Table VI.3.3 EQUIPMENTS REQUIRED FOR DEMONSTRATION AND TRIALS

Item	Requirement
1. Improved tools	
sickles, spades, shovels, improved steel ploughs and hollows for bullock draft power, hand sprayer, hand duster, etc.	1 set for each demonstration and trial plot Tangmachu : 5 sets Masangdaza : 3 sets
planting rope, rotary weeder	1 set for each irrigated demonstration and trial plot Tangmachu : 3 sets Masangdaza : 2 sets
2. Machinery	
pedal threasher, manual winnower, manual husker, manual separator, power tiller, etc.	1 set for each demonstration and trial plot Tangmachu : 5 sets Masangdaza : 3 sets
manual rice polisher	1 set for each irrigated demonstration and trial plot Tangmachu : 3 sets Masangdaza : 2 sets
maize shellar	1 set for each rainfed demonstration and trial plot Tangmachu : 2 sets Masangdaza : 1 sets

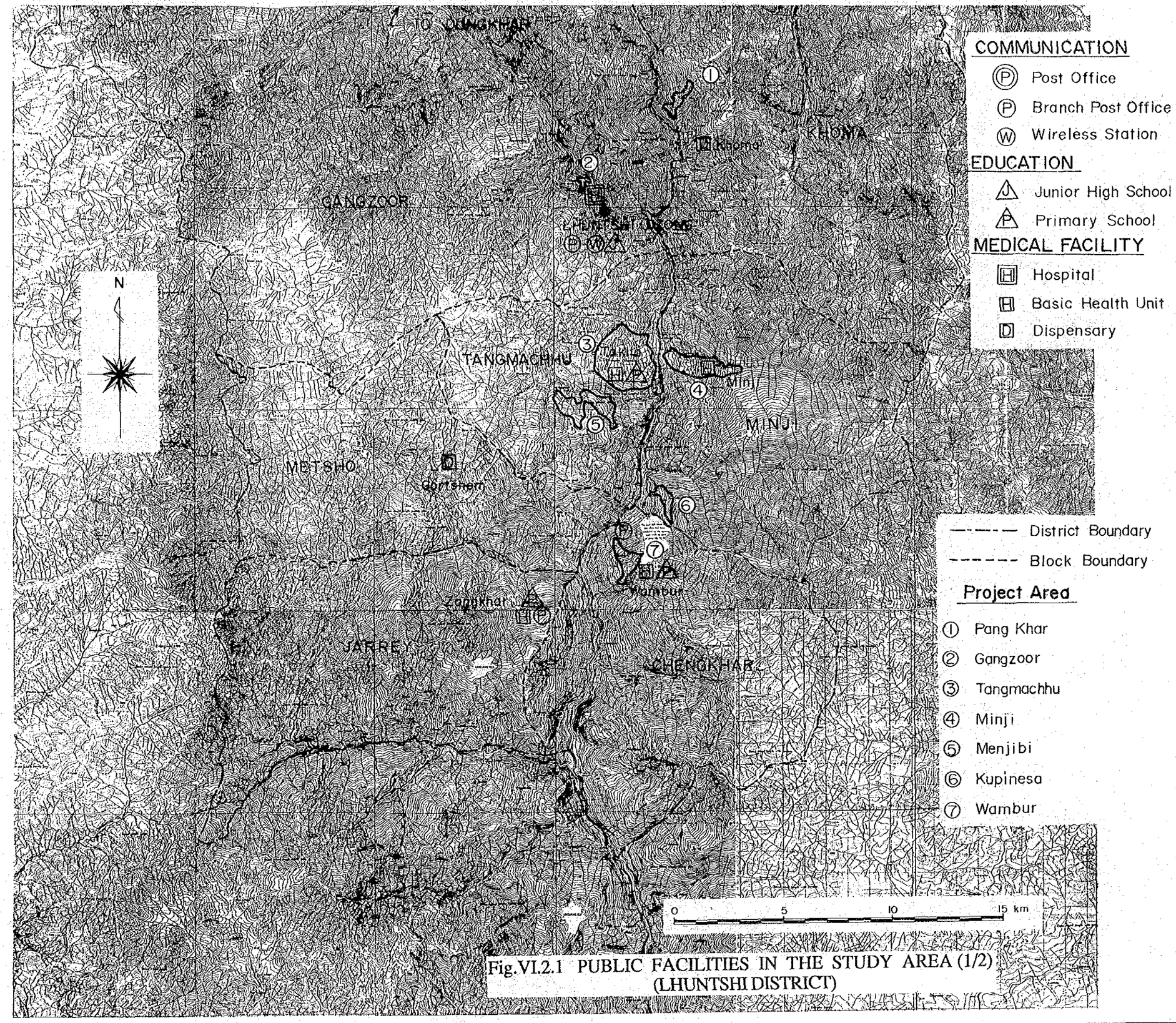


Fig.VI.2.1 PUBLIC FACILITIES IN THE STUDY AREA (1/2)
(LHUNTSHI DISTRICT)

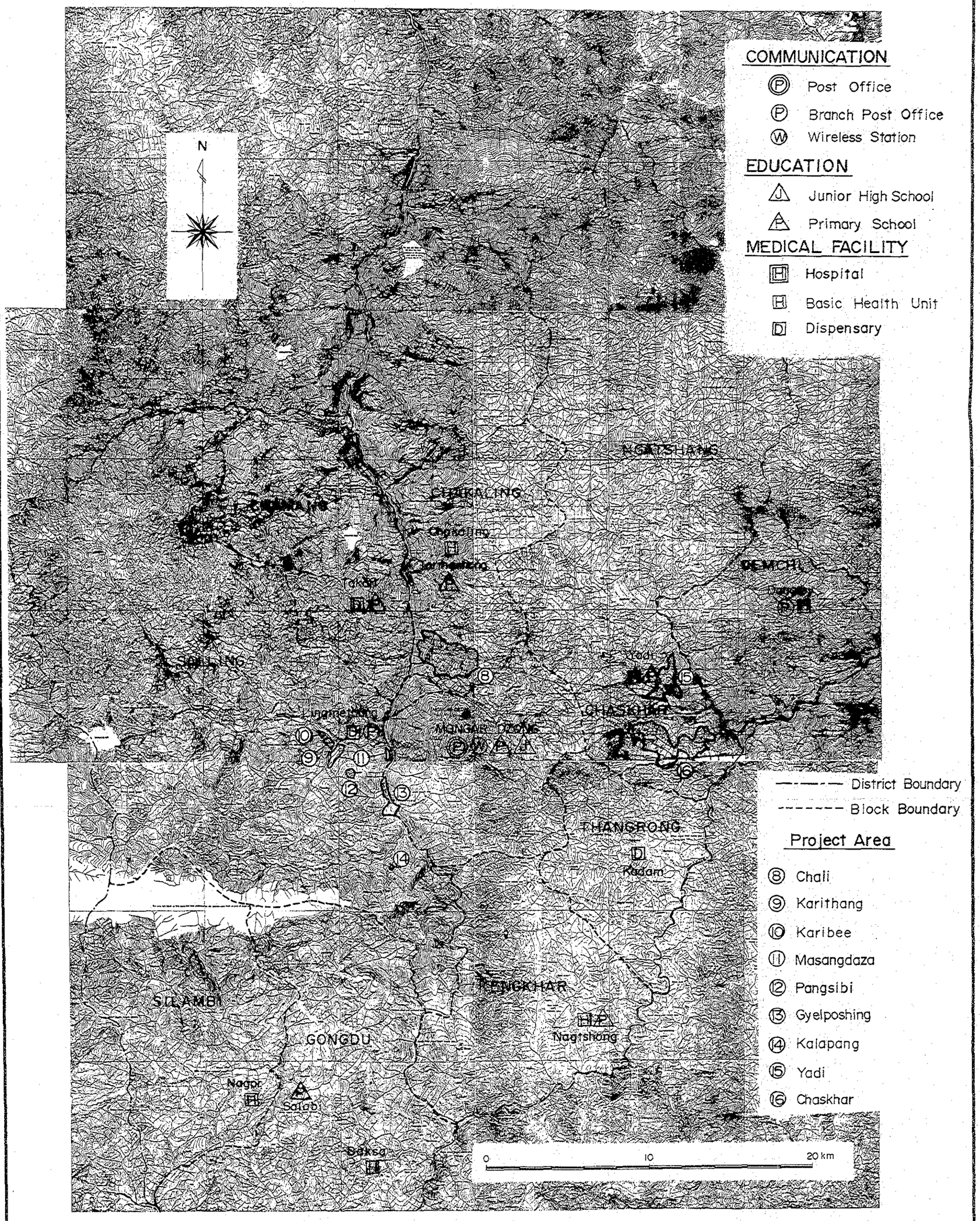


Fig.VI.2.1 PUBLIC FACILITIES IN THE STUDY AREA (2/2)
(MONGAR DISTRICT)

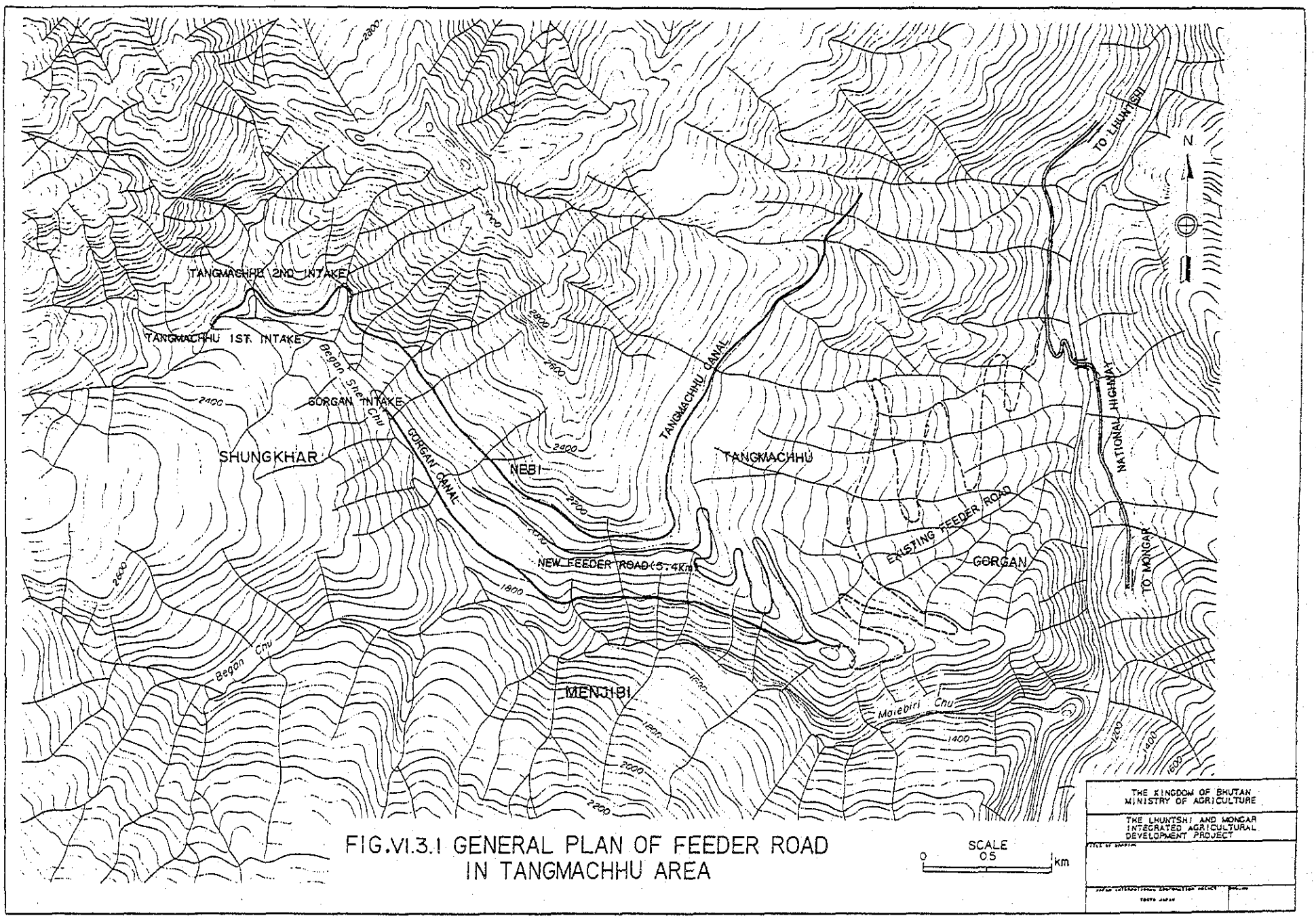
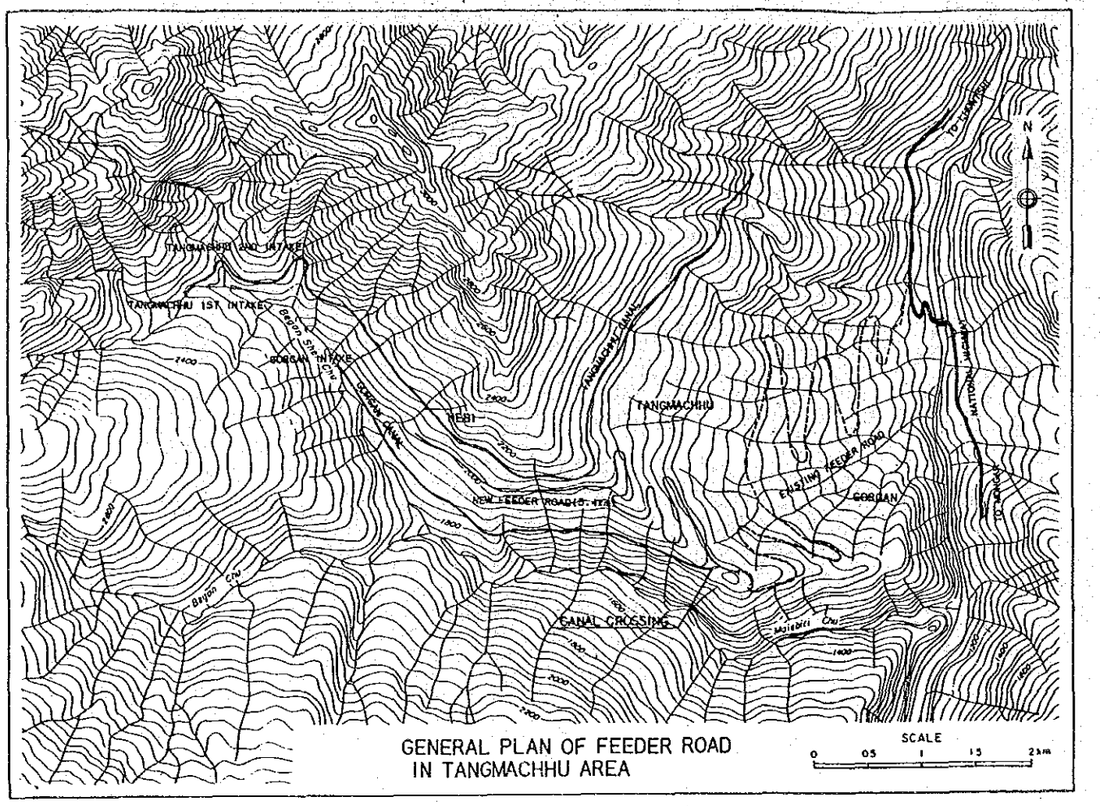
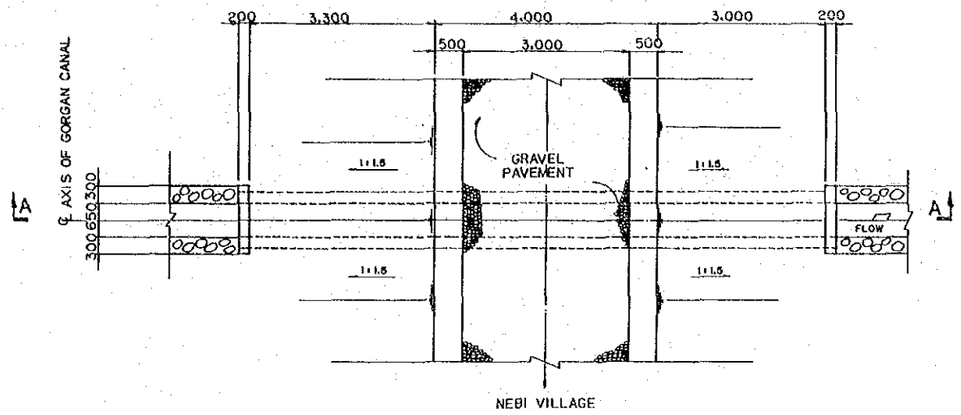


