

#### 4. Land Capability

Generally, potential for agricultural production of land is not high because of undulating topographic condition. It is not practical to apply the criteria usually using to evaluate lands. Therefore, the following two factors were considered for land classification to evaluate potential of land;

##### 1) Present land use

Even in the narrow and low potential land such as stony and steep land, farmers are cultivating by removing stones, bunding and terracing at present. Most paddy fields has already terraced and banded. Contents of stone is very low. These lands can continue to grow crops. Permanent upland crop fields such as dry land have already banded and partly terraced. But usually stones and gravel can seen. These land can also continue to cultivate by removing stones terracing more level. Although much period is required for removing stones and terracing to improve present farm land, these practices should be considered.

##### 2) Conversion of lands under shifting cultivation

Shifting cultivation carried out in tsheri and pangshing lands has been causing deterioration of the forest resources and accelerating soil erosion severely by removing natural vegetation cover from steep slopes. To prevent these reverse condition, such lands as tsheri and pangshing lands should be converted into permanent cultivated land or into natural vegetation for land conservation depending on the steepness. In case of converting into cultivated land, it is necessary to make terraces and bund properly.

In considering the above principles, potential for agricultural production of each soil unit is outlined as follows:

##### a. Phaeozems

Because of steep slopes and high altitude, potential is very low. Although these soils are sometimes utilized for shifting cultivation and grazing at present, it is not easy to make these land terracing and bunding for permanentcultivation. It is recommeded that lands of these soil unit would be left natural vegetation or would be covered by vegetation to prevent soil erosion and keep forestry resource.

b. Lithosols, Regosols and Arenosols

Because of shallow surface soil and high content of gravels and stones, potential is low. Furthermore, these soil unit situated on the steep slopes are easy to be suffered by soil erosion. In this regard, it is better to keep natural vegetation or to cover with vegetation to prevent soil erosion. Tsheri land of these soil units should be converted into natural vegetation.

c. Cambisols, Acrisols and Gleysols

Present cultivated lands extend over these soil units, and potential varies with topographic condition. Therefore, these soils can be cultivated by terracing and can increase production by irrigation water supply and proper farm management. However, some of these soil units should be convert into natural vegetation because of steep slopes.

Lands of the model project areas are covered by Cambisols, Acrisols, Gleysols, Arenosols. Arenosols can be found in the limited area of the Masangdaza area, and this soil has almost no potential for cultivation because of shallow top soils and high gravel content. Gleysols have high potential but drainage is important for upland crops. Potential of Acrisols and Cambisols is not high, but there is no serious limiting factors except slopes. Therefore, Cambisols Acrisols and Gleysols can be cultivated with the model projects.

Basically, present lands cultivated permanently have been already terraced and better potential. Tsheri land is usually marginable or unsuitable.

Although Gleysols has good potential for paddy cultivation, some area should be drained properly. Potential of Acrisols and Cambisols is not so high, but there is no serious limitation for cultivation. Most of tsheri lands are found on Acrisols in the upper part, and these lands are rather steep. These soils have low potential for cultivation and high erodability by removing vegetation cover. Accordingly, it is better to convert natural vegetation or forest.

In the Masangdaza area, the major soils are Cambisols and Regosols. Cambisols extend over the villages of Masangdaza, Karbithang, Karibee and part of Bongdima. These soils, where slope is not steep, are utilized as permanent cultivated land. Potential for cultivation of these soils is moderate, but in some area contents of stone is high. As seen in Bhutan, these lands can be cropped by removing stones.

Table III.2.1 ESTIMATION OF LAND USE THROUGH THE LAND USE SURVEY BY THE DEPARTMENT OF FORESTRY

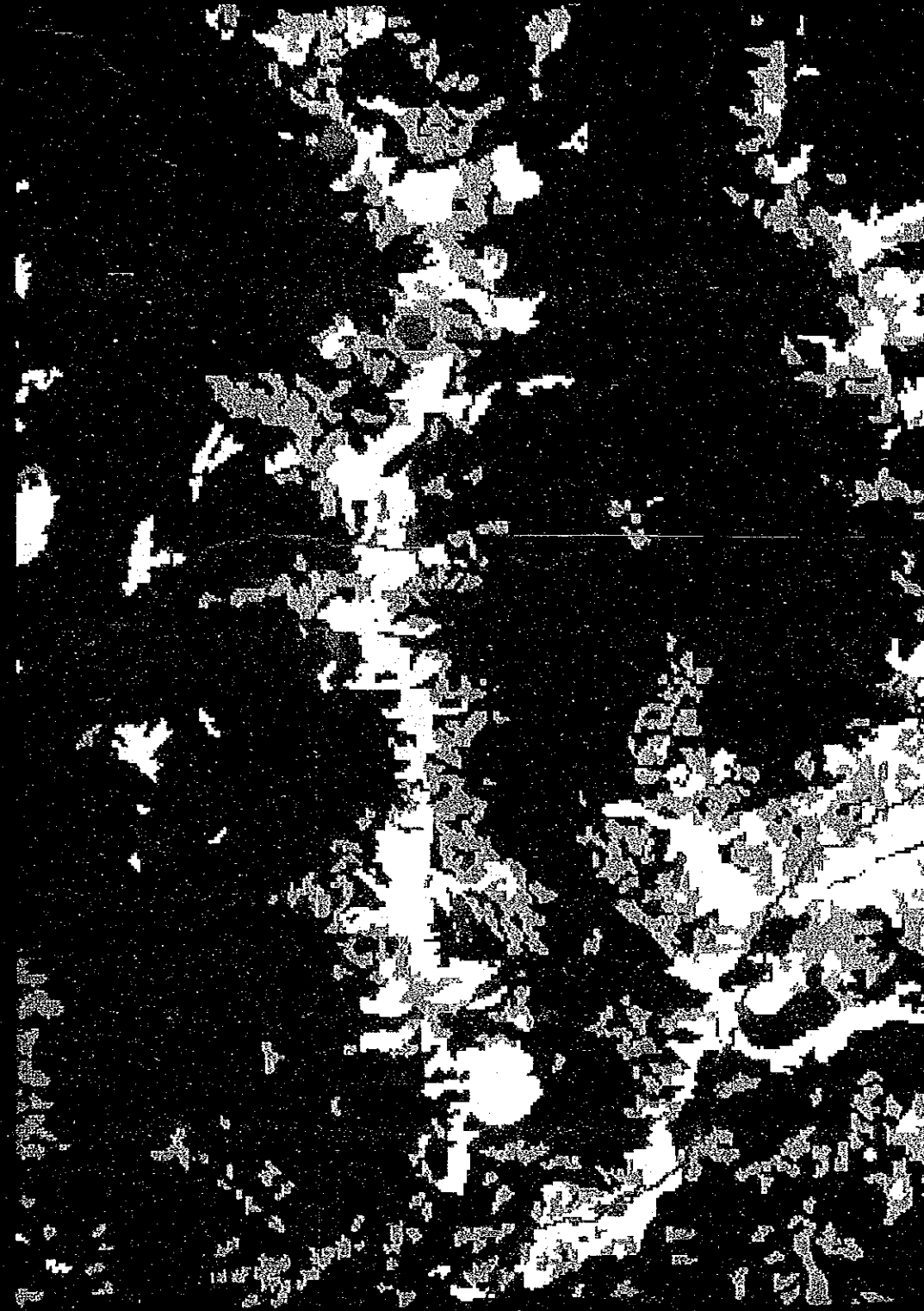
Land use and vegetation type	Lhuntshi		Moncar		Total		Bhutan	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
<b>Non-forested</b>								
Perpetual snow/ Glaciers	40,595	14.0	-	0.0	40,595	8.4	400,630	10.0
Barren exposed and rocky areas	34,649	11.9	318	0.2	34,967	7.3	345,564	8.6
Barren land, grassland and scrubs	2,642	0.9	2,887	1.5	5,529	1.1	30,700	0.8
Water spreads	4,306	1.5	2,716	1.4	7,022	1.5	52,292	1.3
Sub-total	82,192		5,921		88,113		829,186	
<b>Agriculture land including settlements and orchard</b>								
- Valley cultivation	1,150	0.4	245	0.1	1,395	0.3	64,920	1.6
- Terraced cultivation	11,035	3.8	14,829	7.7	25,864	5.4	175,911	4.4
- Old shifting cultivation (tsheri)	6,141	2.1	5,457	2.8	11,598	2.4	115,043	2.9
Sub-total	18,326		20,531		38,857		355,874	
Sub-total	100,518	34.7	26,452	13.8	126,970	26.3	1,185,060	29.4
<b>Forested</b>								
- Alpine pasture/meadows	758	0.3	-	0.0	758	0.2	74,770	1.9
- Alpine scrub	18,841	6.5	-	0.0	18,841	3.9	191,805	4.8
- Fir	19,330	6.7	5,996	3.1	25,326	5.3	295,617	7.3
- Mixed conifers	32,115	11.1	17,204	9.0	49,319	10.2	485,434	12.1
- Blue pine	-	0.0	-	0.0	-	0.0	75,528	1.9
- Chir pine	7,529	2.6	32,107	16.7	39,636	8.2	129,162	3.2
- Hardwood mixed with conifers	27,400	9.4	20,971	10.9	48,371	10.0	219,306	5.4
- Upland hardwood	75,312	26.0	81,168	42.3	156,480	32.5	872,627	21.7
- Lowland hardwood	-	0.0	4,455	0.0	4,455	0.0	351,363	8.7
- Degraded forests	8,197	2.8	3,647	1.9	11,844	2.5	141,590	3.5
- Plantations	-	0.0	-	0.0	-	0.0	2,738	0.1
Sub-total	189,482	65.3	165,548	86.2	355,030	73.7	2,839,940	70.6
Grand Total	290,000	100.0	192,000	100.0	482,000	100.0	4,025,000	100.0

Source : Department of Forest

Table III.2.2 RESULTS OF LAND USE ESTIMATED BY LANDSAT DATA

District	Description	Department of Agriculture	District Office	Landsat Data	Estimation by Category
LHUNTSHI	Agricultural land				
	- Wet land	1,200	840	1,700	1,700
	- Dry land	1,600	1,940	-	2,600
	- Tsheri land	700	760	-	1,000
	- Kitchen garden	100	80	-	100
	- Horticulture	-	20	-	100
	- Grazing land	-	6,300	-	8,300
	- Others	-	-	12,100	-
	Sub-total	3,600	9,940	13,800	13,800
	Forest land				
	- Scarse forest	-	-	11,400	-
	- Dense forest	-	-	84,000	-
	Sub-total	-	-	95,400	-
	Other land	-	-	1,300	-
	Grand total	-	-	110,500	-
MONDAR	Agricultural land				
	- Wet land	500	530	1,300	1,300
	- Dry land	2,900	2,900	-	5,600
	- Tsheri land	900	2,450	-	4,700
	- Kitchen garden	100	40	-	100
	- Horticulture	-	50	-	100
	- Grazing land	-	6,060	-	11,700
	- Others	-	-	22,200	-
	Sub-total	4,400	12,030	23,500	23,500
	Forest land				
	- Scarse forest	-	-	18,800	-
	- Dense forest	-	-	147,500	-
	Sub-total	-	-	166,300	-
	Other land	-	-	3,500	-
	Grand total	-	-	193,300	-
STUDY AREA	Agricultural land				
	- Wet land	1,700	1,370	3,000	3,000
	- Dry land	4,500	4,840	-	8,200
	- Tsheri land	1,600	3,210	-	5,700
	- Kitchen garden	200	120	-	200
	- Horticulture	-	70	-	200
	- Grazing land	-	12,360	-	20,000
	- Others	-	-	34,300	-
	Sub-total	8,000	21,970	37,300	37,300
	Forest land				
	- Scarse forest	-	-	30,200	-
	- Dense forest	-	-	231,500	-
	Sub-total	-	-	261,700	-
	Other land	-	-	4,800	-
	Grand total	-	-	303,800	-

# LAND USE



- Foresty (Dense)
- Cultivation, Grass
- Foresty (Sparse)
- Barren Land
- Paddy Field

Fig.III.2.1 LANDSAT IMAGERY OF LAND USE



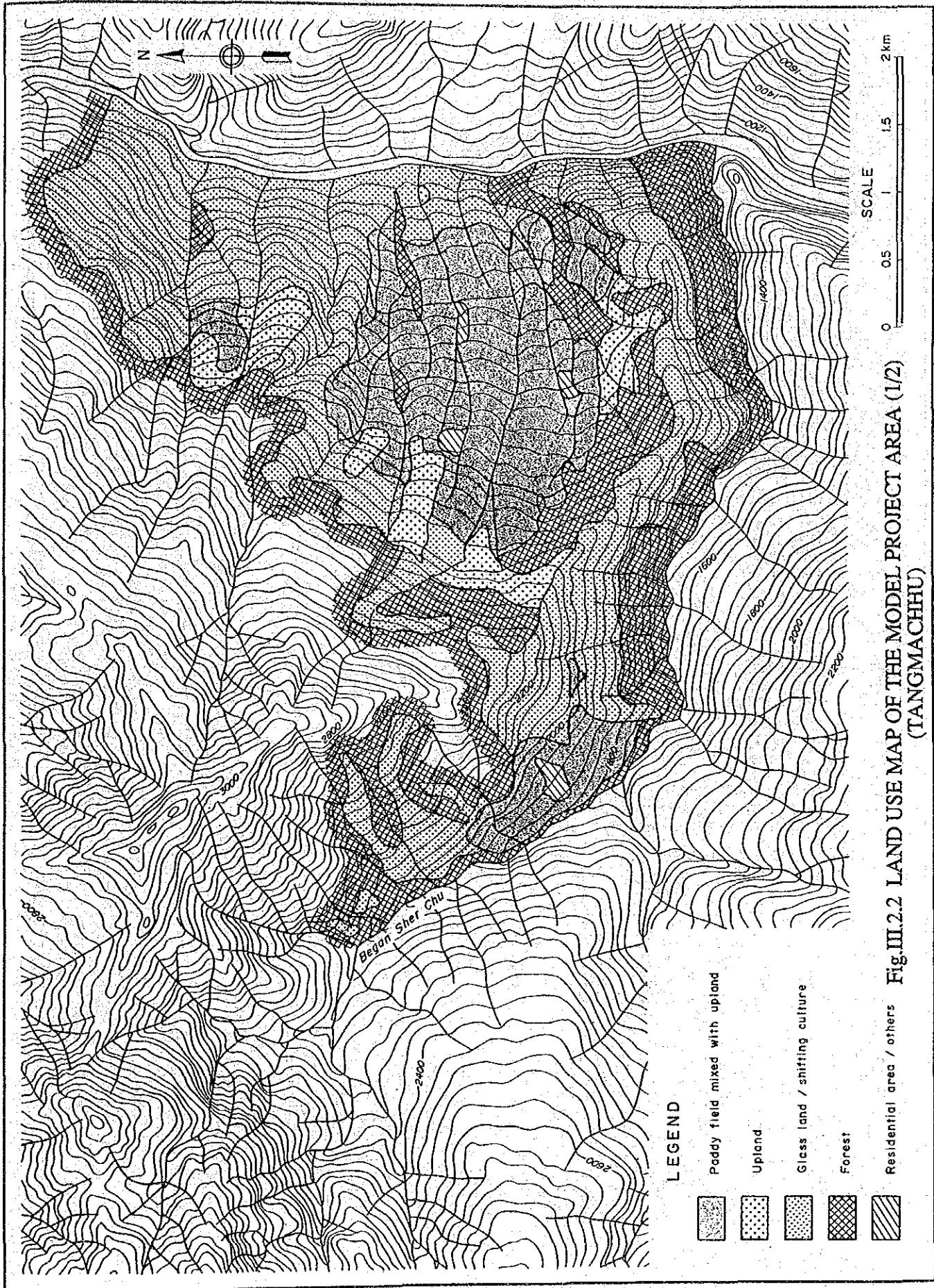







Fig.III.2.2 LAND USE MAP OF THE MODEL PROJECT AREA (1/2)  
(TANGMACHHU)

