intakes. Masangdaza intake at the upper site would cover the upper part of Masangdaza area as same as at present.

Bongdima-Karbithang intake would combine the Bongdima intake and Karbithang intake. The Bongdima side of the intake would cover the lower part of Masangdaza area, Bongdima area and two (2) existing small irrigation areas. The Karbithang side of the intake would cover the command area of the Karbithang and the new irrigation area of Karibee. A small existing canal system would also be included in the Karbithang irrigation system. The irrigation systems in both project areas are shown in Fig. 5.3.2 and irrigation diagrams for both project areas are shown in Annex-V.

5.3.4 Other Rural Facilities Development Plan

(1) Feeder Road Development

The feeder road development plans of both project areas would aim to (i) improve convenience for traffic and the communication systems generally, (ii) solve transportation difficulties for agricultural inputs and outputs and (iii) minimise operation and maintenance costs. Based on the present geographical and topographical conditions, the basic needs of the resident farmers, and the spread of effects to the backyard areas, the feeder road development plan were formulated as follows:

(a) Tangmachhu

	i) Route	;	Heli-port - Nebi village (Connected to the existing feeder road up to the Heli-port)
ii)	Length	;	5.4 km
iii)	Beneficial Area	;	Sungkhar, Menjibi
iv)	Population	;	3,492
v)	Households	;	390

(b) Masangdaza

    i)   Route   ;   National road - near the river mouth
                                    of the Songjari chu

   ii)   Length   ;   2.4 km

  iii)   Facilities   ;   Bridge acrossed the Shongar chu
                                    (60 m length, 2 spans)

   iv)   Beneficial Area ;   Karibee, Karbithang, Masangdaza,
                                    Pangsibi, Chanzabi, Rolambi Brogsar,
                                    Mangling

    v)   Population   ;   1,150

   vii) Households   ;   252
                                    (Details are shown in Annex VI.)

(2) Others

     The development plans for small scale agro-processing facilities, agricultural mechanization, a workshop and an extension center would aim to (i) promote cash crop production, (ii) reduce farm labour requirements through mechanized farming, (iii) promote improved farming practices, and (iv) strengthen O&M activities for feeder road and irrigation facilities. These plans have been made on the basis of the basic integrated agricultural development plan explained in 4.4 and may be summarized as follows:

(a) Agro-processing Facilities

    i) Location   ;   Tangmachhu

   ii) Facilities   ;

	No.	Capacity
Building	1	90 m^2
Mustard oil unit	1	100 kg/hour
Chilli powder unit	1	20 kg/hour
Multi-purpose dryer	1	5 m^3/day

(b) Agricultural Mechanization

    i) Objective Area ; Tangmachhu, Masangdaza

   ii) Equipment   ; Improved tools and machinery

(c) Branch Office of Agricultural Mechanization Center (Workshop)

    i) Location   ; Mongar District

   ii) Facilities   ; Branch office building with repair
                                    tools and machines
                                    Mobile workshop
                                    O&M equipment

(d) Agricultural Extension Center

    i) Location
       - Extension Center   ; Lingmethang (Near Masangdaza)
       - Demonstration Plots ; Tangmachhu   (5 plots)
                               Masangdaza   (3 plots)

    ii) Facilities ;   Extension center building (Lingmethang)
                        Tools and machinery for demonstration and
                        trial
                        (Details are shown in Annex VI)

5.4 Proposed Project Works

5.4.1 Irrigation and Drainage Facilities

Based on the irrigation and drainage development plan, the following irrigation and drainage facilities will be established and rehabilitated in accordance with the basic conditions and design criteria mentioned in Annex-V in detail. The main features of the proposed irrigation and drainage facilities are summarized as follows.

(1) Intake Structure

All the intake structures will be permanent facilities. A fixed weir constructed of masonry will be provided across the river at each site. The weir will intercept underground water flow in order to secure the intake water in the dry season. The flood discharge will be estimated from the rainfall record of the 25 years return period.

For the flushing of sediment a manual sluice gate and a sluice way will be provided. At the head of the canal a sluice gate will be installed to control the intake water and a sand trap with a sluice gate for flushing will be provided in the head reaches of the canals. The intake structures will be as follows:

Tangmachhu

Item/Intake Name	Unit	Tangmachhu-1st	Tangmachhu-2nd	Gorgan
Type of Structure		Masonry	Masonry	Masonry
Weir Length				
Whole length	m	7.4	5.7	8.9
Overflow section	m	4.9	3.2	6.4
Weir Height				
Non-overflow section	m	3.6	4.1	4.1
Overflow section	m	1.5	1.5	1.5
Intake				
Water level	m	El.2,233.7	El.2,206.7	El.1,957.8
Discharge	m³/s	0.13	0.23	0.20
Flood Discharge	m³/s	15.20	9.80	30.40
Gates				
Sluice way (H x W)	mm	1,200x1,500	1,200x1,500	1,200x1,500
Intake (H x W)	mm	500x650	500x750	500x750

Masangdaza

Item/Intake Name	Unit	Masangdaza	Karbithang-Bongdima
Type of Structure		Masonry	Masonry
Weir Length			
Whole length	m	9.4	11.7
Overflow section	m	6.4	8.7
Weir Height			
Non-overflow section	m	4.1	4.1
Overflow section	m	1.5	2.5
Intake			
Water level	m	El.920.5	El.802.3
Discharge	m³/s	0.11	0.14
Flood Discharge	m³/s	30.60	41.40
Gates			
Sluice way (H x W)	mm	1,200x2,000	1,200x2,000
Intake (H x W)	mm	500x700	500x600

(2) Canal

All canals will be permanent facilities to secure an adequate water supply and for easiness of operation and maintenance.

The following four (4) types of typical cross-section will be applied to open canals.

Type-1 : The most common will be a wet masonry canal to be used in comparatively gentle areas. The masonry walls will provide protection to the berms from the hooves of cattle.

Type-2 :   This is a variation on Type-1 with an added retaining
           wall on the cutting face to be used where a collapse
           is possible such as in a paddy area.

Type-3 :   This is a covered canal for the top to be used as an
           O&M road. This type will be used on a steep slope or
           in a rocky area.

Type-4 :   This is a special case to be remodeled from an
           existing masonry canal. The canal section will be
           enlarged and the O&M road may be newly constructed.

In addition to these typical cross-sections, steel pipe syphons,
corrugated pipe aqueducts and other facilities will be provided, where
necessary. The application of each of these to each canal are as
follows:

Tangmachhu

Facilities		Unit	Tangmachhu	Gorgan
Main Canal				
Open Canal	Type-1	m	5,151.5	654.8
	Type-2	m	430.0	1,064.8
	Type-3	m	1,712.5	1,150.0
	Type-4	m	-	-
Syphon	Steel pipe	m	-	251.2
Aqueduct	Corrugated pipe	m	54.3	10.0
Cascade		m	1,201.7	889.0
Drop		No	21	12
Total length of Main Canal		m	8,550.0	4,019.6
Secondary Canal		m	900	-

Masangdaza

Facilities		Unit	Masangdaza	Karbithang	Bongdima
Main Canal					
Open Canal	Type-1	m	934.0	1,296.0	1,304.0
	Type-2	m	-	-	-
	Type-3	m	66.0	129.0	-
	Type-4	m	2,285.0	-	3,142.7
Syphon	Steel pipe	m	-	-	-
Aqueduct	Corrugated pipe	m	16.0	93.0	26.3
Cascade		m	-	125.0	30.0
Drop		No.	-	3	4
Total length of Main Canal		m	3,301.0	1,643.0	4,503.0
Secondary Canal		m	-	200	200

(3) Related Structures

In connection with canals, the following related structures will
be provided in intakes and canals:

Tangmachhu

Facilities	Unit	Tangmachhu	Gorgan
Spillway	No.	11	2
Waste Way	No.	-	-
Sand Trap	No.	2	3
Cross-drain	No.	3	-
Drain Inlet	No.	3	1
Over Chute	No.	1	3
Road Crossing (Footpath)	No.	20	3
Turnout Type-A	No.	6	21
Type-B	No.	8	2
Gorgan Turnout	No.	-	1

Masangdaza

Facilities	Unit	Masangdaza	Karbithang	Bongdima
Spillway	No.	4	1	3
Waste Way	No.	1	-	-
Sand Trap	No.	3	-	1
Cross-drain	No.	2	3	1
Drain Inlet	No.	-	-	-
Over Chute	No.	8	1	7
Road Crossing (Footpath)	No.	6	1	2
Turnout Type-A	No.	6	-	11
Type-B	No.	8	3	1

5.4.2 Feeder Road Facilities

The national road is situated near both project areas, but no
proper feeder road networks have been arranged yet. The inconvenience
of traffic and communication systems is the biggest constraint for
rural development.