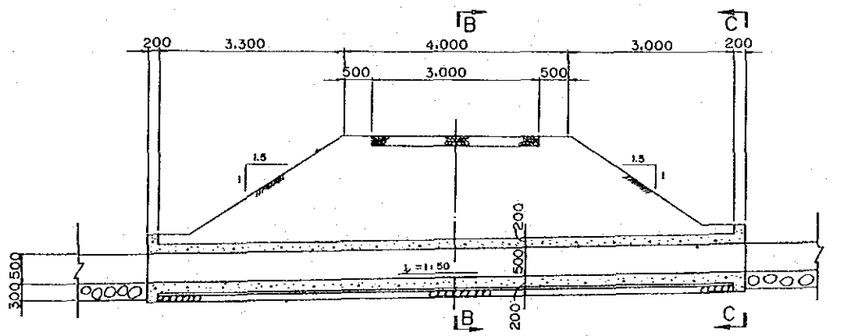
FIG.VI.3.1 GENERAL PLAN OF FEEDER ROAD IN TANGMACHHU AREA



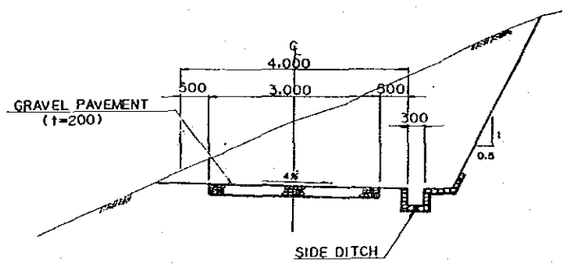
GENERAL PLAN OF FEEDER ROAD
IN TANGMACHHU AREA



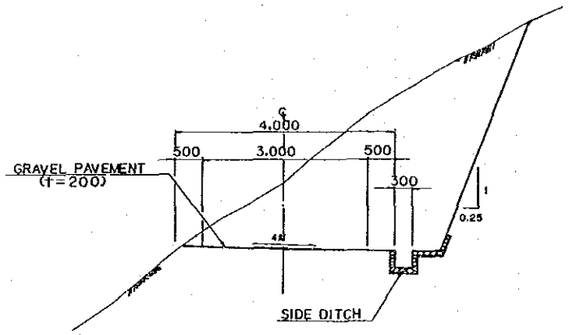
PLAN OF CANAL CROSSING POINT
SCALE A



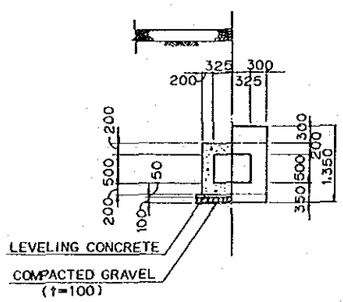
SECTION A-A
SCALE A



CROSS SECTION OF FEEDER ROAD
(TYPE-I) SCALE A



CROSS SECTION OF FEEDER ROAD
(TYPE-II) SCALE A



SECTION B-B SECTION C-C
SCALE A SCALE A

0 1 2 3 4 5m
SCALE A 1:50

THE KINGDOM OF BHUTAN MINISTRY OF AGRICULTURE	
THE LHUNTSHI AND MONGAR INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT	
TITLE OF DRAWING FEEDER ROAD IN TANGMACHHU PROJECT AREA	
JAPAN INTERNATIONAL COOPORATION AGENCY TOKYO JAPAN	DWG. NO

Fig.VI.3.2 TYPICAL CROSS-SECTION AND STRUCTURE OF PROPOSED FEEDER ROAD IN TANGMACHHU

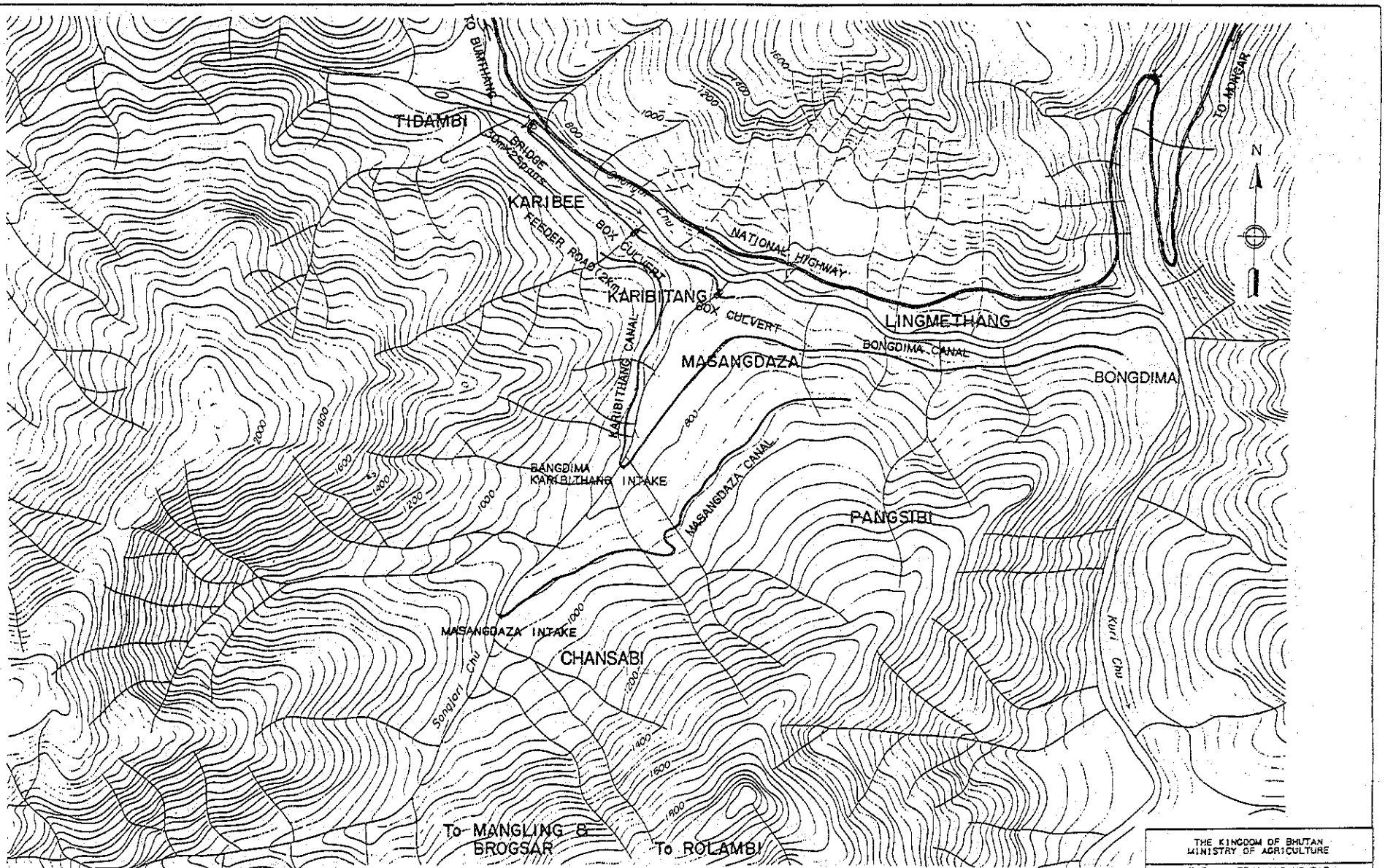
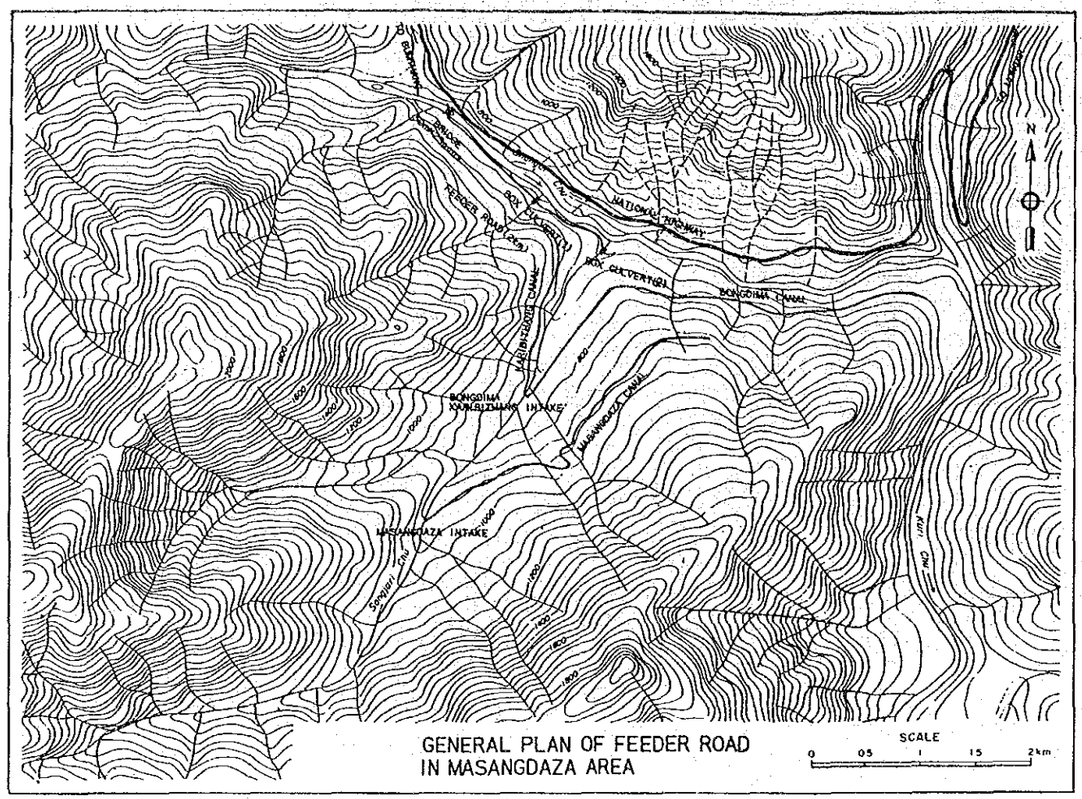
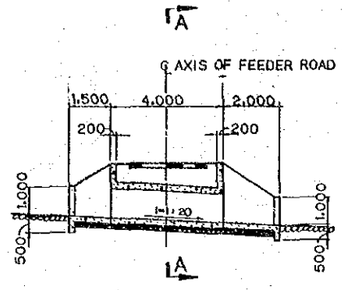


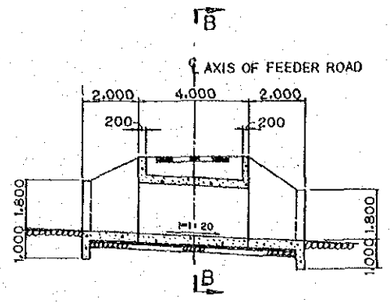
FIG. VI.3.3 GENERAL PLAN OF FEEDER ROAD IN MASANGDAZA AREA



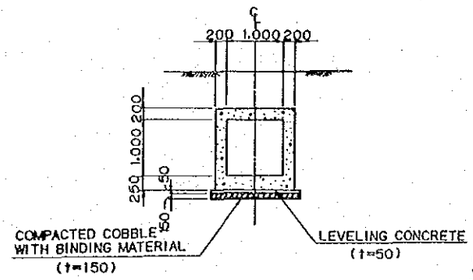
GENERAL PLAN OF FEEDER ROAD
IN MASANGDAZA AREA



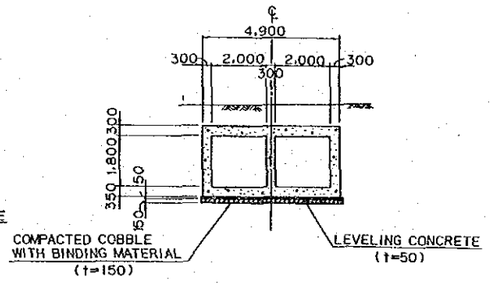
ELEVATION OF BOX CULVERT(1)
SCALE B



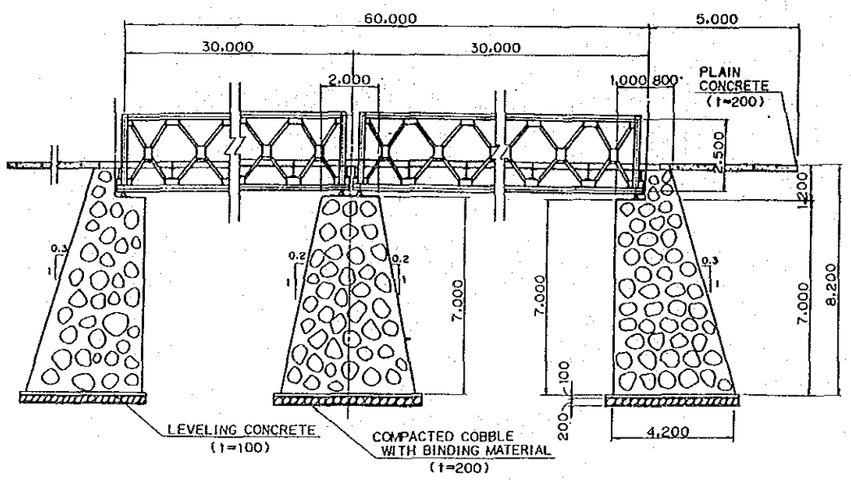
ELEVATION OF BOX CULVERT(2)
SCALE B



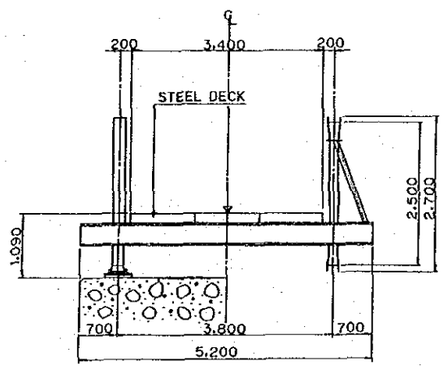
SECTION A–A
SCALE A



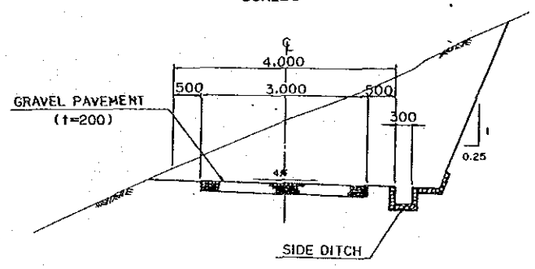
SECTION B–B
SCALE B



ELEVATION OF BRIDGE
SCALE B



CROSS SECTION OF BRIDGE
SCALE A



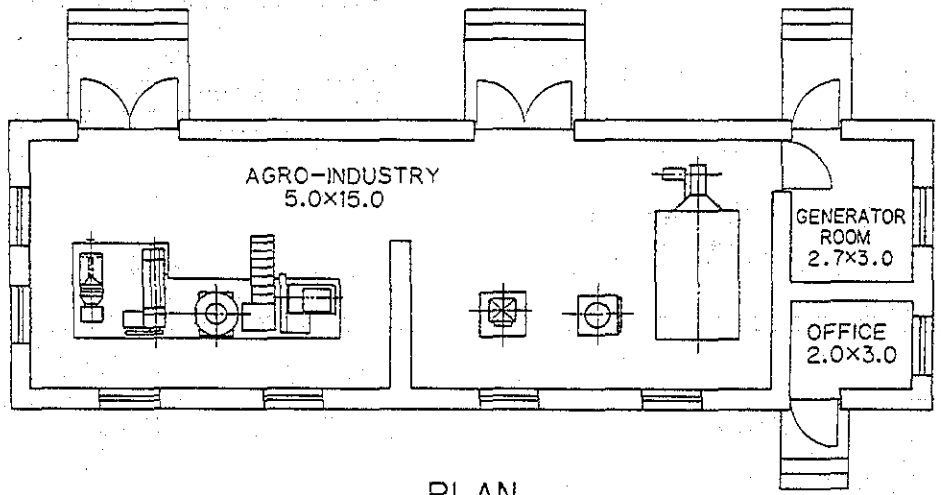
CROSS SECTION OF FEEDER ROAD
SCALE A

0 1 2 3 4 5m
SCALE A 1:50

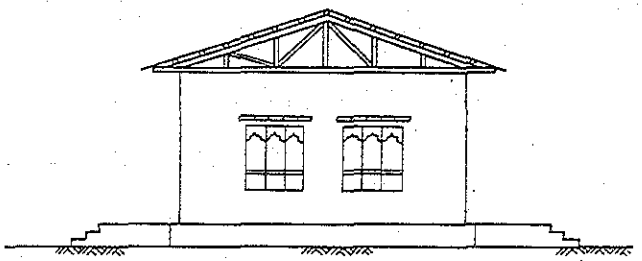
0 2 4 6 8 10m
SCALE B 1:100

THE KINGDOM OF BHUTAN MINISTRY OF AGRICULTURE
THE LHUNTSHI AND MONGAR INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT
TITLE OF DRAWING FEEDER ROAD IN MASANGDAZA PROJECT AREA
JAPAN INTERNATIONAL COOPERATION AGENCY TOKYO JAPAN — DWG. NO.