**LEGEND**

-  Paddy field mixed with upland
-  Upland
-  Glass land / shifting culture
-  Forest
-  Residential area / others

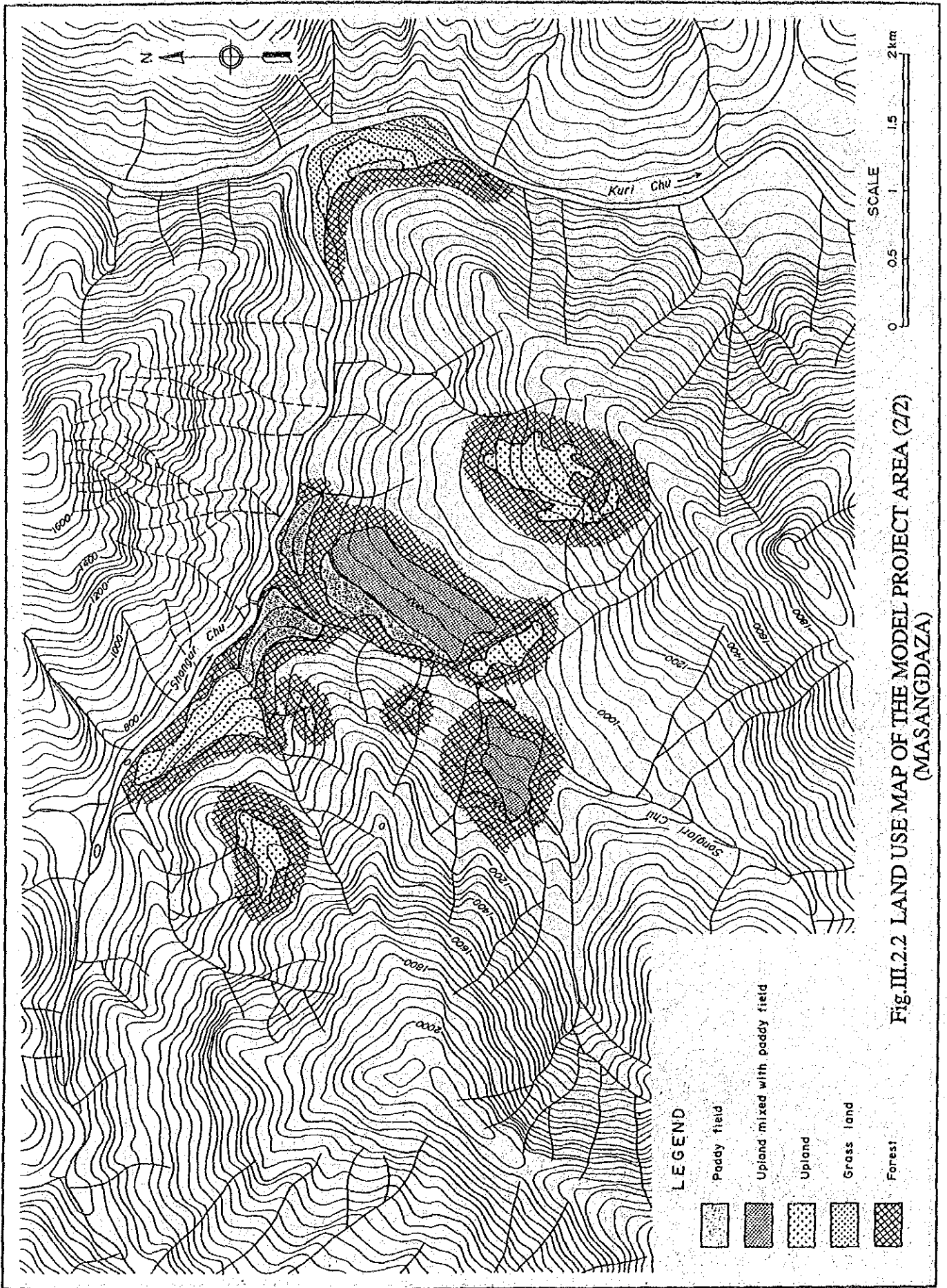


Fig.III.2.2 LAND USE MAP OF THE MODEL PROJECT AREA (2/2)  
(MASANGDAZA)



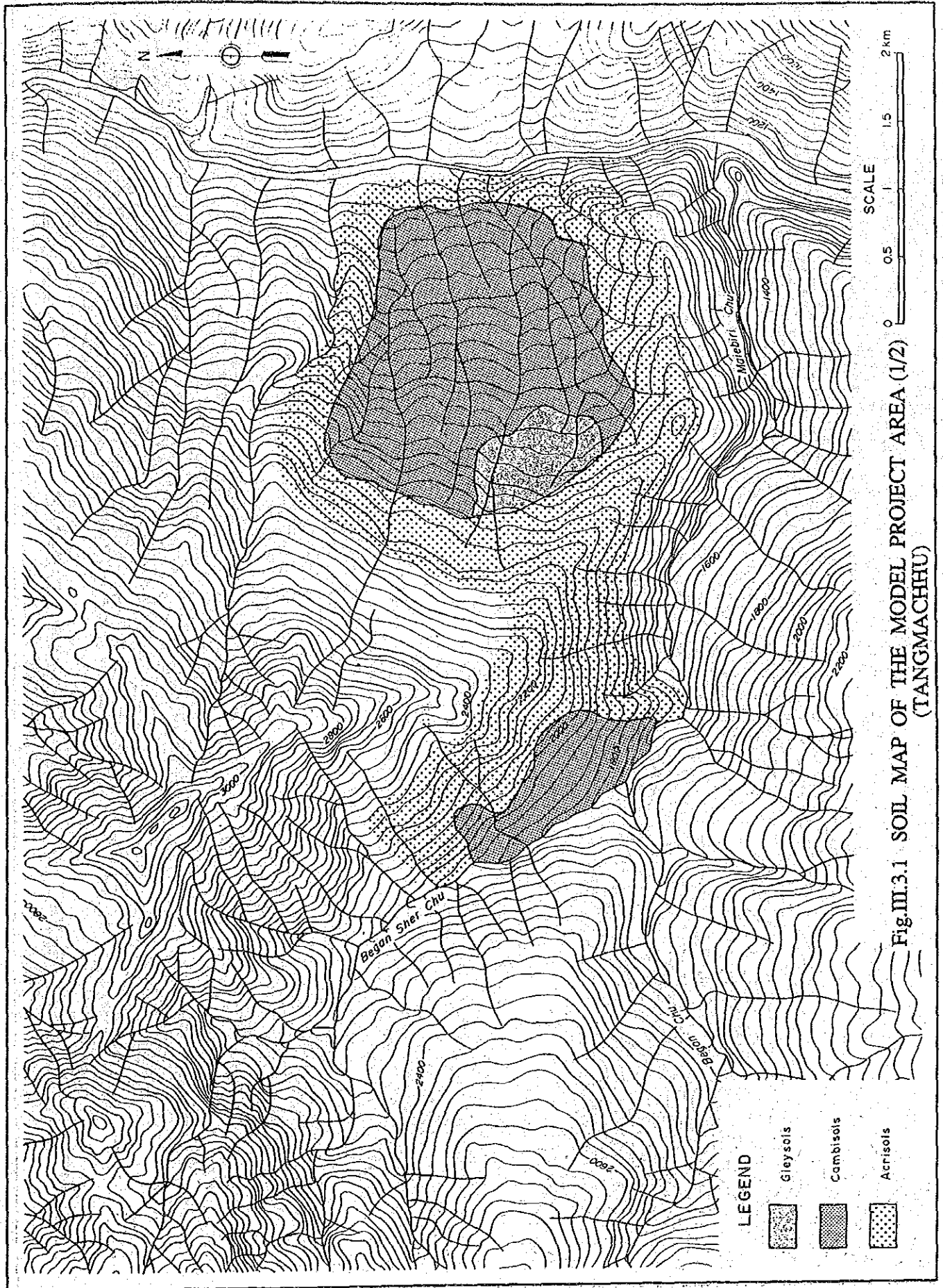


Fig.III.3.1 SOIL MAP OF THE MODEL PROJECT AREA (1/2)  
(TANGMACHHU)

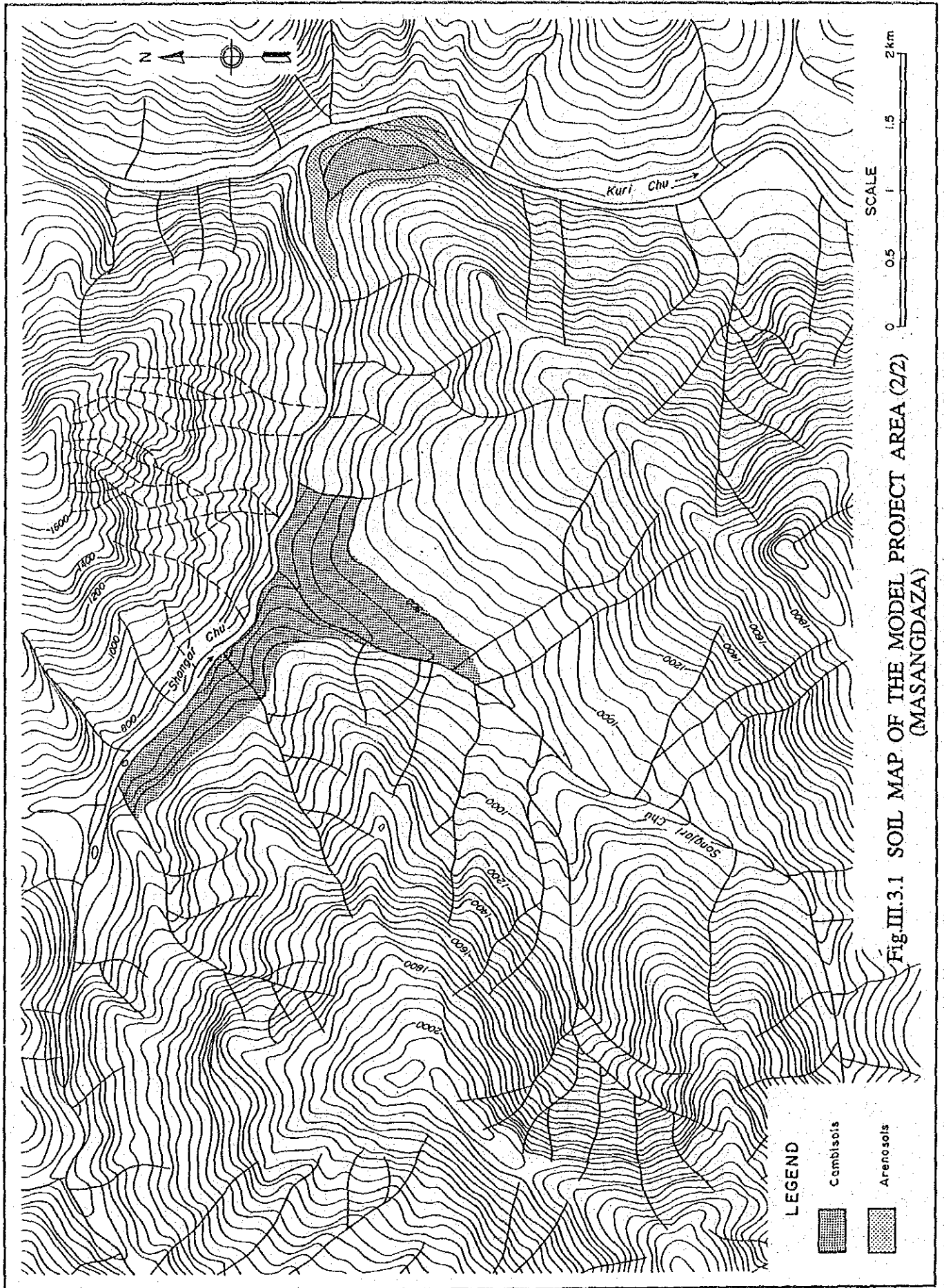


Fig.III.3.1 SOIL MAP OF THE MODEL PROJECT AREA (2/2)  
(MASANGDAZA)

**ANNEX - IV**

**AGRICULTURE  
AND  
AGRO-ECONOMY**



**LHUNTSHI AND MONGAR  
INTEGRATED AGRICULTURAL DEVELOPMENT PROJECT**

**ANNEX-IV AGRICULTURE AND AGRO-ECONOMY**

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## 1. GENERAL

This report entitled Annex IV "Agriculture and Agro-Economy" is the supporting report for agriculture and agro-economy in the feasibility study on "the Lhuntshi and Mongar Integrated Agricultural Development Project."

This report comprises the present conditions of agriculture and agro-economy in the study area (Lhuntshi and Mongar Districts) and the model project areas (Tangmachhu and Masangdaza), the identified constraints of the areas, and the proposed agricultural development plans.

The data and information were mainly collected from the following government authorities concerned:

- 1) Department of Agriculture
- 2) Department of Forestry
- 3) Department of Animal Husbandry
- 4) Planning Commission
- 5) Ministry of Home Affairs
- 6) Ministry of Social Services
- 7) Ministry of Finance
- 8) Ministry of Trade and Industry
- 9) Food Corporation of Bhutan
- 10) Lhuntshi District
- 11) Mongar District

In addition to the above data collection, the following field surveys were carried out:

- 1) Agricultural surveys in the 16 project areas
- 2) Demographic surveys in the 16 project areas
- 3) Land holding and tenure surveys in the 16 project areas
- 4) Farm economic surveys in the 16 project areas

## 2. PRESENT CONDITION

### 2.1 Present Condition of the Study Area

#### 2.1.1 Location

The study area is the two contiguous Districts of Lhuntshi and Mongar from north to south, and is located in the eastern region of Bhutan. The study area is bordered by the Tibet region of China in the north, Tashigang District in the east, Bumthang and Shemgang District in the west, and Pema Gatshel District in the south-east. Maximum north-south distance and east-west distance of the study area are 125 km and 50 km respectively.