The design criteria for the feeder roads are based on the
standards of DOA, but some appurtenant structures are revised a little
for greater safety against floods or land collapse. The gravel paving
is applied for overall road surface. The general features of the
proposed feeder roads with gravel paving may be summarized as follows:

Feeder Road

Project Area	Length	Width
Tangmachhu	5.4 km	4.0 m
Masangdaza	2.2 km	4.0 m
Bailey Type Bridge at Masangdaza	60 m (30m x 2 span)	3.4 m

5.4.3 Others

The buildings required for agro-processing facilities, workshop and the agricultural center would be as follows:

(1) Agro-processing Facilities

a. Floor space
- 90 m^2 (18 m x 5 m), concrete floor
- 15 m^2 (3 m x 5 m), concrete floor

b. Maximum height
- 3.5 m

c. Foundation
- cobble and concrete

d. Structure
- masonry wall and slate roofing

e. Design
- window frames and pillars designed according to the traditional style in Bhutan

f. No. of rooms
- 4 rooms (mustard oil unit, chilli powder unit and dryer, diesel engine generator, and office)
- Each room with a space for temporary storage of material and products.

(2) Branch Office of AMC (Workshop)

a. Floor space
- 400 m^2, concrete floor

b. Maximum height
- 6 m

c. Foundation
- cobble and concrete

d. Structure
- masonry wall and slate roofing
- reinforced concrete (repairing and maintenance room)
- masonry (other rooms)

e. Design
- same as the agro-processing factory

f. No. of rooms
- 7 rooms (office, meeting room, tools and materials room, spare parts room, cubicle room, repair and maintenance room and machine shed)

(3)　Agricultural Extension Center

    a.　Floor space　　　- 62 m^2, concrete floor
    b.　Maximum height　- 3 m
    c.　Foundation　　　- cobble and concrete
    d.　Structure　　　　- masonry wall and slate roofing
    e.　Design　　　　　- same as the agro-processing factory
    f.　No. of rooms　　- 4 rooms (office, meeting room, store for
                              machines and fertilizer, and store for
                              agro-chemicals)

5.5　Construction Plan and Cost Estimation

5.5.1　Construction Plan

(1)　General Description

The construction works for the project will comprise the following:

    a)　Construction of intakes

    b)　Construction/rehabilitation of canals

    c)　Construction of feeder roads

    d)　Construction of buildings

There are two (2) big problems to be considered in the construction plan. The one is construction work in a remote area without adequate access and with the difficulty of recruitment labour both in quality and quantity in the area. The other is that in order to reap early benefits from the project construction must not take a long time.

Heavy mechanized construction to reduce the construction period and costs is simply not practical. Therefore the minor mechanized construction using mini-size equipment has to be considered in construction planning.

(2) Construction of Irrigation and Drainage Facilities

   (a) Intakes

        The main excavation will carried out by using backhoe
   excavators. Compaction of the foundations of the structures will be
   made by vibrating hand compactors. These works will be executed in
   the dry using sufficient dewatering pumps.

   (b) Canals

        The removals of existing masonry linings will be made by
   bulldozers. The earth excavation will also be carried out by
   bulldozer. Rock excavation will be made by blasting using a pneumatic
   rock drill.

        The compaction of the canal bed and structure foundations will
   be essential to create durable structures. These foundations shall
   use impervious materials compacted with proper compaction equipment.

        For masonry lining works a great number of masons will be
   required. Many of these will have to be brought from outside of the
   areas.

   (c) Other Works

        The steel pipe syphon will be embedded in the ground for the
   most part. The excavation and backfilling will be done by manpower
   because the construction sites have no space for use of machinery.
   The syphon pipes will have joints and be coated at the field, which
   will require employment of skilled labour.

(3) Construction of Feeder Roads and a Bridge

        The feeder roads will be constructed during the first stage of
   construction prior to any other site works.

Soft excavation will be done mainly by bulldozers. Excavation of structure foundations will be by use of backhoe excavators. Compaction of gravel paving on the road surface will be done by tired rollers.

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

(4) Implementation Schedule

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

Construction of the irrigation facilities will be done during the off-irrigation season because these works will be mainly the renovation of existing facilities. Taking into due consideration the volume of the work to be done, it will be necessary to take two (2) off-irrigation seasons as the main construction period. Therefore, the implementation period is assumed to be three (3) years from 1989 to 1991 as shown in Fig. 5.5.1.

5.5.2 Cost Estimate

(1) Basic Assumptions

The construction cost is based on the following assumptions:

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

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

(c)   Construction is assumed to be done on a full contract
      basis. The machinery and equipment required for
      construction will 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. The local currency component is
      estimated on the basis of current prices in Lhuntshi and
      Mongar Districts in 1988. The foreign currency component
      is estimated based on the CIF prices at Phuntsholing.

(f)   Physical contingencies at 6 percent of the direct
      construction cost are included in the construction cost in
      view of preliminary nature of the design.

(g)   Price contingencies are also taken into account at an
      annual escalation rate of three (3) percent for the
      foreign currency portion and eight (8) percent for the
      local currency portion.

(2)   Financial Project Cost

      Financial project cost comprises the costs for construction,
land acquisition, procurement of equipment, administration and
engineering services, physical contingencies and price contingencies.

      The construction cost consists of the construction costs of the
irrigation canal networks, intake facilities, canal related
structures, feeder roads including the bridge and other necessary
facilities including contsructor's profit, overheads and taxes.

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

Project Area	F/C Nu 10^6	(%)	L/C Nu 10^6	(%)	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

A summary of the project cost is given in Table 5.5.1.

(3)   Annual Disbursement Schedule

The annual disbursement schedule has been prepared on the basis of the construction implementation schedule. Details are given in Table 5.5.2.

(4)   Annual Operation and Maintenance Costs

Annual operation and maintenance costs will 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 Annex VII.

(5)   Replacement cost

The useful life of mechanical equipment is estimated at 25 years. Their replacement costs are Nu 1,365,000 in Tangmachhu and Nu 881,000 in Masangdaza. Details are shown in Annex VII.

5.6   Organization and Management

5.6.1   Organization for Project Execution

The ministry of Agriculture through the Department of Agriculture (DOA) will be responsible for implementation of the

Lhuntshi and Mongar Integrated Agricultural Development Project in close coordination with other relevant ministries such as the Planning Commission, Ministry of Home Affairs, Ministry of Finance and Ministry of Social Service. It is recommended that, for smooth implementation of the project, the Ministry of Agriculture should organize a steering committee consisting of representatives from the relevant ministries.

DOA will be responsible for execution of the project in consultation with the Steering Committee. DOA will also have to establish a Project Construction Office which will transact the day-to-day business of the project execution.

The Project Manager who will be appointed by the Director General of DOA will be responsible for operation of the Project Office. The technical staff of the Project Office will be provided by the DOA as well as the related agencies concerned. The Project Office shall coordinate and supervise the activities which will including the following:

    a.   Survey

    b.   Detailed Design

    c.   Construction Supervision

The proposed organization chart of the Project Office is given in Fig. 5.6.1. The Project Office will comprise a head office and two (2) branch offices. The head office will be established within DOA. The branch offices will take responsibility for quality control of the construction works, measurement of the work quantities, records of the work progress, etc. at each work site; Tangmachhu and Masangdaza.