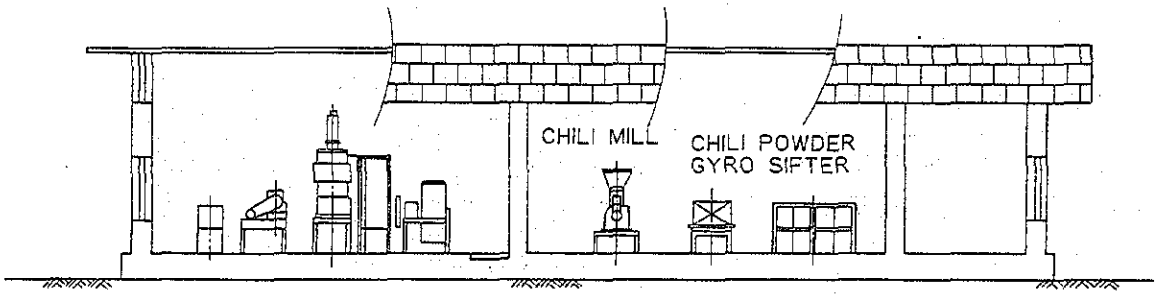
Fig.VI.3.4 TYPICAL CROSS-SECTION AND STRUCTURE OF PROPOSED FEEDER ROAD IN MASANGDAZA



PLAN
SCALE A



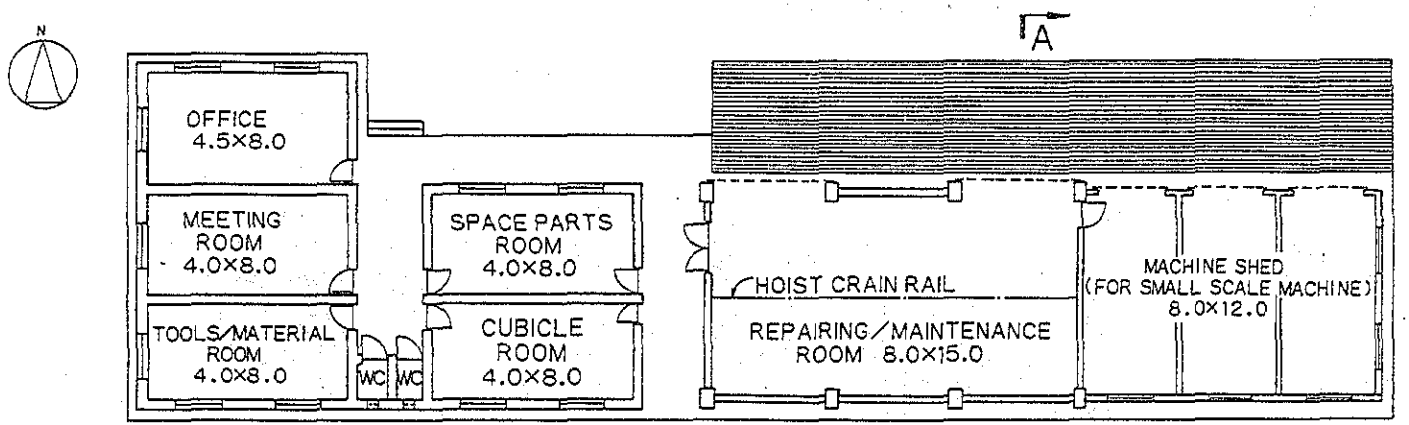
SIDE VIEW
SCALE A



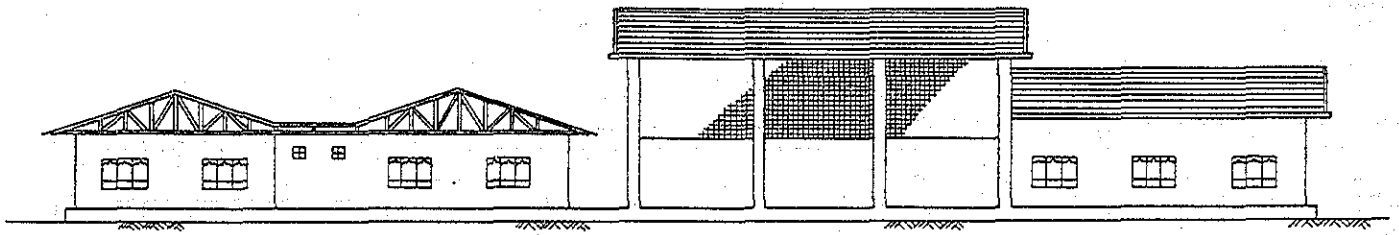
SECTION A-A
SCALE A

0 1 2 3 4 5m
SCALE A 1 : 100

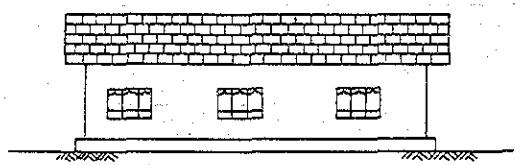
Fig.VI.3.5 PRELIMINARY DESIGN OF AGRO-PROCESSING FACTORY



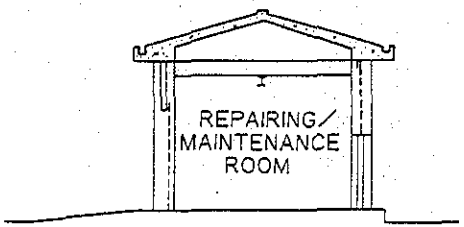
PLAN
SCALE A



SOUTH VIEW
SCALE A



WEST SIDE VIEW
SCALE A

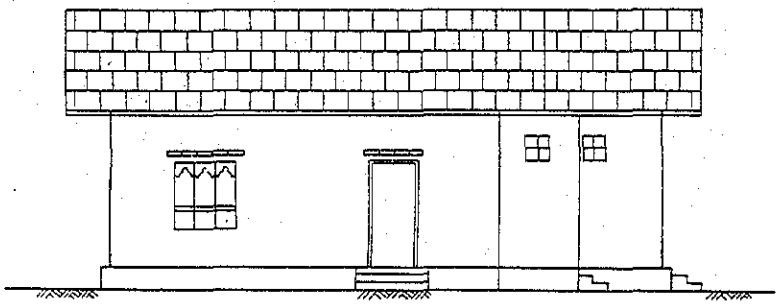


SECTION A–A
SCALE A

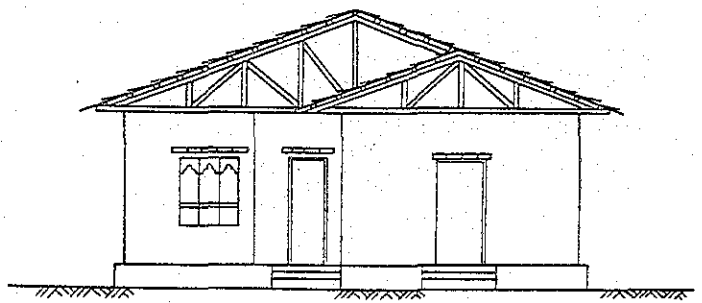
0 2 4 6 8 10m

SCALE A 1 : 100

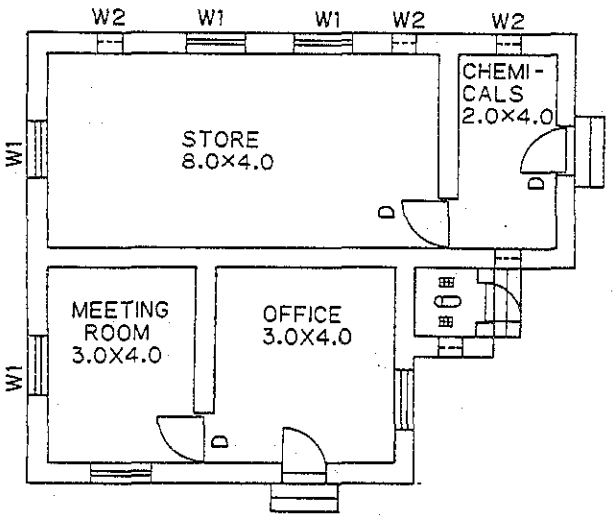
Fig.VI.3.6 PRELIMINARY DESIGN OF WORKSHOP



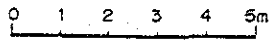
FRONT VIEW
SCALE A



SIDE VIEW
SCALE A



PLAN
SCALE A



SCALE A 1 : 100

Fig.VI.3.7 PRELIMINARY DESIGN OF AGRICULTURAL EXTENSION CENTER

ANNEX - VII

CONSTRUCTION PLAN
AND
COST ESTIMATE

LHUNTSHI AND MONGAR
INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT

ANNEX-VII CONSTRUCTION PLAN AND COST ESTIMATE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. CONSTRUCTION PLAN

1.1 General

The greatest concern for the construction planning in this project is a introduction of the mechanized construction. There are 2 big problems to be considered on the construction planing. This is a construction work at remote area without adequate access road and the recruitment of labours is rather difficult in quality and quantity in the area. The other hand, in order to take the early benefit from the project the construction period shall not consider to take a long time.

The traditional construction method may not apply for this project according to above mentioned reasons. But the mechanized construction method to reduce the construction period and costs are limited due to the geographical and the social local conditions. Therefore the minor mechanized construction method using mini-sized equipment shall be considered on the construction planing.

1.2 Basic Conception

1.2.1 Construction Period

The construction works take considerable times because intake sites are located very far from existing motorable roads, and canals have long lengths. Before commencement of the construction works for the irrigation facilities access roads shall be provided to the sites. These access roads consist of new feeder roads and temporary construction roads.

The construction feeder roads shall be executed in advance of the construction of irrigation facilities as a preparatory works. It is necessary to utilize the feeder road from the earliest stage of the intake and canal construction.

The construction of irrigation facilities shall be executed during the off-irrigation season because these works are the renovation of existing facilities mainly. Taking into due consideration of the construction work volume, it is needed to take 2 off-irrigation seasons as the main construction period as shown in Fig. VII.1.1.

1.2.2 Construction Equipment

There is no possibility to employ suitable numbers of proper sized equipment in Bhutan. While some equipment are available to hire at Agriculture Machinery Center, it is not satisfied with the project requirement in quantity and kinds of machinery. Accordingly, major

construction equipment shall be imported. Following imported machinery are listed to be used for the project.

Bulldozer, 10-12 tons	6 No.	4 No. for Tangmachhu, 2 No. for Masangdaza
Backhoe Excavator, 0.35 cm	4 No.	for excavation, 2 No. each
Air Compressor, 50 HP	10 No.	for rock excavation
Hand Drill, 18 kg	20 No.	for rock excavation
Generator, 40 kW	2 No.	general use 1 No. each
Truck, 10 tons	2 No.	for material transp. 1 No. each
Truck, 4 tons with 2 tons Crane	2 No.	for material transp. 1 No. each
Truck, 4 tons without Crane	2 No.	for material transp. 1 No. each
Dewatering Pump w/engine 2"	10 No.	2 No. for each intake site
Concrete Vibrator w/engine 1.5"	8 No.	
Concrete Mixer, 0.2 cm	4 No.	1 No. for each intake site
Vibrating Compactor, 90 kg	8 No.	for compaction of foundation

Following equipment are considered to hire in Bhutan:

Bulldozer, 12 tons	2 No.	for feeder road construction
Tire Roller, 8 tons	2 No.	for feeder road construction
Truck, 10 tons	2 No.	for feeder road construction

These equipment driven by the engine shall be considered working site condition of altitudes which are 600 m to 1,000 m at Masangdaza, and 1,800 m to 2,200 m at Tangmachhu approximately.

1.2.3 Labour Force

The project area is a too few populated area. It is very hard to recruit sufficient number of labours even unskilled ones. Therefore the mechanized construction method is proposed as far as possible. Most of unskilled labours shall be employed in the area, but some others have to bring from other districts.

Many skilled labours are necessary to employ, such as heavy machine operator, mechanic, welder and others in order to apply the mechanized construction method. It has to consider that some of them are to be employed foreign labours.

1.2.4 Transportation of Construction Equipment and Materials

All the imported equipment and materials are transported to the sites via Phuntsholing and Samdrupjongkha by trucks. Transportations from the nearest National Road to the each site are using the feeder road, the temporary road and the canal construction space which is arranged as a passage of the truck before the canal lining.

Major construction materials such as stone, gravel, sand, cement and other miscellaneous materials are carried by trucks passing through the temporary road and canal construction spaces stated as above. The manpower transportation is considered in a short distance only.

1.3 Construction Method

1.3.1 Road Construction

The feeder road is constructed at the first stage of the construction prior to any other site works. After that the temporary construction road is extended to each intake site.

The earth excavation is made by using bulldozers mainly, and rock excavation is used with pneumatic rock drills for the blasting. The excavation of structure foundations is used with backhoe excavators. Some of bulldozers and trucks may be used hired equipment in Bhutan together with imported equipment. The compaction of gravel paving on the road surface is carried out by tire rollers.

The substructures of the bridge are to be constructed in dry season. The erection of Bailey Type Bridge can be made by using minor equipment in a short time even in rainy season.

1.3.2 Intake Construction

The major excavation is carried out by using backhoe excavators. The compaction of foundation of the structure is made with vibrating hand compactors. These works shall be executed under the dry condition using sufficient dewatering pumps.

Masonry, concrete and other structural works shall be made the quality control of the works performed according to the drawing and the specification.

1.3.3 Canal Construction

The removal of existing structures or masonry linings are made by bulldozers. The earth excavation also carry out by the bulldozer. The rock excavation is made with the blasting using the pneumatic rock

drill. So that many small curvatures existing in the present canal alignment at the rocky area can be diminished.

The compaction of canal bed and structure foundation are the essential problem as a construction method affecting with the durable structure. These foundations shall be used compacted impervious materials with a proper compaction equipment.

For the masonry lining works the great number of masons are to be employed. Many of them have to be brought from out side of the areas.

1.3.4 Other Works

The steel pipe syphon is embedded under the ground in most parts. The excavation and backfilling are made by manpower because these construction sites are no space to use machinery. Syphon pipes shall be the welding joint and coated at the field, so that particular skilled labours shall be employed.

2. COST ESTIMATE

2.1 Basic Assumptions

The construction cost is estimated on the basis of the following assumptions:

(a) The unit prices are estimated on the basis of market price in 1988.

(b) The following exchange rate is employed in the estimate:
US$1.0 = Nu 14.0 = ¥133 (Nu 1.0 = ¥9.5)

(c) Construction works is assumed to be executed on the full contract basis. The machinery and equipment required for construction works shall be provided by the contractors. Therefore, depreciation costs of machinery and equipment are included in construction unit cost.

(d) Taxes due on construction materials, machinery and equipment to be imported are excluded from the cost estimate.

(e) The construction cost is divided into foreign and local currency components. Local currency component is estimated on the basis of the current prices in Lhuntshi and Mongar Districts in 1988. Foreign currency component is estimated based on the CIF prices at Phuntsholing.

2.2 Financial Project Cost

The financial project cost comprises of the following items.

(1) Construction Cost

Construction cost for the project facilities was estimated together with contractor's field expenses, overhead expenses and taxes at the financial basis. Labour wages and material costs for the facilities' construction were summarized in Table VII.2.1 and Table VII.2.2.

Construction cost for irrigation facilities was accounted on irrigation canal networks, intakes and canal related structures as shown in Table VII.2.3. Construction cost for feeder road and temporary road were seprately estimated and the former was included in the other rural facilities development and the latter included in the irrigation development.

The building costs for the agro-processing factory in Tangmachhu, the extension center and the workshop in Masangdaza or Mongar District were also estimated.

(2) Land Acquisition and Reclamation Cost

Land acquisition cost was estimted on the basis of the local land prices of the paddy field of Nu 20,000, the hill area of Nu 2,000, and the structures' design as shown in Table VII.2.4.