The town of Mongar, the capital of Mongar District, is located at about 150 km east of Thimphu, however, the road distance from Thimphu to Mongar is about 470 km, and it takes almost two days' driving. Usually, transportation between Mongar and Thimphu has to be via Phuntsholing and Samdrup Jongkhar because the road condition is much better than the road via Tongsa and Bumthang. The town of Lhuntshi, the capital of Lhuntshi District, is located about 50 km north of Mongar, and road distance between Lhuntshi and Mongar is around 70 km and three to four hours driving.

The project areas of sixteen (16) existing or proposed small irrigation schemes are scattered over the study area, mainly along the Kuri chu except for two areas located in the Sheri chu and basin.

Administratively, 7 project areas are located in the Lhuntshi District, and 9 project areas the Mongar District, and these project areas are under blocks in each District as follows:

District	Project Area	Block
<u>Lhuntshi District</u>	Pang Khar	Khoma
	Gangzoor	Gangzoor
	Tangmachhu	Tangmachhu
	Minji	Minji
	Menjibi	Tangmachhu
	Kupinesa	Minji
	Wambur	Chenkhar
<u>Mongar Districts</u>	Chali	Chakaling
	Karbithang	Salling
	Karibee	Salling
	Masangdaza	Salling
	Pangsibi	Salling
	Gyelposhing	Mongar
	Kalapang	Salling
	Yadi	Ngatshang
	Chaskhar	Chaskhar

### 2.1.2 Demographic Condition

The population of Lhuntshi and Mongar Districts is estimated at 42,100 and 77,200 respectively which accounts for 3% and 6% of the national population of 1,365,700 in 1988 according to the official population estimate.

Villages normally lie scattered on the mountain slopes between the elevations of 600 m and 2,300 m, but people are shifting down to the lower parts of these areas which are more suitable for crop production, especially irrigated rice cultivation. Lhuntshi and Mongar Districts respectively have 53 and 119 villages in 8 and 11 blocks respectively. An average village has 80 to 90 households and a population of 700. The average family size is 10 in Lhuntshi and 8 in Mongar.

The demographic conditions of the two districts, are given in Tables IV.2.1 and IV.2.2, may be summarized as follows:

#### DEMOGRAPHIC INFORMATION OF STUDY AREA

Item	Lhuntshi	Mongar
1. No. of Blocks	8	11
2. No. of Villages	53	119
3. Population	42,100 (100%)	77,200 (100%)
- Per Block (3/1)	5,260	7,020
- Per Village (3/2)	790	650
4. No. of Households	4,200	10,160
- Per Block (4/1)	530	920
- Per Village (4/2)	80	90
5. Family Size (3/4)	10	8
6. Student Population (5-14 age group)	8,640 (21%)	19,650 (25%)
7. Labour Force (15-54 age group)	25,780 (61%)	39,220 (51%)

Note : The age distribution data are based on the results of demographic surveys in the 16 project areas.

### 2.1.3 Land Use

#### (1) Land Use of the Study Area

The total area of the study area is about 5,600 km<sup>2</sup>, consisting of 3,400 km<sup>2</sup> (61%) in Lhuntshi District and 2,200 km<sup>2</sup> (39%) in Mongar District.

To estimate the present land use in the study area, remote sensing was applied using the latest Landsat data. The results of the estimation are shown in Annex III, and may be summarized as follows:

(unit : ha)

Item	Lhuntshi	Mongar	Total
Paddy field	1,700	1,300	3,000
(%)	(1.5)	(0.7)	(1.0)
Upland and pasture	12,100	22,200	34,300
(%)	(11.0)	(11.5)	(11.3)
Bare land	1,300	3,500	4,800
(%)	(1.2)	(1.8)	(1.6)
Sparse forest	11,400	18,800	30,200
(%)	(10.3)	(9.7)	(9.9)
Dense forest	84,000	147,500	231,500
(%)	(76.0)	(76.5)	(76.2)
Total	110,500	193,300	303,800
(%)	(100.0)	(100.0)	(100.0)
Total study area	340,000	220,000	560,000

DOA and the District offices are collecting land use data on a net area basis for the whole country, but the figures for agricultural land use are significantly smaller than those given above. Although these data are estimated on the basis of the gross area of each land use item, the actual cultivated area of wet land and dry land is larger than the statistical data of DOA and the District offices.

#### (2) Land Use in the Project Areas

For the 16 project areas in the study area, agricultural land use was surveyed by interviewing extension workers and supervisors. The results are shown in Table IV.2.3 and may be summarized as follows:

(unit : ha)

Project Area	Wet Land	Dry Land	Tsheri Land	Others Land	Total Land
<b>Lhuntshi District</b>					
1. Pang khar	6	19	9	1	35
2. Gangzoor	16	18	4	1	39
3. Tangmachhu	184	102	98	4	388
4. Minji	116	42	20	28	206
5. Menjibi	12	7	3	1	23
6. Kupinesa	16	38	32	3	89
7. Wambur	43	81	16	0	140
Sub-total	393	307	182	38	920
<b>Mongar District</b>					
8. Chali	54	100	50	0	204
9. Karbithang	10	0	0	0	10
10. Kribee	0	22	15	0	37
11. Masangdaza	16	39	0	0	55
12. Pangsibi	0	18	5	0	23
13. Gyelposhing	38	4	0	0	42
14. Kalapang	0.4	9	5	0	14.4
15. Yadi	29	77	30	0	136
16. Chaskhar	46	186	73	0	305
Sub-total	193.4	455	178	0	826.4
Grand total	586.4	762	360	38	1,746.4

Based on the interpretation of aerial photographs taken in 1978 and field surveys, land use of the fifteen project areas was classified into four categories i.e. forest land, grass land (including shrub land, tsheri land, and pangshing land), dry land or upland, and paddy field. Land use maps for each project area are shown in Annex X, Profiles of the Project Areas in this report.

#### 2.1.4 Land Holding and Tenure System

Statistical data on land holding and tenure in Lhuntshi and Mongar Districts are not available. Field surveys in the 16 project areas have shown that most of the farmers are owner operators, while Tangmachhu and Minji areas have 23 and 13 landless farmers respectively. The monastery in Mongar owns 9.6 ha of wet land in Karbithang area which is cultivated by neighboring farmers under the fixed farm rent of 9.5 t for the total area.

A land owner cannot hold more than 10 ha of land. If a farmer sells part of his land, however, he must retain a minimum of 2 ha. The average farm size of owner operators is 1.7 ha in Lhuntshi and 1.1 ha in Mongar according to the field surveys. Distribution of owner operators and area of farm land by holding size are shown in Table IV.2.4 and summarized as follows:

Holding Size	Owner Distribution		Area Distribution		Average Size ha
	No.	%	ha	%	
<b>Lhuntshi Scheme</b>					
Below 0.2	10	2	1	0	0.1
0.2 - 0.8	45	8	21	2	0.5
0.8 - 1.4	200	36	193	21	1.0
1.4 - 2.0	170	31	289	32	1.7
<u>Above 2.0</u>	<u>124</u>	<u>23</u>	<u>417</u>	<u>45</u>	<u>3.4</u>
Total	549	100	921	100	1.7
<b>Mongar Scheme</b>					
Below 0.2	118	16	11	1	0.1
0.2 - 0.8	211	28	109	13	0.5
0.8 - 1.4	239	31	261	32	1.1
1.4 - 2.0	115	15	194	24	1.7
<u>Above 2.0</u>	<u>78</u>	<u>10</u>	<u>241</u>	<u>30</u>	<u>3.1</u>
Total	761	100	816	100	1.1

### 2.1.5 Cropping Pattern and Farming Practice

#### (1) General

The study area is characterized by steep and rugged topography, ranging in altitude from about 300 m to over 4,000 m above sea level. The various mountain ranges which make up the hilly area are dissected by deep valleys, and most of the agricultural lands are located on the small plateaux dotted with villages at various elevations.

At present, only about 15% of the cultivated land has assured irrigation water, and agricultural production largely depends on the monsoon.

Usually agricultural land is classified into three categories i.e. wet land, dry land, tsheri land. Wet land comprises terraced fields with some sort of irrigation water supply, and is mostly used for paddy cultivation. Dry land comprises unirrigated fields, usually not terraced but sometimes bunded along the contour line. Tsheri land is shifting cultivation land where crops are grown once every five to six years with the land reverting to scrub in between. Several attempts, which include conversion of Tsheri land into permanent fields and contour bunding of dry land slopes, are being made the land development and soil conservation under the assistance of Dzongkhag office.

## (2) Cropping Patterns

Although there are wide variations in topography, climate, soils, and micro-environments, cropping systems in the study area are rather uniform. The main crop is maize, which covers 6,150 ha mainly on the unirrigated hill slopes. Paddy, wheat and barley account for 2,020 ha, 350 ha, and 320 ha, respectively. The dominant cropping patterns in the study area are shown in Fig. IV.2.1.

Cropping patterns in wet land are based on paddy, normally planted in June-July and harvested in October-November. These paddy lands are normally left fallow after harvesting. In upland areas (dry land), maize and pulses are generally planted from March to April and harvested in September, and wheat is planted as the second crop in September and is harvested in February. However, about two-thirds of the dry land is also left fallow in the winter season.

A typical hill farming system has inter-dependent use of land for crop production, livestock production, forage and fire wood. A typical farmer in the study area has about 1.3 ha of net farm land, and the land is located at different places into three or more parcels. These may consist of a combination of hill slopes and household plots such as kitchen gardens (often planted with vegetables, fruit plants or fodder trees).

## (3) Cropping Intensity

The cropping intensity in the study area was estimated on the basis of data collected from the project area. The results are shown in Table IV.2.5, and may be summarized as follows:

	Lhuntshi	Mongar	Total
Wet Land	101	107	103
Dry Land	101	145	127
Tsheri Land	20	24	22
Total	84	110	97

The average cropping intensity in the study area is 97% and is low compared with the national average of 123%. Second cropping after the summer season crop is limited to only 3% in wet land and 27% in dry land. Shifting cultivation is carried out in tsheri land, where the farming frequency is once in 5 years. It is estimated that these low cropping intensities in wet and dry lands arise from the following reasons:

- Traditional practice,

- Labour shortages for farming,
- Shortage of reliable and stable irrigation water supply,
- Lack of incentives for the farmers;

Cereal production is generally sufficient to satisfy family requirements and farmers have no special incentive to grow more crops because of market inadequacies for maize, wheat, buckwheat and other less important cereal crops, and

- Cattle feed requirements can be met by grazing on fallow land during the winter season.

To increase in cropping intensity is considered to be an indispensable development direction. Sufficient irrigation water supply both for summer and winter seasons together with appropriate farming systems would promote the increase in cropping intensity from the physical point of view. However, shortage of feed supply during the winter season should be solved from the social point of view since most of the rural communities in the area are not sufficiently organized for the solution of the grazing problem.

#### (4) Farming Practices

Farming practices have changed very little, retaining labour-intensive practices and using only limited modern technologies. Farming practices are usually carried out by family labour, but most of the farm households provide and exchange labour, as well as draught power. They help one another on farm operations, especially on those for which much labour is needed such as transplanting, manuring, weeding, harvesting, threshing, etc. In these cases, the exchange rates for labour are generally (i) 1 man day to 1 man day, (ii) 1 pair of bullock day to 5 man days, (iii) 1 horse day to 1 man days.

Labour shortage at the peak of labour requirements influences farming practices and limits cropping intensities and yields. In the off-season for cultivation, farmers have compulsory and voluntary labour obligations to the government on communal projects such as construction and maintenance of irrigation facilities and roads as well as individual sharing of house construction in the villages.

##### (a) Land Preparation

Land preparation usually commences 4 to 5 weeks before the intended planting date. Commonly paddy field is ploughed twice and puddled thereafter. Before ploughing, organic manure is often applied. Ploughing is normally carried out by animal power. A pair of bulls is controlled by two persons for ploughing, using a locally made wooden plough. However, narrow fields on steep slopes are ploughed manually with a spade. Land preparation for upland crops is



commonly made only once, but for mustard and potatoes land is ploughed twice.

(b) Seed and Sowing

Generally farmers prefer to grow local varieties and to select seeds from the previous harvest. Farmers select seeds which look vigorous and keep them by panicles. The main varieties of paddy and maize in the study area are shown below:

Main Varieties of Paddy and Maize

Paddy	Maize
Wangdikarma	Asum Marpoo
Bumdalingpa	Samtshelingpa
Kaliphupa	Bodhona
Awsting Bara	Bepa Asum

Recently, however, the government has started to introduce high yielding varieties (HYVs) through demonstration plots carried out under the Tashigang and Mongar Area Development Project. Varieties of HYVs introduced in the study area are Sonalakra for wheat and Desiree, Kufri Jyoti and Maritta of potatoes, but HYVs of paddy and maize are very limited. Usually, nurseries for paddy are prepared in the dry condition, one to two months before transplanting at a sowing rate of 40 kg to 50 kg/ha and at an area proportion of 1 to 15 of the transplanting area, approximately. Sowing of upland crops is usually made by broadcasting, but in mix cropped or inter-cropped areas the first crop is sown in lines.

(c) Transplanting for Paddy

Just after the monsoon starts, wet land is prepared for transplanting. Transplanting of paddy is usually done within a short duration, farmers helping each other on a rotational basis. Random planting with three to four plants per seedling are common in Lhuntshi District and single plants per seedling common in Mongar District.

(d) Fertilizer Application

Soil fertility for both wet and dry land are maintained by application of two methods namely natural manure (cattle tied in fields) and artificial manure (compost). Application of chemical fertilizer is limited to demonstration plots only.

#### (e) Weed and Pest Control

Weeding is carried out manually, and no herbicides are applied. Weeding requires much labour and is generally carried out insufficiently owing to shortage of labour. Pest control is not a common practice in the study area, because the damage by diseases and insects is relatively low, as compared to the damage by wild animals and rats.

#### (f) Other Practices

Other cultural practices such as harvesting, threshing and milling are all done by manual labour. Paddy panicles are cut by sickle and bound for drying in the field. After removal of the panicles, the remaining straw is used for feeding cattle during the dry season. Threshing or milling is done by hand on nets in the farm field or in the farm yard.

#### 2.1.6 Unit Yield and Production

Any analysis of agricultural trends in Bhutan is handicapped by the limited records and data. Statistical data on cultivated area, unit yield and production by the main crops in 1985 were collected from the District offices, and are shown in Table IV.2.6.