5.6.2 Organization of Operation and Maintenance

(1) Irrigation and Drainage Facilities

After completion of construction, well-organised Water Users Associations should be established for operation and maintenance of the system at each project. These associations would be organized by and under the Gup (head of block) or the Chimi (member of national

assembly). The number of Chusumpas (ditch tenderers) would be
determined for the proper functioning of the facilities. The proposed
organization chart of operation and maintenance is shown in
Fig. 5.6.2.

(2) Other Rural Facilities

(a) Feeder Road (Tangmachhu, Masangdaza)

The maintenance work on the feeder roads would be undertaken by
the Public Works Department (PWD) after completion of construction.

(b) Agro-processing Facility (Tangmachhu)

The Lhuntshi District office will have ultimate responsibility
for operation and maintenance of the facilities. It is recommended
however that a farmers' association for O/M should be established with
the assistance of the district and government organizations concerned.

(c) Workshop (Masangdaza, Mongar District)

The workshop will be a branch office of the Agricultural
Mechanization Center (AMC) at Paro under the Agricultural
Mechanization Program.

(d) Agricultural Tools and Machines (Tangmachhu, Masangdaza)

AMC at Paro or the new workshop in Mongar will have
responsibility for distribution, maintenance and repair of tools and
machines.

(e) Agricultural Extension Center (Masangdaza)

The extension center in Masangdaza, demonstration plots and
equipments for both areas will be operated by the Agricultural
Extension Worker (AEW) under the District Administration.

5.7 Project Evaluation

5.7.1 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.

5.7.2 Economic Evaluation

(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) Economic Benefit

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. The 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 benefits of the project areas were estimated in
Table 5.7.1 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

(3) Economic Cost

The total economic capital cost of the irrigation development
schemes were estimated as follows:

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 economic annual 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 68,000 in Tangmachhu and Nu 55,000 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.

(4) Economic Evaluation

The economic internal rate of return (EIRR) of the irrigation development schemes were calculated from the economic project benefit and cost flows for each project area as shown in Annex VIII. EIRRs in Tangmachhu and Masangdaza project areas are 4.6% and 3.8% respectively.

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 will 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 would be implemented under concessional term aid from the international institutions.

5.7.3 Financial Evaluation

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

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 as follows:

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

5.7.4 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 technologies 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.

6. RECOMMENDATION

(1) Early Implementation of the Model Projects

The model agricultural development projects in Tangmachhu and Masangdaza areas have been formulated on the basis of the Basic Integrated Agricultural Development Plan mentioned in Chapter 4, and are required to ensure the development of the study area.

The two model projects have been shown to be technically sound, and indispensable for the regional development. It is strongly recommended that the necessary arrangements for early implementation of these projects should be taken as soon as possible.

(2) Technical Assistance

In order to ensure realisation of the expected benefits of these projects, systematic and effective operation of the project components such as a) introduction of new cropping systems and improved cultivation practices, b) demonstration and trial pilot farms required for extension of the improved agricultural technologies mentioned above, c) operation of the modern irrigation facilities, and d) operation of the agricultural processing facilities as well as the workshop, will be indispensable. Therefore, vigorous guidance and training of the persons concerned will be needed, especially in the initial stages of the project. Considering the present staff limitation of DOA, it is recommended that technical assistance be considered.

At the minimum the experts required for technical assistance will be as follows:

a)   agronomist

b)   water management specialist

c)   agro-mechanical engineer

(3)　　Strengthening of Agricultural Support Services

The strengthening of agricultural support services will be
indispensable to accelerating agricultural development in the study
area.　In this feasibility study, however, strengthening of the
agricultural support services required specifically for the project
components would basically be expected to be provided through the
strengthening of existing and/or new agricultural support development
plans under the National Development Plan, as mentioned in Chapter 4.

It is recommended, therefore, that the agricultural support
service development plans covering the whole country should be
strengthened and expanded especially in the following areas:

a)　　reinforcement of the research activities for paddy as well
　　　as upland crops and activities, and dissemination of
　　　research results,

b)　　strengthening of extension activities including the training
　　　of farmers and extension workers,

c)　　promoting a systematic and appropriate marketing system for
　　　agricultural products and inputs, and

d)　　strengthening of agricultural credit.

(4)　　Establishment of the other agricultural facilities

Such agricultural facilities as a tree nursery, and a paddy seed
multiplication facility would contribute to agricultural development
in the study area in the medium to long term.　These facilities,
however, have been excluded from the model project components because
of their low priority at this stage.

It is recommended that DOA should examine the necessity for
establishing such facilities for development of the area.

(5)   Improving Social Infrastructure

Such social infrastructure as water supply, electrification and
health services in the study area are all undeveloped. It is
recommended that these social infrastructure be improved step by step
according to a long term national plan.

(6)   Implementation of a Next Phase Survey

After completion of the model projects, it is recommended that
other projects be chosen mainly from the existing irrigation schemes
for successive development. It is further recommended that the
necessary arrangements for implementation of the new projects should
be taken as early as possible.

TABLES

Table 2.3.1 Central Program/Project under the Sixth Plan of DOA (1/2)

Project	Duration	Present Centre of Execution	Objective/Components	Financial and Technical Assistance	Total Project Cost
I. On Going Project					
(1) Agricultural Mechanization Center (AMP)	Since 5th Plan	Paro Bondey Farm	a) Promotion of powered and simple improved tools and implements to increase cropping intensity and labour productivity	JICA	Nu. 132.6 Million
(2) National Seed and Plant Production Program (NASEPP)	Since 5th Plan (1983)	Paro Bondey Farm	a) Production, certification, packing and distribution of improved seed and plants for the existing major crops. b) Production of vegetable and other high value seeds for export. c) Establishment of nurseries for major horticultural crops. d) Production of virus-free materials with tissue culture	JICA	Nu. 95.2 Million
(3) Input Procurement and Supply Program (IPSP)	Since 2nd Plan	Head Quarter (Thimphu)	a) Supply of fertilizers and soil nutrients at subsidized prices	—	Nu. 5.0 Million
(4) Plant Protection Program (PPP)	Since 2nd Plan	Head Quarter (Thimphu)	a) Reduction of field and storage damages lossed by pest and diseases b) Training and supply of agro-chemicals.	EEC	Nu. 30.0 Million

RGOB : Royal Government of Bhutan
JICA : Japan International Cooperation Agency
EEC : European Economic Community

CIP : International Potato Center
Helvetas : Swiss Association for Development Cooperation

IRRI : International Rice Research Center
IDRC : International Development Research Center

Table 2.3.1 Central Program/Project under the Sixth Plan of DOA (2/2)

Project	Duration	Present Centre of Execution	Objective/Components	Financial and Technical Assistance	Total Project Cost
I. On Going Program					
(5) Bhutan National Potato Program (PPP)	Since 4th Plan (1980)	Head Quarter (Thimphu)	a) Increase in potato production and productivity with improved seeds. b) Training and marketing studies to get high returns.	CIP Helvetas/SDC	Nu. 27.5 Million
(6) Research/Extension on Rice-Based and Maize-Based Farming System	Since 5th Plan (1984)	CARD (Wangdi-phodrang)	a) Research and extension of improved farming systems of rice and maize.	IRRI IDRC CIMMYT	
(7) Manpower Development and Training	Since 5th plan (1984)	Head Quarter (Thimphu)	a) Additional recruitment and replacement to expatriate staff b) Establishment of National Agriculture Training Institute and three regional sub-centers at Kanglung, Bur and Paro. c) Promotion of training for staff and farmers.	UNDP SDC	Nu 51.4 Million
II. New Project					
Assessment Project on Water and Land Resources	6th Plan	Head Quarter (Thimphu) CARD	a) Implementation of survey on soil and ground water potential. b) Preparation of land use and land resource maps (1:20,000)	RGOB	Nu. 14.8 Million

SDC : Swiss Development Community

Table 2.3.2   Integrated Area Development Project under the Sixth Plan of DOA   (1/2)