Land reclamation cost for the terracing of the dry land in Masangdaza project area was estimated in Table VII.2.5. Reclamation works will be carried out by farmers' labours.

(3) Procurement Cost

Procurement cost comprises (i) the agro-processing machines, (ii) improved tools and machine for agricultural mechanization, (iii) repair tools, machines and mobile workshop, (iv) tools and machinery for agricultural trials, and (v) O&M equipment for irrigation facilities and feeder roads. These procurement costs were estimated at FOB prices in Japan with their freight and other charges on the way to the project site as shown in Table VII.2.6.

(4) Administration Cost

Administration cost is roughly estimated on the assumption that DOA will supervise the construction works directly. The cost estimate is shown in Table VII.2.7.

(5) Engineering Service

The cost for engineering service is roughly estimated on the assumption that the consultants will be engaged in the detailed design work and construction supervision. The estimate is fixed at ten (10) persent of the total cost for construction.

(6) Physical Contingency

The physical contingency is accounted at six (6) percent of the above five (5) items.

(7) Price Contingency

Price contingency is also taken into account at an annual escalation rate of three (3) percent for the foreign currency component and eight (8) percent for the local currency component. The price escalation is estimated on the basis of the project implementation.

The total project costs are estimated at Nu 120.2 million, details as well as percentages of foreign and local components thereof are tabulated below:

Project Area	F/C Nu 10^6	F/C (%)	L/C Nu 10^6	L/C (%)	Total Nu 10^6
Tangmachhu	50.1	(69)	22.3	(31)	72.4
Masangdaza	37.4	(78)	10.4	(22)	47.8
Total	87.5	(73)	32.7	(27)	120.2

The summary of the project cost is shown in Table VII.2.8.

2.3 Annual Disbursement Schedule

The annual disbursement schedule of the project costs is prepared on the basis of the construction implementation schedule. Details and summary on the project cost disbursement are shown in Table VII.2.9 and VII.2.10 respectively.

2.4 Annual Operation and Maintenance Costs

Annual operation and maintenance costs include the salaries for O&M staff and materials and labour costs for repair and maintenance of the project facilities and O&M equipment. The annual operation and maintenance costs are estimated at Nu 25,000 in Tangmachhu and Nu 20,000 in Masangdaza.

The savings of annual O&M costs after completion of the project are estimated at Nu 76,000 in Tangmachhu and Nu 61,000 in Masangdaza. Details are shown in Table VII.2.11.

2.5 Replacement Cost

Some of the facilities, especially mechanical works have shorter useful life than the civil works and require replacement at a certain time within the project useful life. The useful life of mechanical equipment is estimated 25 years. Their replacement costs are Nu 1,365,000 in Thangmachhu and Nu 881,000 in Masangdaza shown in Table VII.2.12.

Table VII.2.1 LABOUR WAGES

Items	Unit	Cost	Component		Unit Cost	
			F/C(%)	L/C(%)	F/C(Nu)	L/C(Nu)
1 Labour	md	15	0	100	0	15
2 Foreman General	md	120	0	100	0	120
3 Carpenter	md	40	0	100	0	40
4 Head of Carpenter(Labour)	md	45	0	100	0	45
5 Mason Worker	md	40	0	100	0	40
6 Head of Mason	md	45	0	100	0	45
7 Steel Worker	md	40	0	100	0	40
8 Head of Steel Worker	md	45	0	100	0	45
9 Driver(Light Equipment)	md	40	0	100	0	40
10 Operator(Heavy Equipment)	md	45	0	100	0	45
11 Mechanical	md	40	0	100	0	40
12 Electric Worker	md	40	0	100	0	40
13 Head of Mechanical	md	45	0	100	0	45
14 Driller	md	40	0	100	0	40
15 Blaster	md	120	0	100	0	120
16 Explosive Worker	md	40	0	100	0	40
17 Watchman	md	15	0	100	0	15
18 Janitor	md	15	0	100	0	15
19 Driver(General)	md	40	0	100	0	40
20 Supervisory Expence	md	5,000	100	0	5,000	0
21 Welder	md	40	0	100	0	40
22 Skilled labour	md	40	0	100	0	40
23 Technician	md	40	0	100	0	40

Table VII.2.2 MATERIAL COST

NO.	Items	Unit	Cost	Component F/C(%)	Component L/C(%)	Unit Cost F/C	Unit Cost L/C
1	Aggregate						
	(a) Sand	cum	200.0	38	62	76.0	124.0
	(b) Gravel <25mm	cum	250.0	15	85	37.5	212.5
	(c) Gravel <50mm	cum	221.0	17	83	37.6	183.4
	(d) Rubble Stone	cum	164.0	23	77	37.7	126.3
2	Lumber						
	(a) Form Lumber	cum	2,484.0	0	100	0.0	2,484.0
	(b) Plywood 1/2&4*8	cum	4,780.0	100	0	4,780.0	0.0
3	Reinforced Iron Bar	kg	7.9	100	0	7.9	0.0
4	Nail,Bolt,Nut	kg	26.9	100	0	26.9	0.0
5	Hardware	kg	53.8	100	0	53.8	0.0
6	H-Beam	kg	8.6	80	20	6.9	1.7
7	Trash Rack	kg	43.0	100	0	43.0	0.0
8	Cement (1bag=50kg)	bag	53.0	75	25	39.8	13.3
9	Fuel						
	(a) Gasoline	lit	7.8	100	0	7.8	0.0
	(b) Diesel	lit	3.6	100	0	3.6	0.0
10	Blasting						
	(a) Dynamite	kg	22.4	100	0	22.4	0.0
	(b) Detonator	pc	0.9	100	0	0.9	0.0
11	Drilling						
	(a) Rod(for Sinker)	pc	1,620.0	100	0	1,620.0	0.0
	(b) Bit(for Sinker)	pc	555.0	100	0	555.0	0.0
12	Steel Pipes (STPW, l=6.00m)					0.0	0.0
	300mm	pc	7,650.0	100	0	7,650.0	0.0
	350mm	pc	8,020.0	100	0	8,020.0	0.0
	400mm	pc	9,020.0	100	0	9,020.0	0.0
	450mm	pc	10,040.0	100	0	10,040.0	0.0
	500mm	pc	10,730.0	100	0	10,730.0	0.0
	600mm	pc	12,350.0	100	0	12,350.0	0.0
13	Corrugate Pipes (l=1.00m)						
	400mm, t=2mm	pc	730.0	100	0	730.0	0.0
	600mm, t=2mm	pc	1,010.0	100	0	1,010.0	0.0
	800mm, t=2mm	pc	1,330.0	100	0	1,330.0	0.0
	1500mm, t=2.7mm	pc	2,840.0	100	0	2,840.0	0.0
14	Sluice Valve						
	D=75mm	pc	2,480.0	100	0	2,480.0	0.0
	D=200mm	pc	8,540.0	100	0	8,540.0	0.0
	D=300mm	pc	16,800.0	100	0	16,800.0	0.0
	D=450mm	pc	42,800.0	100	0	42,800.0	0.0
	D=600mm	pc	149,900.0	100	0	149,900.0	0.0
15	Elbow						
	D=75mm	pc	1,187.0	100	0	1,187.0	0.0
	D=200mm	pc	6,490.0	100	0	6,490.0	0.0
	D=300mm	pc	9,090.0	100	0	9,090.0	0.0
	D=450mm	pc	11,110.0	100	0	11,110.0	0.0
	D=600mm	pc	15,610.0	100	0	15,610.0	0.0
16	Air Valve D=50mm	pc	7,000.0	100	0	7,000.0	0.0
17	Mastic filler	m2	130.0	100	0	130.0	0.0
18	Oil paint	lit	57.0	100	0	57.0	0.0
19	Staff Gage	m	420.0	100	0	420.0	0.0

Table VII.2.3 BREAKDOWN OF CONSTRUCTION COST (1/3)
(TANGMACHEU)

(Unit : Nu '000)

Items	Quantity	Unit	Construction Cost F/C	L/C	Total
1 Irrigation Facilities					
1-1 Tangmachhu Canal					
(1) Intake	2	nos.	1,011	598	1,609
Sub-Total (1)			1,011	598	1,609
(2) Main Canal					
a. Open Canal	7,294.0	m	7,583	6,205	13,788
b. Syphon	-	m	0	0	0
c. Aqueduct	54.3	m	107	18	125
d. Cascade	1,201.7	m	950	661	1,611
e. Drop	21	nos.	63	50	113
Sub-Total (2)	8,550.0	m	8,703	6,934	15,637
(3) Related Structures					
a. Spillway	11	nos.	82	47	129
b. Waste Way	-	nos.	0	0	0
c. Sand Trap	2	nos.	31	28	59
d. Cross Drainage	3	nos.	41	39	80
e. Drain Inlet	3	nos.	44	41	85
f. Over Chute	1	nos.	4	4	8
g. Road Crossing	20	m	4	3	7
h. Turnout Type-A	6	nos.	42	7	49
i. Turnout Type-B	8	nos.	253	20	273
Sub-Total (3)			501	189	690
(4) Secondary Canal	900.0	m	880	516	1,396
Sub-Total (4)			880	516	1,396
Total 1-1			11,095	8,237	19,332
1-2 Gorgan Canal					
(1) Intake	1	nos.	604	388	992
Sub-Total (1)			604	388	992
(2) Main Canal					
a. Open Canal	2,869.6	m	3,200	2,933	6,133
b. Syphon	251.2	m	239	139	378
c. Aqueduct	10.0	m	21	4	25
d. Cascade	889.0	m	963	644	1,607
e. Drop	12	nos.	36	29	65
Sub-Total (2)	4,019.6	m	4,459	3,749	8,208

(Unit : Nu '000)

Items	Quantity	Unit	Construction Cost F/C	L/C	Total
1-2 Gorgan Canal					
(3) Related Structures					
a. Spillway	2	nos.	15	8	23
b. Waste Way	-	nos.	0	0	0
c. Sand Trap	3	nos.	46	41	87
d. Cross Drainage	-	nos.	0	0	0
e. Drain Inlet	1	no.	14	14	28
f. Over Chute	3	nos.	11	10	21
g. Road Crossing	3	m	1	1	2
h. Turnout Type-A	21	nos.	147	26	173
i. Turnout Type-B	2	nos.	63	5	68
j. Gorgan Turnout	1	no.	319	41	360
Sub-Total (3)			616	146	762
(4) Secondary Canal	-	m	0	0	0
Sub-Total (4)			0	0	0
Total 1-2			5,679	4,283	9,962
2 Feeder Roads	5,400.0	m	8,399	3,099	11,498
3 Temporary Roads	5,400.0	m	2,455	592	3,047
4 Buildings	1	set	202	68	270

Total

1 Irrigation Facilities			
1-1 Tangmachhu Canal	11,095	8,237	19,332
1-2 Gorgan Canal	5,679	4,283	9,962
2 Feeder Roads	8,399	3,099	11,498
3 Temporary Roads	2,455	592	3,047
4 Buildings	202	68	270
Total Tangmachhu Area	27,830	16,279	44,109

Table VII.2.3 BREAKDOWN OF CONSTRUCTION COST (2/3)
(MASANGDAZA)

(Unit : Nu '000)

Items	Quantity	Unit	Construction Cost F/C	L/C	Total
1 Irrigation Facilities					
1-1 Masangdaza Canal					
(1) Intake	1	nos.	518	240	758
Sub-Total (1)			518	240	758
(2) Main Canal					
a. Open Canal	3,285.0	m	934	801	1,735
b. Syphon	-	m	0	0	0
c. Aqueduct	16.0	m	33	6	39
d. Cascade	-	m	0	0	0
e. Drop	-	nos.	0	0	0
Sub-Total (2)	3,301.0	m	967	807	1,774
(3) Related Structures					
a. Spillway	4	nos.	30	17	47
b. Waste Way	1	nos.	39	6	45
c. Sand Trap	3	nos.	46	41	87
d. Cross Drainage	2	nos.	27	25	52
e. Drain Inlet	-	no.	0	0	0
f. Over Chute	8	nos.	30	25	55
g. Road Crossing	6	m	1	1	2
h. Turnout Type-A	6	nos.	42	7	49
i. Turnout Type-B	8	nos.	253	24	277
Sub-Total (3)			468	146	614
(4) Secondary Canal	-	m	0	0	0
Sub-Total (4)			0	0	0
Total 1-1			1,953	1,193	3,146
1-2 Bongdima Canal					
(1) Intake	-	nos.	0	0	0
Sub-Total (1)			0	0	0
(2) Main Canal					
a. Open Canal	4446.7	m	928	909	1,837
b. Syphon	-	m	0	0	0
c. Aqueduct	26.3	m	217	9	226
d. Cascade	30.0	m	23	16	39
e. Drop	4	nos.	12	10	22
Sub-Total (2)	4503.0	m	1,180	944	2,124
(3) Related Structures					
a. Spillway	3	nos.	23	13	36
b. Waste Way	-	nos.	0	0	0
c. Sand Trap	1	nos.	15	14	29
d. Cross Drainage	1	nos.	14	12	26
e. Drain Inlet	-	no.	0	0	0
f. Over Chute	7	nos.	26	22	48
g. Road Crossing	32	m	1	1	2
h. Turnout Type-A	11	nos.	76	13	89
i. Turnout Type-B	1	nos.	31	3	34
Sub-Total (3)			186	78	264
(4) Secondary Canal	200.0	m	472	45	517
Sub-Total (4)			472	45	517
Total 1-2			1,837	1,067	2,905
1-3 Karibithang Canal					
(1) Intake	1	nos.	1,034	615	1,649
Sub-Total (1)			1,034	615	1,649
(2) Main Canal					
a. Open Canal	1425.0	m	963	722	1,685
b. Syphon	-	m	0	0	0
c. Aqueduct	93.0	m	192	41	233
d. Cascade	125.0	m	95	68	163
e. Drop	3	nos.	9	7	16
Sub-Total (2)	1643.0	m	1,259	838	2,097
(3) Related Structures					
a. Spillway	1	nos.	7	5	12
b. Waste Way	-	nos.	0	0	0
c. Sand Trap	-	nos.	0	0	0
d. Cross Drainage	3	nos.	41	38	79
e. Drain Inlet	-	no.	0	0	0
f. Over Chute	1	nos.	4	3	7
g. Road Crossing	1	m	1	1	2
h. Turnout Type-A	-	nos.	0	0	0
i. Turnout Type-B	3	nos.	93	7	100
Sub-Total (3)			146	54	200
(4) Secondary Canal	200.0	m	114	45	159
Sub-Total (4)			114	45	159
Total 1-3			2,553	1,552	4,105

Table VII.2.3 BREAKDOWN OF CONSTRUCTION COST (3/3)
(MASANGDAZA)

(Unit : Nu '000)

Items	Quantity	Unit	Construction Cost F/C	L/C	Total
B. Masangdaza Area					
2 Feeder Roads	2,000.0	m	4,214	1,970	6,184
Bridge	60.0	m	6,007	29	6,036
3 Temporary Roads	3,000.0	m	2,160	249	2,409
4 Buildings	1	set	2,093	697	2,790
Total					
1 Irrigation Facilities					
1-1 Masangdaza Canal			1,953	1,193	3,146
1-2 Bongdima Canal			1,838	1,067	2,905
1-3 Karibithang Canal			2,553	1,552	4,105
2 Feeder Roads			4,214	1,970	6,184
Bridge			6,007	29	6,036
3 Temporary Roads			2,160	249	2,409
4 Buildings			2,093	697	2,790
Total Masangdaza Area			20,818	6,757	27,575

Table VII.2.4 LAND ACQUISITION COST

Work Item	Project Area	Land Use	Area (ha)	Amount (Nu)
Canal	Tangmachhu	Paddy field	0.51	10,200
		Hilly area	2.03	4,060
	Masangdaza	Paddy field	0.10	2,000
		Hilly area	1.20	2,400
Road	Tangmachhu	Paddy field	1.50	30,000
		Hilly area	7.80	15,600
	Masangdaza	Hilly area	1.32	2,640
		Total	14.46	66,900

Table VII.2.5 LAND RECLAMATION COST

Description	Unit	Amount
Height of terrace riser	m	0.25
Earth volume to be moved	m3/ha	625
Labour output	man.days/m3	0.7
Labour required to terracing	man.day/ha	893
Terracing cost per ha	Nu/ha	13,395
Terracing cost for 50 ha	Nu	669,750

Note: Man.day labour wage is applied Nu 15.