Crop production in the study area was estimated on the basis of land use survey described in Annex-III. The results of the estimation are shown in Table IV.2.7 and may be summarized as follows:

Crop	Cropped Area (ha)			Production (t)		
	Lhuntshi	Mongar	Total	Lhuntshi	Mongar	Total
Paddy	1,190	830	2,020	1,430	1,000	2,430
Maize	1,350	4,800	6,150	2,300	8,160	10,460
Wheat	70	280	350	70	280	350
Barley	70	250	320	60	200	260
Buckwheat	90	170	260	60	120	180
Millet	200	20	220	140	10	150
Soyabean	360	220	580	220	130	350
Mustard	40	230	270	30	160	190
Potato	50	260	310	420	2,180	2600
Chilli	320	90	410	320	90	410

The main cereal crops in the study area are paddy, maize, wheat, millet and barley. The main limiting factors to cultivating these crops are the altitude, availability of irrigation water and topographic conditions. Paddy is cropped on the terraced land under irrigation at altitudes lower than 2,000 m. Maize is the dominant crop on dry and tsheri lands at middle hill (800 - 1,600 m) and foot hill (lower than

800 m). Wheat, barley and buckwheat are the main crops instead of maize in dry land at upper hill (higher than 1,600 m). In both of dry and wet land wheat, barley and buckwheat are often cropped as the second crop of paddy or maize.

In general, paddy is the preferred crop and is grown wherever land and climate conditions permit, however, it accounts for less than 20% of net cereal production. Maize is grown very widely and is the principal subsistence crop in the study area. It accounts for over 60% of total net cereal production. Wheat and barley are primarily grown at high altitudes or as the second crops of rice and maize, and significant amounts are utilized for local wine preparation. Wheat in particular may be harvested green for fodder when fodder is short. Millets and buckwheat are subsistence crops in areas unsuitable for paddy or maize cultivation. Soybean is intercropped with maize and is one of the important cash crops in the study area. Chilli, mustard and potatoes are basically consumed by farmers themselves but they are sold when farmers have surplus.

Generally, unit yields of main crops in the study area are low compared to those in whole Bhutan. Estimated unit yields of the main crops based on the interview surveys are 1.2 t/ha for paddy, 1.6 t/ha for maize and 1.0 t/ha for wheat as shown Table IV.2.6.

These low yields of the main crops in the area are caused by various factors, such as shortage of irrigation water, inadequate application of fertilizers or inadequacies in the cultivation practices such as weeding and harvesting. Of these constraints, shortage of water is the most serious reason. For example, irrigation water was sufficiently supplied in the Gangzoor, but was inadequate in the Pang Khar in 1987. These different conditions of irrigation water supply resulted in the different unit yields, i.e. 3.3 t/ha for paddy and 2.5 t/ha for maize in Gangzoor, as compared to 1.5 t/ha for paddy and 1.3 t/ha for maize in Pang Khar in the same year.

#### 2.1.7 Livestock Production

Livestock and poultry in the study area amount to 46,800 head of cattle, 2,700 head of horses, 9,700 head of pigs and 23,600 head of poultry. The distribution of livestock and poultry in the two districts shown in Table IV.2.8 is summarized as follows:

	Cattle	Yak	Sheep	Horse	Pigs	Poultry
Lhuntshi	15,623	276	490	1,129	3,093	8,228
Mongar	31,141	-	140	1,457	6,607	15,335
Total	46,764	276	630	2,676	9,700	23,563

Source : District (Dzongkhag) Administration

Livestock raising plays a very important role in agricultural production and the farmers' livelihood. The farming system, including seasonal land use is a rotation comprising crops, forage and livestock production all of which are interdependent.

The objective of cattle raising is mainly for production of dairy products and manure and animal power for land preparation. The farmers in the study area do not like to slaughter cattle for meat production for religious reasons. Milk is processed to cheese, curd, and butter mainly for home consumption. Most farmers keep a few chickens but only for egg production, again for religious reasons, and a few pigs for meat purposes.

The main breed of cattle is the local Siri breed (black and white, pure black and some red in color). The Siri cattle together with the local varieties of chicken and pig are adapted to the local conditions, but are very poor producers. To increase the productivity of local livestock, the Department of Animal Husbandry (DAH) under MOA is introducing more productive varieties into the study area. The experimental data as shown in Table IV.2.9 indicate higher productivity of improved livestock varieties. DAH has been encouraging cross breeding of local Siri cattle with Jersey since the Fifth Plan, although this progress has not been substantial. In addition to this trial, the support service on cross breeding of local Siri cows with Mithun (Assam) bulls, which is very popular among the farmers, has been begun by DAH. Mithun crosses, called locally Jatsa (males) and Jatshams (females), are easier to maintain than Jersey crosses of which feeding and maintenance requirements are heavy. The butter fat content of Mithun crosses is relatively higher, while their milk yield is comparatively lower than Jersey crosses of 5 liters a day.

In the summer, most cattle are grazed on community grazing lands located in forests and scrub lands near a village. Owing to the shortage of feed in the winter, farmers take cattle back to the vicinity of their village in order to graze them on private pasture lands or farm lands left fallow. Farmers usually feed their cattle with crop residues and by-products like dry straw and cobs. No supplementary or concentrate feeds are given. Subsidiary crops such as wheat, buckwheat and barley are sometimes utilized for fodder on the case of shortage in feed. Winter cattle grazing on the farm land brings natural manure, but hinders the cultivation of winter crops.

The main diseases of livestock observed in the study area were as follows:

- Cattle : Foot and mouth disease, Haemorrhage, Septicemia, Blackquarter, Babesiasis
- Pigs : Swine Fever
- Poultry : Coccidiosis

The experiment and extension center for the livestock development in the study area is the animal husbandry farm at Lingmethang, Mongar. Trials on cross breeding and fodder production and distribution of improved livestock are made on this farm. On the other hand, there are two veterinary hospitals, one in each district, and seven veterinary centers, three in Mongar and four in Lhuntshi as shown in Fig. IV.2.2. The network of these veterinary dispensaries has been established in the block level for the improvement of livestock hygienic condition and farmers' farming practices. While the main services of these facilities at present are limited to the distribution of improved livestock and fodder trees, and farmers' training has not been emphasized yet.

Development policy has concentrated on introducing exotic crossbred animals into domestic livestock population. Initially, imported animals were distributed directly to the farmers, but presently emphasis has been placed on establishing a domestic breeding capacity of the animal husbandry farms. Breeding services are provided free of charge, but in contrast to the subsidies of the past, sales of crossbred animals are now to be made on a no-profit and no-loss basis.

The main constraints on livestock development are the lack of feed production and pasture management technology in addition to the lack of vaccination and other preventing practices. The government has initiated programs to distribute seed of grass, legume and fodder trees, to establish managed pastures and to introduce fodder crops (Oats) into dry land. Nevertheless, the shortage of winter feed will continue to limit the livestock population.

#### **2.1.8 Processing and Marketing**

##### **(1) Processing and Storage of Agricultural Product**

After harvesting basic grains such as paddy, maize and wheat, the majority of farmers are processing and storing them in conventional ways as follows:

- 1) In case of paddy, farmers usually harvest the whole plant with iron sickle and dry them on the stubbles in the field for several days. After drying, paddy is threshed by beating against rock or beating with bamboo stick on bamboo mats. Paddy grains are usually kept in bamboo crates and stored in a loft or barn. Before milling, paddy grains are dried again in the sun for a few hours. Farmers are using a wooden mortar and pounder for milling. Threshing and milling are the most labour intensive and time consuming works, but improved implements and machines, except for rice mills, are yet to be introduced in the study area.

- 2) Maize is usually hand-harvested by removing the complete cobs and brought to farmers' houses. Cobs are kept hanging under the roof both for drying and storage. Summer cropping maize is hard to dry due to the high humidity and frequent rains. Storage losses, especially insect loss, are severe during the summer season. Dried cobs are shelled by hand and the maize grains are ground for food consumption as required, using grinding stones. Some portion of grains are often used for local wine preparation.
- 3) Other grains like wheat, buckwheat and barley are harvested and threshed in the same way as paddy. Flour is made from wheat and buckwheat, but they are mostly processed domestically into alcohol. Sometimes these crops are fed to animals.

Some rice and oil mills equipped with diesel engines have been introduced in the study area under the Agricultural Mechanization Program since the Fourth Plan. The price of a mill with a diesel engine is Nu 8,490. A credit service is proposed under which farmers deposit half amount of the cost, repayment period of the loan is 3 years with an interest rate of 8% per year are applied. The present milling capacity of paddy and mustard is estimated at 150 kg/hour and 30 kg/hour respectively on the basis of local conditions. Blockwide facilities of mills are shown in Table IV.2.10. If these mills are operated and maintained regularly, the total capacity of rice mills would be over the total paddy production as follows:

District	Paddy		Mustard	
	Milling Capacity (t/year)	Total Production (t)	Milling Capacity (t/year)	Total Production (t)
Lhuntshi	4,100	1,430	-	30
Mongar	3,500	1,000	30	160

Paddy production aims at home consumption and is commonly milled by manpower. Most of the mills belong to rich farmers or shopkeepers and operate for the neighboring farmers with a milling charge of Nu 2-4 to mill 10 kg of paddy. This rate is costly for ordinary farmers, taking into consideration the present transportation difficulties and lack of cash income. Consequently, the existing rice mills do not operate up to their capacities.

The milling rate of paddy is estimated at 65%, while the broken rice content after milling is bigger than manually done due to a one-pass operation that removes the husk and bran at the same time.

Mustard oil mills have a milling rate of 30% after 3-4 times extraction.

Another major agro-processing facility is a lemon grass oil factory owned by Tashi Corporation in Mongar. This factory has a processing capacity of 30 t of grass per day with an extraction rate of about 0.3%. Wild lemon grass grows in the two districts, and the harvest season is from June to November. Around 700 farmers in Mongar are selling lemon grass or grass oil which is extracted by farmers, at the rate of Nu 15/100 kg of grass or Nu 50/kg of oil.

## (2) Marketing and Prices

The surplus of basic grains, mainly paddy and maize, is sold within villages and/or with neighboring villages to civil servants in public facilities or monastery. Basic grains are sometimes bartered for other agro-products such as chilli, butter or cheese with other farmers and for daily necessities such as salt, soap or oil with shopkeepers.

Cash crops other than basic grains in the study area are potato, soyabean, dry chilli, orange, apple and vegetables. They are traded in the Sunday market; which is held in the district capital, while the customers are limited mainly to government or private employees. The main market for cash crops from the study area is Samdrup Jongkhar which is a border town in the eastern part of Bhutan and the sole export destination from the study area.

Some of the local shop keepers, 33 in Lhuntshi and 54 in Mongar, are marketing leaders of cash crops. They are buying most of the products from farmers and transporting them to Samdrup Jongkhar. The food Corporation of Bhutan (FCB), a government marketing agency for food grains and cash crops, aims to guarantee minimum supporting prices to the farmers. FCB has its centers in both district capitals, and has an auction yard in Samdrup Jongkhar. FCB's procurement of cash crops from the study area is very limited at present.

Marketing quantities of cash crops from the study area is assumed on the basis of the data from the district offices and field survey as follows:

	Lhuntshi (t)	Mongar (t)
Soybean	200	50
Potato	10	1,000
Dry Chilli	200	10
Orange	-	50
Apple	-	2

The basic constraints on marketing of cash crops from the study area are the only marketing channel through Tashigang to Samdrup Jongkhar and the heavy transportation costs in which 5-t truck load costs at least Nu 2,500 from Mongar and Nu 3,000 from Lhuntshi. A new road to connect Mongar directly to Samdrup Jongkhar through Pema Gatshel, which is under planning, is expected to encourage more production of cash crops in the study area.

Wholesale and retail prices of domestic basic grains are not clearly distinguished due to the limited marketing quantities. The retail price of local rice is usually higher than imported Indian rice. Prices of basic grains and cash crops are summarized as follows:

	(Nu/kg)		
	Retail Price	Wholesale Price	Farm Gate Price
Rice			
- Local	6.0	6.0	5.3
- Imported	5.0	4.1*2	-
Maize	2.7	2.7	2.4
Wheat (local)	2.9	2.9	2.6
Buckwheat	-	-	1.5
Soybean	-	3.5*2	2.7
Potato(local)	2.5	1.9*2	1.8
Chilli	-	13.0*2	10.0
Apple	4.0*1	5.0	2.0
Orange (Nu/10.No.)	1.7*1	2.3*2	1.0

Note: \*1; Retail price in the study area.

\*2; Wholesale price in Samdrup Jongkhar.

#### 2.1.9 Farmers' Economy and Intention

The present farm economy in the project areas was analyzed on the basis of average holding size, average yield and production, farm and non-farm income, and living expenses derived from the field survey. Farm economic survey was conducted on three typical farmers in each project area; 48 sample farmers in total. District by district features of farm economy are shown in Table VI.2.11 and summarized as follows:



Item	Unit	Lhuntshi	Mongar
(1) Average Farm Size	(ha)	1.7	1.1
- Wet land		(0.7)	(0.3)
- Others		(1.0)	(0.8)
(2) Crop Production Value	(Nu)	10,940	5,320
(3) Farm Income	(Nu)	2,250	920
- Crop		(980)	(130)
- Others		(1,270)	(790)
(4) Commercial Rate of Crops*1	(%)	9	2
(5) Non-Farm Income	(Nu)	630	760
(6) Total Income	(Nu)	2,880	1,680
(7) Living Expenses	(Nu)	2,840	1,680
- Food		(630)	(600)
- Others		(2,210)	(1,080)
(8) Net Reserve	(Nu)	40	0

Note: \*1; Percentage of crop income to crop production value.

The average farm size, especially the holding size of wet land, reflects to the farm economy in the study area together with land productivity. Cash crops such as soyabean, potato, chilli, orange and some vegetables have been introduced in the study area, though at present their production and share of farm income are limited. Commercial sales of crops in the study area are 9% in Lhuntshi and 2% in Mongar which indicate that most of the farm products are consumed by family members. Therefore, it is clear that farmers' livelihood is still under self-sufficient condition. Surpluses of paddy and maize are sold to civil servants, schools, monasteries or shopkeepers, and are often bartered for other agro-products. Limited farm and non-farm cash incomes are mostly spent for living expenses and the net reserves are negligibly small.

Farmers' intentions about development were collected in accordance with the farm economic surveys of 48 sample farmers. Development requirements of the farmers and their priority are summarized as follows:

- 1st) Improvement and rehabilitation of existing irrigation facilities in order to alleviate shortage of water.
- 2nd) Construction of motorable feeder road for accessibility improvement.
- 3rd) Strengthening of agricultural extension services including promotion of agricultural mechanization.
- 4th) Rural electrification.

It is concluded that farmers' intentions are mainly about the agricultural sector, especially on about and feeder road developments.

