costs, including operation and maintenance cost and agricultural benefit, the financial basis of internal rate of return for each alternative has been estimated. The Alternative Plan 2 shows the highest FIRR and lowest cost per hectare. As a result, the Alternative Plan No.2 has been selected to be proposed for the Project development. Consequently, the net irrigation area in the whole Project area is 51,200 ha in which the Barind area is 42,200 ha and Paba area, 9,000 ha.

14. Agricultural Development Plan

As for the agricultural development plan, several cropping pattern and statistical data have been examined and proposed cropping calendars for Paba and Barind have been determined as shown in Fig. 1. The unit yield production and crop intensity for the present, without project and with project conditions are shown in Table 1.

FIGURE -1. PROPOSED CROPPING PATTERN

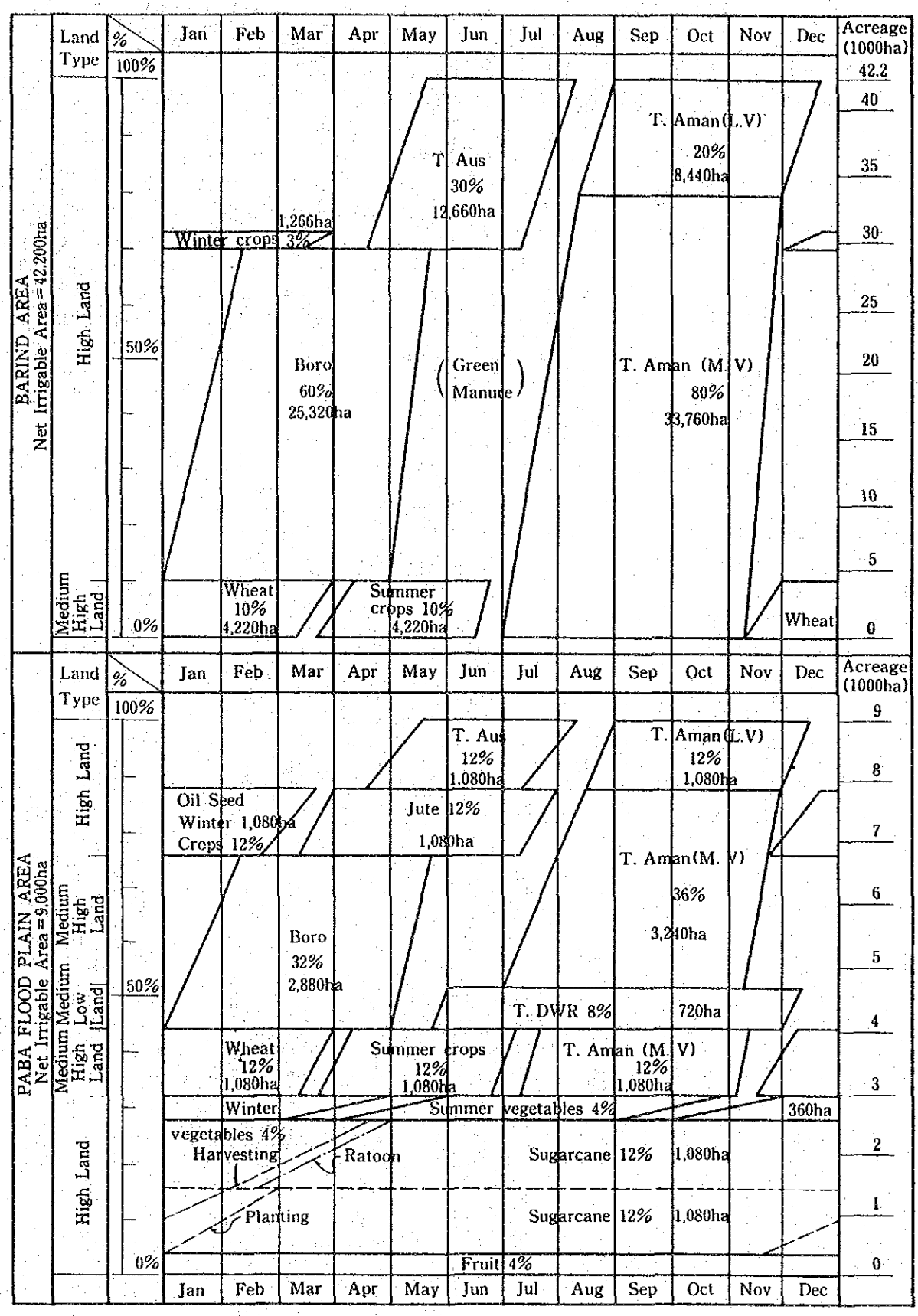


TABLE-1. TARGET YIELD AND PRODUCTION IN THE PROJECT AREA

TARGET YIELD AND PRODUCTION IN BARIND AREA

	Present			Without Project			With Project		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
Rice (total)	50,470	1.35*	67,920	50,470	2.28*	114,843	80,180	4.24*	339,710
Aus	7,980	0.89	7,102	7,980	2.0	15,960	12,660	3.5	44,310
T.aman	39,960	1.39	55,544	39,960	2.3	91,908	42,200	4.0	168,800
Deepwater rice	590	1.08	637	590	1.3	767	-	-	-
Boro	1,940	2.39	4,637	1,940	3.2	6,208	25,320	5.0	126,600
Wheat	2,490	1.96	4.880	2,490	2.3	5,727	4,220	3.2	13,504
Pulses	170	0.71	121	170	0.8	136	4,010	1.2	4,812
Oilseeds	340	0.58	197	340	0.7	238	630	1.0	630
Patatoes	210	6.75	1,417	210	8.0	1,680	210	12.0	2,520
Vegetables & Others	1,940	-	-	1,940	-	-	720	-	-
Total Cropped Area	55,620			55,620			89,970		
Net Cropped Area	42,200			42,200			42,200		
Cropping Intensity	131.8%			131.8%			213.2%		

Note : * weighted average yield

TARGET YIELD AND PRODUCTION IN PABA FLOOD PLAIN AREA

	Present			Without Project			With Project		
	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)	Area (ha)	Yield (ton/ha)	Production (ton)
Rice (total)	7,790	1.18*	9,237	7,960	1.97*	15,655	10,080	4.05*	40,860
Aus	3,370	0.89	2,999	3,450	2.0	6,900	1,080	3.5	3,780
T.aman	2,360	1.59	3,752	2,360	2.3	5,428	5,400	4.0	21,600
Deepwater rice	1,780	1.06	1,887	1,870	1.3	2,431	720	1.5	1,080
Boro	280	2.14	599	280	3.2	896	2,880	5.0	14,400
Wheat	1,230	2.13	2,620	1,530	2.3	3,519	1,080	3.5	3,780
Pulses	500	0.75	375	500	0.8	400	1,080	1.2	1,296
Oilseeds	270	0.65	175	270	0.7	189	1,080	1.0	1,080
Patatoes	300	7.41	2,223	300	8.0	2,400	270	12.0	3,240
Vegetables	320	7.47	2,390	590	8.0	4,720	450	12.0	5,400
Sugarcane	1,820	45.82	83,392	1,950	50.0	97,500	2,160	65.0	140,400
Jute	750	1.45	1,088	1,670	1.5	2,505	1,080	2.0	2,160
Fruits	350	8.10	2,835	350	8.1	2,835	360	12.0	4,320
Others	900	-	-	900	-	-	-	-	-
Total Cropped Area	14,230			16,020			17,640		
Net Cropped Area	9,000			9,000			9,000		
Cropping Intensity	158%			178%			196%		

Note : * weighted average yield

15. Irrigation Water Requirements

Consumptive use : Observed evaporation data
Percolation rate : 1.0 mm/day
Pre-saturation period: 40 days
Pre-saturation requirement:
Land soaking : 60.0 mm
Standing water : 20.0 mm
Total : 80.0 mm

Effective rainfall: less than 5.0 mm/day ineffective, more than 5.0 mm/day is 80% effective.

Irrigation Efficiencies:

	Conveyance	Operation	Field	Total	Overall
Main	0.97	0.98	-	0.95	0.57 (0.61)
Secondary	0.96	0.97	-	0.93	0.60 (0.64)
Tertiary	0.97	0.95	-	0.92	0.64 (0.69)
On-farm	-	-	0.70 (0.75)	0.70 (0.75)	0.70 (0.75)
Total	0.90	0.90	0.70 (0.75)	0.57 (0.61)	

Note: ( ) = Dry season.

Considering the estimated irrigation efficiencies for each irrigation canal, the design unit water requirements were decided, and the results are shown below.

Canal	Design Unit Water Requirement
Main and Pump	1.0484 l/sec/ha
Secondary	1.2345 l/sec/ha
Tertiary & SFD	1.5456 l/sec/ha

Accordingly, the maximum intake capacity for Barind and Paba areas are shown below. However, the design capacity for the proposed pump station has been selected in the maximum value during dry season as also shown as follows:

	Barind Area	Paba Area	Total
Net Irrigation Area (ha)	42,200	9,000	51,200
Wet Season-Maximum Intake Capacity (m^3/s)	44.242	9.436	53.678
Dry Season-Maximum Intake Capacity (m^3/s)	42.588	8.247	50.835

16. Sedimentation Volume

Based on the observed suspended discharge at Harding Bridge, the relationship between the Ganges river discharge (Q m^3/sec) and unit suspended load has been estimated. In accordance with the obtained equation, the intake sedimentation volume of the irrigation water has been estimated for 10-year period. The estimated average annual volumes are approximately 16,000 m^3 and 3,400 m^3 for Barind and Paba area, respectively.