TABLE VII.2.6 PROCUREMENT COST OF FOR THE MODEL PROJECTS (1/5)
(AGRICULTURAL MECHANIZATION)

Machinery	FOB Price (Nu/unit)	Quantity (unit)	Ammount (Nu)
TANGMACHHU			
1. Pedal threasher	11,000	40	440,000
2. Manual winnower	5,000	40	200,000
3. Manual separator	5,000	9	45,000
4. Manual rice husker	25,000	9	225,000
5. Manual rice polisher	12,000	9	108,000
6. Manual maize huller	18,000	8	144,000
7. Power tiller	48,000	14	672,000
8. Freight		Lump sum	183,000
			2,017,000
MASANGDAZA			
1. Pedal threasher	11,000	22	242,000
2. Manual winnower	5,000	22	110,000
3. Manual separator	5,000	4	20,000
4. Manual rice husker	25,000	4	100,000
5. Manual rice polisher	12,000	4	48,000
6. Manual maize huller	18,000	4	72,000
7. Power tiller	48,000	8	384,000
8. Freight		Lump sum	98,000
			1,074,000
TOTAL			
1. Pedal threasher	11,000	62	682,000
2. Manual winnower	5,000	62	310,000
3. Manual separator	5,000	13	65,000
4. Manual rice husker	25,000	13	325,000
5. Manual rice polisher	12,000	13	156,000
6. Manual maize huller	18,000	12	216,000
7. Power tiller	48,000	22	1,056,000
8. Freight		Lump sum	281,000
			3,091,000

TABLE VII.2.6 PROCUREMENT COST OF FOR THE MODEL PROJECTS (2/5)
(EQUIPMENTS FOR DEMONSTRATION AND TRIAL)

Tools/machinery		FOB Price (Nu)
1. Improved tools 1 set for each demonstration and trial plot sickels, spades, shovels, improved steel ploughs and hallows for bullock draft power, hand sprayers, hand dusters, etc.	1 set	14,000
2. Agricultural machinery for every demonstration and tial plots 1 set of pedal thresher, manual winnower, manual husker, manual separator, power tiller	1 set	40,000
3. Agricultural machinery for irrigated demonstration and tial plots Manual rice polisher	1 no.	10,000
4. Agricultural machinery for rainfed demonstration and tial plots Maize sheller	1 no.	16,000

Tools/machinery	FOB price (Nu)	Quantity (set)	Amount (Nu)
TANGMACHHU			
1. Improved tools	14,000	5	70,000
2. Agricultural machinery (for every plot)	40,000	5	200,000
3. Agricultural machinery (for irrigated plot)	10,000	3	30,000
4. Agricultural machinery (for rainfed plot)	16,000	2	32,000
5. Freight		Lamp Sum	26,000
6. Total			358,000
MASANGDAZA			
1. Improved tools	14,000	3	42,000
2. Agricultural machinery (for every plot)	40,000	3	120,000
3. Agricultural machinery (for irrigated plot)	10,000	2	20,000
4. Agricultural machinery (for rainfed plot)	16,000	1	16,000
5. Freight		Lamp Sum	16,000
6. Total			214,000
TOTAL			572,000

TABLE VII.2.6 PROCUREMENT COST OF FOR THE MODEL PROJECTS (3/5)
(WORKSHOP)

Description	Quantity	Amount (Nu '000)
I Stationary Workshop		
1 Engine and general tool	Lump sum	145,000
2 Tire and chassis	Lump sum	130,000
3 Electrc and welder	Lump sum	85,000
4 Electric tool	Lump sum	45,000
Sub-total		405,000
II Mobile Workshop		
1 Truck chassis	1	676,000
2 Machine and tool	Lump sum	210,000
Sub-total		886,000
III Freight	Lump sum	145,000
IV Total (I+II+III)		1,436,000

TABLE VII.2.6 PROCUREMENT COST OF FOR THE MODEL PROJECTS (4/5)
(AGRO-PROCESSING FACILITY)

Description			Quantity	Amount (Nu '000)
I Mustard oil unit			1	3,008,000
II Chilli powder unit	1	Chilli mill	1	95,000
	2	Shifter	1	295,000
		Sub-total		390,000
III Multi-purpose dryer			1	44,000
IV Freight			Lump sum	172,000
V Total (I+II+III+IV)				3,614,000

TABLE VII.2.6 PROCUREMENT COST OF FOR THE MODEL PROJECTS (5/5)
(O/M EQUIPMENTS)

Item/Specification		Quantity (No.)	Unit cost (Nu '000)	Amount (Nu '000)
1. Bulldozer	11 ton class	1	1,295	1,295
2. Backhoe	0.35 cu.m	1	1,070	1,070
3. Truck	4 ton w/crane	1	420	420
4. Pickup (double cab)	2,800cc 4WD	2	200	400
5. Moter cycle	125cc	3	30	90
6. Dewatering pump	2" dia	2	30	60
Sub-total				3,335
7. Spare parts,etc		Lump sum		501
Total				3,836

* Since all the bove equipments will be procured for the both model projects, 50% of the total cost is allocated to each model project.

Table VII.2.7 ADMINISTRATION COST

(Unit: Nu)

Item	Required Number	Monthly Rate	Monthly Amount
Project Manager	1	5,000	5,000
Site Manager	2	3,000	6,000
Supervisor	2	2,000	4,000
Clerical Staff	5	1,000	5,000
Sub-total			20,000
Other Expense	(50%)		10,000
Living Allowance	10	900	9,000
Total			39,000

Note: 2nd Year 39,000 x 12 month = 468,000 Nu
3rd Year 39,000 x 12 month = 468,000 Nu

Table VII.2.8 SUMMARY OF PROJECT COST

(Unit : Nu'000)

Project Area	Tangmachhu Area			Masangdaza Area			Total		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Irrigation Facilities	23,121	13,126	36,247	12,396	4,735	17,131	35,517	17,861	53,378
2. Other Rural Facilities	16,508	3,213	19,721	17,667	2,699	20,366	34,175	5,912	40,087
Sub-Total (1-2)	39,629	16,339	55,968	30,063	7,434	37,497	69,692	23,773	93,465
3. Administration Cost	0	560	560	0	376	376	0	936	936
4. Engineering Services	4,321	480	4,801	2,896	321	3,217	7,217	801	8,018
Sub-Total (3-4)	4,321	1,040	5,361	2,896	697	3,593	7,217	1,737	8,954
5. Physical Contingency (P/C:6%)	2,638	1,044	3,682	1,979	487	2,466	4,617	1,531	6,148
Sub-Total (1-5)	46,588	18,423	65,011	34,938	8,618	43,556	81,526	27,041	108,567
6. Price Contingency (F/C:3%,L/C:8%)	3,460	3,882	7,342	2,486	1,786	4,272	5,946	5,668	11,614
TOTAL (1-6)	50,048	22,305	72,353	37,424	10,404	47,828	87,472	32,709	120,181

Table VII.2. 9 BREAKDOWN OF PROJECT COST DISBURSEMENT (1/2)
(TANGMACHHU AREA)

(Unit:Nu'000)

I. TANGMACHHU AREA	Total			1989			1990			1991		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Irrigation Facilities												
1-1 Preparatory Works												
(1)Mobili/Demobilization	3,892	0	3,892	0	0	0	2,830	0	2,830	1,062	0	1,062
(2)Temporary Roads	2,455	592	3,047	0	0	0	2,455	592	3,047	0	0	0
Sub-Total 1-1	6,347	592	6,939	0	0	0	5,285	592	5,877	1,062	0	1,062
1-2 Irrigation Facilities												
(1)Intakes	1,615	986	2,601	0	0	0	1,292	789	2,081	323	197	520
(2)Tangmachhu C/RS	9,204	7,123	16,327	0	0	0	3,129	2,422	5,551	6,075	4,701	10,776
(3)Gorgan C/RS	5,075	3,895	8,970	0	0	0	1,624	1,246	2,870	3,451	2,649	6,100
(4)Secondary C/RS	880	516	1,396	0	0	0	0	0	0	880	516	1,396
Sub-Total 1-2	16,774	12,520	29,294	0	0	0	6,045	4,457	10,502	10,729	8,063	18,792
Sub-Total 1-1---1-2	23,121	13,112	36,233	0	0	0	11,330	5,049	16,379	11,791	8,063	19,854
1-3 Land Acquisition	0	14	14	0	0	0	0	14	14	0	0	0
Sub-Total 1-3	0	14	14	0	0	0	0	14	14	0	0	0
1-4 Land Reclamation	0	0	0	0	0	0	0	0	0	0	0	0
Total 1-1 ---1-4	23,121	13,126	36,247	0	0	0	11,330	5,063	16,393	11,791	8,063	19,854
1-5 Administration Cost	0	422	422	0	0	0	0	211	211	0	211	211
1-6 Engineering Services	3,261	362	3,623	1,794	199	1,993	815	91	906	652	72	724
Total 1-5---1-6	3,261	784	4,045	1,794	199	1,993	815	302	1,117	652	283	935
Total 1-1---1-6	26,382	13,910	40,292	1,794	199	1,993	12,145	5,365	17,510	12,443	8,346	20,789
1-7 Physical Contingency	1,584	835	2,419	108	12	120	729	322	1,051	747	501	1,248
Total 1-1---1-7	27,966	14,745	42,711	1,902	211	2,113	12,874	5,687	18,561	13,190	8,847	22,037
1-8 Price Conti.(F3%,L8%)	2,064	3,261	5,325	57	17	74	784	946	1,730	1,223	2,298	3,521
TOTAL 1-1---1-8	30,030	18,006	48,036	1,959	228	2,187	13,658	6,633	20,291	14,413	11,145	25,558
2. Other Rural Facilities												
2-1 Preparatry Works												
(1)Mobili/Demobilization	381	0	381	0	0	0	0	0	0	381	0	381
Sub-Total 2-1	381	0	381	0	0	0	0	0	0	381	0	381
2-2 Other Rural Facilities												
(1)Feeder Roads	8,399	3,099	11,498	0	0	0	8,399	3,099	11,498	0	0	0
(2)Buildings	202	68	270	0	0	0	0	0	0	202	68	270
Sub-Total 2-2	8,601	3,167	11,768	0	0	0	8,399	3,099	11,498	202	68	270
Sub-Total 2-1---2-2	8,982	3,167	12,149	0	0	0	8,399	3,099	11,498	583	68	651
2-3 Procurement Cost												
(1)Agro-Industry	3,442	0	3,442	0	0	0	0	0	0	3,442	0	3,442
(2)Agri-Mechanization	1,834	0	1,834	0	0	0	0	0	0	1,834	0	1,834
(3)Demonst. Plots	332	0	332	0	0	0	0	0	0	332	0	332
(4)O&M Equipment	1,918	0	1,918	0	0	0	0	0	0	1,918	0	1,918
Sub-Total 2-3	7,526	0	7,526	0	0	0	0	0	0	7,526	0	7,526
2-4 Land Acquisition	0	46	46	0	0	0	0	46	46	0	0	0
Total 2-1 ---2-4	16,508	3,213	19,721	0	0	0	8,399	3,145	11,544	8,109	68	8,177
2-5 Administration Cost	0	138	138	0	0	0	0	69	69	0	69	69
2-6 Engineering Services	1,060	118	1,178	583	65	648	265	29	294	212	24	236
Total 2-5---2-6	1,060	256	1,316	583	65	648	265	98	363	212	93	305
Total 2-1---2-6	17,568	3,469	21,037	583	65	648	8,664	3,243	11,907	8,321	161	8,482
2-7 Physical Contingency	1,054	209	1,263	35	4	39	520	195	715	499	10	509
Total 2-1---2-7	18,622	3,678	22,300	618	69	687	9,184	3,438	12,622	8,820	171	8,991
2-8 Price Conti.(F3%,L8%)	1,396	621	2,017	19	5	24	559	572	1,131	818	44	862
TOTAL 2-1---2-8	20,018	4,299	24,317	637	74	711	9,743	4,010	13,753	9,638	215	9,853
3. Grand Total												
3-1 Irrigation(Total1-1---1-3)	23,121	13,126	36,247	0	0	0	11,330	5,063	16,393	11,791	8,063	19,854
3-2 Other Rural F(Total2-1--2-5)	16,508	3,213	19,721	0	0	0	8,399	3,145	11,544	8,109	68	8,177
Total 3-1---3-2	39,629	16,339	55,968	0	0	0	19,729	8,208	27,937	19,900	8,131	28,031
3-3 Administration Cost	0	560	560	0	0	0	0	280	280	0	280	280
3-4 Engineering Services	4,321	480	4,801	2,377	264	2,641	1,080	120	1,200	864	96	960
Total 3-3---3-4	4,321	1,040	5,361	2,377	264	2,641	1,080	400	1,480	864	376	1,240
3-5 Physical Contingency	2,638	1,044	3,682	143	16	159	1,249	517	1,766	1,246	511	1,757
Total 3-1---3-5	46,588	18,423	65,011	2,520	280	2,800	22,058	9,125	31,183	22,010	9,018	31,028
3-6 Price Conti.(F3%,L8%)	3,460	3,882	7,342	76	22	98	1,343	1,518	2,861	2,041	2,342	4,383
TOTAL 3-1---3-6	50,048	22,305	72,353	2,596	302	2,898	23,401	10,643	34,044	24,051	11,360	35,411

Table VII. 2. 9 BREAKDOWN OF PROJECT COST DISBURSEMENT (2/2)
(MASANGDAZA AREA)

(Unit:Nu'000)

I. MASANGDAZA AREA	Total			1989			1990			1991		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Irrigation Facilities												
1-1 Preparatory Works												
(1)Mobili/Demobilization	3,892	0	3,892	0	0	0	2,830	0	2,830	1,062	0	1,062
(2)Temporary Roads	2,160	249	2,409	0	0	0	2,160	249	2,409	0	0	0
Sub-Total 1-1	6,052	249	6,301	0	0	0	4,990	249	5,239	1,062	0	1,062
1-2 Irrigation Facilities												
(1)Intakes	1,552	855	2,407	0	0	0	1,164	641	1,805	388	214	602
(2)Masangdaza C/RS	1,435	953	2,388	0	0	0	0	0	0	1,435	953	2,388
(3)Bongdima C/RS	1,366	1,022	2,388	0	0	0	519	388	907	847	634	1,481
(4)Karibithang C/RS	1,405	892	2,297	0	0	0	1,054	669	1,723	351	223	574
(5)SEcondary C/RS	586	90	676	0	0	0	0	0		586	90	676
Sub-Total 1-2	6,344	3,812	10,156	0	0	0	2,737	1,698	4,435	3,607	2,114	5,721
Sub-Total 1-1---1-2	12,396	4,061	16,457	0	0	0	7,727	1,947	9,674	4,669	2,114	6,783
1-3 Land Acquisition	0	4	4	0	0	0	0	4	4	0	0	0
Sub-Total 1-3	0	4	4	0	0	0	0	4	4	0	0	0
1-4 Land Reclamation	0	670	670	0	0	0	0	0	0	0	670	670
Total 1-1 ---1-4	12,396	4,735	17,131	0	0	0	7,727	1,951	9,678	4,669	2,784	7,453
1-5 Administration Cost	0	192	192	0	0	0	0	96	96	0	96	96
1-6 Engineering Services	1,481	165	1,646	815	91	906	370	41	411	296	33	329
Total 1-5---1-6	1,481	357	1,838	815	91	906	370	137	507	296	129	425
Total 1-1---1-6	13,877	5,092	18,969	815	91	906	8,097	2,088	10,185	4,965	2,913	7,878
1-7 Physical Contingency	833	265	1,098	49	5	54	486	125	611	298	135	433
Total 1-1---1-6	14,710	5,357	20,067	864	96	960	8,583	2,213	10,796	5,263	3,048	8,311
1-8 Price Conti.(F3%,L8%)	1,037	993	2,030	26	8	34	523	368	891	488	617	1,105
TOTAL 1-1---1-7	15,747	6,350	22,097	890	104	994	9,106	2,581	11,687	5,751	3,665	9,416
2. Other Rural Facilities												
2-1 Preparatry Works												
(1)Mobili/Demobilization	970	0	970	0	0	0	551	0	551	419	0	419
Sub-Total 2-1	970	0	970	0	0	0	551	0	551	419	0	419
2-2 Other Rural Facilities												
(1)Feeder Roads	4,214	1,970	6,184	0	0	0	4,214	1,970	6,184	0	0	0
(2)Bridge	6,007	29	6,036	0	0	0	6,007	29	6,036	0	0	0
(3)Buildings	2,093	697	2,790	0	0		0	0	0	2,093	697	2,790
Sub-Total 2-2	12,314	2,696	15,010	0	0	0	10,221	1,999	12,220	2,093	697	2,790
Sub-Total 2-1---2-2	13,284	2,696	15,980	0	0	0	10,772	1,999	12,771	2,512	697	3,209
2-3 Procurement Cost												
(1)Work Shop	1,291	0	1,291	0	0	0	0	0	0	1,291	0	1,291
(2)Agri-Mechanization	976	0	976	0	0	0	0	0	0	976	0	976
(3)Extension Centers	198	0	198	0	0	0	0	0	0	198	0	198
(4)O&M Equipment	1,918	0	1,918	0	0	0	0	0	0	1,918	0	1,918
Sub-Total 2-3	4,383	0	4,383	0	0	0	0	0	0	4,383	0	4,383
2-4 Land Acquisition	0	3	3	0	0	0	0	3	3	0	0	0
Total 2-1 ---2-4	17,667	2,699	20,366	0	0	0	10,772	2,002	12,774	6,895	697	7,592
2-5 Administration Cost	0	184	184	0	0	0	0	92	92	0	92	92
2-6 Engineering Services	1,415	156	1,571	778	86	864	354	39	393	283	31	314
Total 2-5---2-6	1,415	340	1,755	778	86	864	354	131	485	283	123	406
Total 2-1---2-6	19,082	3,039	22,121	778	86	864	11,126	2,133	13,259	7,178	820	7,998
2-7 Physical Contingency	1,146	222	1,368	47	5	52	668	128	796	431	89	520
Total 2-1---2-7	20,228	3,261	23,489	825	91	916	11,794	2,261	14,055	7,609	909	8,518
2-8 Price Conti.(F3%,L8%)	1,449	793	2,242	25	7	32	718	376	1,094	706	410	1,116
TOTAL 2-1---2-8	21,677	4,054	25,731	850	98	948	12,512	2,637	15,149	8,315	1,319	9,634
3. Grand Total												
3-1 Irrigation(Total1-1---1-3)	12,396	4,735	17,131	0	0	0	7,727	1,951	9,678	4,669	2,784	7,453
3-2 Other Rural F(Total2-1--2-5)	17,667	2,699	20,366	0	0	0	10,772	2,002	12,774	6,895	697	7,592
Total 3-1---3-2	30,063	7,434	37,497	0	0	0	18,499	3,953	22,452	11,564	3,481	15,045
3-3 Administration Cost	0	376	376	0	0	0	0	188	188	0	188	188
3-4 Engineering Services	2,896	321	3,217	1,593	177	1,770	724	80	804	579	64	643
Total 3-3---3-4	2,896	697	3,593	1,593	177	1,770	724	268	992	579	252	831
3-5 Physical Contingency	1,979	487	2,466	96	10	106	1,154	253	1,407	729	224	953
Total 3-1---3-5	34,938	8,618	43,556	1,689	187	1,876	20,377	4,474	24,851	12,872	3,957	16,829
3-6 Price Conti.(F3%,L8%)	2,486	1,786	4,272	51	15	66	1,241	744	1,985	1,194	1,027	2,221
TOTAL 3-1---3-6	37,424	10,404	47,828	1,740	202	1,942	21,618	5,218	26,836	14,066	4,984	19,050