#### 2.1.10 Agricultural Support System

Agricultural support services in the study area are supervised by each district agricultural officer (DAO) under the Dzongkhag administration. Extension works in the field are carried out by agricultural extension workers (AEW) appointed at each block of the district as shown in Fig. IV.2.2. There are no any agricultural research and experiment stations except for the animal husbandry farm at Lingmethang, Mongar. Agricultural support activities implemented in the study area are limited to extension matters.

Extension subjects in the study area cover mostly the Central Programs; AMP, NASEPP, IPSP, PPP and BNPP, carried by the Department of Agriculture at Thimphu. Seeds, fertilizer and farm equipments are delivered at subsidized prices throughout the country at the farmers' requests. Agro-chemicals are provided free to the farmers with lendable sprayers. Farmers can apply for credit services for the purchase of fertilizer, farm machinery and implements, and the recommended land development, conversion of tsheri land and contour bounding of dry land.

The major constraints on the agricultural support services in the study area are considered as follows:

- 1) Regular and close contacts with farmers by one AEW at each block is impossible due to difficulties of access to the scattered villages in the mountainous terrain.
- 2) The extension services concentrate on input supply rather than on the diffusion of improved technology to farmers.
- 3) AEW cannot provide proper advice to farmers due to the lack of satisfactory experimental data and informations, particularly on appropriate farming systems for paddy and maize production in the area; the study area does not have any experiment or trial stations.
- 4) Cattle grazing on wet and dry land during the winter season interferes with the second cropping. Most of the rural communities in the area are not sufficiently organized for solving of the grazing problem.

The establishment of agricultural experiment or trial stations in the study area will be one of the effective measures to solve the above constraints.

## 2.2 Present Condition of the Model Project Area

### 2.2.1 Location

The Tangmachu model project area is located about 8 km south from the capital of the Lhuntshi District. The distance along the national road from the capital to the entrance of the feeder road of the Tangmachu area is around 15 km and it takes almost 30 minutes of driving. The area is situated along the Kuri chu in a fan shape on the mountain slope. The Tangmachu model project area consists of such small villages as Nebi, Takila, and others.

The Masangdasa model project area is located about 8 km west of the capital of the Mongar District. The distance along the national road from the capital to the entrance of the Masangdaza area, Lingmethang GREF camp, is around 30 km and it takes 50 minutes by car. There is no motorable road from the GREF camp, and it is necessary to walk 20 minutes through the bridge crossing the Shongar chu. The Masangdasa model project area is composed of the 3 areas of Masangdaza, Karbithang and Karibee.

### 2.2.2 Demographic Condition

The Tangmachhu model project area covers 20 local villages containing 253 households with a total population of 2,427. The average family size in Tangmachhu is 9.6 persons. The Masangdoza model project area comprises 4 local villages which are Karibee, Karbithang, Masangdaza and Bongdima. However, farm land owners of Masangdaza model project area live at Karibee, Masangdaza, and Bongdima in the project area, and Pangsihi out of the project area. Karibithan has no resident households. The total number of population and households related to Masangdaza model project area are 498 and 87 respectively. The average family size in Masangdaza is 5.7 persons.

Farmers in the project areas are categorized as i.e. (i) wet land owner, (ii) dry land owner, (iii) landless farmer. A wet land owner is a holder of wet land together with or without dry land, tsheri or other land. A dry land owner is a holder of dry land, tsheri, or other land without wet land. About 84% - 85% of the total resident households in both project areas are wet land owners. Tangmachhu and Masangdaza project areas have 23 and 3 landless farmers respectively which accounts for 9% and 3% in total. Absent land owners are 29 in Tangmachhu, and 18 in Masangdaza of which 11 are absent resettlement farmers in Bongdima. The composition of households by village in the project areas is shown in Table IV.2.12 and summarized as follows:

Item	Tangmachhu	Masangdaza
1. Wet Land Owner	216 (85%)	73 (84%)
2. Dry Land Owner	14 (6%)	11 (13%)
3. Landless Farmer	23 (9%)	3 (3%)
	253 (100%)	87 (100%)
4. Absent Land Owner	29	18

Population distribution by age and sex in two project areas is shown in Table IV.2.13 and Fig. IV.2.3. Demographic condition of both project areas is summarized as follows:

Item	Tangmachhu	Masangdaza
1. District (Block)	Lhuntshi (Tangmachhu)	Mongar (Salling)
2. No. of Local Villages	20	5/1
3. Population	2,427 (100%)	498 (100%)
- Per Local Village (3/2)	121	100
- Share of Population in Block	50%	11%
4. Family Size	9.6	5.7
5. Student population (5-14 age group)	582 (24%)	133 (27%)
6. Labour Force (15-54 age group)	1,464 (60%)	272 (55%)

/1: Included Pangsibi out of the project area.

### 2.2.3 Land Use

Through the field survey and interpretation of aerial photographs, present land use maps for both Tangmachu and Masangdaza areas are prepared and are shown in Annex III.

Based on the land use map of the Tangmachu area, the gross area of wet land is 445 ha, consisting of 391 ha in Tangmachu and 54 ha in Nebi. This gross area of wet land includes small segments of non-wet land such as dry land, tsheri land, road and foot path, residential area, kitchen garden, etc. The gross area of dry land is 74 ha, which includes small segments of non-dry land. Tsheri land is located at steep places along the mountain ridges.

In the masangdaza area, the gross area of wet land is 44 ha, consisting of 2 ha in Bongdima, 22 ha in Masangdaza, and 19 ha in Karbitang. This gross area includes small segments of non-wet land

such as dry land, road and foot path, residential area, kitchen garden, etc. The gross area of dry and tsheri land is 106 ha consisting of Bongdima, 63 ha in Masangdaza and 32 ha in Karibee. This gross area includes small segments of non-dry land.

Because the net area of cropped land can not be measured through the field survey, the net cropped area is estimated on the basis of the land registration and the interview survey as follows:

Description	Tangmachhu Area (ha)	Masangdaza Area (ha)
Irrigated land	220	30
Rainfed land	114	81
Tsheri land	95	3
Others <sup>/1</sup>	<u>49</u>	<u>9</u>
Total	478	478

<sup>/1</sup> : Others includes fallow land, kitchen garden, glassland, etc.

#### 2.2.4 Land Holding and Tenure System

Land holding and tenure system surveys were carried out on the basis of the register land records in both project areas. According to the analysis of the above records, total areas of register farm land comprising wet, dry, tsheri and others are 478 ha in Tangmachhu and 123 ha in Masangdaza. The average holding size of land is 1.84 ha in Tangmachhu and 1.20 ha in Masangdaza.

Wet land owners in Tangmachhu and Masangdaza project areas hold 1.99 ha and 1.22 ha of farm land on average respectively. On the other hand, the average holding size of dry land owner in Tangmachhu is a small scale of 0.49 ha compared with 1.00 ha in Masangdaza. The economic situation of dry land owners in Tangmachhu is supposed to be low.

Land holding status by ownership in both project areas is shown in Table IV.2.14 and summarized as follows:

Item	Tangmachhu	Masangdaza
1. Register Farm Land (ha)		
1) Wet Land	224 (47%)	30 (24%)
2) Dry Land	114 (24%)	81 (66%)
3) Tsheri/Others	140 (29%)	12 (10%)
Total	478 (100%)	123 (100%)
2. No. of Owners	259	102
3. Average Holding Size (ha)		
1) Wet Land Owner	1.99	1.22
2) Dry Land Owner	0.49	1.00
3) Absent Land Owner	1.38	1.28
4) Total Land Owner	1.84	1.20
- Wet Land	(0.86)	(0.29)
- Dry Land	(0.44)	(0.79)
- Tsheri/Others	(0.54)	(0.12)

Farm lands of absent land owners are mainly cultivated by landless farmers or small scale land owners with the tenants sharing around 40% of the total harvest. The distribution of land owners and farm lands by holding size are shown in Table IV.2.15 and Fig. IV.2.4 and summarized as follows:

Holding Size ha	Owner Distribution		Area Distribution		Average Size ha
	No.	%	ha	%	
Tangmachhu					
Below 0.8	82	32	39	8	0.48
0.8 - 1.6	69	27	84	17	1.22
1.6 - 2.4	50	19	99	21	1.98
2.4 - 3.2	29	11	81	17	2.79
Above 3.2	29	11	175	37	6.03
Total	259	100	478	100	1.84
Masangdaza					
Below 0.8	10	10	4	3	0.40
0.8 - 1.6	75	73	80	65	1.07
1.6 - 2.4	13	13	22	18	1.69
2.4 - 3.2	3	3	8	7	2.67
Above 3.2	1	1	9	7	9.00
Total	102	100	123	100	1.20

Half of the land owners is holding only 20% of the total land and 15% of wet and dry lands in Tangmachhu, and 35% and 29% in Masangdaza respectively. Farm lands in Tangmachhu are unequally distributed between the land owners compared with the situation in Masangdaza.

Classification of land owners is done by wet and dry land holding size based on the registered land records of the land owners as a whole. The first quartile, median and third quartile farmers in ascending wet and dry land holding size are identified. Their holding sizes may be summarized as follows:

Farmers Classified by Wet/Dry Land Size	Wet/Dry Land Holding			
	Tangmachhu		Masangdaza	
	No.	Area (ha)	No.	Area (ha)
First Quartile Farmer	65th	0.59	26th	0.80
Median Farmer	130th	1.08	51st & 52th	1.20
Third Quartile Farmer	195th	1.74	77th	1.20
Total No. of Farmers	259		102	

## 2.2.5 Cropping Pattern and Farming Practice

### (1) Cropping Pattern

The cropping patterns of both model project areas are basically the same as those in Lhuntshi and Mongar Districts.

#### (a) Tangmachu model project area

The main crops grown in the area are paddy in wet land, followed by maize in dry and tsheri land. Other crops grown adjunct to rice and maize farming are wheat, potato, soybean (intercropped with maize), chilli, mustard, millet, vegetables like radish, cabbage, green leaves etc.

In wet land, nursery of paddy starts from February and seedlings are transplanted from the middle of May to the end of November. Nursery period is more than two (2) months. The second crop of paddy is mainly wheat with small area of potato and sometimes mustard.

In the dry land, the first maize crop starts from February and the second crop starts the August. Soyabean is intercropped with the first maize. Chilli are planted from March to the end of September. Wheat and mustard is planted after the first maize. Millet is planted from July/August to November/December in dry and tsheri land. Vegetables are grown in the kitchen garden of each farm household.

Based on the interview survey and the field reconnaissance, the cropping pattern in the area is estimated and shown in Fig. IV.2.5, and cropping intensity is estimated at 79% in wet land, 108% in dry land, 40% in tsheri land and 78% on average.

(b) Masangdaza model project area

The main crops grown in the area are paddy in wet land, followed by maize in dry and tsheri land. Other crops are mungo beans (intercropped with maize), buckwheat, mustard, potato, tapioca, groundnuts, orchards such as orange, papaya and banana, vegetables like radish, cabbage, cucumber, green leaves etc.

In wet land, nursery of paddy starts from the middle of April and seedlings are transplanted from July to the end of November. Nursery period is sometimes more than two (2) months. The second crop of paddy is mainly buckwheat and mustard, but the area of the second crops is negligibly small.

In dry land, the first maize crop starts from March and the second crop starts in August. Soyabean is intercropped with the first maize. The second crop of the first maize is the second maize if the first maize is harvested earlier, otherwise farmers grow buckwheat and mustard after maize. Orchard, potato, chilli and vegetables for home consumption are grown in the kitchen garden of each farm household. Tapioca and groundnuts are planted in the Bongdima area under dry land condition, but the planted area is very small. In tsheri land, the main crop is maize, but its area is negligibly small.

Based on the interview survey and the field reconnaissance, the cropping pattern in the area is estimated and shown in Fig.IV.2.5, and cropping intensity is estimated at 100% in wet land, 62% in dry land, and 20% on average.

(2) Farming Practices

Farming practices of all the crops are carried out by labour intensive form from sowing to harvesting and threshing. Although the family members participate in farming, there is still a labour force shortage. Accordingly farmers help each other on a rotation basis for such laborious works as land preparation, transplanting and harvesting. Bullock power is extensively used for land preparation. Usually two operators control wooden tools using a pair of bullocks for ploughing and puddling. Although farm yard manure is applied for main crops, chemical fertilizers and agro-chemicals like pesticide, herbicide and fungicide are not commonly used.

The major varieties of paddy are local ones such as Wangdi Karma, Bumdering pa, Asu, Kaliphu Pa, Ku Pa, Dakupa Karupa, Dakupa Marupu. Paddy seeds are selected from the previous harvest, and are sown in the dry nursery which is prepared in the ratio of about 1/15 to 1/20 of the paddy field size to be transplanted. Seedlings are generally grown for more than 2 months, sometimes 3 months. Field preparation (two times of ploughing and Puddling) is made before



transplanting by using bullock power. Transplanting is carried out by hand. Random transplanting is popular and one (1) plant per seedling is applied. Weeding is also made by hand. Harvesting is generally carried out by using sickle and harvested paddy is dried on the bunds of the paddy field. After drying, threshing is carried out by hitting on the stone on the local bamboo mat and threshed grains are carried to the farm house and stored in bamboo pots.

High yielding varieties of Pusa 33, No.11, IR64 and Milyang 54 are planted in the demonstration trial plots which the Lhuntshi District office started from the 1988 crop. Farming practices in these trial plots use semi-wet nursery and line transplanting. Weeding is made by the rotary weeder, and inorganic fertilizers such as urea and triple-super-phosphate are applied. During the field inspection, the paddy planted in the demonstration plots grew better than around.

The major varieties of maize are Ashum Karupa, Bepa Ashum, Ashum Marupo and Hybrid 410 in the Tangmachu model project area, and Bepa (the first crop), Teksumpa (the second crop) and X440 in the Masangdaza model project area. For the first crop of maize, ploughing for land preparation is made twice by bullocks. The random sowing is usually applied. Seeds of soybean and mungo bean are usually sown at the same time or at the first weeding after about 30 days. The second weeding carried out at the plant height of 120 cm. Harvesting is carried out by cutting maize stems and removing corn. Drying and threshing of corn is made in the farm yard.

For other minor crops like millet the second crops such as the second maize, wheat and buckwheat, ploughing by bullocks is carried out only once just after harvesting the first crop. While only wheat is irrigated before sowing in the Tangmachu area, other crops are cultivated under rainfed condition.

#### **2.2.6 Unit Yield and Production**

The crop yield and production under present condition are estimated on the basis of production data obtained from the District offices in Lhuntshi and mongar as well as from interview survey.

The average unit yields of crops in the Tangmachu area are 2.2 t/ha for paddy, 1.0 t/ha for wheat, 1.4 t/ha potato, 1.4 t/ha and 0.6 t/ha for maize in dry land and tsheri land respectively, 0.3 t/ha for soyabeans, 0.9 t/ha for chilli, 0.2 t/ha for mustard.