17. Selection of Pump Station Type

From the economical and technical points of view, three types of pumping station have been considered: (1) Floating-type, (2) Inclined-type, and (3) Fixed-type. In addition, the site for the pumping station at Sultanganj and Baraipara together with the types of pump stations have been compared.

As a result, the fixed-type pumping station has been selected as the most economical and technically reliable type of pump station. The fixed-type pumping station at Baraipara site has been selected for the Barind area, and the same type at Kasba site for the Paba flood plain area.

18. Irrigation Plan

To increase the irrigation area as much as possible, sub-secondary canals diverted from the secondary canal have been provided in the undulating area.

As for the on-farm development, three types of layout of the terminal facilities have been proposed in the Barind area and one type has been proposed in the Paba area.

19. Drainage Plan

In the Barind area, the river course is rather steep and the river bank is too much eroded. It will be too costly to perform river training works such as re-excavation, bank protection and drop structures construction. This area has been neglected from the beneficial area.

The outlet of the drainage canal is located quite near the proposed Kasba pumping station. During the peak flood time, the Ganges water level is higher than the water level in the Paba area. The Kasba pumping station could be utilized for drainage purposes.

During the peak flood in the Ganges river, the water level becomes higher than the inland water level. So there is no possibility to drain to the Ganges river by gravity. However, during pre-monsoon and post-monsoon period, there will be a possibility to drain the Sib river through Joakhali river to the Ganges river through Damkura Khal.

Accordingly, the drainage plan is proposed to connect the Joakhali river at Kasba to the Ganges river site with a regulator.

IV. PROJECT IMPLEMENTATION AND COST

20. Executing Agency of the Project

The Bangladesh Water Development Board (BWDB) will be the principal implementing agency. Under the Ministry of Irrigation Water Development and Flood Control, BWDB is responsible for planning and implementing new water development projects as well as for operation and maintenance of the completed projects.

The North Rajshahi Irrigation Project (NRIP) will be implemented by Rajshahi Water Development Circle under the Chief Engineer Project II, Pabna. The superintending engineer's office for NRIP will be newly established under the Chief Engineer Project II Pabna and three executive engineers (two for civil, one for mechanical) will be assigned under the superintending engineer.

21. Implementation Schedule

The construction of the Project is planned to commence within two and half years after the completion of the Feasibility Study taking into consideration the loan procedure, detailed design and tendering.

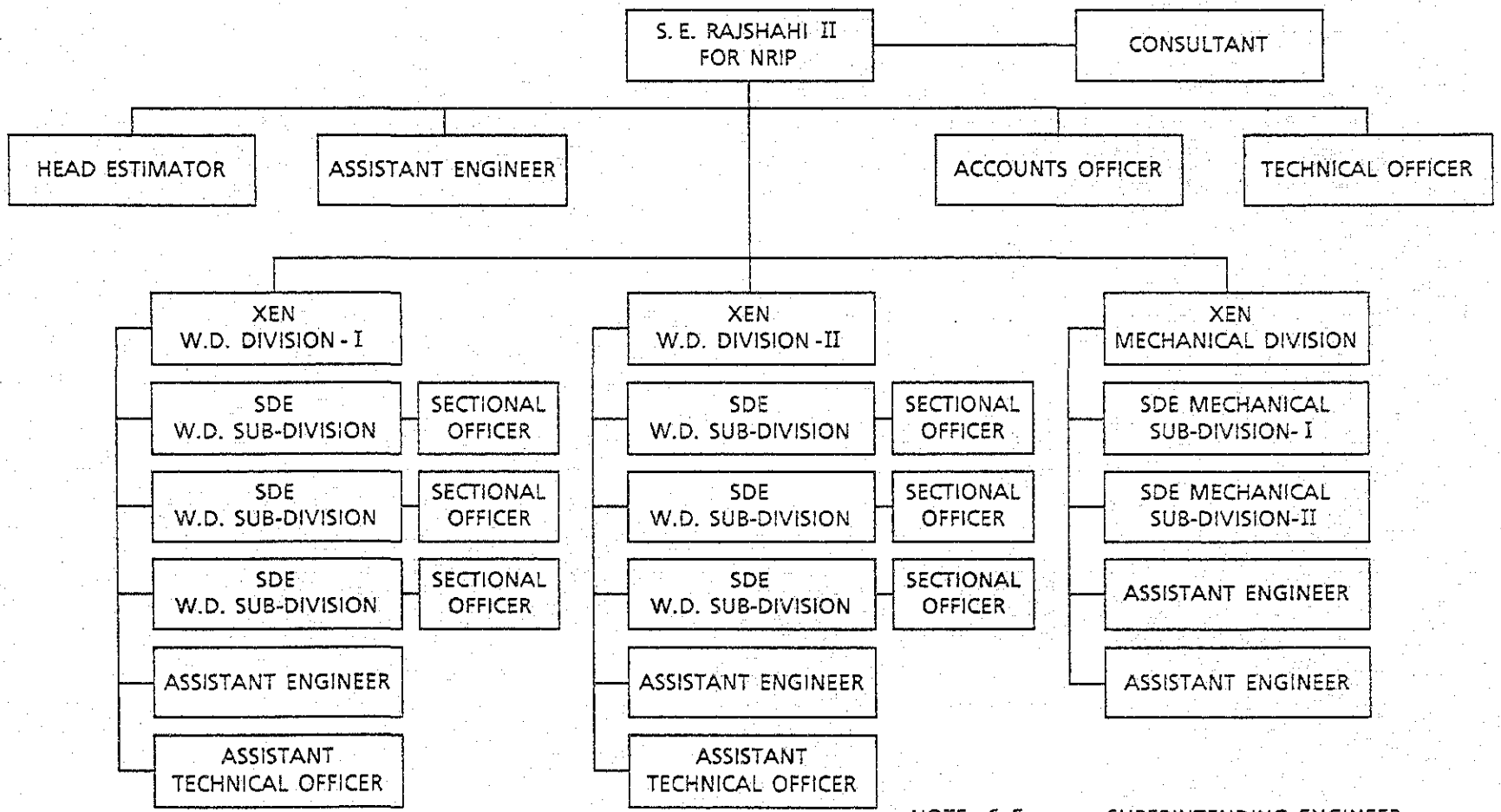
The construction of major works will take about six years. On-farm works will also be carried out in parallel with the major works to supply irrigation water as early as possible. The implementation program is shown in Figure 2.

22. Project Cost

The total cost of the Project is estimated at about TK. 4,983 million, which includes the foreign currency component of TK. 2,358 million (47%), local currency of TK. 1,818 million (37%), and import tax of TK. 807 million (16%).

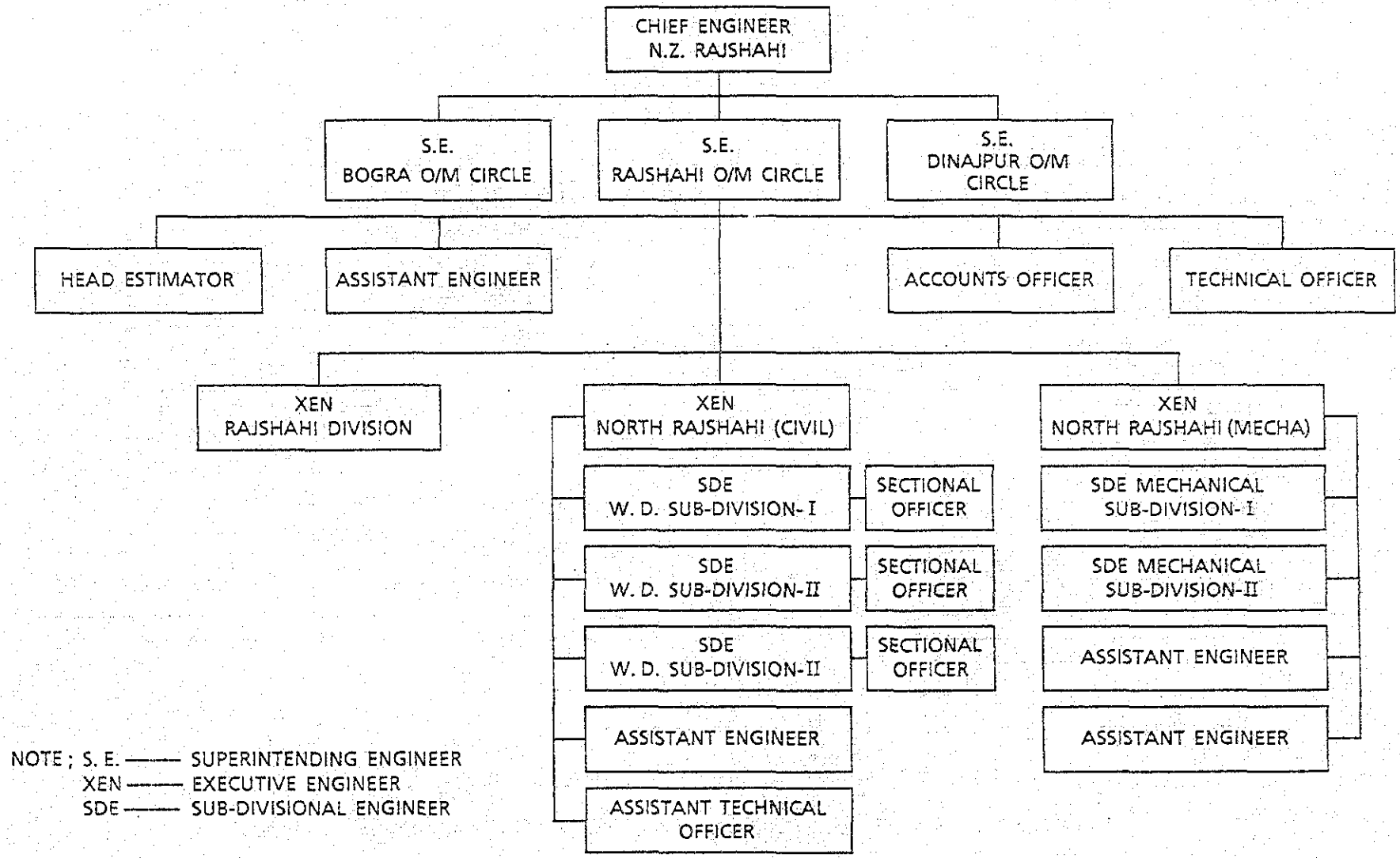
The summary of the project cost is shown in Table 2.