Table VII.2.10 DISBURSEMENT SCHEDULE OF THE PROJECT COST

(Unit : Nu'000)

Project Area	Total			1989			1990			1991		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
Tangmachhu Area												
1. Irrigation Facilities	23,121	13,126	36,247	0	0	0	11,330	5,063	16,393	11,791	8,063	19,854
2. Other Rural Facilities	16,508	3,213	19,721	0	0	0	8,399	3,145	11,544	8,109	68	8,177
Sub-Total (1-2)	39,629	16,339	55,968	0	0	0	19,729	8,208	27,937	19,900	8,131	28,031
3. Administration Cost	0	560	560	0	0	0	0	280	280	0	280	280
4. Engineering Services	4,321	480	4,801	2,377	264	2,641	1,080	120	1,200	864	96	960
Sub-Total (3-4)	4,321	1,040	5,361	2,377	264	2,641	1,080	400	1,480	864	376	1,240
5. Physical Contingency (P/C:6%)	2,638	1,044	3,682	143	16	159	1,249	517	1,766	1,246	511	1,757
Sub-Total (1-5)	46,588	18,423	65,011	2,520	280	2,800	22,058	9,125	31,183	22,010	9,018	31,028
6. Price Contingency (F/C:3%,L/C:8%)	3,460	3,882	7,342	76	22	98	1,343	1,518	2,861	2,041	2,342	4,383
TOTAL (1-6)	50,048	22,305	72,353	2,596	302	2,898	23,401	10,643	34,044	24,051	11,360	35,411
Masangdaza Area												
1. Irrigation Facilities	12,396	4,735	17,131	0	0	0	7,727	1,951	9,678	4,669	2,784	7,453
2. Other Rural Facilities	17,667	2,699	20,366	0	0	0	10,772	2,002	12,774	6,895	697	7,592
Sub-Total (1-2)	30,063	7,434	37,497	0	0	0	18,499	3,953	22,452	11,564	3,481	15,045
3. Administration Cost	0	376	376	0	0	0	0	188	188	0	188	188
4. Engineering Services	2,896	321	3,217	1,593	177	1,770	724	80	804	579	64	643
Sub-Total (3-4)	2,896	697	3,593	1,593	177	1,770	724	268	992	579	252	831
5. Physical Contingency (P/C:6%)	1,979	487	2,466	96	10	106	1,154	253	1,407	729	224	953
Sub-Total (1-5)	34,938	8,618	43,556	1,689	187	1,876	20,377	4,474	24,851	12,872	3,957	16,829
6. Price Contingency (F/C:3%,L/C:8%)	2,486	1,786	4,272	51	15	66	1,241	744	1,985	1,194	1,027	2,221
TOTAL (1-6)	37,424	10,404	47,828	1,740	202	1,942	21,618	5,218	26,836	14,066	4,984	19,050
Total												
1. Irrigation Facilities	35,517	17,861	53,378	0	0	0	19,057	7,014	26,071	16,460	10,847	27,307
2. Other Rural Facilities	34,175	5,912	40,087	0	0	0	19,171	5,147	24,318	15,004	765	15,769
Sub-Total (1-2)	69,692	23,773	93,465	0	0	0	38,228	12,161	50,389	31,464	11,612	43,076
3. Administration Cost	0	936	936	0	0	0	0	468	468	0	468	468
4. Engineering Services	7,217	801	8,018	3,970	441	4,411	1,804	200	2,004	1,443	160	1,603
Sub-Total (3-4)	7,217	1,737	8,954	3,970	441	4,411	1,804	668	2,472	1,443	628	2,071
5. Physical Contingency (P/C:6%)	4,617	1,531	6,148	239	26	265	2,403	770	3,173	1,975	735	2,710
Sub-Total (1-5)	81,526	27,041	108,567	4,209	467	4,676	42,435	13,599	56,034	34,882	12,975	47,857
6. Price Contingency (F/C:3%,L/C:8%)	5,946	5,668	11,614	127	37	164	2,584	2,262	4,846	3,235	3,369	6,604
TOTAL (1-6)	87,472	32,709	120,181	4,336	504	4,840	45,019	15,861	60,880	38,117	16,344	54,461

Table VII.2.11 ANNUAL OPERATION AND MAINTENANCE COST

(Unit: Nu x 1,000)

Project Area	Tangmachhu	Masangdaza	Total
Without Project	101	81	182
With Project	25	20	45
Balance	76	61	137

Note: These costs include the renovation cost of facilities.

Table VII.2.12 REPLACEMENT COST

(Unit: Nu x 1,000)

Project Area	Tangmachhu	Masangdaza	Total
Steel Gate	1,131	724	1,855
Corrugated Pipe	234	157	391
Total	1,365	881	2,246

Note: These facilities are to be replaced 25 years after installation

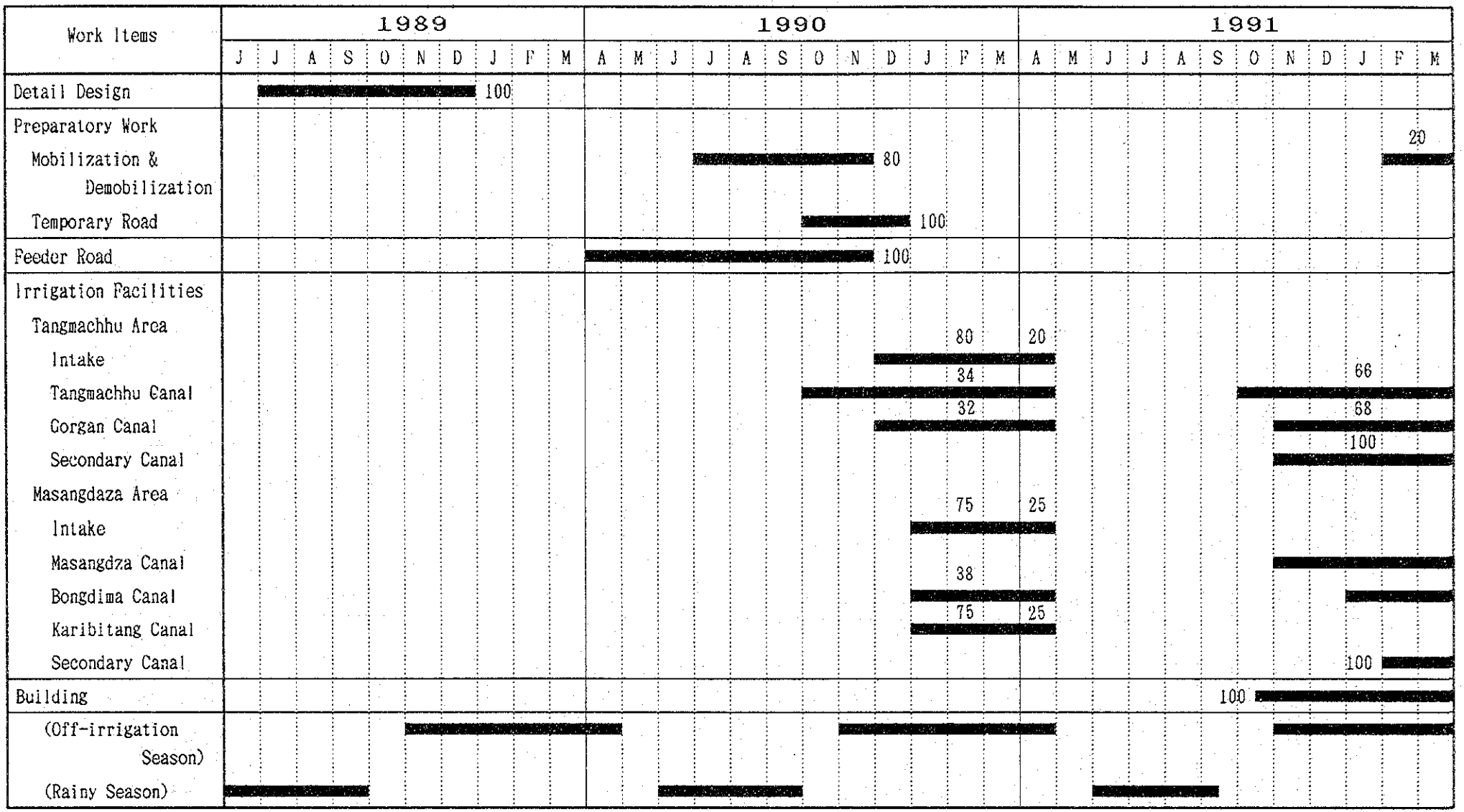


Fig. VII. 1. 1 TIME SCHEDULE OF PROJECT IMPLEMENTATION

ANNEX - VIII

PROJECT EVALUATION

LHUNTSHI AND MONGAR
INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT

ANNEX-VIII PROJECT EVALUATION

TABLE OF CONTENTS

LIST OF TABLES

1. GENERAL

Project evaluations have been made on the Tangmachhu and Masangdaza model projects through assessments of project feasibility in their economic, financial and socio-economic aspects.

The ultimate goals of the projects are for the fulfillment of the Basic Human Needs (BHN) of the inhabitants living in the Lhuntshi and Mongar Districts which are remote regions of Bhutan. Thus the projects will contribute to the regional economy as well as the national economy. Hence, the project can be categorized as a BHN project rather than a national economy project.

It is quite difficult to evaluate the project as a whole from the economic point of view, because the methodology to measure impacts on BHN has not yet been established. Therefore, the economic analysis was only made for the irrigation development scheme in this study. The direct benefit from the road development projects were not included since (i) the influence areas of the projects are limited due to the topography and the scattered villages, (ii) the beneficiaries are rather few, (iii) transportation means are mainly on foot at present, and (iv) direct benefits are not significant compared with the indirect benefit which are substantial for the inhabitants.

The farmers' economy will be benefited by the projects not only through the irrigation schemes but also through the other rural facilities development scheme. Hence the financial evaluation was carried out by analyzing the development effects both on the farmers' economy and on land and labour productivity. The socio-economic impacts were studies on the overall development schemes.

2. ECONOMIC EVALUATION

2.1 Basic Assumption

The economic evaluation was made on the basis of the following basic assumptions:

1) The economic useful life of the project is 50 years.

2) All prices are expressed at 1988 constant prices.

3) The exchange rate of US$ 1.00 = Nu 14.0 = Yen 133 (Nu 1.00 = Yen 9.50) is applied.

4) The construction period is three (3) years including preparatory works and detailed design.

5) The economic prices of non-trade goods and services are converted from financial prices by a standard conversion factor (SCF) of 0.90.

6) The price contingency (8% for local currency component and 3% for foreign currency component) and transfer payments (10% for sales tax) are excluded from the economic project cost.

2.2 Economic Benefit

Economic prices for trade goods were estimated on the basis of the projected world market prices of the World Bank in the long term range for the period of 1987 to 1995. The world market prices of trade gods were converted to 1988 constant price by the rate of 1.403 based on the manufacturing unit value index. The other economic prices were converted from financial prices by SCF of 0.90. Details are given in Annex IV.

Economic benefits were estimated on irrigation development benefit derived from the future irrigated land.

The irrigation development benefit to be expected is defined as the difference of the annual net production value between the future with and without project conditions on irrigated land. On the basis of the estimated production value and production cost, agricultural development benefit were estimated as shown in Annex IV and summarized as follows:

(Unit: Nu 10^3)

Area	Net Production Value		Development Benefit
	Without	With	
	(I)	(II)	(II)-(I)
Tangmachhu	405	2,593	2,188
Masangdaza	51	943	892

It is assumed that the irrigation development benefit will be increased year by year and will reach the full benefit in and after the 5th year after the completion of the construction. The irrigation development benefit flow of two (2) model project areas is shown in Table VIII.2.1.

2.3 Economic Cost

The capital cost comprises (i) construction cost for project facilities, (ii) procurement cost of agricultural tools, machines and workshop equipments, (iii) administrative expenses, (iv) expenses for engineering services, (v) physical contingencies, and (vi) price contingencies. All these costs are estimated on a financial basis as shown in Annex VII.

The local currency component of the financial capital cost may be separated into the labour cost and the others. The portion of the labour cost and the others excluding 10% of the transfer payments were converted into the economic value by applying SCF of 0.90. The economic capital cost excluding the price contingency was estimated on the irrigation development scheme as follows:

(Unit: Nu 10^3)

Item		Tangmachhu	Masangdaza
Total economic cost	(Nu 10^3)	40,131	19,170
Project Area	(ha)	220	80
Economic cost per ha	(Nu 10^3/ha)	182.4	239.6

The financial annual operation and maintenance (O&M) cost and the replacement cost for the irrigation facilities are given in Annex VII. The economic annual O&M costs both in without and with project conditions were converted from the financial cost by SCF of 0.90. The economic anual O&M cost will be decreased between without and with project conditions, hence the difference on O&M cost is considered as a development benefit. The economic annual O&M cost savings in the future are estimated at Nu 68 thousand in Tangmachhu and Nu 55 thousand in Masangdaza.

The irrigation facilities requiring replacement will be imported goods, hence the economic replacement cost was estimated to be same as the financial replacement cost. The useful life of the replacement facilities is estimated at 25 years for the irrigation facilities.

According to the implementation schedule of the projects as shown in Annex VII, the flow of the economic capital cost, the operation and maintenance cost and replacement cost were estimated as shown in Table VIII.2.1.