The average unit yields of crops in the Masangdaza area are 1.5 t/ha for paddy, 1.1 t/ha for maize, 0.4 t/ha for buckwheat, and 0.3 t/ha for mustard.

Cropped area is estimated in both areas through field survey as follows:

(Unit: ha)

	Tangmachhu Area		Masangdaza Area			
	Crop	Summer Crop	Winter <sup>/1</sup> Crop	Crop	Summer Crop	Winter <sup>/1</sup> Crop
1) Irrigated land						
paddy		170	0	paddy	30	0
wheat		0	2	wheat	0	0 <sup>/3</sup>
potato		0	2	buckwheat	0	0 <sup>/3</sup>
fallow		50 <sup>/2</sup>	216	fallow	0	30
Total		220	220	Total	30	30
2) Upland						
maize/soyabean		58	0	maize/bean	32	0
maize		54	2	maize	0	8
chilli		2	0	buckwheat	0	8
mustard		0	7	mustard	0	2
fallow		0	105	fallow	49	63
Total		114	114	Total	81	81
3) Shifting culture						
maize		38	0	maize	0 <sup>/4</sup>	0
fallow		57	95	fallow	3	3
Total		95	95	Total	3	3

<sup>/1</sup> : Winter crops in irrigated land are grown under rainfed condition.

<sup>/2</sup> : 50 ha of irrigated land is estimated to be fallow in average year because of shortage and fluctuation of irrigation water supply.

<sup>/3</sup> : Winter crops in irrigated land in the Masangdaza area is grown in negligible small area.

<sup>/4</sup> : Cropped area in tsheri land in the Masangdaza area is less than 1 ha.

Out of 220 ha of irrigated land in the Tangmachhu area, about 170 ha is cultivated with rice in average year owing to the shortage of irrigation water. Other 50 ha of irrigated land is not cultivated.

The annual production of the model project areas is summarized as shown below:

	Unit Yield (t/ha)	Havested Area (ha)	Production (t)
<b>Tangmachu area</b>			
paddy	2.2	170	374
wheat	1.0	2	2
potato	2.1	2	4
maize	1.2	152	183
(1st maize)	(1.4)	(112)	(157)
(2nd maize)	(1.4)	(2)	(3)
(tsheri land)	(0.6)	(38)	(23)
soybean	0.3	58	17
chilli	0.9	2	2
mustard	0.2	7	1
<b>Masangdaza area</b>			
paddy	1.5	30	45
buckwheat	0.4	8	3
maize	1.1	40	44
(1st maize)	(1.1)	(32)	(35)
(2nd maize)	(1.1)	(8)	(9)
mustard	0.3	2	1

### 2.2.7 Livestock Production

The number of livestock and poultry in the model project areas is estimated on the basis of (i) the livestock raising data which are collected at the Animal Husbandry Farm in Lingmethang and the veterinary center in Tangmachhu and (ii) the average raising numbers per household which were obtained from the farm economic survey. The estimated result is shown in Table IV.2.16 and summarized as follows:

Item	Cattle	Horse	Pig	Poultry
<b>1. Tangmachhu</b>				
- Total Number	1,541	161	529	966
- No. per Household	6.1	0.6	2.1	3.8
<b>2. Masangdaza</b>				
- Total Number	647	59	92	353
- No. per Household	7.4	0.7	1.1	4.1

Livestock raising plays an important role in agricultural production and farmers' livelihood. Most of the farmers are raising cattles not only for animal power but also for dairy production such as milk, cheese, curd and butter. Some of the large cattle raising farmers sell their dairy products and derive incomes for their livelihood. Livestock productivity is generally low due to poor raising technology and little diffusion of improved breeds. Improved

cattle breeds such as Jarsy and Mithum are estimated at 31% of total cattle in Tangmachhu and 38% in Masangdaza as follows:

Item	Tangmachhu		Masangdaza	
	No.	%	No.	%
Local Siri Cattle	1,063	69	401	62
Improved Cattle	478	31	246	38
- Jarsy	(77)	(5)	(39)	(6)
- Mithum	(401)	(26)	(207)	(32)
Total	1,541	100	647	100

### 2.2.8 Processing and Marketing

Eight (8) rice mills equipped with diesel engines of 7 H.P were introduced in the Tangmachhu project area. The mill made in India is a one-pass operation and has a capacity of 150 kg/hour. The total capacity of the 8 mills is estimated at 1,200 t of paddy/year. These mills are mainly located at such villages as Rakidung, Tangmachhu, Dangsha and Takila along the Tangmachhu feeder road. Farmers who live in villages far from the feeder road still depend on manual milling due to difficult accessibility to a mill site.

The Masangdaza project area has no rice mills. The whole paddy production in Masangdaza project area is manually milled at present.

No oil mills have been introduced in both project areas. Mustard oil is manually extracted by using a lever with a pair of concave-convex wooden plate. Manual extraction is a time and labour consuming work and results in large processing loss.

Most of the farm products in the project areas are locally consumed at present. In Tangmachhu about 20 t of soyabean and 3 t of potato are annually transported to Samdrup Jhongkhar by some of local shop keepers. There are not any prevailing sales of cash crops in Masangdaza.

### 2.2.9 Farmers' Economy and Intention

#### (1) General

The farm economic survey was carried out in the model project areas during the Second Phase field survey from July to August, 1988. Contents on the survey are demographic condition, land holding and tenure, agricultural and livestock production, farmers' income and

expenditure, and farmers' intention. The number of valid sampling farmers is 40 in Tangmachhu and 29 in Masangdaza, which are representative farmers in the project areas. The sampling farmers in Tangmachhu and Masangdaza comprise 16% and 33% of the total resident household respectively.

## (2) Farmers' Classification

The sampling farmers were classified into four (4) groups according to the wet and dry land sizes on first quartile, median and third quartile farmers mentioned 2.2.3. The general feature of the sampling farmers is classified as shown in Table IV.2.17 and summarized as follows:

Area/Farm Size (ha)	No. of Sample	Land Holding (ha)		
		Wet Land	Dry Land	Total
<b>Tangmachhu</b>				
Below 0.59	10	0.25	0.16	0.41
0.59 - 1.08	19	0.64	0.19	0.83
1.08 - 1.74	5	1.07	0.29	1.36
Over 1.74	6	2.20	0.60	2.80
Average	(40)	0.83	0.26	1.09
<b>Masangdaza</b>				
Below 0.80	8	0.14	0.42	0.56
0.80 - 1.20	9	0.17	0.68	0.85
1.20	3	0.11	1.09	1.20
Over 1.20	9	0.38	1.38	1.76
Average	(29)	0.22	0.86	1.08

## (3) Disposal of Farm Products

Farm products are mainly for home consumption, while some of surplus products are sold. The quantity of sold paddy to the total production is estimated at 12% in Tangmachhu and 4% in Masangdaza on average. About 6% of maize in Masangdaza are sold.

Per capita food consumption of cereals is 260 kg in Tangmachhu and 307 kg in Masangdaza on average of which share of paddy is about 81% in Tangmachhu and 23% in Masangdaza. On the other hand, the share of maize to cereals food consumption is about 15% in Tangmachhu and 75% in Masangdaza. Staple food is paddy in Tangmachhu and maize in Masangdaza.

Details on disposal of farm products and per capita consumption by farm size classification are shown in Table IV.2.17 and summarized as follows:

Item	Tangmachhu		Masangdaza	
<b>I. Per Capita Cereals</b>				
Consumption (kg)				
- Paddy		212		71
- Maize		39		230
- Others		9		6
Total		260		307
	<b>Paddy</b>	<b>Maize</b>	<b>Paddy</b>	<b>Maize</b>
<b>II. Disposal (%)</b>				
- Food	82	87	81	75
- Alcohol	2	8	0	8
- Seed	2	4	3	3
- Sold	12	0	4	6
- Others	2	1	12	8
Total	100	100	100	100

(4) Living Expenses

One family member spends around Nu 382 in Tangmachhu and Nu 151 in Masangdaza as for living expenses on average.

Major items of farmers' living expenses are clothes and foods such as rice, salt and edible oil. Clothing expenses are different among the classified farmers and varied at 20% to 42% in total expenses. The share of food expenses is 9% to 64%. Living expenses by item and farmer are shown in Table IV.2.17 and the average situation is as follows:

Item	(Unit: %)	
	Tangmachhu	Masangdaza
Foods	27	42
Clothing	32	30
Fuel	8	2
Transportation	3	1
Ceremony	15	13
Others	15	12
Total	100	100

(5) Farm Economy

Cash income of the farmers derived from farm income and non-farm income such as wages in construction or maintenance works of public facilities, remittances and temporary private employment. Farm income mainly accrues from paddy in Tangmachhu and maize in Masangdaza. Dairy products such as cheese and butter and cash crops such as soyabean and potato provide secondary farm income, mainly for farmers

with more than the median scale of land holding which is 1.08 ha in Tangmachhu and 1.20 ha in Masangdaza. Farmers below the median scale rely heavily on non-farm incomes for their living expenses. On the other hand, farmers' livelihood of more than the median scale is sustained by farm incomes.

Farmers' net reserves which are the rest of cash income excluding living expenses, become larger according to the farm size. Farmers of more than the median scale (1.08 ha) in Tangmachhu and the third quartile scale (1.20 ha) in Masangdaza can reserve an amount over Nu 500. Farm economy by the farm size classification is shown in Table IV.2.17 and summarized as follows:

(Unit: Nu)					
Area/Farm Size (ha)	Farm Income	Non-Farm Income	Total Income	Living Expenses	Net Reserve
<b>I. Tangmachhu</b>					
Below 0.59	305	1,590	1,895	1,840	55
0.59 - 1.08	895	2,020	2,915	2,520	395
1.08 - 1.74	3,470	2,195	5,665	4,910	755
Over 1.74	3,860	980	4,840	3,590	1,250
Average	1,510	1,775	3,285	2,805	480
<b>II. Masangdaza</b>					
Below 0.80	290	395	685	690	-5
0.80 - 1.20	215	670	885	880	5
1.20	280	225	505	320	185
Over 1.20	1,295	375	1,670	1,100	570
Average	570	455	1,025	840	185

#### (6) Farmers' Intention

The farmers' priority development requirements in the project areas are the same as in the study area mentioned in 2.1.8. Developments on irrigation facilities are commonly needed. Desires on agricultural support services include timely distribution of fertilizer and agro-chemicals, extension of cash crops, diffusion of agricultural machines and tools, and marketing services. Rural electrification is also required mainly for lighting and as power source for rice mills instead of diesel engines.

Farmers' organizations for water management, solution the a cattle grazing problem for winter cropping, and marketing were not made in the project areas although these necessities are understood by the farmers. Especially, desires for an effective water management in Tangmachhu are strong because farmers sometimes dispute about water rights between the upper and lower project areas.

### 2.2.10 Labour Balance

Labour balance study was carried out on the basis of (i) present labour requirement of crop production, (ii) present cropping pattern, and (iii) available labour force. Annual workable days is 277 days or 76% of the year after deducting sundays (52 days) and national or religious holdings (36 days). Labour requirements were calculated by work items and weighted by the rate of workable days of 76% into consideration.

Cultivated area per resident household and weighted labour requirement are summarized as follows:

Item	Tangmachhu		Masangdaza	
	Area (ha/house)	Labour Requirement (man-days)	Area (ha/house)	Labour Requirement (man-days)
I. Wet Land	<u>0.89</u>	-	<u>0.22</u> <sup>/1</sup>	
- Paddy	0.89	232	0.22	232
- Wheat	0.02	79	-	-
- Potato	0.01	45	-	-
II. Dry Land	<u>0.45</u>		<u>0.93</u>	
- Maize/Soyabean	0.44	84	0.93	84
- Maize	0.01	84	0.49	84
- Wheat	-	-	0.09	79
- Chilli	0.11	264	-	-
- Mustard	0.03	45	0.03	45
III. Tsheri Land	<u>0.38</u>		-	
- Maize	0.15	84	-	-

<sup>/1</sup>: Excluded 11 ha of absent land owners which are mainly cultivated by farmers outside of project area.

The peak labour requirement is estimated at 2.44 persons/day/household during the last ten days of May in Tangmachhu and 1.76 persons/day/household during the last ten days of July in Masangdaza as shown in Table IV.2.18. On the other hand, available farm labour force per day per household in Tangmachhu and Masangdaza were estimated at 2.58 and 1.87 respectively as shown in Table IV.2.19.

The peak labours requirement in the project area is 94% - 95% of the available labour force. It is considered that demand and supply on farming labours is barely balanced at present. Low intensity of land use and low productivity of crops would be derived from the shortage of labour force.



### 2.2.11 Agricultural Support System

An extension center together with a veterinary center, a basic health unit and a primary school covering the Tangmachhu Block is located at Takila in the Tangmachhu project area. Takila is a rural center of the Tangmachhu Block. An extension center covering the Masangdaza project area in Salling Block is located at Lingmethang which is on the opposite side of the project area after crossing the Shongar Chu. An animal husbandry farm, a dispensary and a primary school are also located at Lingmethang.

Facilities at each extension center comprise one building with one office room and one store. The buildings were poorly constructed and some part of walls and roofs have been deteriorated, storage condition of fertilizers and agro-chemicals is unsatisfactory. Both centers have no meeting facilities. The Tangmachhu extension center together with the other public service facilities will be renovated by 1990 under the nationwide project of "Rural Development Service Centers." The site of Tangmachhu Center is located at the upper part of Takila within a 12 ha bush area. Layout plans on a new extension center with trial fields and other facilities on forestry, animal husbandry, health and education will be completed by December 1988. On the other hand, renovation of the Lingmethang extension center is not planned at present.

Agricultural support services at each project area are carried out by one agricultural extension worker (AEW) assigned each block. Activities usually implemented are limited to extension matters such as guidance on farming practices, diffusion of farm inputs and tools, arrangement of agricultural credit, and collection of production data.

As each AEW has to supervise a whole block, sufficient contacts with local farmers are often not possible due to difficulties of access in some areas. Arrangement for the Dzongkha new schemes on land development and irrigation are also adding to the work loads of the AEWs. The study area of Lhuntshi and Mongar Districts does not have any experimental or trial stations at present, therefore AEW cannot extend proper guidances due to the lack of satisfactory experimental data and informations.

Present constraints on extension activities based on interviews with AEWs are summarized as follows:

#### (a) Guidance/Demonstration

- lack of technical data and informations for proper guidance.
- lack of seeds suitable for local conditions.

- lack of transportation facilities to contact farmers sufficiently.
- insufficient training of AEWs in latest technologies.

(b) Plant Protection

- limited number of spraying machines at Block level.
- lack of proper diagnosis knowledge for recommendation to farmers.

(c) Distribution of Farm Inputs

- difficulties on timely supply of inputs due to lengthy arrangement.
- poor economic condition of farmers to buy necessary inputs.
- transportation difficulty from a motorable road to a extension center.