Project	Duration	Location (Phase)	Objective/Components	Financial and Technical Assistance	Total Project Cost
I. On Going Project					
(1) Chirang Hill Irrigation Project	1986–	(Implementing)	a) Increases in production and incomes in five watersheds in Chirang District (5,000ha) through: b) Improvement of existing irrigation infrastructure (1,310ha). c) Conservation works and water shed management (1,210ha). d) Support services on demonstration, training and seed production.	ADB Loan RGOB Loan	Nu. 43.3 Million Nu. 10.0 Million
(2) Tashigang-Mongar Area Development Project	1986–1992	Tashigang Mongar (Implementing)	a) Increase in food production and employment through: b) Improvement of irrigation schemes (200ha) and new irrigation development (350 ha). c) Provision of feeder road (34km). d) Strengthening extension services. e) Establishment of a center on a adaptive trial. f) Credits services for production and weavings.	IFAD Loan UNDP Grant RGOB Loan	Nu. 57.0 Million Nu. 9.0 Million Nu. 14.0 Million
(3) Punakha Wangdi Valley Area Project	1988–	Thimphu Punakha Wangdi-phodrang (Implementing)	a) Increase land and labour productivity through: b) Irrigation rehabilitation; area of 2,200 ha, canal length of 115 km. c) Improvement of water distribution and on-farm water management. d) Strengthening of the extension services.	IFAD Loan RGOB Loan	Nu. 45.8 Million Nu. 14.5 Million

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Table 2.3.2 Integrated Area Development Project under the Sixth Plan of DOA (2/2)

Project	Duration	Location (Phase)	Objective/Components	Financial and Technical Assistance	Total Project Cost
I. On Going Project					
(4) Gaylegphug Integrated Area Development Project	Since 5th Plan	Gaylegphug (Under preparation of implementation)	a) Formulation of agricultural development plan covering 11,000 ha out of Gaylegphug District through: b) Improvement of cropping pattern with integrated support services. c) Establishment of multipurpose agro-industry. d) Construction (10km) and rehabilitation (62.4km) of irrigation canal. e) Land terracing (320 ha) and soil conservation.	Indian Grant	Nu. 40.5 Milion
II New Project					
(1) Lhuntshi-Mongar Integrated Agricultural Development Project	6th Plan	Lhuntshi Mongar (Under F/S)	a) Formulation of integrated agricultural development project through the investigation of 16 schemes in the area.	JICA Grant T/A	—
(2) Paro Valley Development Project	6th Plan	Paro (Pre-F/S completed)	a) Up-grading social and economic conditions through: b) Rehabilitation of irrigation schemes and feeder roads. c) Construction of a bridge. d) Land consolidation. e) Strengthening support services. f) Promotion of powered and simple improved tools and implements to increase cropping intensity and labour productivity.	—	—

Table 3.4.1 DROUGHT DISCHARGE ON PROJECT TRIBUTARIES

1) Lhuntshi District

(Unit: lit./s)

Tributary	Project Area	C.A. (km²)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Paka chu	Pangkhar	0.25	2.6	2.4	2.2	2.7	3.9	5.0	7.7	5.9	4.5	4.2	4.0	3.2	4.0
Lekpagang chu	Gangzoor	8.60	88.6	81.7	74.8	91.1	135.0	172.0	264.0	202.1	153.9	144.5	137.6	110.1	137.8
Begang Sher chu	Tangmachhu/1	15.10	155.5	143.5	131.4	160.1	237.1	302.0	463.6	354.9	270.3	253.7	241.6	193.3	242.0
Narigang chu	Minji/1	36.20	372.9	343.9	314.9	383.7	568.3	724.0	1111.3	850.7	648.0	608.2	579.2	463.4	580.1
Begang chu	Menjibi	13.28	136.8	126.2	115.5	140.8	208.5	165.6	407.7	312.1	237.7	223.1	212.5	170.0	212.8
Dungkhar chu	Kupinesa	6.80	70.0	64.6	59.2	72.1	106.8	136.0	208.8	159.8	121.7	114.2	108.8	87.0	109.0
Kheba chu	Wambur	9.93	102.3	94.3	86.4	105.3	155.9	198.6	304.9	233.4	177.8	166.8	158.9	127.1	159.1

2) Mongar District

(Unit: lit./s)

Tributary	Project Area	C.A. (km²)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Thruwan chu	Chali	3.53	36.4	33.5	30.7	37.4	55.4	70.6	108.4	83.0	63.2	59.3	56.5	45.2	57.6
Shongjari chu	Karibithang	21.90	225.6	208.1	190.5	232.1	343.8	438.0	672.3	514.7	392.0	367.9	350.4	280.3	350.9
Shongjari chu	Karibee/2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shongjari chu	Masangdaza/1	22.00	226.6	209.0	191.4	233.2	345.4	440.0	675.4	517.0	393.8	369.6	352.0	281.6	352.6
Shongjari chu	Pangsibi/2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Drodi ri	Gyelposhing	13.88	143.0	131.9	120.8	147.1	217.9	277.6	426.1	326.2	248.5	233.2	222.1	177.7	222.4
Kalapang and Dabrang ri	Kalapang/1	4.03	41.5	38.3	35.1	42.7	63.3	80.6	123.7	94.7	72.1	67.7	64.5	51.6	64.6
Seri chu	Yadi	2.03	20.9	19.3	17.7	21.5	31.9	40.6	62.3	47.7	36.3	34.1	32.5	26.0	32.5
Goda and Loda ri	Chaskhar/1	3.73	38.4	35.4	32.5	39.5	58.6	74.6	114.5	87.7	66.8	62.7	59.7	47.7	59.8

Note: /1: Drought discharge at lower intake point.
/2: Drought discharge can't be assessed because of no intake point at present.

Table 3.7.1   ESTIMATED CROP PRODUCTION IN THE STUDY AREA

Crop	Wet land (ha)	Dry land (ha)	Tsheri land (ha)	Total area (ha)	Total Production (ton)	Unit*1 Yield (ton/ha)
I. LHUNTSHI DISTRICT						
Total net area	1,190	1,820	700	3,710		
Paddy	1,190	0	0	1,190	1,430	1.2
Maize	0	1,220	130	1,350	2,300	1.7
Wheat	10	50	10	70	70	1.0
Barley	0	70	0	70	60	0.8
Buckwheat	0	90	0	90	60	0.7
Millet	0	200	0	200	140	0.7
Soyabean	0	340	20	360	220	0.6
Mustard	0	40	0	40	30	0.7
Potato	0	50	0	50	420	8.4
Chilli	0	320	0	320	320	1.0
Total	1,200	2,380	160	3,740		
II. MONGAR DISTRICT						
Total net area	910	3,920	3,290	8,120		
Paddy	830	0	0	830	1,000	1.2
Maize	80	4,020	700	4,800	8,160	1.7
Wheat	0	200	80	280	280	1.0
Barley	0	250	0	250	200	0.8
Buckwheat	70	100	0	170	120	0.7
Millet	0	20	0	20	10	0.7
Soyabean	0	220	0	220	130	0.6
Mustard	0	230	0	230	160	0.7
Potato	0	260	0	260	2,180	8.4
Chilli	0	90	0	90	90	1.0
Total	1,890	9,310	4,070	15,270		
III. STUDY AREA						
Total net area	2,100	5,740	3,990	11,830		
Paddy	2,020	0	0	2,020	2,430	1.2
Maize	80	5,240	830	6,150	10,460	1.7
Wheat	10	250	90	350	350	1.0
Barley	0	320	0	320	260	0.8
Buckwheat	70	190	0	260	180	0.7
Millet	0	220	0	220	150	0.7
Soyabean	0	560	20	580	350	0.6
Mustard	0	270	0	270	190	0.7
Potato	0	310	0	310	2,600	8.4
Chilli	0	410	0	410	410	1.0
Total	2,180	7,770	940	10,890		

*1 :   Unit yields of crops are the average yields of statisyical data,
       mentioned in Table IV. 2.6.