FIGURE - 3. PROPOSED ORGANIZATION CHART OF IMPLEMENTATION FOR THE NORTH RAJSHAHI IRRIGATION PROJECT



NOTE ; S. E. ——— SUPERINTENDING ENGINEER
XEN ——— EXECUTIVE ENGINEER
SDE ——— SUB-DIVISIONAL ENGINEER

FIGURE - 4 . PROPOSED ORGANIZATION CHART OF OPERATION AND MAINTENANCE FOR THE PROJECT



NOTE ; S. E. —— SUPERINTENDING ENGINEER
XEN —— EXECUTIVE ENGINEER
SDE —— SUB-DIVISIONAL ENGINEER

FIGURE 2. The Project Implementation Schedule

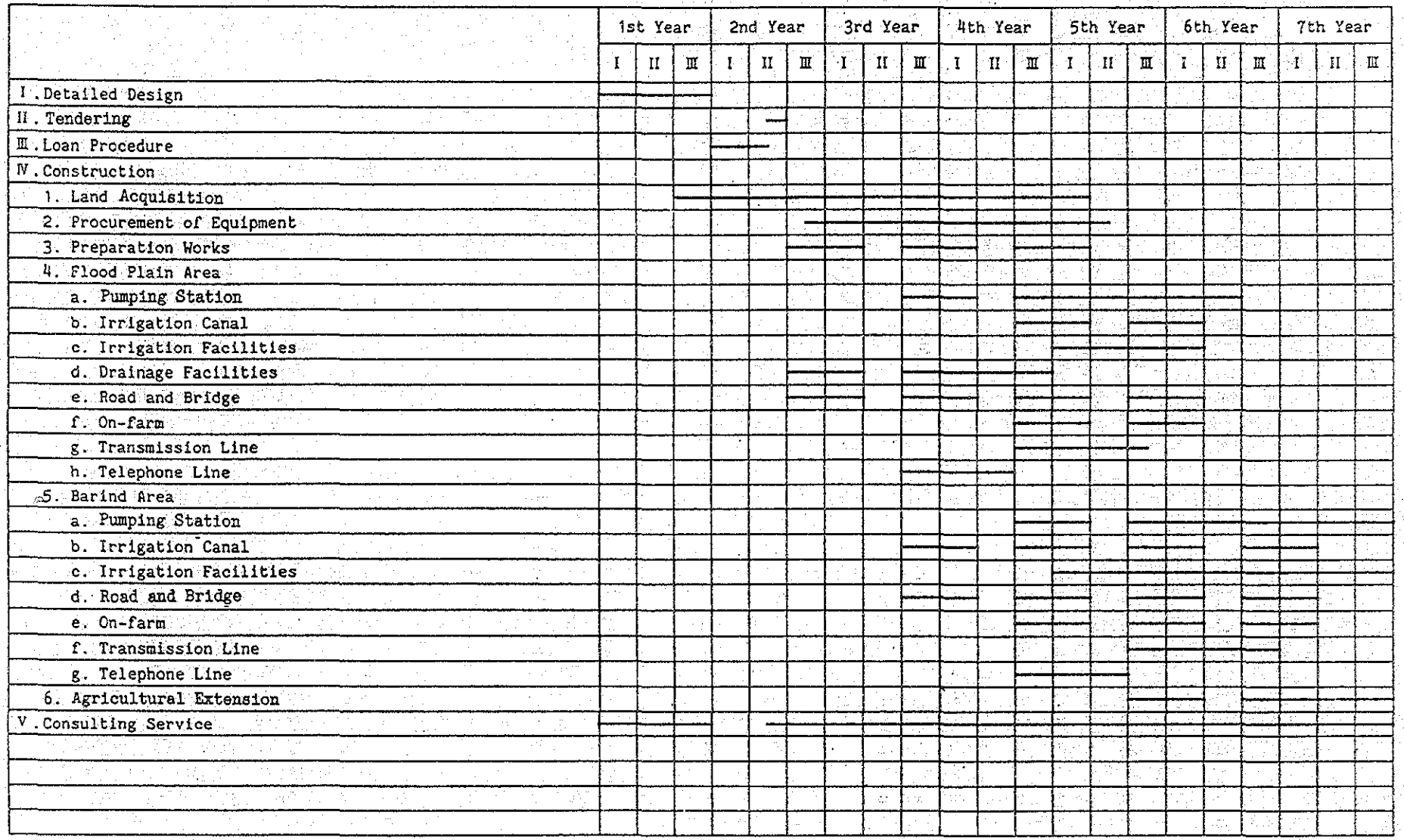


TABLE 2. PROJECT COST

(Unit: '000 Taka)

Item	F/C	L/C	Tax	Total
1. Construction Cost				
a. Pumping Station	1,402,887	183,039	572,036	2,157,962
b. Irrigation Canal	36,082	235,875	-	271,957
c. Irrigation Facilities	54,898	57,328	-	112,226
d. Drainage Facilities	89,810	114,165	-	203,975
e. Road and Bridge	14,118	222,723	-	236,841
f. On-farm	-	70,663	-	70,663
g. Transmission Line	46,705	6,765	23,352	76,822
h. Telephone Line	240	960	-	1,200
Sub-total	1,644,740	891,518	595,388	3,131,646
	(53%)	(28%)	(19%)	
2. Associated Cost				
a. Construction Machinery	102,363	5,473	51,402	159,238
b. Agricultural Supporting Facilities	11,900	12,190	5,400	29,490
c. Land Acquisition	-	222,875	-	222,875
d. Consulting Service	190,938	38,016	-	228,954
e. Project Administration	4,332	74,642	2,166	81,140
Sub-total	309,533	353,196	58,968	721,697
Total (1 + 2)	1,954,273	1,244,714	654,356	3,853,343
3. Physical Contingency	256,623	170,500	98,153	525,276
4. Price Escalation	140,312	407,903	56,307	604,522
Grand Total	2,351,208	1,823,117	808,816	4,983,141

V. PROJECT EVALUATION

23. Economic Justification

Comparison between project cost and benefits is shown in Table 3 in the succeeding page.

The overall FIRR is 13.6% and EIRR, 18.4%. FIRR and EIRR for the Barind area are respectively 14.4% and 19.7%. FIRR and EIRR for the Paba Flood Plain area are 10.2% and 13.0%, respectively. The benefit cost ratio (B/C ratio) with discount rate of 15% of the overall is 1.26. The figures of overall EIRR and B/C ratio seem reasonable for an irrigation improvement scheme which aims at production improvement in the agricultural sector including inland fisheries sector and rural road network sector.

24. Analysis of Farm Household Income

Farm households (including landless farmers) in the Project area depend mainly on paddy culture with an average area of 1.0 ha (1.5 ha in case of excluding landless farmers). According to Farm Economic Survey, the income of a farm household with an average operated area of 1.7 ha of medium farm is assumed to be TK 20,991 per year at present. Upon implementation of the Project, however, income will become TK 58,073 per year, out of which agricultural income is TK 45,184 per year and non-agricultural income is TK 12,827 per year, with a disposable income of TK 57,174 per year and with farm household economic surplus of TK 33,178 per year due to the enhancement and upgrading of cropping ratio, and increase in yield.