### 3. AGRICULTURAL DEVELOPMENT PLAN OF THE MODEL PROJECT AREA

#### 3.1 Land Use Plan

Based on the basic integrated agricultural development plan, the present land use will be changed with the project as follows;

Description	Without project Condition (ha)	With project Condition (ha)
Tangmachu area		
irrigated land	170	220
(non-irrigated) <sup>/1</sup>	50	
rainfed land	114	114
tsheri land	95	0
others (rainfed) <sup>/2</sup>	<u>49</u>	<u>141</u>
total	478	478
Masangdaza area		
irrigated land	30	80
rainfed land	81 <sup>/3</sup>	31
tsheri land (rainfed)	3	0
others (rainfed) <sup>/2</sup>	<u>9</u>	<u>12</u>
total	123	123

- <sup>/1</sup> : About 50 ha of irrigated land would not be cultivated in average year because of fractuation of irrigation water supply.  
<sup>/2</sup> : Others include fallow land, kitchen garden, glassland, etc.  
<sup>/3</sup> : About 49 ha of rainfed land would not be cultivated same as present condition.

In both model project areas, the cultivated area under the without project condition will be same as the present condition.

Since livestock grazing in farm land in the winter season will be critical for land use under the with project condition, half of the farm land in the wet (irrigated) and dry (rainfed) land will be used for livestock grazing. In addition, all the tsheri land will be converted into natural vegetation or grass land where livestock could graze throughout the year.

In the Tangmachu model project area, not all the registered lands would be cultivated under the without project condition because of labour shortage and water unavailability. Under the with project condition, 220 ha will be irrigated, and 114 ha will be cultivated under rainfed condition.

In the Masangdaza model project area, 80 ha will be irrigated under the with project condition by converting 50 ha of rainfed land in addition to the presently irrigated land (30 ha). 31 ha of the dry

land will be cultivated under the same rainfed condition as in the present condition.

Kitchen garden for vegetables for farm household consumption is included in the other land.

### 3.2 Proposed Cropping Pattern

Based on the basic integrated agricultural development plan, the following crops have been selected for the model projects;

- (a) Paddy will be the main crop in wet land, and maize is the main crops in dry land to achieve food self-sufficiency. Other crops presently grown in the area such as wheat, potato and other cereals will be supplementary planted.
- (b) Major cash crops are soyabeans, chilli and mustard to increase farmers' income.

Rice will be the farmers' staple food, whose main food is presently maize and other cereals, in the model project areas. Maize, wheat, other cereals and potatoes are supplemental foodstuff of paddy. Parts of maize and wheat are used for wine preparation. The major cash crops are soyabean and mustard in both areas, and chilli is the main cash crop in the Tangmachu area.

In formulating the proposed cropping pattern, the followings are considered;

- (a) Research results conducted in the study area and in the area having similar physiographical and climatic conditions in Bhutan.
- (b) Climatic conditions such as temperature and sunshine radiation in the model project areas.
- (c) Maximum utilization of irrigation water for crops.
- (d) Avoiding high labour requirements by overlapping the farming practices of crop cultivation.

Research activities on the above crops are now under way, and the best varieties for each crop have not been bred yet. Research for the best farming practices and dosage of farm inputs are also being made.

Based on the completed research data obtained from the IFAD project (Tashigang and Mongar Area Development Project) and CARD (Centre for Agricultural Research and Development), varieties of the

crops are selected as follows, but improved varieties should be introduced depending on the progress of research:

- Paddy : No.11 for higher altitude (cold tolerant and early matured variety)  
IR 64 for middle and low altitude (medium matured variety)
- Wheat : Sonalica
- Mustard : M 27 or local variety (Yungkere)
- Maize : Local varieties (Ashum Karpa, Bepa Ashum, Ahum Marupo, Maringmo Ashum, etc.)
- Soyabean : Local varieties (Sawling Kurupa, Sawling Nagpo, etc.)
- Chilli : Local varieties (Kurtetpa Bengala, Ngalung Bengala, Sha local, etc.)

The meteorological conditions on a 10 day basis in the model project areas are illustrated on the Fig. IV.3.1. Because the sunshine hour records are not available in the areas, the mean monthly sunshine hours per day in the whole country are applied. Sunshine hours in the summer season are generally low and the lowest is 2.7 hours in July. On the other hand, sunshine hours in winter season from October to March are more than 5 hours/day. Since the target yield of the crops in the summer season is not so high, the solar radiation in the areas is sufficient to attain the target yields.

Paddy requires higher temperature to grow properly. While the Tangmachu model project area is situated at 1,200 m to around 2,000 m in altitude, low temperature is expected in the upper part of the area.

To examine temperature suitability for paddy in the Tangmachu model project area, the mean and minimum temperature on the 10 days basis by altitude are estimated through processing and converting meteorological data, and are shown on Fig. IV.3.2.

Although the optimum temperature of paddy varies with varieties, growth stages and duration of low temperature, the optimum temperatures by growth stage are estimated based on the research data conducted in Japan and international research institutions as follows;

- 10°C in minimum for germination,
- 16°C in mean for transplanting (root development),
- 18°C in mean for tillering, and
- 20°C in mean for flowering and maturing.

Applying the estimated temperature at altitude around 1,800 m to the optimum temperatures, sowing seeds on nursery bed can start from the first 10 days of March, transplanting can start from the last 10 days of April, tillering should be started from the second 10 days of May, flowering and maturing can put in the period from the first 10 days of June upto the second 10 days of October. Maturing can be delayed to the second 10 days of November.

Based on the above mentioned conditions together with irrigation water supply (given in Annex V) and overlapping of farming practices of crops, the rotational cropping is formulated.

Tangmachu model project area

Crop	Summer Crop (ha)	Winter Crop (ha)	Total (ha)
Irrigated crops in the wet land			
paddy	220	-	220
wheat	-	55	55
mustard	-	55	55
total	220	110	330
Rainfed crops in the dry land			
maize/soyabean	58	-	58
chilli	59	-	59
wheat	-	29	29
mustard	-	29	29
total	117	58	175

Masangdaza model project area

Crop	Summer Crop (ha)	Winter Crop (ha)	Total (ha)
Masangdaza area			
Irrigated crops in the wet land			
paddy	80	-	80
wheat	-	20	20
mustard	-	20	20
total	80	40	120
Rainfed crops in the dry land			
maize/soyabean	32	-	32
wheat	-	8	8
mustard	-	8	8
total	32	16	48

In wet land, paddy for the summer crop will be planted in the whole area. After paddy, wheat and mustard for winter crops will be grown in 25% of the area respectively. The sequence of the crops in

one plot will be 4 years rotation of paddy-wheat in the first year, paddy-fallow in the second year, paddy-mustard in the third year and paddy-fallow in the last (forth) year.

In dry land of the Tangmachu area, chilli and maize intercropped with soyabean for the summer crop will be planted in 50% each of the area. In the Masangdaza area, maize intercropped with soyabean for summer crop will be planted in whole area of the Masangdaza area. After summer crops, wheat and mustard for winter crops will be grown in 25% each of the area. The sequence of the crops in one plot of the dry land will be 4 years rotation as follows;

Year in Order	Tangmachu	Masangdaza
1st year	maize/soyabean-mustard	maize/soyabean-wheat
2nd year	chilli-fallow	maize/soyabean-fallow
3rd year	maize/soyabean-fallow	maize/soyabean-mustard
4th year	chilli-wheat	maize/soyabean-fallow

The proposed cropping pattern is illustrated in Fig. IV.3.3.

Since the fallow land of wet and dry land in the winter season will be used for grazing livestock with the project, legume grass will be recommended to be introduced as fodder for livestock and green manure for next crops in the winter season. The proper regime grass to be introduced should be selected through the trials. Milk vetch, *Astragalus sinicus* was cropped for the same objective in wide area in Japan formerly.

### 3.3 Proposed Farming Practice

To increase agricultural production based on the proposed cropping pattern, proper farming practices should be adapted. The present farming practices have been locally developed through long periods in the areas, but the practices are sometimes not properly done at present.

Farming practices with the project will be;

- (a) seeds will be properly renewed with the registered/certified seeds to prevent contamination and to keep genetic characteristics,
- (b) land preparation is made by pairs of bullocks with a single operator and use of improved steel plough to conduct timely operation and to reduce labour requirement,

- (c) harvests of paddy, wheat, maize are threshed using machines operated manually or by small engine to save labour force,
- (d) weeding is done by rotary weeder for paddy and cultivation or intertiller for upland crops as much as possible,
- (e) proper application of fertilizer together with farm yard manure is essential for full exploitation of agricultural potential, but application of potassium fertilizer is minimized because the soils is generally rich in potassium,
- (f) agro-chemicals are applied to minimize damage from insects and disease,

The proposed farming practices of the proposed crops under the with project condition are presented in Table IV.3.1.

The proposed farming will be basically practiced by family labour and bullock power through labour exchange and on rotational base similarly to the present practice. The labour balance is studied on the basis of the proposed cropping pattern and farming practices. The available labour force per farm household is 2.58 man-days in the Tangmachu area and 1.87 man-day in the Masangdaza area as shown in Table IV.2.19. Estimated peak labour requirement per farm household is 2.55 man-days in the Tangmachu area and 1.84 man-days in the Masangdaza area as shown in Table IV.3.2. These peak labour requirements are less than the available labour force. This indicates that the proposed farming practices can be made.

(a) Paddy

Seed and nursery preparation

Seeds will be switched to the registered seeds every four years. Although seed treatment is not commonly carried out at present, paddy seeds should be selected by using clean water. Pre-germination practice is recommended to increase the germination ratio. The seed requirement is 50 kg per ha. Considering low temperature, sowing in the higher altitude area has to be done so as to finish transplanting in June.

The semi-dry method of the wet nursery has to be prepared as flat as possible. The size of nursery is about 5% of the paddy field to be transplanted. Fertilization is essential as basal application. The recommended dosage is 5 kg of Urea. Careful water management is very important for healthy growth of seedlings. The nursery period is 40 days after seeding.



### Field preparation

Field preparation is carried out twice by bullock power about 20 days before transplanting. Puddling works are also required after ploughing.

### Transplanting

Transplanting is made by manual labour in line using a planting rope, and planting 3 seedling per one hill is recommended. Irrigation water has to be drained just before transplanting so that transplanting in shallow depth can be made for accelerating vigorous tillering. Irrigation water is taken into the field again after rooting.

### Fertilizer application

The total fertilizer requirement for sustaining the target yields would be 150 kg/ha of Urea, 70 kg of T.S.P and 4 t of farm yard manure. The basal application is 80 kg/ha of urea, 70 kg/ha of T.S.P. and 4 t of farm yard manure when field preparation is practiced. Top dressing of 70 kg of urea is made at panicle initiation stage of about 30 days after transplanting.

### Weeding

After transplanting, weeding is carried out at least 2 times, depending on the conditions of weed growth, by rotary weeder. While herbicides such as Butachlor have not yet been utilized in the areas for weeding purposes, their efficiency are highly acceptable particularly for saving labour.

### Plant protection

As regards the plant protection, intensive application of insecticide is not practical in the areas. It is necessary to apply agro-chemicals depending upon the diagnosis of insects and disease. In this regard, it is recommended that plant protection works should be carried out in a systematic and organized way through the extension workers and the district agricultural officer. Individual protection is not recommended because insects and disease are not limited to individual from which will be re-infected unless protection is undertaken on as wide an area as possible.

The recommended application of agro-chemicals is as follows;

<u>Insects and diseases</u>	<u>Application of chemicals</u>
Blast	1 ml of Hinosan 50 EC per liter
Stem borer	25 kg of Thimet 10 granules per ha
Caseworm	1 to 2 ml of Nuvan per liter
Gundy bug	37.5 kg of Cythion 5% dust per ha
Leaf hopper	25 kg of Thimet 10 granules per ha
Plant hopper	1 ml of Nuvacron per liter

Basical plant protection, however, is to increase the healthiness of the plant. If the rice plant is quite healthy it would hardly suffer from disease and insect pests. In this sense, it is essential to make the leaves of the plant pale during the period from 40 days to 20 days before heading, and furthermore to increase the healthiness of roots by practicing soil drying.

#### Harvesting

Harvesting is carried out by manual labour. The harvested paddy is dried on the bund or by piling. Use of pedal thresher, instead of traditional hand threshing, is recommended. After threshing, grains are stored with water content of less than 14%.

(b) Wheat and mustard

#### Field preparation

Field preparation is carried out once by bullock power before seeding. Irrigation water is applied for easy ploughing. Planking soil is carried out as needed.

#### Seeding

Seeds will be switched to registered seeds every four years for wheat and every year for mustard. Although seed treatment is not commonly carried out at present, the wheat seeds should be treated with Vitavax for Loose Smut. Wheat seed is sown in line at the rate of 100 to 125 kg per ha. Considering low temperature, sowing wheat in the higher altitude area has to be finished by November. Mustard seed is broadcasted at the rate of 10 kg per ha, and thinning is carried out during the growth period.

#### Fertilizer application

Basically fertilizers will be applied for irrigated wheat and mustard only. Rainfed crops will be grown with no fertilizer application.

The total fertilizer requirement of wheat for sustaining the target yields would be 60 kg/ha of urea and 4 t of farm yard manure. The basal application is 4 t of farm yard manure when field preparation is practiced. Top dressing is made 30 days after germination. The amount of fertilizer to be applied per ha is about 60 kg of urea at top dressing time.

The total fertilizer requirement of mustard for sustaining the target yields would be 70 kg/ha of urea and 60 kg of T.S.P for the basal application.

#### Weeding

Weeding for wheat is carried out one time, 4 to 5 weeks after germination. Weeding for mustard is carried out 2 times at least depending the conditions of weed growth.

#### Plant protection

Since wheat and mustard are planted as winter crops, serious damage by the insects and disease are not expected. However, based on the diagnosis, application of Nuvacron for Aphid damage of mustard is recommended.

#### Harvesting

Harvesting of wheat is carried out by manual labour after full maturing. The harvested wheat is threshed by the pedal thresher, instead of traditional hand threshing. Mustard is harvested after the pod colour changing to yellow.

(c) Maize and soyabean

#### Field preparation and seeding

Seeds of maize and soyabean will be switched to registered seeds every four years. Although the seed treatment is not commonly carried out at present, soybean seeds should be inoculated. Field preparation is carried out two times by bullock power before seedling. Seeds are sown with alternating interval of seven lines of maize and three lines of soyabean. Seed requirement is 25 kg/ha for maize and 30 kg for soyabeans in one time. After seedling, soil covering by ploughing lightly is recommended to increase the germination rate and to prevent by birds.

#### Fertilizer application

Basically maize and soyabean will be grown under rainfed condition, and only farm yard manure will be applied. The total

fertilizer requirement of maize and soyabean for sustaining the target yields would be 4 t of farm yard manure. 4 t of farm yard manure is applied as the basal when field preparation is practiced.