Table 3.7.2   PRESENT FARM ECONOMY IN THE STUDY AREA

Item	Lhuntshi Project Area			Mongar Project Area		
I. Average Farm Size (ha)						
-Wet Land	0.7			0.3		
-Dry Land	0.6			0.6		
-Tshery Land	0.3			0.2		
-Others	0.1			-		
Total	1.7			1.1		

	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
II. Crop Production						
-Paddy	0.70	2.90	2.03	0.27	1.50	0.41
-Maize	0.66	1.90	1.25	0.69	2.00	1.38
-Wheat	0.01	0.50	0.02	0.01	1.00	0.01
-Buckwheat	-	-	-	0.06	0.90	0.05
-Barley	-	-	-	0.18	0.90	0.16
-Soybeans *	0.37	0.70	0.26	-	-	-
-Others	0.06	-	-	-	-	-
Total	1.43			1.21		

Item	Lhuntshi	Mongar
III. Cropping Intensity	84%	110%
IV. Crop Production Value (Nu) (IV)	10,940	5,320
V. Farm Income		
-Crops	980	130
-Livestocks	1,270	730
-Others	-	60
Total (V)	2,250	920
* Commercial Rate of Crops (%) (Crop Income / IV)	9	2
VI. Non-Farm Income (Nu)		
-Government Employment	270	320
-Others	360	440
Total (VI)	630	760
VII. Total Income (Nu) (VII = V + VI)	2,880	1,680
VIII. Living Expenses (Nu)		
-Foods	630	600
-Clothes	1,060	510
-Fuel	140	130
-Others	1,010	440
Total (VIII)	2,840	1,680
IX. Net Reserve (Nu) (VII - VIII)	40	0

Note :   *; Intercropped with maize.

Table 3.8.1   EXISTING IRRIGATION SCHEME
IN THE STUDY AREA (1/2)

	Block	Number of Scheme	Comand Area (ha)	Canal Length (Km)	Beneficiary House- hold	Year of Construction
1	Dungkhar	1	121	3	50	-
2	Gangzoor	4	150	10	144	1984-1885
3	Khoma	3	128	6	104	1983
4	Minji	4	231	23	153	1983
5	Tangmachhu	4	321	19	293	1982
6	Metsho	2	45	3	60	1984
7	Jarrey	-	-	-	-	-
8	Chengkhar	3	150	10	121	1985
	Total	21	1,146	74	925	-

Table 3.8.1   EXISTING IRRIGATION SCHEME
IN THE STUDY AREA (2/2)

	Block	Number of Scheme	Comand Area (ha)	Canal Length (Km)	Beneficiary House- hold	Year of Construction
1	Chakaling	4	416	11.3	280	1974-1983
2	Chamang	-	-	-	-	-
3	Chaskhar	1	292	6.81	332	1984-1985
4	Demchi	3	48.8	22.1	60	1973-1985
5	Ngatshang	3	66	5.85	172	1974-1978
6	Gongdu	3	104	3.93	12	1975-1985
7	Kengkhar	-	-	-	-	-
8	Mongar	3	123	6.72	177	1977-1979
9	Salling	5	102	14.4	83	1974-1984
10	Silambi	-	-	-	-	-
11	Thangrong	-	-	-	-	-
	Total	22	1,152	71.2	1,116	-

Table 3.8.2   PRESENT CONDITION OF IRRIGATION FACILITIES IN THE STUDY AREA (1/2)

Name of System	Year Constructed/Renovated	Intake Structure			Main Canal		Description
		Type	Altitude (m)	Capacity (m³/sec)	Length (km)	Tail Altitude (m)	

Lhuntshi District

Name of System	Year Constructed/Renovated	Type	Altitude (m)	Capacity (m³/sec)	Length (km)	Tail Altitude (m)	Description
1. Pang Khar	1984	Natural spring	2,190	0.01	3.0	2,050	Water right is under the law suit. No use since 1987 due to landslide. No intake facility. Most of canals are earth. 3 places, 200 m destroyed.
2. Gangzoor	1972	Random stone fill	1,560	0.005	2.5	1,450	Very poor facilities. Most of canals are earth. 2 places, 50 m landslided.
3. Tangmachhu							
- Tangmachhu Canal	Renovated in 1985	Random stone fill	2,240	0.8	8.6	1,960	Poor intake. Mostly earth canal. 2 km masonry canal, 8 km earth canal. 4 places, 120 m canal collapsed.
- Gorgan Canal	- do -	- do -	1,960	0.3	4.1	1,840	Poor intake. Mostly earth canal. 0.6 km masonry canal, 3.4 km earth canal. 3 places, 300 m canal collapsed. Big landslide at Nebi.
4. Minji							
- Minji Canal	1984	- do -	2,190	0.09	5.6	2,020	No functioned upper part system due to canal collapse, 4 places 100 m long. Mostly earth canal, 14 Nos of wooden shoots are provided.
- Lekpachu Canal	1985	- do -	1,700	0.085	5.5	1,550	1.5 km earth canal, 4 km masonry canal. 9 places, 50 m long collapsed.
5. Menjibi	1982	- do -	1,920	0.1	4.0	1,730	Poor facilities, and poor maintenance. No maintenance road. 3.6 km earth canal, 0.4 km masonry canal. 3 places, 75 m long collapsed.
6. Kupinesa	1984	- do -	2,100	0.09	6.9	1,740	No use since 1986 due to canal collapse. 3 places, 1,000 m long. 6.3 km earth canal, 0.6 km masonry canal.
7. Wambur	1984	- do -	2,300	0.17	5.2	2,200	Good facilities, good maintenance. 2.2 km earth canal. 3 places, 100 m long collapsed.

Table 3.8.2   PRESENT CONDITION OF IRRIGATION FACILITIES IN THE STUDY AREA (2/2)

Name of System	Year Constructed/ Renovated	Intake Structure			Main Canal		Description
		Type	Altitude (m)	Capacity (m³/sec)	Length (km)	Tail Altitude (m)	
Mongar District							
8. Chali	1983	Random stone fill	1,670	0.141	5.5	1,590	All masonry canal, good maintenance. Renovation is on going. 2 places, 10 m collapsed.
9. Karbithang	Renovated in 1974	Random stone fill with logs	819	0.022	1.8	714	Poor intake and canal. 2.1 km earth canal, 0.1 km masonry, 1 No. wooden aqueduct. 1 places, 20 m long collapsed.
10. Karibee	-	-	-	-	-	-	No irrigation facility.
11. Masongdaza							
- Masongdaza Canal	1982	Wet masonry	919	0.16	3.3	906	Good intake. Masonry canal in mostly. 2 places, 30 m long collapsed due to landslide.
- Bongdima Canal	1984 Renovated in 1986	Random stone fill with logs	804	0.176	4.6	640	Masonry canal in mostly, but much leakage water. 2 places, 20 m long destroyed.
12. Pangsibi	-	-	-	-	-	-	No irrigation facility.
13. Gyelposhing	1979 Renovated in 1982	Random stone fill	730	0.149	3.7	520	Worst condition of intake site due to unstable ground. All masonry canal except 3 places. 200 m collapsed areas.
14. Kalapang	-	-	-	-	-	-	No irrigation facility. New construction started in 1987, but it was interrupted.
15. Yadi	-	No facility	1,580	-	1.3	1,490	All masonry canal along Highway. No more development of improvement of facility.
16. Chaskhar	1985	Random stone fill 2 Nos.	1,980 1,960	0.28	6.3	1,850	Renovation is under progress. 18 additional water resources from small inlets. All masonry canal except 0.6 km long earth canal.