TABLE 3. COMPARISON OF PROJECT COST AND BENEFITS

	Barind	Paba Flood Plain	Overall
A. Financial Indicator			
1. Construction Cost (000TK)	3,953,547	1,029,594	4,983,141
15% Discount Rate	2,535,640	674,830	3,210,440
2. Benefit (000TK)			
- Annual Benefit	960,100	142,100	1,102,200
- Present Worth Value (15% Discount Rate)	2,415,050	464,520	2,879,570
3. Benefit Cost Ratio			
- 10% Discount Rale	1.44	1.01	1.36
- 15% - do -	0.95	0.69	0.90
- 20% - do -	0.67	0.50	0.63
4. Internal Rate of Return (%)	14.4	10.2	13.6
B. Economic Indicator			
1. Construction Cost (000TK)	2,450,119	713,881	3,164,000
15% Discount Rate	1,631,940	473,580	2,105,480
2. Benefit (000TK)			
- Annual Benefit	896,700	126,800	1,023,500
- Present Worth Value (15% Discount Rate)	2,250,270	411,100	2,661,450
3. Benefit Cost Ratio			
- 10% Discount Rate	2.05	1.28	1.89
- 15% - do -	1.38	0.87	1.26
- 20% - do -	0.98	0.64	0.90
4. Internal Rate of Return (%)			
- Proto - type (Sensitivity Test)	19.7	13.0	18.4
a) 10% increases in Construction Cost	18.4	12.0	17.1
b) 10% reduction in benefit	18.1	11.7	16.8
c) Two year delay in benefits	18.1	12.0	16.9
d) Combination of (a) and (b)	16.9	10.7	15.7
e) Combination of (a) and (c)	17.0	11.1	15.8
f) Combination of (b) and (c)	16.7	10.8	15.5
g) Combination of (a), (b) & (c)	15.6	9.9	14.5

VI. CONCLUSION AND RECOMMENDATION

(1) According to the studies, investigations, survey and analysis for the North Rajshahi Irrigation Project, the economic feasibility, technical soundness as well as the advantageous impacts were verified in this report, and an early implementation of the Project is strongly recommended in order to achieve rural development and thus contribute to the development of the nation as a whole.

(2) Annual investment for overall development, however, is large taking into consideration the present financial situation in the country. In the event that immediate overall implementation is not feasible, staged development is recommended as presented in this report.

(3) In the Project area, the development schemes have been divided into two areas; namely, Barind area in high elevated flood-free area and Paba flood plain area. Comparing the economic viability of the two areas, the Barind area is more economically advantageous than the flood plain area.

The flood plain area is the most common and predominant area in Bangladesh and most of the irrigation projcts in the past have been implemented in such areas. The large-scale irrigation project, however, in the high elevated area in the Barind Tract has been firstly studied in Bangladesh and has been concluded that the economic viability is higher than that of the flood plain area. It has been recommended to consider the results of the study for the selection of a priority project to be implemented in the future.

Also, in order to utilize the limited capacity of the Ganges river water for irrigation, it is recommended to study a master plan to decide the priority of the project implementation along the area located in the Ganges river basin such as extension of G-K project, Barnai irrigation project. The study should be carefully analyzed considering the environmental impact to the downstream area especially salt water intrusion.

(4) The Study has been performed to use the topographic maps scale in 1:7,920 which had been surveyed for about 20 years before. For detailed design and implementation, the lastest topographical map of scale about 1:10,000 scale will be required to cover the whole project area.

(5) Periodical survey for river bank shifting and cross-section will be necessary at the proposed pumping stations at Baraipara and Kasba in the Ganges river.

(6) Detailed geological investigation will be required at proposed pumping station sites and major facility sites in the Project area.

(7) This Project is the first large-scale irrigation project in the Barind area. It is recommended that a pilot farm for research works of crops, farming system, water management, etc. is necessary to be constructed in the Barind area considering the soil type and topographic conditions. The pilot farm will be recommendable including the extension services.

(8) The main component of the Project is agricultural development through the introduction of year-round irrigation. Various rural development components such as road network and inland fisheries development have been also incorporated in the Project and thus a substantial impact on promotion of development in rural society is envisioned with the project implementation. In order to obtain maximum benefit, it is recommended that BWDB should discuss the Project with related agencies for smooth implementation and effective operation and management.

(9) After implementation of the Project, rice production in the Barind area and Paba area will be respectively 5 times and 4.3 times of the present one. Accordingly, the quantities of farm input such as fertilizer, seeds, etc. will also be increased. Although the capacity of the existing rice mill facilities will be insufficient under project conditions, milling is sufficiently profitable as a private industry to stimulate private investment. It is envisioned that

milling under the Project will depend on enlargement and improvement of private facilities. Promotion of these activities should be conducted by BWDB in consultation with related agencies. Also, the improvement and strengthening of the farm input supply system will be required.

(10) It will be necessary to promote the inland fisheries development project to utilize the existing ponds and beels along the Sib river because fresh water supply throughout the year after the completion of the Project.

Also, training and demonstration of water management for both inland fisheries use and irrigation water use will be required for the farmers.

(11) Plantation of trees will be recommendable along the main canal and operation and maintenance road.

(12) In order to confirm and monitor the project benefit increase after the project implementation, a post-project evaluation should be carried out.

CHAPTER 1
INTRODUCTION

CHAPTER 1. INTRODUCTION

1-1. General

In response to the request of the Government of the People's Republic of Bangladesh (hereinafter referred to as "the Government of Bangladesh"), the Government of Japan has entrusted the implementation of the Feasibility Study (hereinafter referred to as "the Study") on the North Rajshahi Irrigation Project to the Japan International Cooperation Agency (hereinafter referred to as "JICA") under the technical cooperation programme. Toward this end, JICA had dispatched a Preliminary Survey Team to Bangladesh from 26 January 1987 to 7 February 1987. On 5 February 1987, an agreement had been reached between the Bangladesh Water Development Board (hereinafter referred to as "BWDB"), the executing agency of the Government of Bangladesh.

In accordance with the above agreement, JICA dispatched the Feasibility Study Team (F/S) composed of 9 members to Bangladesh from 15 July 1987 to 12 September 1987. During this period, the Team, in cooperation with BWDB officials, carried out the field survey. The results of the First Stage Field Work were compiled in a report (Field Note(I)) and submitted to BWRD.

From 13 September to 4 November 1987, the Team undertook various studies in the home office, the results of which were compiled and presented to BWDB in the Interim Report. Subsequently, JICA dispatched the Team for the Second Stage Field Work composed of 11 members to Bangladesh from 5 November to 30 January 1988. During this period, the Team, in cooperation with the BWDB officials carried out the Second Stage Field Work. Prior to the actual field study, the Team met with BWDB officials concerned to discuss the Interim Report and the scope and purpose of the Second Stage Field Work.

Upon completion of the field work, the Team compiled the results in Field Note(II) and presented to BWDB. From 31 January 1988 to 25 March 1988, the Team has integrated all of the previous works, studies, design,

cost estimation and economic justification in the draft Final Report. Subsequently, in April 1988, the Draft Final Report was presented to the Government of Bangladesh.

The Team completed the Final Reort in August 1988 incorporating the comments of BWDB officials and other related agencies on the draft Final Report.

1-2. Background

From administrative point of view, the Study area is located in two zilas (districts); namely, Rajshahi and Naogaon of Rajshahi Region which is included in Rajshahi Division, adjoining the West Bengal of India. This area displays the typical type of alluvial plain of the delta in the east and south, and the hills called Barind Tract in the West. The alluvial plain is about 12 m (40 ft) above the mean sea level, whereas Barind Tract being between 12-45 m (EL. 40-130 ft).

Population of this area is about 800,000, and the estimated annual population growth rate is about 3%. 90% of the population are engaged in agriculture, of which 60% are independent farmers, 10% tenant-farmers and 30% landless-farmers.

The average annual rainfall in the Study area is 1,400 mm, which is less as compared to the other regions of Bangladesh.

The present cropping intensity of the area is about 130%, which is relatively low as compared with the national average of 140%.

On the Third National Five-Year Development Plan, the Government of Bangladesh has put an emphasis on self-sufficiency in food and improvement of productive employment; viz., job opportunities for 5,000,000 people, of which 2/3 are expected to be absorbed in the agricultural sector.

Following this policy, the North-Western Agricultural Development Project was planned in 1983 by the Asian Development Bank, and a part of this proposed area was already implemented. However, the irrigation water

resources of this region depend on middle-and small-sized rivers and groundwater; thereby, the expansion of irrigable land is quite limited. Therefore, the Government of Bangladesh has put strong emphasis on this Project to utilize the water from the Ganges River.

1-3. Objective of the Study

The objectives of the Study are to formulate the North Rajshahi Irrigation Project and to establish technical feasibility, economic viability and socio-economic acceptability.

1-4. Study Area

As for the selection of the Study area for the Feasibility Study, the area mentioned in the Scope of Works has been studied on the basis of topography, river flooding area, soil and land use, on-going development projects, potentiality and necessity of irrigation. As a result, the selected Study area was accounted at about 150,000 ha, embracing mainly the eastern slope of the Barind tract and lower flat area in the western side of the Rajshahi City.

1-5. Activities of the Study Team

1-5-1. Study Period

The Study has been conducted according to the following two phases and each phase consisted of field work in Bangladesh and home office work in Japan.

(1) First Phase Field Work (Rainy Season)

After preparatory home office work for one week starting on 8 July 1987 in Japan, the first stage field work in Bangladesh was commenced from 15 July to 12 September 1987. The field work consisted of basic fact-finding survey, data collection and field investigation during rainy season.

At the end of field work, Field Note(I) was submitted.

(2) First Phase Home Office Work: 13 Sep to 4 Nov 1988
Basic concepts of the development strategies and alternative plans were studied on the basis of the data and information collected in the field. The results of these studies and the second stage survey works were compiled in the Interim Report.