2.4 Economic Evaluation

The economic internal rate of return (EIRR) was calculated from the economic project benefits and costs flows for each project area as shown in Table VIII.2.1. The results are as follows:

(Unit: EIRR %)

Development Scheme	Tangmachhu	Masangdaza
Irrigation Scheme	4.6	3.8

By normal criteria, the economic viability of these irrigation schemes is not considered sufficient. The reason is that most of the irrigation development will have been implemented under very disadvantageous conditions such as the necessity for construction of long canals from intake sites for scattered small terraces of less than 50 ha on the mountain slope, and additional difficulties due to the inferior conditions of new development areas. Economic irrigation project costs per ha in this study areas were required Nu 182,400 in Tangmachhu and Nu 239,600 in Masangdaza. If the EIRRs of both projects have to be increased to 10%, the project costs per ha would be reduced to Nu 89,300 and Nu 102,100 respectively which are less than half the present estimates.

From the economic viable point of view, local designs and construction methods depending on man-powers are suitable in order to cut down the project costs. While the local development ways have been required a long construction period and man-powers and have not improved irrigation facilities with low efficiency, small capacity and short durableness at present. These facilities could not effectively utilize the limited land and water resources in Bhutan.

It is concluded that these irrigation developments are not suitable for the International Funding Agencies. Nevertheless, the farmers of the areas are eager for these developments which are based on Basic Human Needs (BHN). It is recommended that these projects be implemented under concessional term aid from the international institutions.

3. FINANCIAL EVALUATION

3.1 Financial Cost

The financial cost at the current prices as of mid 1988 is estimated on the basis of the price contingency of 8% per annum for local currency component and 3% per annum for foreign currency component detailed in Annex VII. The total project cost per ha on the project area was estimated at Nu 217 thousand in Tangmachhu and Nu 431 thousand in Masangdaza. The project cost per ha in Masangdaza is heavier than that in Tangmachhu because (i) the irrigated land in Masangdaza is separately located at 4 sites, hence the cost for canal renovation become much, (ii) the feeder road development includes the Bailey bridge construction acrossed the Shongar chu (60 m). While the renovation of the long canals and the construction of bridge in Masangdaza are indispensable for the Model Project. The financial cost may be summarized as follows:

(Unit: Nu 10^3)

Item	Tangmachhu	Masangdaza
I. Project Cost (Nu 10^3)		
- Irrigation	48,036	22,097
- Others	24,317	25,731
Total	72,353	47,828
II. Project Area (ha)		
- Irrigated Land	220	80
- Rainfed Land	114	31
Total	334	111
III. Cost per ha (Nu 10^3/ha)		
- Irrigated Land	218	276
Total	217	431

3.2 Farmers' Economy

For the assessment of the projects from farmers' economic view point, future farmers' economy was examined by financial farm budgets as shown in Annex IV.

Farmers' economy in without and with project conditions is summarized according to the farm size classification as follows:

(Unit: Nu)

Area/Farm Size (ha)	Without Project			With Project		
	Total Income	Total Outgo	Net Reserve	Total Income	Total Outgo	Net Reserve
Tangmachhu						
Below 0.59	1,895	1,840	55	3,650	3,090	520
0.59-1.08	2,915	2,520	395	8,410	3,000	4,710
1.08-1.74	5,665	4,910	755	14,740	5,460	9,280
Over 1.74	4,840	3,590	1,250	32,830	6,790	26,040
Masangdaza						
Below 0.80	685	690	-5	4,140	2,120	2,020
0.80-1.20	885	880	5	7,050	2,830	4,220
1.20	505	320	185	10,420	3,120	7,300
Over 1.20	1,670	1,100	570	16,360	3,900	12,460

After the implementation of these projects, a significant increase of net reserve can be expected in each farmer classified. The net reserve of each farmer may be expected to be more than Nu 500 in the future with project condition.

Land and labour productivities in without and with project conditions were examined on irrigated and rainfed lands. Future land and labour productivity on irrigated land may be expected to be more than three (3) times as much as the present on average. On the other hand, land productivity on rainfed land will be improved from Nu 4,300 to Nu 13,620 in Tangmachhu and Nu 3,750 to Nu 6,440 in Masangdaza. Labour productivity on rainfed land will be increased to 1.6 times on average.

Land/Area	Land Productivity (Nu/ha)		Labour Productivity (Nu/man-day)	
	Without Project	With Project	Without Project	With Project
I. Irrigated Land				
(1) Tangmachhu	5,050	16,620	28	81
(2) Masangdaza	5,300	16,620	23	81
Average	5,180	16,620	26	81
II. Rainfed Land				
(1) Tangmachhu	4,300	13,620	47	65
(2) Masangdaza	3,750	6,440	31	61
Average	4,030	10,030	39	63

4. SOCIO-ECONOMIC IMPACTS

In addition to the direct benefits assessed in the economic and financial evaluations, various secondary and intangible benefits and/or favourable socio-economic impacts may be expected from implementation of the project as follows:

(1) Activation of Regional Economy

Agricultural productivity and crop production would be increased through project implementation. Production surpluses would be increased and marketed in or out of the regions. The closed and subsistence farmers' economy in the remote region would be smoothly transferred to a monetary economy by the shipment of agricultural products by the government marketing support services. In particular, the initial development of the agro-industry in the project area would produce a lot of effects on the promotion of cash crop production and the trade in products.

The feeder road development in the mountainous project area will accelerate trade in agricultural inputs and outputs. The development of feeder roads and agro-industry would together introduce an active and open economy into the project areas.

Projects in the remote region would activate the economy and reduce regional disparity. The project contribution to the maintenance of national security will be large.

(2) Expenses Saving and Export Earning

Annual renovation of the irrigation facilities will reduce not only operation and maintenance expenses but also the farmers' farm works for the irrigation water management. Accessibility in the project areas can be improved by the feeder roads, hence traffic expenses, especially travelling time, would be reduced.

Most of the marketable products in the project areas can be consumed in substitution for imported goods or be directly exported. The value of import substitution which comprises; rice, maize, wheat and oil is estimated at Nu 880,000 per annum. The export earnings on soyabean and chilli is estimated at Nu 1.5 million per annum.

(3) Spreading Effects to Other Area

Each of model project areas will be located at the center of its block. Diffusion of the development activities at the block level will therefore be easy done. The development effects will be easily spread to other district areas by the feeder roads which will improve the accessibility between the project and other district areas.

Experiences and technologie introduced through the project execution will be used effectively and development of other areas will be accelerated by the know-how and trained personnel generated by the project.

(4) Effective Utilization of Available Labour Force

Present agricultural field works are generally concentrated during the summer crop season due to the predominant single cropping system especially on the irrigated land. The increase in second cropping in the area, through renovation of the irrigation facilities and the improvement of agricultural support services, will make year round employment opportunities possible.

Agricultural mechanization, with the establishment of a workshop will make the peak labour requirement smaller and will promote balanced farm works between the first and second cropping.

The labour requirement for operation and maintenance of irrigation facilities can be reduced by irrigation development in the project areas, and utilized for more productive activities.

In addition to the farm works, the initiation of small-scale agro-industry will generate non-farm employment opportunities in the area.

(5) Enhancement of Farmers' Organization

The establishment of the various projects will inevitably require new farmers' organizations such as irrigators' associations and agro-processing users' associations, etc. These organizations will also strengthen the farmers' community spirit.

(6) Improvement of Livestock Production

The livestock production will be improved through the rotational land use in the fields and the increase of feed supply such as rice and wheat straws and mustard meals.

(7) Improvement of Dietary Life and Social Welfare

It will be possible to satisfy the demand for staple foods after project execution. The increase in farm incomes can be spent for the production or purchase of vegetables and meat. This will further improve the farmers' diet.

Development strategies in Bhutan require not only economic viability but also improvement of social welfare. Accordingly these model projects will accelerate the development of the remote Lhuntshi and Mongar Districts. The selected project components are based on the basic local needs and are indispensable for the improvement of farmers' livelihood.

Table VIII.2.1 ECONOMIC COST AND BENEFIT FLOW FOR THE MODEL PROJECT

TANGMACHHU MODEL POJECT AREA

IRR : 4.59% (Unit : Nu 10^3)

Year in Order	Cost Flow: Capital Cost	O&M Cost	Replace-ment Cost	Total Cost	Irrigation Benefit Flow	Benefit mainus Cost
1	2,073	0	0	2,073	0	-2,073
2	17,581	0	0	17,581	0	-17,581
3	20,477	0	0	20,477	0	-20,477
4	0	-68	0	-68	1,313	1,381
5	0	-68	0	-68	1,750	1,818
6	0	-68	0	-68	1,969	2,037
7	0	-68	0	-68	2,079	2,147
8	0	-68	0	-68	2,188	2,256
9	0	-68	0	-68	2,188	2,256
10	0	-68	0	-68	2,188	2,256
11	0	-68	0	-68	2,188	2,256
12	0	-68	0	-68	2,188	2,256
13	0	-68	0	-68	2,188	2,256
14	0	-68	0	-68	2,188	2,256
15	0	-68	0	-68	2,188	2,256
16	0	-68	0	-68	2,188	2,256
17	0	-68	0	-68	2,188	2,256
18	0	-68	0	-68	2,188	2,256
19	0	-68	0	-68	2,188	2,256
20	0	-68	0	-68	2,188	2,256
21	0	-68	0	-68	2,188	2,256
22	0	-68	0	-68	2,188	2,256
23	0	-68	0	-68	2,188	2,256
24	0	-68	0	-68	2,188	2,256
25	0	-68	1,365	1,297	2,188	891
26	0	-68	0	-68	2,188	2,256
27	0	-68	0	-68	2,188	2,256
28	0	-68	0	-68	2,188	2,256
29	0	-68	0	-68	2,188	2,256
30	0	-68	0	-68	2,188	2,256
31	0	-68	0	-68	2,188	2,256
32	0	-68	0	-68	2,188	2,256
33	0	-68	0	-68	2,188	2,256
34	0	-68	0	-68	2,188	2,256
35	0	-68	0	-68	2,188	2,256
36	0	-68	0	-68	2,188	2,256
37	0	-68	0	-68	2,188	2,256
38	0	-68	0	-68	2,188	2,256
39	0	-68	0	-68	2,188	2,256
40	0	-68	0	-68	2,188	2,256
41	0	-68	0	-68	2,188	2,256
42	0	-68	0	-68	2,188	2,256
43	0	-68	0	-68	2,188	2,256
44	0	-68	0	-68	2,188	2,256
45	0	-68	0	-68	2,188	2,256
46	0	-68	0	-68	2,188	2,256
47	0	-68	0	-68	2,188	2,256
48	0	-68	0	-68	2,188	2,256
49	0	-68	0	-68	2,188	2,256
50	0	-68	0	-68	2,188	2,256

MASANGDAZA MODEL POJECT AREA

IRR : 3.96% (Unit : Nu 10^3)

Year in Order	Cost Flow: Capital Cost	O&M Cost	Replace-ment Cost	Total Cost	Irrigation Benefit Flow	Benefit mainus Cost
1	942	0	0	942	0	-942
2	10,404	0	0	10,404	0	-10,404
3	7,221	0	0	7,221	0	-7,221
4	0	-55	0	-55	535	590
5	0	-55	0	-55	714	769
6	0	-55	0	-55	803	858
7	0	-55	0	-55	847	902
8	0	-55	0	-55	892	947
9	0	-55	0	-55	892	947
10	0	-55	0	-55	892	947
11	0	-55	0	-55	892	947
12	0	-55	0	-55	892	947
13	0	-55	0	-55	892	947
14	0	-55	0	-55	892	947
15	0	-55	0	-55	892	947
16	0	-55	0	-55	892	947
17	0	-55	0	-55	892	947
18	0	-55	0	-55	892	947
19	0	-55	0	-55	892	947
20	0	-55	0	-55	892	947
21	0	-55	0	-55	892	947
22	0	-55	0	-55	892	947
23	0	-55	0	-55	892	947
24	0	-55	0	-55	892	947
25	0	-55	881	826	892	66
26	0	-55	0	-55	892	947
27	0	-55	0	-55	892	947
28	0	-55	0	-55	892	947
29	0	-55	0	-55	892	947
30	0	-55	0	-55	892	947
31	0	-55	0	-55	892	947
32	0	-55	0	-55	892	947
33	0	-55	0	-55	892	947
34	0	-55	0	-55	892	947
35	0	-55	0	-55	892	947
36	0	-55	0	-55	892	947
37	0	-55	0	-55	892	947
38	0	-55	0	-55	892	947
39	0	-55	0	-55	892	947
40	0	-55	0	-55	892	947
41	0	-55	0	-55	892	947
42	0	-55	0	-55	892	947
43	0	-55	0	-55	892	947
44	0	-55	0	-55	892	947
45	0	-55	0	-55	892	947
46	0	-55	0	-55	892	947
47	0	-55	0	-55	892	947
48	0	-55	0	-55	892	947
49	0	-55	0	-55	892	947
50	0	-55	0	-55	892	947

ANNEX - IX

BASIC INTEGRATED AGRICULTURAL DEVELOPMENT PLAN

LHUNTSHI AND MONGAR
INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT

ANNEX-IX BASIC INTEGRATED AGRICULTURAL DEVELOPMENT PLAN

TABLE OF CONTENTS

1. NECESSITY OF INTEGRATED AGRICULTURAL DEVELOPMENT PLAN

The study area which is relatively less developed than average for Bhutan is a virtually independent economic-social zone having little relation to the central and western regions in Bhutan due to the inferior conditions of location, underdeveloped transportation system including national roads and subsistence oriented economy. Since the Fifth 5 year Development Plan, the goverment of Bhutan has given development priority to the eastern region for equitable development of the nation and has promoted the integrated area development projects on the basis of the water-shed linked area development concept mentioned in Annex I.

The physical and economic environment in the study area, however, is in no sense favourable for industrial development. It would be quite difficult to find, any industry with a higher development potential than agriculture. On the other hand, the large majority of the rural inhabitants is engaged in agriculture and has acquired a certain level of techniques to increase production and to exploit their farm lands. Therefore, the prospects for development of the study area will heavily rely on agricultural development which will encompass crop and livestock production, irrigation, and agro-based industries as integrated components.

2. CURRENT SITUATION AND CONSTRAINTS

Agriculture in the study area is of an extensive nature in the subsistence oriented communities. Villages lie scattered on the mountain slopes. The social and economic connections between villages are very weak due to the topography and poorly developed transportation and communication facilities. Farming practices are traditional without improved seed, fertilizers, agro-chemicals, improved farm equipment and machinery. The main crops grown in the area are paddy, maize and other cereals, and cash crops such as soyabean, mustard, chilli, potatoes, etc. are as yet uncommon. Crops other than paddy are mainly planted under rainfed conditions. In general irrigation during the wet season is limited. Farmers rely heavily on these cereals for home consumption. However, unit yield of these crops are generally low; 1.2 t/ha of paddy and 1.6 t/ha of maize, and yields fluctuate from year to year. This makes the farm economy unstable and keeps it low and at a subsistence level.

The reasons for unstable and low productivity are manifold; however major constraints are considered to be as follows:

1) The arable lands for crop production are limited due to the steep and rugged topography. Most of the farm lands are on slopes and at various elevations.

2) Rainfall is distributed seasonally and is concentrated in the period of June to September. Agricultural production relies heavily on rainfall, while irrigation and land developments such as contour bunding and terracing are limited to specific areas. Cropping intensity is at the low level of 97% on average, comprising wet land at 103%, dry land at 127% and tsheri land at 22%.

3) Tributaries of the Kuri chu are used for irrigation of the steep terraced land, while the Kuri chu itself has never been used for any irrigation purposes because of the heavy cost of high head pumping.

4) Most of the irrigation facilities are poorly constructed and dilapidated due to insufficient O/M practices and lack of organizations; water losses in the canals and water shortage at the farm level are common, and heavy maintenance works are required.

5) The extension services of one extension officer appointed for each block of the district are not sufficient, and concentrate on input supply rather than on the diffusion of improved farming technologies; there are no experimental data on appropriate farming practices in the study area.

6) Cattle grazing during the winter (dry) season interferes with the second cropping of wet and dry land; the shortage of feed in winter necessitates cattle grazing on the farm land, and most of the rural communities are insufficiently organized for solution of the grazing problem.

7) The sole marketing channel from the study area through Tashigang to Samdrup Jongkhar requires heavy transportation costs and this obstructs the expansion of cash crop production.

3. BASIC CONCEPT FOR INTEGRATED AGRICULTURAL DEVELOPMENT PLAN

Social and economic development efforts in the study area have only just begun. Development constraints of the study area are manifold and interrelated. Mitigation of the development constraints is naturally required in order to accelerate the regional development to:

1) expand the regional economy through increasing agricultural production, and

2) improve the farmers' present subsistence situation, together with adaptation or smooth transfer to a monetary economy.