Table 5.1.1 SELECTION OF MODEL PROJECT AREA

Project Area	Development Requisites					Development Potentiality		
	Economic Advance	Population Related	No. of Household Related (Irrigated Household)	Facilities of Road, etc.	Typical Area/ Spread Effects Expected	Water Resources	Land Resources	Duplication of Same Projects
Lhuntshi District								
1. Pang Khar	O	221	37 (31)	X	X	X	X (35 ha)	Non
2. Gangzoor	X	200	23 (9)	O (Feeder Road)	O	⊚	X (53 ha)	Non
3. Tangmachhu	⊚	2,683	278 (222)	⊚ (Feeder Road)	⊚	⊚	⊚ (389 ha)	Non
4. Minji	⊚	750	92 (79)	X	X	⊚	⊚ (206 ha)	Non
5. Menjibi	X	173	15 (15)	X	X	⊚	X (23 ha)	Non
6. Kupinesa	O	207	57 (49)	X	X	⊚	⊚ (89 ha)	Non
7. Wambur	O	520	60 (60)	X	X	⊚	⊚ (140 ha)	Non
Mongar District								
1. Chali	⊚	1,591 /1	134 (67)	O (Near national road)	O	⊚	⊚ (204 ha)	IFAD
2. Karbithang	⊚	(144)	18 (18)	O (Near national road)	O	⊚	X (10 ha)	Non
3. Karibee	⊚	150	31 (-)	O (Near national raod)	O	⊚	X (37 ha)	Non
4. Masangdaza	⊚	179	47 (47)	O (Near national road)	O	⊚	O (55 ha)	Non
5. Pangsibi	X	65	25 (-)	X	X	X	X 23 (ha)	Non
6. Gyelposhing	O	798	69 (50)	O (Near national road)	O	⊚	X (42 ha)	Non
7. Kalapang	X	125	10 (-)	X	X	O	X (14 ha)	Non
8. Yadi	⊚	773	108 (90)	⊚ (National road goes through)	O	⊚	⊚ (136 ha)	Non
9. Chaskhar	O	2,656	332 (191)	O (Near national road)	O	⊚	⊚ (305 ha)	IFAD
Integrated Area (Karbithang, Karibee and Masangdaza)	⊚	473	96 (65)	O (Near national road)	O	⊚	⊚ (102 ha)	Non

Note: ⊚: Fair   O: Normal   X: Poor

/1: Estimation of related population of 18 farm households with the average family size of 8.

Table 5.2.1   AVAILABLE DISCHARGE OF THE MODEL PROJECT AREA

(Unit: l/s)

| Project Area / Name of Intake | Tangmacchu Area | | | | | | Masangdaza Area | | | |
| Month / Day | Tangmachhu No. 1 | | Tangmachhu No. 2 | | Gorgan | | Masangdaza | | Bongdima | |
	Mean	Drought	Mean	Drought	Mean	Drought	Mean	Drought	Mean	Drought
Jan. 1 - 10	89	57	74	47	248	159	249	160	361	231
11 - 20	91	58	76	48	254	162	255	163	370	235
21 - 31	89	51	74	43	249	143	251	144	363	209
Feb. 1 - 10	76	53	63	45	213	149	214	150	310	218
11 - 20	66	52	55	44	186	146	187	147	271	213
21 - 28	68	47	57	39	190	131	192	132	277	191
Mar. 1 - 10	80	48	67	40	223	133	225	134	326	194
11 - 20	77	48	64	40	214	134	216	135	314	196
21 - 31	72	45	60	37	202	125	204	126	295	183
Apr. 1 - 10	98	56	81	47	273	157	275	158	398	229
11 - 20	112	48	94	40	314	133	316	134	458	194
21 - 30	117	68	97	57	326	190	328	192	475	277
May 1 - 10	139	67	116	56	388	187	391	188	565	273
11 - 20	131	91	109	76	367	254	369	255	535	370
21 - 31	130	95	108	79	364	266	366	268	530	387
Jun. 1 - 10	180	102	150	85	503	285	506	287	733	416
11 - 20	187	103	156	86	522	287	526	289	761	418
21 - 30	245	118	204	99	686	331	690	333	999	482
Jul. 1 - 10	327	159	272	132	914	444	920	447	1,331	647
11 - 20	355	167	296	140	994	468	1,000	471	1,448	682
21 - 31	386	168	321	140	1,078	471	1,085	474	1,571	686
Aug. 1 - 10	303	160	252	133	847	447	853	450	1,234	651
11 - 20	247	116	206	96	692	323	696	325	1,008	471
21 - 31	259	104	216	87	723	291	728	293	1,054	425
Sep. 1 - 10	305	95	254	79	852	264	857	266	1,241	385
11 - 20	345	104	287	86	963	290	970	292	1,404	422
21 - 30	210	92	175	77	586	258	590	260	854	376
Oct. 1 - 10	161	87	135	73	451	245	454	246	658	356
11 - 20	145	84	121	70	406	236	409	237	592	343
21 - 31	138	99	115	83	385	278	388	280	561	405
Nov. 1 - 10	125	87	104	72	350	243	353	245	510	354
11 - 20	115	86	96	72	322	240	324	242	469	350
21 - 30	111	86	92	72	310	242	312	243	451	352
Dec. 1 - 10	103	77	86	64	288	214	290	216	420	312
11 - 20	101	70	84	59	282	196	284	198	411	286
21 - 31	91	61	76	51	255	171	257	172	372	249

Table 5.3.1 EFFECTIVE RAINFALL (RE) AND FARM WATER REQUIREMENT

(Unit: mm/10-day)

Area Crop Month Day		Tangmachhu Area						Masangdaza Area					
		Rice		Wheat		Mustard		Rice		Wheat		Mustard	
Month	Day	RE	FWR	RE	FWR	RE	FWR	RE	FWR	RE	FWR	RE	FWR
Jan.	1 - 10			0	21	0	16			0	20	0	23
	11 - 20			0	24	0	10			0	23	0	14
	21 - 30			0	29	0	13			0	28	0	13
Feb.	1 - 10			0	32	0	17			0	36	0	19
	11 - 20			0	33	0	20			5	32	5	18
	21 - 28			0	27	0	19			0	29	0	21
Mar.	1 - 10			7	33	7	27			6	34	4	30
	11 - 20			0	37	0	37			0	38	0	36
	21 - 31			0	38	0	41			0	37	0	40
Apr.	1 - 10			22	8	22	15			17	13	17	19
	11 - 20			21	2	21	10			33	0	30	5
	21 - 30	56	1	0	9	0	15			65	0	33	1
May	1 - 10	34	1	8	1	43	0	0	1	0	6	0	10
	11 - 20	6	13					14	3	14	0	11	2
	21 - 31	0	43					0	40				
Jun.	1 - 10	14	54					0	102				
	11 - 20	5	68					26	136				
	21 - 30	5	77					123	82				
Jul.	1 - 10	43	50					49	145				
	11 - 20	37	51					50	119				
	21 - 31	39	41					58	115				
Aug.	1 - 10	14	50					18	137				
	11 - 20	0	65					9	148				
	21 - 31	28	45					59	116				
Sep.	1 - 10	22	38					22	131				
	11 - 20	14	37					54	87				
	21 - 30	6	33					22	82				
Oct.	1 - 10	0	26					40	41				
	11 - 20	62	0					23	16	42	6		
	21 - 31	12	5	12	17					0	32		
Nov.	1 - 10			11	46					8	35		
	11 - 20			8	63					0	42	0	7
	21 - 30			0	56	0	11			0	45	0	20
Dec.	1 - 10			0	24	0	30			0	39	0	26
	11 - 20			0	14	0	40			0	25	0	28
	21 - 31			10	10	10	28			17	7	17	21