(3) Second Phase Field Work (Dry Season): 5 Nov 1987 to 30 Jan 1988
Taking into account the dry season period, field investigation at the project site such as topographic survey, geological and soil investigation were carried out from 22nd October 1987.

At the beginning of the second stage, the basic concepts of the development strategies along with the Interim Report were discussed with BWDB. In accordance with the discussion on the basic development approach and data collection in the dry season, the basic final development plan was formulated. Preliminary project cost and economic evaluation were estimated. The results of the formulation were presented in the Field Note(II) which was submitted at the end of January 1988.

(4) Second Phase Home Office Work: 31 Jan to 25 Mar 1988
All previous works such as survey results, field investigation, studies, analysis and design outlines were reviewed and integrated and finalized. On the basis of the analysis and studies, the final development plan, cost estimation and project evaluation were compiled in the draft Final Report which was sent to Bangladesh at the end of April 1988.

(5) Compilation of Final Report
Discussions were held in accordance with the comments from the Bangladesh Government officials from 14th June to 23rd June 1988 at BWDB on the draft Final Report. The Final Report has been compiled in August 1988 which incorporates the comments and results of discussions of the Government of Bangladesh.

1-5-2. Personnel Involved in the Study

During the Feasibility Study period, the personnel involved in the Study are as listed below:

Members of Feasibility Study Team

Speciality	Name
Team Leader	IWAMOTO Ikuzo
Irrigation & Drainage/ Co-Leader	KOBAYASHI Toshimasa
Meteorology & Hydrology	TANAKA Hirofumi
Structural Design (I)	TAKAGI Tadashi
Structural Design (II)	KANEKO Yoshikazu
Foundation Analysis	GOTOH Hyosaku
Construction Planning & Cost Estimate	GOTOH Eiji
Soil & Land Use	TERASAWA Shiroh and NAGAI Masao
Agronomy	FUJII Sadakichi
Supervise for Topo-Survey	HORI Shinwa
Agro-Economy	INADA Shou

BWDB Counterpart Personnel

Names and Designation	Responsibilities
Mr. Md. Taslimuddin, Director, Planning (General) BWDB, Dhaka	Team Leader at Dhaka Camp Office
Mr. Sk. Amir Ali Superintending Engineer Rajshahi WD Circle BWDB, Rajshahi	Team Leader at Rajshahi Camp Office
Mr. Emam Hossain Khan Chief Soil & Agri. Survey Officer Planning (General), BWDB	Soil and Land Use

BWDB Counterpart Personnel (cont'd.)

Mr. K.B.M. Safiuddin Superintending Engineer Design Circle, South Eastern Zone	Structural Design, Irrigation & Drainage
Mr. Azizul Haque Sr. Agricultural Planning Officer Dte. of Planning (General), BWDB, Dhaka	Agronomist
Mr. Shahadat Hossain Chowdhury Executive Engineer Dte. of Planning (General) BWDB, Dhaka	Meteorology & Hydrology at Dhaka
Mr. A. Baten, Executive Engineer Rajshahi W.D Division, BWDB Rajshahi	Meteorology & Hydrology at Rajshahi
Mr. H.S.M. Faruque Executive Engineer, Dte. of Planning (General), BWDB, Dhaka	Irrigation and Drainage
Mr. Nityananda Chakravarty Economist Dte. of Planning Schemes-I, BWDB, Dhaka	Economist

BWDB Officials Contacted during the Study

Name	Position
Mr. Amjad Hossain Khan	Chairman, BWDB
Mr. Shamsur Rahman	Member Planning, BWDB, Dhaka
Mr. Abdul Barik Bhuiyan	Chief Engineer, Planning, BWDB, Dhaka
Dr. A. Sattar	Director, Land & Water Use, BWDB, Dhaka
Mr. Syed Shahadat Hossain	Director, Surface Water Hydrology-1, BWDB, Dhaka
Mr. A. Matin	Director, Surface Water Hydrology-2, BWDB, Dhaka
Mr. Lutfor Rahman	Director, Planning Schemes-1, BWDB, Dhaka

BWDB Officials Contacted during the Study (cont'd.)

Mr. A.B.M. Abdul Hai	Director, Planning Schemes-3, BWDB, Dhaka
Mr. Lutfor Rahman	Executive Engineer, Planning Schemes-2, BWDB, Dhaka
Mr. Golam Robbani	Executive Engineer, Planning Schemes-4, BWDB, Dhaka
Mr. Aftab Alam Ansari	Chief Staff Officer, Chairman's Secretariat, BWDB, Dhaka
Mr. S.A. Ainul Qavi	Executive Engineer, Office of the Chief Engineer, Planning, BWDB, Dhaka
Mr. Md. Abdul Gofur	Assistant Engineer, Rajshahi W.D Circle, BWDB, Rajshahi
Mr. Md. Abdus Sobhan	Assistant Engineer, Rajshahi W.D. Division, BWDB, Rajshahi
Mr. Ahmd. Abdul Momen	Sub-divisional Engineer Rajshahi, W.D. Sub-division BWDB, Rajshahi
Mr. Md. Rafiand Islam Chowdhury	Assistant Engineer Dte. of Planning (General) BWDB, Dhaka

Other Offices Contacted during the Study

° Agricultural Extension, Rajshahi Zone

Mr. Golam Rasul, Deputy Director

Md. Mojaher Uddin Mondal, Subject Matter Specialist (Plant Protection)

Md. Abul Hasanat, Subject Matter Specialist (Horticulture)

Mr. Brojahari Das, Upazila Agricultural Officer, Tanore, Raj.

Mr. S. M. Anwarul Azim, Upazila Agricultural Officer, Paba, Raj.

° BRRI, Regional Station, Rajshahi

Md. Abu Yussouf, Principal Scientific Officer

Other Offices Contacted during the Study (cont'd.)

° BARI, Sub-station Extension & Research Project, Rajshahi
Saroi F.S. R Site, Godagari (Farming System Research)

Mr. Abu Mussa, Senior Scientific Officer (Soil Scientist)

Mr. Nirmal Kar, Senior Scientific Officer (Agronomist)

Mr. Fakhrul Islam, Scientific Officer (Agricultural Economist)

° District Fisheries Office, Rajshahi

Mr. Ali Akbar, Deputy Director

Mr. Anwarul Huq, District Fisheries Officer

° District Livestock Office, Rajshahi

Dr. Abdul Haq Biswas, District Livestock Officer

Dr. Muhammad Altaf Ali, Additional District Livestock Officer

° SRDI, Regional Office (Soil Resources Development Institute)

Mohd. Idris Ali, Principal Scientific Officer

Mr. Delawar Hossain, Scientific Officer

° Regional Statistical Office, Rajshahi

Md. Kaikobad, Regional Statistical Officer

Alhaj Md. Abdur Razzaque, Assistant Statistical Officer

° BADC, Rajshahi

Mr. R. H. Khan, Project Director, BIADP

Mr. S.M. Ali Imam, Superintending Engineer

° BRDB, Rajshahi (Bangladesh Rural Development Board)

Md. Mahbubur Rahman, Project Director, Raj.

Md. Mahfuzur Rahman, Deputy Project Director, Raj.

CHAPTER 2
PROJECT BACKGROUND

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2-1. National Background

2-1-1. Socio-economy

(1) Economy

The Government of Bangladesh has undertaken the First Five-Year (FY 1973-78), Two-Year (FY 1978-80) and the Second Five-Year (FY 1981-85) Plans successively with the objectives of satisfying the basic human needs of the people, accelerating the economic growth, establishing food self-sufficiency and promoting self-reliance on national economy for the purpose of getting out of dependence on foreign aid since her independence in 1971. But planned efforts could not have achieved the expected target, influenced by external and internal events. Externally, the world economy has worsened as it passed through the period of rapid inflation and stagnation during the last decade followed by the recession in the first half of 1980's because of the first and the second oil crisis and international monetary adjustment. Internally, frequent natural calamities such as floods, droughts, and cyclones have caused significant loss of crops. Generally speaking, however, the national economy of Bangladesh has made remarkable progress.

The gross domestic production (GDP) of Bangladesh recovered its pre-independence level of GDP by 1976/77 (Tk. 7829 crore in 1984-85 at 1972-73 factor cost giving an annual real growth rate of 4.7% from 1976 to 1985. During this period (1973-85), significant development was made in the industries and other sectors with an annual real growth rate of 6.2% and 5.8%, respectively. On the contrary, the agricultural sector dropped to 3.8%.

In spite of the fact mentioned above, the agricultural sector occupied a large portion of GDP, i.e., 54.3% in 1984/85. Also, in industrial sector, the main industries achieving significant development are those related to agriculture, for example, jute and cotton textile industries

which use agricultural crops as their raw materials, and fertilizer industry. The fundamental structure of national economy of Bangladesh is therefore based on agriculture.

The cultivated area in Bangladesh amounts to 63% of the total area. 85% of total households is in rural and 85% of total population reside in the rural area. 86% of economically active population is occupied by agriculture. These ratios also show that Bangladesh is primarily an agricultural country.