The basic principles of the development outlined above correspond exactly to the agricultural development policy given in the Sixth plan. In order to attain these objectives, agricultural development should play a pivotal role. While considering the absolute limitation of the physical resources, the possibilities for intensification of agricultural production basically lie in better utilization of existing land and water. The following basic and priority developments have been conceived for the achievement of these objectives:

a) increasing agricultural productivity, e.g. by improving yields on existing crops,

b) increasing intensity of resource use, e.g. expansion of double cropping,

c) encouragement of farmers to move into higher value crops,

d) improving irrigation efficiency through rehabilitation and/or improvement of the existing irrigation facilities, and

e) converting upland into wet land as well as tsheri land into upland where it is feasible.

4. BASIC INTEGRATED AGRICULTURAL DEVELOPMENT PLAN

4.1 Land Use

Suitable land for agricultural production is situated sporadically on flat to gently sloping areas in the mountains, and some tsheri land and dry land is cultivated even on steep slopes. Therefore, almost all land available for cultivation of crops is already under utilization or over-utilization for agriculture, and it is impossible to expand agricultural land significantly by converting steep and gravely forest land, bare land, pasture and other land with shallow soils of low fertility.

Owing to the limited land suitable for agriculture in the study area, land use for the agricultural development should be planned taking following matters into consideration:

- Expansion of wet land (irrigated land)
- Maintenance or improvement of soil fertility
- Conversion of tsheri land (shifting culture) into dry land (annual cropped upland)

Thus increasing agricultural production has to be achieved by improving land productivity through expansion of the irrigated area as much as land and water availability permit, through improvement and maintenance of soil fertility, and by increasing the annual cropped area through converting tsheri land into dry land.

Tsheri land and some of the dry land are marginal for agricultural production, because this kind of land is situated on steep slopes with little vegetation cover. This causes severe and rapid soil erosion, and results in low productivity. Out of these lands, available land should be converted into permanently cultivated dry land by contour terracing and leveling to avoid soil erosion. These conversions will retain surface soil on the land, and will result in improvement and maintenance of soil fertility. Other lands such as steep slopes, where contour terracing is impossible or not economical, should be converted into forest for land conservation.

4.2 Agricultural Development

4.2.1 Objectives

The objective of the basic agricultural development plan is to increase agricultural production in the study area. Increasing production will stimulate and expand the regional economy, and will improve the living standards of the farmers. Increasing agricultural

production will be attained by the following approaches in combination:

- increase of unit yield
- increase of cropping intensity
- promotion of cash crops
- improvement and constructio of irrigation facilities
- promotion of agricultural mechanization

4.2.2 Increase of Unit Yield

Because of land and water resources limitations, agricultural production must be increased primarily by increasing the unit yield of the main crops through (i) introduction of improved varieties suited to the natural conditions of the area and (ii) improvement of the present traditional cropping systems and farming practices.

(1) Introduction of Suitable Varieties

The main varieties of paddy in the study area are local varieties such as Wangdikarma and Bumdalingpa, and are grown by the traditional farming methods. Although over 3 t/ha is recorded in some areas, the unit yield is generally low owing to irregular growth period, lodging by long culm (stature) plant type, poor responsiveness to fertilizer, in addition to shortage of available labour.

To overcome these constraints, it is necessary to introduce high yielding varieties (HYVs) selected in terms of high unit yield, high adaptability to the natural conditions such as climate and soil, taste preferred by the inhabitants, and short growing period for combination with other crops.

It will take a long time to select the HYVs most suited to the study area through varietal trials under the present research system of Bhutan. Therefore, for short term development, high yielding varieties such as IR-36, IR-64 and No.11, which were selected by CARD, should be introduced. These varieties should be extended to farmers through demonstration and field trials in the study area.

The main varieties of other cereal crops such as maize are also local, and seeds are multiplied by farmers themselves. It would be difficult and not practical to introduce HYVs in the study area immediately because of the low commercial value of these crops. Therefore, for short term development, the unit yields of local varieties have to be increased through improvement of farming methods.

As maize shows hetrosis, various kinds of hybrid seeds have been developed in many countries, and hybrid seeds are commonly used for high production. Therefore, for long term development, it is

necessary to conduct research trials to introduce HYVs like hybrid seeds. It is necessary to enhance research activity for introduction of superior varieties developed in other countries and for selecting suitable HYVs varieties for both food and feed purposes.

(2) Improvement of Cropping Systems and Farming Practices

Cropping systems and farming practices for paddy cultivation should be improved to obtain maximum yield. In addition to improvement and construction of irrigation facilities, HYV seeds, chemical fertilizers and agro-chemicals such as pesticide should be introduced.

Although it is necessary to improve the cropping systems and farming practices of other cereals, introduction of modern and costly input materials such as chemical fertilizers and agro-chemicals should be postponed for future development because such drastic changes will not be acceptable. Increases in unit yield by agronomic improvement of farming practice have already been achieved in other countries as shown Table 4.3.1 and the same approach to improvement of farming practices should be applied in the study area for short term development. As research programmes on cereal crops other than paddy have just been started in Bhutan, it is recommended that these be strengthened in terms of cropping systems and farming practices together with introducing HYVs for long term development.

4.2.3 Increase of Cropping Intensity

Cropping intensity in the study area is estimated at 97%, which is low compared with the 123% of average for Bhutan. The increase of cropping intensity on wet land is essential for increasing agricultural production. Double cropping in particular can be introduced where sufficient irrigation water can be supplied through the year coupled with establishment of proper cropping systems. For short term development, mustard and potatoes will be selected as the second crops to paddy because the cropped area of these crops is expanding in the study area. However, for long term development, it is necessary to select crops having high commercial value and to enhance research programmes on other crops for field trials on adaptability to the natural conditions of the study area and on marketability of the products through the activities of the Cash Crop Research Center now under construction.

It is also necessary to increase the cropping intensity on dry land. For short term development, crops to be cultivated extensively are chilli, maize as the second crop, wheat and barley, because of the local demand. Pulses such as soyabean are intercropped with maize locally. Such cropping systems are useful for maintaining soil fertility, and should be extended in the cropping area.

4.2.4 Promotion of Cash Crops

The cropping area of cash crops such as soyabeans, mustard, chilli, potatoes, vegetables and oranges has been expanding recently in the study area. Farm households in the study area, however, are subsistence oriented and no marketing channel for selling cereals has yet been established except by small barter exchange. Therefore, income from cash crops is an important potential source of income for the farmers.

Promotion of cash crops cultivation to increase farm income is also required since the monetary economy is rapidly developing in the study area, and the expenditure of the farm households is increasing. It is necessary therefore to select cash crops taking into account the following criteria: (i) high unit yield (production ability), (ii) no conflicts with the main cereal crops in the cropping season (cropping ability), (iii) price stability, (iv) marketability, and (v) demand stability in the market. These criteria are applied to the main cash crops in the study area as follows:

Kind of Crop	Production Ability	Cropping Adaptability	Price Stability	Market-ability	Demand Stability
Soyabeans	4	4	3	3	3
Mustard	4	4	3	3	3
Chilli	2	3	3	3	4
Potatoes	3	4	2	2	2
Vegetables	2	4	1	4	4
Oranges	4	4	2	3	3
Apples	3	4	2	3	3

Remarks; 4:Excellent, 3:Fair, 2:Normal, 1:Poor

Based upon the above table, the following crops have been identified as important cash crops for the study area : mustard as the second crop after paddy on wet land, soyabeans intercropped with maize on dry land, chilli at low to middle altitude on dry land, and potatoes at middle to high altitude on dry and wet land.

4.2.5 Strengthening of Agricultural Support Services

For implementation of the basic agricultural development plan through increase of unit yield, increase of cropping intensity and promotion of cash crops as mentioned above, it will be essential to strengthen the agricultural support services such as research, extension and training as follows:

(1) Research

A national research center (CARD) has been established at Wangdiphodrang, and this is to be supported by applied research stations at Tashigang and Gaylegphug. Varietal trials for paddy and research on irrigated cropping systems have been initiated with technical assistance from abroad. Trial cultivation of vegetables and seed production for varieties most suitable for Bhutan has also been started at the Bondy Farm in Paro. However, all of these stations are encountering difficulties due to the overall shortage of professional manpower, inadequate research facilities and shortage of operation budget.

Although it would be desirable to establish a new regional research station for applied research in the study area to accelerate agricultural development, this should be left to the long term because establishment of research stations needs to be planned according to national priorities and a long term development plan for research. Accordingly, it is recommended that the existing research stations should be strengthened as far as possible, and that research should be directed to the transfer of satisfactory results of research to farmers through extension workers.

(2) Extension

Agricultural extension services are provided under the District extension programme. Each District has one District Agricultural Officer, who is in charge of the extension programme, and supervises inspectors and supervisors at the intermediate level and extension workers at the lowest level.

However, the extension service has concentrated up to now on input supply rather than on technical advice to farmers. Furthermore, subsistence farmers getting extension services are conservative and prefer to avoid risks in applying new technology. However, farmers will accept new cultivation practices, improved cropping systems or new crops if the risks of introducing them can be reduced.

In order to develop farmers' confidence in the introduction of new cultivation systems, pilot farms should be established for demonstration and trials on:

- demonstration and trials of new farming practices for rice using HYVs and modern agricultural inputs,
- improved farming practices for mustard using local or improved varieties, and
- demonstration and trials of improved farming practices for maize more suitable for local varieties.

(3) Training

In Bhutan, the present facilities for training of farmers and extension workers is inadequate. However, DOA is now establishing the National Agricultural Training Institute (NATI), which will have its headquarters located at Wangdiphodrang with branches in Tashigang and Gaylegphug Districts, under assistance from Switzerland. After completion of these facilities, it is proposed to enrol farmers and extension workers on training courses promoted by NATI.

4.3 Irrigation and Drainage Development

4.3.1 Objectives

Constraints for development of irrigation facilities in the area are the topographical conditions of steep slopes and the technical limitations of existing water resources, and the requirement for comparatively large budgets financially. Renovation works for small scale existing irrigation facilities will have first priority in the development of irrigation facilities in the 6th Five Year Development Plan. This is logical and practical.

Accordingly, the following general priorities should apply to the development of irrigation and drainage projects in the area:

- In order to obtain the maximum benefits from project implementation and to secure the irrigation water supply instantly and constantly, existing facilities should be renovated first.

- Operation and maintenance must be organized on a sound basis to maintain the facilities satisfactorily and for smooth operation.

- Any new irrigation and drainage development projects which have technical and economical advantages should be implemented.

4.3.2 Development Principles

On the basis of the above considerations, the irrigation development plan will be made in accordance with following principles in relation to water resources, intake structure, irrigation canals and others.

(1) Water Resources

Irrigation water has be taken from the natural run-off-water of small rivers, and intake facilities must have adequate functions to

ensure high intake efficiency to make the fullest use of flows available.

(2) Intake Structures

In May and June when river discharge is relatively low, irrigation water requirements reach a maximum for land preparation and transplanting of paddy. Therefore, the intake structure must function to minimize the intake loss. The structure must prevent excessive inflow to the canal so as to maintain the canal safely and therefore must be a durable permanent facility which can be easily operated and maintained. This means that in general the intake weir should be made of wet masonry or concrete, and furnished with a steel intake gate, sand trap, and waste facility with a gate and other necessary apparatus.

(3) Canals

The existing canals are mainly earth canals and lack related structures for canal safety. Consequently, many troubles occur to canals such as landslides, collapses or canal destruction. As a result, irrigation water supplies are frequently interrupted, and very often at many places simultaneously, and the costs of operation, maintenance and repair every year are very high.

Accordingly, the following considerations have to be taken into account in the planning and the design of the renovation or renewal of the canals.

a) Generally, canals should be lined with wet masonry to avoid the canal destruction, and operation and maintenance troubles. Earth canals may shall be used in limited areas under favorable site conditions.

b) Reinforced concrete covers should be used in places where falling stone and/or earth can be expected.

c) In unstable ground, buried reinforced concrete pipes should be used.

d) Canal alignments in landsliding areas should be relocated on stable ground.

(4) Related Structures to Canals

The following structures must be provided in order to secure the canals.

a) Cross Drains

b) Spillways and Waste Ways
c) Road Crossings
d) Turnouts

(5) Introduction of Mechanized Construction Works

Although conventional construction including the transportation of materials has up till now been by manpower, mechanized construction should be introduced and promoted wherever site conditions and the scale of the construction works permit.

(6) Operation and Maintenance

The Water Users' Associations should be introduced to provide a sound organization of operation and maintenance to promote improved functioning of irrigation facilities and to minimize operational troubles.

4.4 Other Rural Facilities' Development

4.4.1 Agricultural Mechanization

Shortage of agricultural labour in the area, especially during land preparation, planting and harvesting, is a obvious fact to be considered due to the small population and minimal farm mechanization. Agricultural mechanization including diffusion of improved farm tools and implements, therefore, should be promoted to increase labour productivity in the area. Agricultural machines and tools selected have to meet the following basic requirements taking the topography and accessibility of the area, farm land conditions, availability of electricity and oil, and farmers' capacity to pay into consideration:

a) Portable machine; easy to transport by man power or animal power, or stationary machines
b) Robustness and ease of repair
c) Low price and low operation and maintenance costs
d) Ease of operation

Such machines or tools are now essential to alleviate the labour requirements for the present farming practices of the area, farm works on land preparation, weeding, harvesting and processing.

4.4.2 Small Scale Agro-industry

Development of cash crop production in the study area is one of the necessary steps to increase farmers' income. The study area has a disadvantage in its locality due to its remoteness from Samdrup

Jongkhar as the border market together with poor road conditions and shortage of transportation. An increase in cash crop value added and a decrease in transportation costs are absolutely necessary in order to accelerate cash crop development. Hence agro-processing facilities are indispensable for cash crop development in the area.

The following small scale agro-processing facilities will be given priority on the basis of the promising cash crops of the area:

a) Oil extraction facilities for mustard and soyabean
b) Milling facilities for chilli

Agro-processing facilities which are sustainable and maintainable will be appropriate to the area. For the effective use of facilities, farmers' organizations for the operation and maintenance have to be established under the District Administration.

4.4.3 Establishment of Workshop

The study area has no workshop for diffusion and repair of agricultural machines and tools at present. The Master Plan of the Agricultural Mechanization Program as a Central Program by DOA proposes that one branch workshop established by Bhutan Government in Mongar District which covers the eastern region for the development promotion. Since renovation of the Agricultural Mechanization Center (AMC) in Paro with the assistance of JICA, no other branch workshops under AMC have been established due to budget constraints.

For promotion of agricultural mechanization and small scale agro-industry mentioned above, establishment of a workshop will be indispensable.

4.4.4 Improvement of Agricultural Extension Center

The existing agricultural extension centers in the study area are inadequate in all respects. Improvement of these centers is essential for improvement of the agricultural extension services. The DOA is now considering the improvement of the centers in the study area. Hence, through this study, requirement on the improvement of agricultural extension centers should be examined.

4.4.5 Other Development

The study area is characterized by its underdevelopment not only in agricultural infrastructures but also in such social infrastructures as roads, power and water supply. The improvement of social infrastructures will have an important impact in improving the living conditions of rural inhabitants as well as in increasing agricultural productivity. Thus it may be argued that improvement of

the social infrastructures is urgently required. However, the unfavorable state of social infrastructure is a common problem throughout the country and one that should be solved nationwide and on a long term basis taking requirements and priorities into consideration.

In this study, the basic development plan for social infrastructures will not be considered independently. Rather, when specific social infrastructures are required in the context of facilities' planning for the improvement of agricultural productivity of the area, the improvement and/or the construction of social facilities should be integrated with the project.

5. APPROACH TO THE DEVELOPMENT

The villages and farm lands are scattered throughout the study area. In view of the shortage of development funds and of trained personnel, full-scale implementation of the basic plans mentioned above throughout the study area in the short-term is considered to be an impractical development approach. Hence the approach should be directed to the long-term and step by step.

The following strategies for integrated agricultural development of the area are therefore recommended on the basis of the development constraints:

1) Selection and development of priority project areas which have relatively large development potentials and which will spread effects to the other areas.

2) Expansion of these project areas according to the availability of funds and personnel taking development experiences in the priority projects into consideration.

According to the above development approach, selection of one model project area in each of Lhuntshi and Mongar Districts out of 16 project areas is considered as a realistic approach. Feasibility plans for two model project areas should conform to the basic concept and plans for integrated agricultural development of the area.