Table 5.3.2   WATER BALANCE CALCULATION

| Project Area | | Tangmachhu Area | | | | Masangdaza Area | | | |
Month	Day	Drought Discharge (l/s)	Diversion Req. (l/s/ha) Rice	Wheat	Mustard	Irrigable Area (ha)	Drought Discharge (l/s)	Diversion Req. (l/s/ha) Rice	Wheat	Mustard	Irrigable Area (ha)
Jan.	1 – 10	159		0.45	0.34	803	221		0.42	0.48	982
	11 – 20	162		0.51	0.20	910	225		0.48	0.31	1,141
	21 – 30	143		0.56	0.25	708	199		0.53	0.25	1,021
Feb.	1 – 10	149		0.68	0.35	581	208		0.75	0.40	723
	11 – 20	146		0.70	0.42	523	203		0.67	0.38	775
	21 – 28	131		0.70	0.50	438	181		0.77	0.56	546
Mar.	1 – 10	133		0.70	0.57	419	184		0.72	0.63	544
	11 – 20	134		0.79	0.77	345	186		0.80	0.76	476
	21 – 31	125		0.72	0.78	334	173		0.70	0.76	473
Apr.	1 – 10	157		0.17	0.32	1,282	219		0.28	0.40	1,287
	11 – 20	133		0.05	0.21	2,044	184		0.00	0.10	7,344
	21 – 30	190	0.01	0.19	0.31	1,409	267		0.00	0.02	53,440
May	1 – 10	187	0.02	0.01	0.00	8,322	263	0.02	0.13	0.21	2,503
	11 – 20	254	0.26			976	360	0.06	0.00	0.03	5,327
	21 – 31	266	0.75			354	377	0.69			547
Jun.	1 – 10	285	1.04			274	406	1.96			207
	11 – 20	287	1.30			221	408	2.63			155
	21 – 30	331	1.49			222	472	1.57			301
Jul.	1 – 10	444	0.97			458	637	2.79			228
	11 – 20	468	0.98			478	672	2.29			293
	21 – 31	471	0.73			645	676	2.02			335
Aug.	1 – 10	447	0.96			466	641	2.65			242
	11 – 20	323	1.26			256	461	2.85			162
	21 – 31	291	0.79			369	415	2.03			204
Sep.	1 – 10	264	0.73			362	375	2.54			148
	11 – 20	290	0.71			408	412	1.67			247
	21 – 30	258	0.64			403	366	1.58			232
Oct.	1 – 10	245	0.50			489	346	0.79			438
	11 – 20	236	0.00			--	333	0.30	0.13		1,002
	21 – 31	278	0.08	0.36		1,634	395		0.67		2,357
Nov.	1 – 10	243		0.96		1,013	344		0.74		1,861
	11 – 20	240		1.32		728	340		0.88	0.14	1,333
	21 – 30	242		1.18	0.24	681	342		0.95	0.41	1,006
Dec.	1 – 10	214		0.51	0.62	759	302		0.81	0.55	889
	11 – 20	196		0.29	0.85	689	276		0.53	0.58	995
	21 – 31	171		0.19	0.53	948	239		0.13	0.40	1,801

Table 5.5.1   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 5.5.2   DISBURSEMENT SCHEDULE OF THE PROJECT COST

(Unit ; Nu'000)

Project Area	Total F/C	Total L/C	Total	1989 F/C	1989 L/C	1989 Total	1990 F/C	1990 L/C	1990 Total	1991 F/C	1991 L/C	1991 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 5.7.1   IRRIGATION DEVELOPMENT BENEFIT IN THE MODEL PROJECT AREA

Crop	Area (ha) A	Unit yield (ton/ha) B	Total production (ton) C=AxB	Unit Price (Nu/kg) D	Gross production value (Nu) E=Dx1000xE	Unit production cost (Nu/ha) F	Total production cost (Nu) G=AxF	Net production value (nu) H=E-G
Tangmachhu								
Without project								
Paddey	170	2.2	374	2.9	1,084,600	4,030	685,100	399,500
Wheat	2	1.0	2	3.9	7,800	1,350	2,700	5,100
Potato	2	2.1	4	1.6	6,700	3,130	6,300	400
Total	-	-	-	-	1,099,100	-	694,100	405,000
With project								
Paddey	220	5.0	1,100	2.9	3,190,000	4,600	1,012,000	2,178,000
Wheat	55	1.8	99	3.9	386,100	1,410	77,600	308,500
Mustard	55	0.9	50	3.6	178,200	1,310	72,100	106,100
Total	-	-	-	-	3,754,300	-	1,161,700	2,592,600
Net Incremental {(With project)-(Without project)}								2,187,600
Masangdaza								
Without project								
Paddey	30	1.5	45	2.9	130,500	4,030	120,900	9,600
Maize (1st)	20	1.1	22	3.1	68,200	1,870	37,400	30,800
Maize (2nd)	5	1.1	6	3.1	17,100	1,530	7,700	9,400
Buckwheat	5	0.4	2	1.4	2,800	510	2,600	200
Mustard	1	0.3	0	3.6	1,100	610	600	500
Total	-	-	-	-	219,700	-	169,200	50,500
With project								
Paddey	80	5.0	400	2.9	1,160,000	4,600	368,000	792,000
Wheat	20	1.8	36	3.9	140,400	1,410	28,200	112,200
Mustard	20	0.9	18	3.6	64,800	1,310	26,200	38,600
Total	-	-	-	-	1,365,200	-	422,400	942,800
Net Incremental {(With project)-(Without project)}								892,300

FIGURES

Fig.1.3.1 GENERAL WORK FLOW FOR THE STUDY

Work Item	1987 Nov	Dec	1988 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1989 Jan	Feb	Mar
I. First Phase																	
(1) Preparatory Work in Japan		☐															
(2) Field Survey and Investigation		▬	▬	▬													
(3) Data Analysis and Study (in Japan)							☐										
II. Second Phase																	
(1) Field Survey and Investigation									▬	▬							
(2) Data Analysis and Study (in Japan)											☐						
(3) Explanation of Draft Final Report (in Bhutan)													▬				
(4) Preparation of Final Report														☐			
Submission of Report																	
1. Inception Report		▲															
2. Progress Report					▲												
3. Interim Report								▲									
4. Draft Final Report												▲					
5. Final Report																▲	

▬ : Field Work in Bhutan.   ☐ : Home Office Work in Japan.