The annual real growth rates of GDP at constant market prices for six years (1981/82-1985/86) are 0.8%, 3.6%, 4.2%, 4.2%, 4.1%, and 5.2%, respectively. These indicate a steady growth of the economy. GDP at constant factor cost per capita is Tk. 776 in 1984/85 and Tk. 798 in 1985/86. Its average annual real growth rate of population is 2.8%.

In spite of significant development in national economy, Bangladesh still depends on foreign financial aid, which is nearly fifty percent of government financial resources. The ratio of grants to loans in foreign economic aid is about 52-58% to 42-48% during the last five years. The government of Bangladesh repays foreign debt, ranging from US$660 to US$1,120 million (commitment) every year.

In foreign trade, the government has taken export-promoting and import-controlling policy. The total import amount in 1984/85 was Tk. 68,263 million with nominal increasing rate of annual average is 16.3% during 1980/81 to 1984/85.

The total export amount is Tk. 26,225 million with nominal increasing rate of 22.9%. But in the year of 1984/85, growth rate of import exceeded that of export. The excess of import in 1984/85 increased to Tk. 42,000 million. The deficit in balance of payment of foreign trade is covered with current account and off-set by surplus on capital account.

The expenditure on development plan increased drastically during 1980/81 to 1984/85 with annual average nominal increasing rate of 12.0% and reached Tk. 38,800 million in 1984/85. This expenditure is distributed to agriculture, flood control and water resources, power and natural resources, and transport sectors so as to plan food self-sufficiency and capital stocks in fundamental sectors of national economy.

Gross investment in GDP in 1985/86 is 12.7% which decreased as compared with 16% in 1980/81, but was nearly equal to 12.3% in 1983/84 and 13.3% in 1984/85. Gross domestic savings in GDP in 1985/86 is 3.8% which increased remarkably as compared with 0.4% in 1981/82, 0.3% in 1982/83 and 1.2% in 1983/84.

Indices of wholesale price and consumer price show an upward tendency, especially, those of wholesale price are rising at high rate. Annual rising rate of whole price is 12.8% in 1981/82, 5.6% in 1982/83, 16.2% in 1983/84, 17.1% in 1984/85, and 11.8% in 1985/86. Annual rising rate of consumer price also shows 16.5% in 1981/82, 9.8% in 1982/83, 9.5% in 1983/84, 11.2% in 1984/85 and 9.8% in 1985/86, though these are not as high rate as those of wholesale price. The national economy of Bangladesh has thus been under the inflation to a considerable degree.

The value of the currency Taka has been comparatively stable as appeared from the exchange rates for US$1.00 against Tk. 29.38 (WES rates) in 1984/85, Tk. 32.74 in 1985/86 and Tk. 33.08 in 1986/87.

(2) Social Conditions

The objectives of social development of Bangladesh are to alleviate poverty, particularly in rural areas, and to satisfy the basic human needs. For this purpose, various necessary programs have been implemented in the national development plans such as the First Five-Year Plan, Two-Year Plan and the Second Five-Year Plan, etc.

The population, which is the maximum restricting factor, is about 100 million in the small land area of 144,000 sq. km. The population density has reached 698 per sq.km. Owing to the effect of population control policy, the population growth rate was tentatively lowered to 2.32% (1974-81) but it shows rapid increase, i.e. 2.8%, again in the recent years. Therefore, more effective population control measures are required to be undertaken.

The literacy of nationals is about 20%. The government has concentrated on the primary education (for children between 5 to 10 years old). As a result, the number of pupils has increased. The enrolment ratio is about 63%.

Supply of other social infrastructures relating to BHN has increased year by year. The number of beds in hospitals in 1985 is 0.32 bed per 1,000 persons, number of drinking water supply facilities in 1981 is 35 units per 1,000 households in 1985, and available new clothing material is 7.9 m per person in 1985.

In particular, the growth rates of drinking water supply facilities and rural electrification are high, with annual growth of 6.4% and 22.5%, respectively.

Economically active population is about 44% of total population of 10 years and up. About 80% of male population is actively working. Only 8% of female are working (1983-84). About 30% of the total population (about half of the male population and about 5% of female), are engaged in economic activities.

Agriculture provides the highest occupation (61%). In particular, 63% of male are engaged in agriculture. On the other hand, about 26% of total population, excluding students, suffers from unemployment. 40% of total households is engaged as agricultural labour, of which 23% of total available labour forces are only employed.

Urban population is 17.5 million in 1985. The growth rate of urban population during the period from 1974 to 1981 was 11.2%, and 7.2% during the period 1981 to 1985. This is the result of population inflow from rural areas. Accordingly, the working population in urban area has rapidly increased with high growth rate of 4.4% (1974-81) and 5.7% (1981-85). This population inflow to urban area has caused the housing problems and unemployment problem in the urban areas.

At present, average daily calorie intake per capita is 1,950 kilo calorie. The necessary calorie is 2,200 kilo calorie and it is estimated that the population taking less amount of the necessary calorie reaches 71% in 1981-82. Namely, more than 70% of the nation's population are suffering from malnutrition. Furthermore, it is projected that people suffering from malnutrition would increase due to low wage (especially agricultural laborer) and inflation. However, the government has been pursuing programs for improving calorie-intake condition of the people lying on or below poverty-line through higher food production and distribution. The proportion of population taking calories less than 2,200, 1,800, and 1,600 during 1973/74 has therefore been reduced by 2, 5, and 9 percent, respectively, during 1981/82.

2-1-2. Agricultural Production and Food Balance

Due to the rapid increase in population, the ratio of land area or arable area to population shows the tendency of decreasing year by year. Accordingly, the supply to demand for foods have become unbalanced. This fact induces the nation's malnutrition and increases foods import. So increase in food production and self-sufficiency of foods have been given the highest priority in Bangladesh.

(1) Agricultural Production

Cropping area of rice has been decreasing but the production shows increasing tendency, owing to the extension of cultivation technology, expansion of HYV cropped area, increase in irrigation facilities and progress in flood control projects. The rice production in 1984/85 is 14.4 million tons.

Both cropping area and the production of wheat have been increased. The wheat production in 1984/85 is 1.44 million tons. HYV contributes a major portion.

The production of foodgrains (rice and wheat) is 15.8 million tons, which is 95% of production target.

(2) Food Balance

The food deficiency is conspicuous because of the growing demand and population increase even though the supply of foodgrains (rice and wheat) is increasing gradually. The deficiency ratio exceeds 10% and the food self-sufficiency becomes difficult. The food deficiency is supplemented by the import from foreign countries. In 1984/85, 729,000 tons of rice and 1,805,000 tons of wheat are imported. They are the major components of import.

Assuming that 1,600 kilo calories per capita per day are taken from foodgrains, 450 grams of foodgrains are necessary. Based on the population data in 1984/85, a total of 16.09 million tons of foodgrains (equivalent to 24.75 million ton of paddy) is necessary.

2-1-3. Third Five-Year Plan (1985-1990)

(1) Second Five-Year Plan

The size and actual outlay (monetary base) of the national plans since independence show that the actual outlay of the First Plan was only 47%,

but those of the Two-Year Development Plan and Three-Year Development Plan were nearly 90%. On the other hand, the proportion of aid inflow is gradually decreasing. Still the percentage of aid inflow to the actual outlay remains more than 60%.

During the Second Plan, the GDP growth was 3.8% (target 5.4%). However, it is noticed that the export was increased, the import was decreased and the proportion of investment to GDP was increased.

The achievement rate of physical target in the Second Plan shows that only two sectors of power supply and tea production have achieved the target. Other sectors could not achieve their targets. Especially, cotton, sugar, steel and cement as well as rural electrification and mass education enrolment could not achieve even a half of the respective targets.

Food self-sufficiency, which is a major objective of the national plan obtained 90% of the targets.

(2) The Third Five-Year Plan

As mentioned above, the basic objectives of all three development plans was to satisfy the basic human needs, accelerate economic growth, establish food self-sufficiency and promote self-reliance. But successive efforts for planned development of the economy in the desired direction have been frustrated by unforeseen developments. There have been recurrent floods and droughts more often in recent years. On the other hand, international economic environment also grew increasingly adverse having debilitating effect on the economy of Bangladesh.

The Third Five-Year Plan has, therefore, been taken up for implementation following the Second Five-Year Plan to achieve these objectives as basic targetd. Therefore, this Plan takes an integrated view

of development in a long-term perspective and has formulated eight major objectives of the Plan, as follows:

1) Reduction of population growth
2) Expansion of productive employment
3) Universal primary education and human resource development
4) Development of technological base for bringing out a long-term structural change
5) Food self-sufficiency
6) Satisfaction of minimum basic needs of the people
7) Acceleration of economic growth
8) Promotion of self-reliance.

The main focus of the Third Plan (TFYP) is the reduction of poverty through expanded and more productive employment. According to current projections, TFYP aims at an average annual real growth rate in gross domestic products (constant factor cost of 1984/85) of 5.4%, while annual population growth is projected to decrease from 2.4% currently to 1.8% at the end of TFYP. Foodgrain output is projected to rise by about 29% during the period, while employment is expected to increase by about 17%. TFYP has a total size of Tk. 386,00 crore (at 1984/85 prices) of which Tk. 250,00 crore is in the public sector and Tk. 136,00 crore in the private sector. About 55% will be financed by external assistance. It is noticed that this is also financed by government's initiative as the same of the Second Plan and pressed lower down concerning the dependence on external assistance.