F - 1

Fig. 2.3.1 ORGANIZATION OF NATIONWIDE AGRICULTURAL SUPPORT SYSTEM

LHUNTSHI DISTRICT
Project Area

1. Pang Khar
2. Gangzoor
3. Tangmachhu
4. Minji
5. Menjibi
6. Kupinesa
7. Wambur

MONGAR DISTRICT
Project Area

8. Chali
9. Karbithang
10. Karibee
11. Masangdaza
12. Pangsibi
13. Gyelposhing
14. Kalapang
15. Yadi
16. Chaskhar

LEGEND
- District Boundary
- River

SCALE
0   10   20 km

Fig.3.4.1   RIVER   SYSTEM
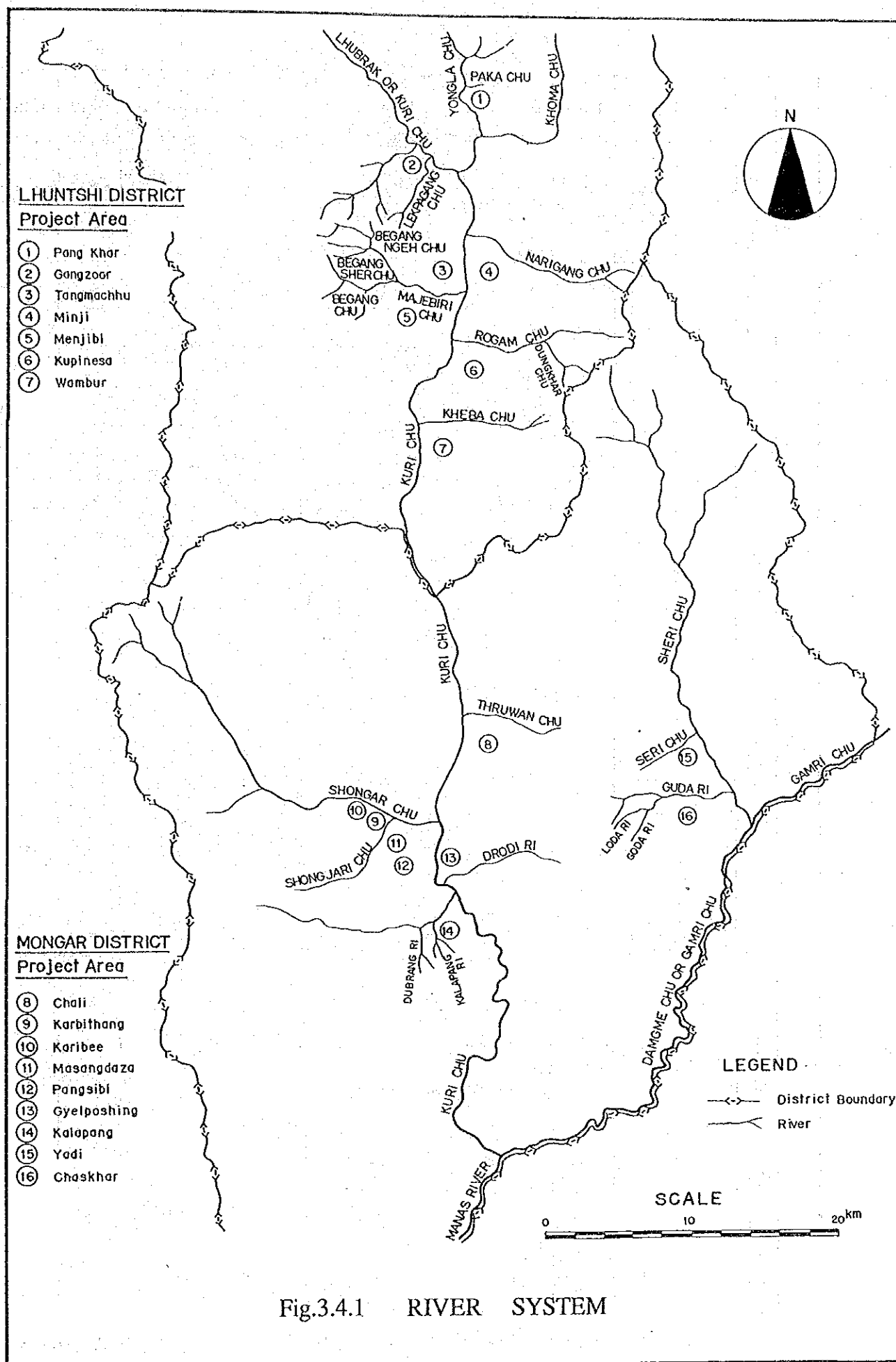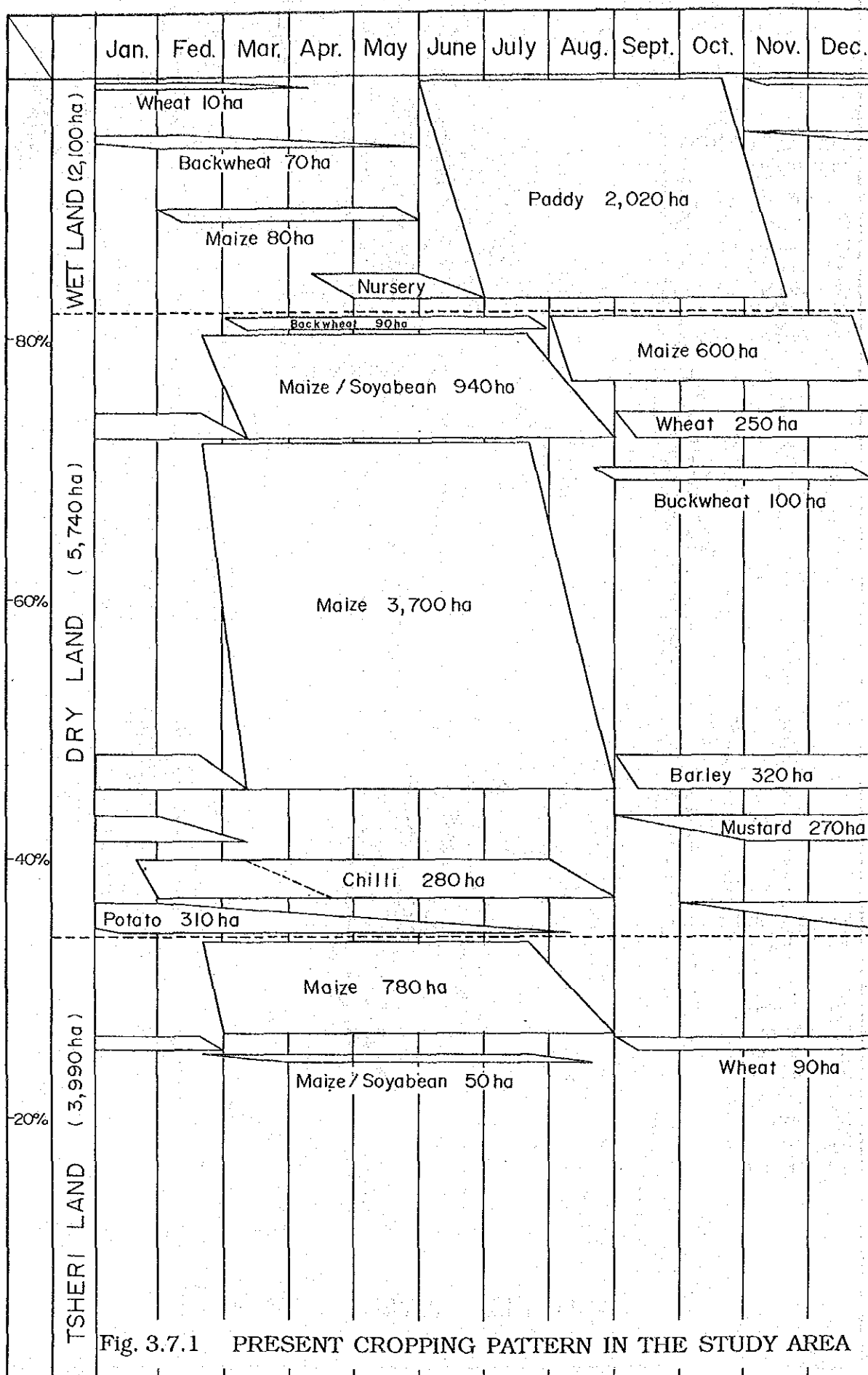
Fig. 3.7.1   PRESENT CROPPING PATTERN IN THE STUDY AREA

The chart shows cropping patterns by month (Jan. through Dec.) across three land types:

WET LAND (2,100 ha)
- Wheat 10 ha
- Backwheat 70 ha
- Maize 80 ha
- Nursery
- Paddy 2,020 ha

DRY LAND (5,740 ha)
- Backwheat 90 ha
- Maize / Soyabean 940 ha
- Maize 600 ha
- Wheat 250 ha
- Buckwheat 100 ha
- Maize 3,700 ha
- Barley 320 ha
- Mustard 270 ha
- Chilli 280 ha
- Potato 310 ha

TSHERI LAND (3,990 ha)
- Maize 780 ha
- Maize / Soyabean 50 ha
- Wheat 90 ha

AGRICULTURE
Ⓔ   Agri Extension Center

ANIMAL HUSBANDRY
HF   A.H. Farm
VH   Veterinary Hospital
Ⓥ   Veterinary Center

— — — — —   District Boundary
- - - - - -   Blook Boundary

Project Area
① Pang Khar
② Gangzoor
③ Tangmachhu
④ Minji
⑤ Menjibi
⑥ Kupinesa
⑦ Wambur

Fig.3.7.2 AGRICULTURAL SUPPORT SERVICE CENTER IN THE STUDY AREA (1/2)
(LHUNTSHI DISTRICT)

AGRICULTURE

⒠ Agri. Extension Center

ANIMAL HUSBANDRY

[HF] A.H. Farm

[VH] Veterinary Hospital

Ⓥ Veterinary Center

─ ─ ─ District Boundary
─ ─ ─ Block Boundary

Project Area

⑧ Chali
⑨ Karbithang
⑩ Karibee
⑪ Masangdaza
⑫ Pangsibi
⑬ Gyelposhing
⑭ Kalapang
⑮ Yadi
⑯ Chaskhar

Fig.3.7.2 AGRICULTURAL SUPPORT SERVICE CENTER IN THE STUDY AREA (2/2)
(MONGAR DISTRICT)