Concerning the sectoral allocation of the TFYP, the ratio of agriculture, water resource and rural development sectors to total outlay allocation of the TFYP is about 29%. The TFYP emphasized on achievement of food self-sufficiency and alleviation of poverty in rural area by way of rural integrated development. The government placed emphasis on industries, and energy and natural resources sectors also due to strengthening basic structure of economy of Bangladesh and promoting industrialization.

The TFYP aims at an average annual growth rate in GDP (at constant factor cost of 1984/85) of 5.4%; agriculture sector aims at a growth rate of 4.0%, both of which are moderate rates; and domestic savings and investment have been proposed to increase from 4.2% in 1984/85 to 7.0% in 1989/90 and from 17.3% in 1984/85 to 19.0% in 1989/90, respectively.

The main objective of agricultural sector for the TFYP is to attain self-sufficiency in foodgrain production. To attain this, foodgrain production needs to grow at an annual growth rate of 5.2% from the benchmark production of 16.1 million tons (1984/85) for reaching the target of 20.7 million tons in the terminal year (1989/90) of TFYP. This target is set to ensure food availability of 16 oz. (453 g) per capita per day.

The employment target of TFYP has been estimated at 243.8 lac in the terminal year (1989/90) at the rate of 4.8 percent per annum against the projected growth rate of 5.4% for GDP during the plan period. This means that 50.9 lac men-year of fresh employment will
be generated, and it is pointed out that about 67.2 percent of the additional employment will arise from expanded activities in the agricultural sector during the TFYP.

Regarding the projection of external resources, in order to reduce the import amount by means of utilizing investment for the existing facilities effectively, the rate of increase in imports will be pressed down to average annual growth rate of 2.8 percent (1985/86-1989/90), while the exports will increase at average annual growth rate of 4.9 percent by devoting the maximum efforts to exports.

Besides, the TFYP aims at the achievement of the following targets for water resources development. The primary objective of water resources development is to accelerate the process of technological transformation of agriculture in order to reach higher level of agricultural production, particularly foodgrain.

Specific objectives during TFYP are:

i) to provide timely and dependable supply of irrigation water for increased foodgrain production of 20.7 million tons;

ii) to regulate and control floods and drainage, salinity, tidal water inundation and river erosion to avert crop and other material damages and human sufferings;

iii) to generate productive employment opportunities for rural people in order to ensure equitable distribution of benefits of development;

iv) to promote efficient use of water resources in respect of time and geography through interbasin water balances and optimal cropping pattern.

The target of the TFYP is to expand the irrigated area to about 39 lac hectares by the end of 1989/90 at an annual growth rate of 9.5%. This will represent about 88% of the total potential area (about 45 lac hectares).

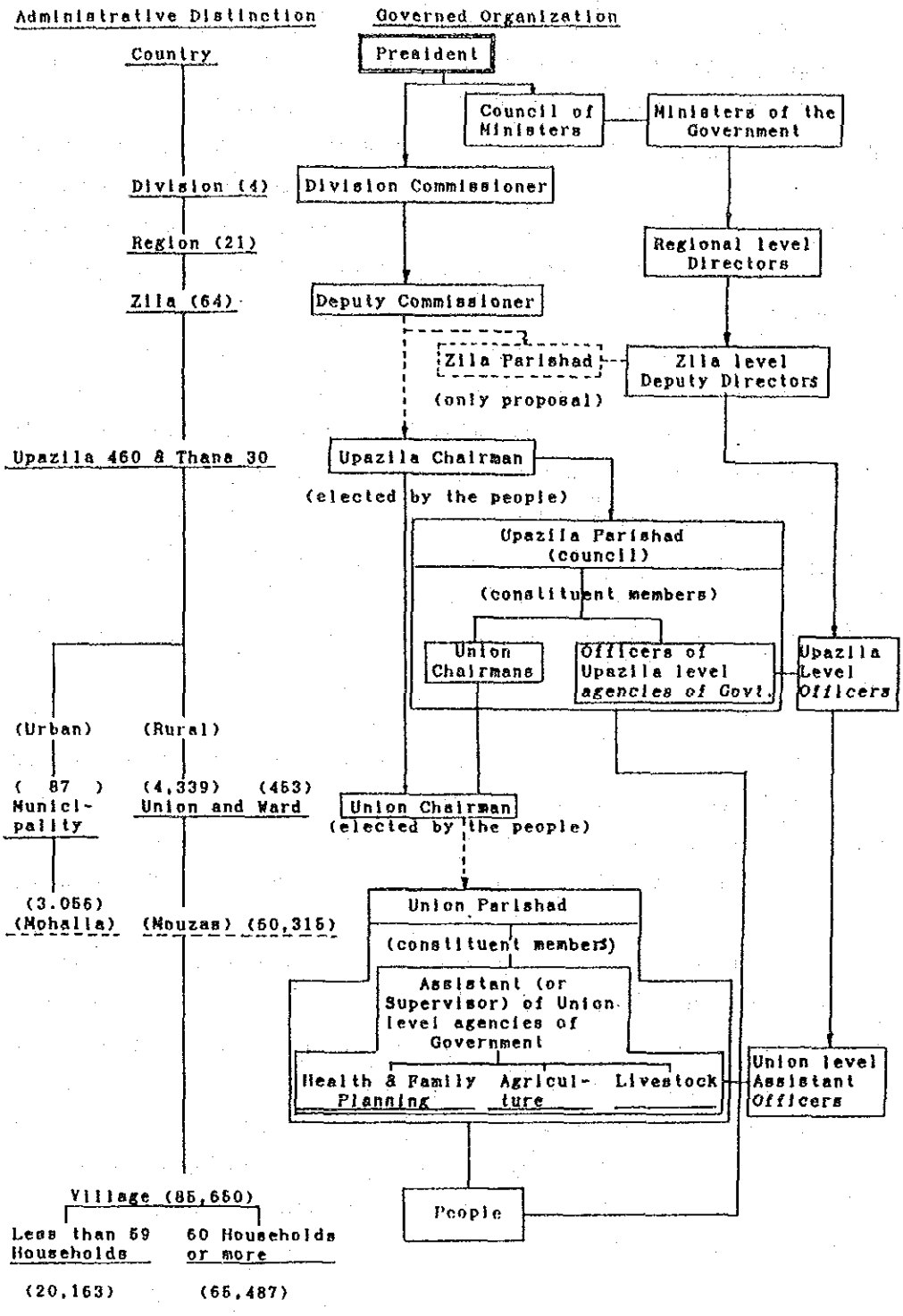
2-2. Regional Background

2-2-1. General Conditions in Rajshahi Region

(1) Administrative System in Bangladesh

The country is divided into four administrative Divisions. Each Division is sub-divided into Regions and each Region is further sub-divided into zilas. After the administrative re-organization carried out in 1984, the country is now divided into 64 zilas. The newly created zilas are basically former sub-divisions. Each zila consists of several Upazilas and each Upazila consists of administrative system comprising a number of villages in rural area, and wards in the municipality in urban area as shown in Figure 2-1.

Figure 2-1. ADMINISTRATIVE CHART OF BANGLADESH



Source : 1986 Statistical Yearbook of Bangladesh and others.

Note : 1) See Appendix-E, Figure

2) On chart of governed organization, ⟶ shows to have authority of both control and coordinate, and ⇢ shows to have only authority of coordinate.

Bangladesh is governed by a unitary form of Government of presidential type. The President is the chief executive of the country. He has a council of ministries who assist him in the discharge of his duties. Four divisions are placed under four Division Commissioners and the administration of each zila is headed by a Deputy Commissioner who is assisted by other officials. Under the recognised set-up, Upazila is the focal point of public administration in the country, taking the administration to the door-step of the people and making it more responsive to the needs of the people and capable of providing quick decisions in solving local problems.

The administration of each Upazila is headed by an elected Upazila Chairman who is assisted by the Upazila Parishad (Councils), which is composed of the elected Union Chairmen and officers of the Upazila level department of each government development offices. Besides, it is noticed that he has the authority both to control and coordinate the activities of the members of the Upazila Parishad, although the Division Commissioner or Deputy Commissioner and Union Chairman has only the authority to coordinate.

This representative local government called the Upazila Parishad serves as the functional tie between the local administration with the will of the people and the national administration. Under this system, public administration has been made more responsive to the needs of the people.

The officials of most of the Government development departments have been deputed to the Upazila Parishads to help the Upazila Parishads function as administratively effective and viable local government. To have a clear delineation of the administrative and development responsibilities of the national government vis-a-vis the Upazila Parishad, it has been decided that while the national government has retained certain functions, the Upazila Parishads have been entrusted to perform all local level development activities.

The Upazila Parishads have thus become the focal point of all development activities at the local level programmes of their own on a reasonable scale and also the implementing authority for execution of the divisible components of national level projects and programmes. The Upazila Parishads should prepare a Five-Year Upazila Development Plan which will be reflected in the country's Five-Year Plan and for financial year they are also to prepare an Annual Upazila Development Programme.

The administration of each Union is the lowest local organization is headed by an elected Union Chairman who is also a constituent member of the Upazila Parishad. He is assisted by the Union Parishad, but he has only authority to coordinate the Parishads. The Union Parishad consists of three sections of Health & Family Planning, Agriculture and Livestock which are closely related with day-to-day life of the people. The officers of these sections also are that of Union level department of each government development offices and are placed for catering the daily needs of the rural peoples.

(2) Present Situation of Rajshahi Region

Rajshahi Region is located at the northwestern corner of the country. Rajshahi is the center of Rajshahi Division headed by a Division Commissioner. The development of Rajshahi Division has been lagged behind due to long-term flood damages, droughts and other geographical and socio-economic reasons.

Rajshahi Region consists of four Zilas, i.e., Naogaon, Natore, Nawabganj and Rajshahi, and includes 32 Upazilas, 297 Unions and 7,384 villages. In addition, it contains 4 municipalities and 238 Mohallas.

The total land area, population, number of farm households of this region are about 6% of whole country, as follows:

Land area	:	9,462 sq.km
Population	:	527 million
No. of households	:	866,000
No. of farm households	:	613,000

Population has increased rapidly at the rate of 3.0% per year on an average. This growth rate is higher than that of whole country and it requires urgent measures. The population density is 557 per sq.km.

Agricultural indicators such as available land area, net cultivated area, and irrigated area per capita as well as average area of farm household are higher than the country's averages. Therefore, Rajshahi Region is considered to be an agricultural region in the country.

According to 1981 Population Census, the working population of more than 10 years old accounts to 1,300 thousand (male, 1,222 thousand), i.e., about 25% of the total population, and the employment rate is lower than the country's average. On the other hand, unemployment ratio, except for students and home workers, is 28% and higher than the country's average. Accordingly, the employment opportunities of this Region can be considered less than the whole country.

As regards occupation, agriculture is dominant and occupies about 70%. This proportion is about 10% higher than the country's average. However, the ratio has been suddenly decreased. On the other hand, service and other sectors have grown by 14% per year since 1974.

According to agricultural census 1983-84, the number of farm households are 613,000, i.e., about 71% of the total number of households. Out of them, small-scale farmers (less than 1.0 ha) occupy 60%, medium-scale ones (1.0-3.0 ha) occupy 31% and large-scale ones (more than 3.0 ha) occupy 8%. Comparing with those proportion of the whole country, i.e., 70%, 15% and 5%, respectively, medium and large-scale farmers are in higher proportions in Rajshahi than in the country as a whole.

Looking over the share of operated area under each scale farmers, this fact is still more clear, i.e., that of small-scale, medium-scale and large-scale farmers is 21% (whole country, 29%), 45% (whole country, 45%) and 34% (whole country, 26%), respectively.

According to the Land Occupancy Survey in 1977-78, on the other hand, own-holdings are 52% and owner cum tenant holdings are 47%. The results of the recent survey in Barnai area show that pure tenant farmers are less, viz., own-holding, 50%, owner cum tenant holding, 40%, and tenant farmers, 10%.

In Bangladesh, a "farmer" is defined as one who holds cultivated land more than 0.02 ha. Many non-farmers, according to the definition, are engaged in farming. "Landless" includes the small-scale farmers having less than 0.2 ha of agricultural lands, and is classified into three categories as Landless I, II and III.

According to agricultural census 1983-1984, the landless in this region is 390,000 and occupy 45% of the total households. But the proportion is less than the country's average (49%). Landless I, which do not have house nor land are 54,000 (6% of total households); Landless II, which have house but no cultivable land, are 183,000 (21% of the total); and Landless III, which have both house and cultivable land up to 0.2 ha, are 156,000 (18% of the total).

This landless forms the poverty in rural area, and flows into urban area seeking the job opportunity. It causes the employment and housing problems in urban area. Therefore, it is very important to establish the governmental socio-economical policy to provide the employment opportunities and Basic Human Needs for them.

About 54% (whole country, 40%) of small-scale farmers having less than 1.0 ha are agricultural labourers, viz., their agricultural income is more than the income from other sources. Nearly half of the small-scale farmers are very close to landless.

The GDP in this region is 21.6% billion Taka (1984-85 current market price) and occupies about 5% of the whole country. This is lower than the proportions of land area and population. It is said that the economic power of this region is relatively low, because the economic structure of it inclines more to agriculture compared with that of the whole country.

GDP per capita is 3,379 Taka (661 Taka at constant price) which is 85% of that in whole country. The agricultural sector occupies 54% (whole country, 50%) but both large-scale and small-scale industry sectors occupy only 1% each (1984/85). This composition has not almost changed year by year also. The annual growth rate of the agricultural sector is 16% per year, on the other hand, that of whole sectors is 15% per year, so the growth of agricultural sector is just a little higher. Within the agricultural sector, the cropping sector is predominant and occupies 45% (85% of agricultural sector). The ratio of cropping sector has not changed through years, while livestock shows a rapid growth.

Comparing with social indicators of the whole country, primary education enrolment rate and number of hand tubewells for drinking per 1,000 households are larger, but literacy rate and diffusion of other social infrastructure have lagged behind.

2-2-2. Regional Development Plan

The Government has been pursuing the policy of formulating the national land planning from the point of view which the integrated development planning in every regional area must be formed and implemented so as to promote the balanced economic growth among each region and to meet effectively the following problems:

1) fast growing population
2) rapid increase of population in urban area
3) development gap among regions
4) inefficiency of investments distribution to sectoral projects

However, this view has recently been adopted in the regional planning. Accordingly, efforts for integrated development planning in the division, region or zila level are being made.

Developing in the context of agriculture and forestry has been proposed at the first stage mainly by Upazilas/* based on which ministries concerned along with their local offices compile and finalize individual projects and implement them.

/* ... Upazila Parishad should prepare a Five-Year Development Plan, which is reflected in the country's Five-Year Plan.

As mentioned above, agriculture is by far the most important sector in Bangladesh economy. Targets of agricultural sector were established to fulfill food self-sufficiency as well as the creation of additional labor opportunities equivalent to 70% of the total target (5 million laborer). Therefore, agricultural sector was allocated to be about 30% of national investment (114.6 billion Taka) in order to alleviate local poverty.

This allocated amount was invested for the development as individual project budgets. For example, several irrigation projects among various areas have been implemented or planned in the irrigation sector for the purpose of expanding commandable area from the current level of 1.4 million ha to the target of 3.9 million ha in 1989/90 with the additional 1.4 million ha of newly created irrigable area. The irrigation project in the North Rajshahi is also a component of this national scheme.

CHAPTER 3

THE PROJECT AREA

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3-1. Delimitation of the Study Area

3-1-1. Selection of the Study Area

The area in the northern portion of the Rajshahi City can be distinctly divided into two areas in the eastern side of low flat area and in the western side of elevated high land, called Barind tract, by the Sib river which flows from north to south as the boundary of the both areas. The characteristics of these areas are different from each other in the natural conditions such as topography, soil and flood effect, etc. Also, the cropping pattern and crop intensity are different from each other.

The elevation of the lower flat area is about EL. 12.2 m to EL. 18.3 m. The soil type is a silty loam and alkalinity. The cropping pattern is rather complex and consists of mainly paddy rice from about 60% of total cropped area and others such as sugarcane, jute and vegetables. The crop intensity is about 170% at present.

As for the high land of Barind tract, the elevation is about EL. 15.2 m to EL. 45.7 m with undulated topographic conditions. The soil is a clayey texture, weak acidity and moderate soil fertility. The cropping pattern is simple compared with the lower flat area and consists of paddy rice from more than 90% of total cropped area and others wheat. The crop intensity is about 130%.

The Barind tract is a flood-free area due to the high elevation. On the other hand, the lower flat area had been affected by floods from the Atrai and Barnai rivers every year. Under these circumstances, the Chalan Beel Project financed by Netherlands, Canada and IDA, has been started with the implementation of flood protection dike in Polders A, B, C and D area. The construction of the Polders A, B, and C has been completed and the Polder D is almost completed. As for the southern portion of the Barnai

river, a feasibility study for the Barnai Project was finished in 1984 for the flood protection in the area. The construction of the flood protection dike will be started from the end of 1987.

As for the flood protection schemes in the lower flat areas, Chalam Beel Project is completed, while the Barnai Project will be implemented by the end of 1987. Irrigation by LLP for the low flat area will not be so difficult and the LLP scheme has been included in the Barnai Project. Accordingly, several development schemes in the low flat area have been considered in the field of flood protection and irrigation.

On the other hand, in the Barind tract, in spite of its flood free conditions, simple or easy irrigation method such as LLP and STW will not be applicable due to high elevated land. At present, DTW irrigation in the Barind Integrated Area Development Project under BADC is under implementation. However, necessary capacity of the DTW will be rather difficult to attain during dry season due to low ground water level and clayey texture. Accordingly, the present crop intensity is lower than the low area.

Due to unstable and insufficient irrigation water supply, unit yield in irrigated as well as rainfed areas is very low with a weighted average of 1.3 ton/ha. Especially, yield is low in dry season. The major constraint for development in the Barind tract is the water resources availability for irrigatoin.

Consequently, the development potentiality in the Barind tract will be higher than that of low flat area by means of irrigation water supply. In addition, several development schemes have been completed or on-going in the low flat area such as flood protection, drainage improvement and partially irrigation by LLP. It will be urgently necessary to establish a development scheme, especially irrigation, in the Barind tract to avoid development gap between low and high land.