#### Weeding

Weeding is carried out 2 time every 3 to 4 weeks after germination at least, depending on the conditions of the weed growth.

#### Plant protection

The recommended application of agro-chemicals is as follows:

<u>Insects and diseases</u>	<u>Application of chemicals</u>
Stem borer	1 ml of Nuvacron per litter
Cutworm	25 kg of Thimet 10 granules per ha
Armyworm	25 kg of Thimet 10 granules per ha

#### Harvesting

Harvesting maize is carried out by picking corn cobs. Threshing is done by maize sheller, instead of traditional hand threshing. Soybeans are harvested by picking up plants.

### (d) Chilli

#### Seed and nursery preparation

Seeds will be renewed with the registered seeds every year. The raised dry nursery has to be prepared with application of farm yard manure. The size of nursery is about 5 to 10% of the field to be transplanted. The seeds are sown with the intervals of 5 cm in lines.

#### Field preparation

Field preparation is carried out twice by bullock power 20 days before transplanting. Ploughed soil is plunked as required.

#### Transplanting

Transplanting is made by manual labour with intervals of 40 cm in rows and 30 cm in lines.

#### Fertilizer application

The total fertilizer requirement for sustaining the target yields would be 220 kg/ha of Urea, 110 kg of T.S.P and 4 t of farm yard manure. The basal application is 120 kg/ha of urea, 110 kg/ha of T.S.P. and 4 t of farm yard manure when the field preparation is

practiced. Top dressing of 100 kg of urea is made about 30 to 40 days after transplanting.

#### Weeding

After transplanting, weeding is carried out 4 times at least, depending on the conditions of the weed growth.

#### Plant protection

The recommended application of agro-chemicals is as follows;

<u>Insects and diseases</u>	<u>Application of chemicals</u>
Anthracnose	2 g of Copper fungicide per liter
Cutworm	25 kg of Thimet 10 granules per ha

#### Harvesting

Harvesting is carried out by picking pods. The harvested chilli is fully dried.

### 3.4 Anticipated Yield and Production

After completion of the projects, the present yields of crops are stabilized and increased. The anticipated crop yields are estimated as follows;

Crop	Without Project		With Project (t/ha)
	Tangmachu (t/ha)	Masangdaza (t/ha)	
irrigated crops			
paddy	2.4	1.5	5.0
wheat	-	-	1.8
mustard	-	-	0.9
rainfed crops			
maize	1.5	1.1	1.5
maize (tsheri)	0.6	-	-
soyabean	0.3	-	0.5
wheat	1.0	-	1.2
mustard	0.2	0.3	0.6
chilli (dried)	0.3	-	2.0
potato	2.1	-	-
buckwheat	-	0.4	-

These unit yields are estimated on the basis of the results of research data.

Based on the proposed cropping pattern, the cropped area, crop yields and total crop production under "with project" condition are estimated in Table IV.3.3 and are summarized as follows:

Crops	Tangmachu	Masangdaza	Total
Production (t)			
irrigated land			
paddy	1,100	400	1,500
wheat	99	36	125
mustard	50	18	68
rainfed land			
maize	86	47	133
soyabean	29	16	45
chilli	114	-	114
wheat	36	16	42
mustard	17	5	22

The annual paddy production at the full development stage in the Tangmachu area would amount to 1,100 t of dried paddy in total, and the expected annual increment of paddy production would be about 726 t. The annual production chilli, wheat, mustard and soyabeans will be 114 t, 134 t, 67 t and 29 t respectively. However, the maize production will decrease to 86 t at the full development stage from 160 t under without project condition.

The annual paddy production at the full development stage in the Masangdaza area would amount to 400 t of dried paddy in total, and the expected annual increment of paddy production would be about 355 t. The annual production maize, soyabean, wheat and mustard will be 47 t, 16 t, 46 t and 23 t respectively.

### 3.5 Price Forecast and Marketing

#### 3.5.1 Price Forecast

Financial prices of farm inputs and outputs were estimated on the basis of current market or farmgate prices prevailing in the project area as of 1988.

Economic prices for trade goods such as paddy, maize, wheat, soyabean, mustard and fertilizers 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 goods were converted to 1988 constant price by the rate of 1.403 based on the manufacturing unit value index. Details of those forecast are presented in Table IV.3.4. Economic prices of agro-chemicals were calculated by the multiplication of (i) financial prices of most

prevailing agro-chemicals, (ii) standard conversion factor (SCF) of 0.9, and (iii) average increasing rate of fertilizer prices from 1988 to 1995 of 1.54. The other economic prices were converted from financial prices by SCF of 0.9.

Financial and economic prices of all outputs and inputs are shown in Table IV.3.5 and summarized as follows:

Item	Unit	Financial Price (1988)	Economic Price (1995)
<b>Outputs</b>			
1) Paddy	(Nu/t)	3,000	2,900
2) Maize	(Nu/t)	2,600	3,100
3) Wheat	(Nu/t)	2,400	3,900
4) Soyabean	(Nu/t)	2,700	5,300
5) Mustard	(Nu/t)	4,000	3,600
6) Chilli (dry)	(Nu/t)	10,000	9,000
7) Buckwheat	(Nu/t)	1,500	1,400
8) Potato	(Nu/t)	1,800	1,600
<b>Inputs</b>			
1) Fertilizers			
- N	(Nu/kg)	2.3	10.7
- P <sub>2</sub> O <sub>5</sub>	(Nu/kg)	1.2	9.2
- K <sub>2</sub> O	(Nu/kg)	1.4	4.8
2) Agro-chemicals			
- Liquid	(Nu/l)	72.2	100.1
- Granular	(Nu/kg)	11.8	16.4
3) Labour	(Nu/day)	15.0	13.5
4) Hired animal power	(Nu/day)	60.0	54.0

### 3.5.2 Marketing of Agricultural Products

Demand and supply analysis on the future agricultural products in the project areas is carried out on the basis of (i) future crop production and (ii) local consumption of foods, seeds and others in 1995 based on the future population estimation. The result of the analysis is shown in Table IV.3.6 and summarized as follows:

(Unit: t)

Area/Item	Paddy (Rice)	Maize	Wheat	Soyabean	Mustard (Oil)	Chilli
<b>I. Tangmachhu</b>						
1. Production	1,100	86	134	29	67	114
2. Local Demand	765	86	88	5	8	6
3. Marketable Quantity	335 (217)	0	46	24	59 (20)	108
<b>II. Masangdaza</b>						
1. Production	400	47	46	16	23	-
2. Local Demand	173	35	9	3	3	-
3. Marketable Quantity	227 (147)	12	37	13	20 (7)	-

The marketable quantity of rice can make up around 93% of the present deficit of the both Districts with 390 t of rice. 12 t of marketable maize will be consumed within both Districts. A surplus of wheat after meeting a deficit of about 40 t is estimated at 43 t which can be transported to other regions in Bhutan mainly through the channel of Food Corporation of Bhutan (FCB). Surplus of soyabean and chilli can be exported to India through FCB and private channels. Marketable mustard oil after meeting with a deficit of about 23 t is estimated at 4 t. This edible oil surplus can supplement the deficit in Bhutan. Distribution of marketable agricultural products from the project areas is shown in Table IV.3.7 and summarized as follows:

(Unit: t)

Product/Item	Tangmachhu/Masangdaza
<b>I. Rice</b>	
1. Marketable Quantity	364 (93%)
2. Present Deficit	390 (100%)
3. Future Deficit	26
<b>II. Wheat</b>	
1. Marketable Quantity	83
2. Present Deficit	40
3. Surplus (1-2)	43
<b>III. Mustard Oil</b>	
1. Marketable Quantity	27
2. Present Deficit	23
3. Surplus (1-2)	4
<b>IV. Export Quantity</b>	
1. Soyabean	37
2. Chilli	108



### 3.6 Agricultural Development Benefit

An agricultural development benefit of the model projects was estimated on irrigation benefit on the irrigated land. The net production value defined as the difference between the gross production value and the production cost is estimated as shown in Table IV.3.8 without condition and Table IV.3.9 with condition. The agricultural development benefit is the difference of the annual net production value between the future with and without project conditions on irrigated land. The estimation of the development benefits is shown in Table IV.3.10 and summarized as follows:

(Unit: Nu 10<sup>3</sup>)

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

### 3.7 Improvement of Agricultural Support System

Agricultural support services in the project areas would be improved through the development of other rural facilities which comprises feeder road construction, promotion of small scale agro-industry, agricultural mechanization, establishment of workshop, and improvement of agricultural extension center. These development would benefit the farmers of the areas directly and indirectly. Details on the above developments were mentioned in Annex VI.

DOA, the both District Offices, the Food Corporation of Bhutan, Bhutan Development Finance Corporation, and other related agencies would have the following responsibility for the support of the effective utilization of the above development components as follows:

(a) Department of Agriculture

- Diffusion of the new cropping patterns and farming practices into the project areas through the strengthening of the extension activities using the new extension facilities and equipment introduced.
- Preparation of O/M manual for the irrigation facilities, the agro-processing factory, the agricultural machine leased and the workshop.
- Operation of the new workshop.

(b) District Offices

- Organization of a farmers' association for (i) an effective use of irrigation facilities and water, (ii) timely harvest, processing and marketing of cash crops, (iii) prevention of cattle damages during the winter season.
- Operation and maintenance of the irrigation and agro-processing facilities and the extension centers.
- Coordination of the departments and agencies concerned.

(c) Food Corporation of Bhutan

- Marketing services of surplus cereals; maize, wheat and paddy, and cash crop products; soyabean, dry chilli and chilli power, and mustard oil.

(d) Bhutan Development Finance Corporation

- Arrangement of agricultural credit services in the project areas.

(e) Others

- Coordination of the feeder road construction, and operation and maintenance of feeder road by PWD.
- Buck support on operation and maintenance of the agro-processing facilities.

### 3.8 Future Farmers' Economy

For the assessment of the projects from farmers' economic view point, future farmers' economy was examined by financial farm budgets shown in Table IV.3.11, which were prepared on the farmers classified by the farm size mentioned in Chapter 2.2.3. The farm budget analysis was made on the basis of the following assumptions:

- 1) Cropping pattern and crop yield are based on the agricultural development plan.
- 2) Production costs of agricultural products are calculated at the financial prices mentioned in Chapter 3.5.
- 3) Farm income is estimated on the basis of a marketable production after deducting a home consumption.

- 4) Future non-farm income is assumed to be the same amount of the present.
- 5) Future living expenses are assumed to be Nu 460 per one family member which is around 1.5 times as much as the present average expenses of Nu 305.

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
<b>Tangmachhu</b>						
Below 0.59	1,895	1,840	55	3,650	3,090	560
0.59-1.08	2,915	2,520	395	8,410	3,700	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
<b>Masangdaza</b>						
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 the projects, drastic increase of net reserve can 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.

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 will 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 from Nu 3,750 to Nu 6,440 in Masangdaza. Labour productivity on rainfed land will be increased to 1.6 times on average. The details on the productivity analysis are shown in Table IV.3.12 and summarized 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

The farmers less than the first quartile scale (1.08 ha) in Tangmachhu and the whole farmers in Masangdaza can't prepare the future production costs as follows:

Area/Farm Size (ha)	(Unit: Nu)		
	Net Reserve at Present	Future Production Cost	Balance
	(I)	(II)	(I) - (II)
Tangmachhu			
Below 0.59	55	140	-85
0.59-1.08	395	340	55
1.08-1.74	755	550	205
Over 1.74	1,250	1,140	110
Masangdaza			
Below 0.80	-5	230	-235
0.80-1.20	5	350	-345
1.20	185	490	-305
over 1.20	570	720	-150

In order to spread the project benefits to the farmers earlier, financial assistance will be required.

A new agricultural credit scheme since 1988 shown in Table IV.3.13, which consists of a seasonal loan of Nu 200 to Nu 5,000 and a term loan of Nu 500 to Nu 20,000 under repayment terms of one (1) year and two (2) to five (5) years with interest rate of 10%, have to be applied for the procurement of farm inputs.

Table IV.2.1 POPULATION AND HOUSEHOLD IN THE STUDY AREA

District/Block	Number of Villages	Population		Household		Family Size
		Number	Share (%)	Number	Share (%)	
<u>I. Lhuntshi</u>						
Dungkhar	5	6,500	15.4	470	11.2	13.8
Gangzoor	8	5,300	12.6	650	15.5	8.2
Khoma	6	5,500	13.1	500	11.9	11.0
Minji	8	3,500	8.3	500	11.9	7.0
Tangmachhu	11	4,900	11.6	520	12.4	9.4
Metsho	5	6,800	16.2	550	13.1	12.4
Jarrey	5	4,700	11.2	510	12.1	9.2
Chengkhar	5	4,900	11.6	500	11.9	9.8
Total	53	42,100	100.0	4,200	100.0	10.0
<u>II. Masangdaza</u>						
Chakaling	5	9,700	12.6	1,210	11.9	8.0
Chamang	3	3,200	4.1	330	3.2	9.7
Chaskhar	4	5,600	7.2	710	7.0	7.9
Demchi	7	10,700	13.9	1,350	13.3	7.9
Ngatshang	6	11,000	14.2	1,570	15.5	7.0
Gongdu	24	8,300	10.8	1,090	10.7	7.6
Kengkhar	28	5,800	7.5	870	8.6	6.7
Mongar	9	9,400	12.2	1,270	12.5	7.4
Salling	10	4,700	6.1	600	5.9	7.8
Silambi	10	4,700	6.1	620	6.1	7.6
Thangrong	13	4,100	5.3	540	5.3	7.6
Total	119	77,200	100.0	10,160	100.0	7.6

Source: Lhuntshi and Mongar District Administration.

Table IV.2.2 POPULATION DISTRIBUTION BY AGE AND SEX IN THE STUDY AREA (1/2) (LHUNTSHI DISTRICT)

Age Group	Population			Percentage Distribution (%)		
	Male	Female	Total	Male	Female	Total
0 - 4	1,735	1,508	3,243	8.30	7.11	7.70
5 - 9	2,249	2,543	4,792	10.76	11.99	11.38
10 - 14	1,877	1,975	3,852	8.98	9.32	9.15
15 - 19	2,593	2,421	5,014	12.41	11.42	11.91
20 - 24	1,806	1,541	3,347	8.64	7.27	7.95
25 - 29	1,674	1,736	3,410	8.01	8.19	8.10
30 - 34	1,611	1,614	3,225	7.71	7.61	7.66
35 - 39	1,248	1,345	2,593	5.97	6.34	6.16
40 - 44	1,398	1,452	2,850	6.69	6.85	6.77
45 - 49	1,496	1,737	3,233	7.16	8.19	7.68
50 - 54	982	1,127	2,109	4.70	5.32	5.01
55 - 59	1,292	1,436	2,728	6.18	6.77	6.48
60 - 64	645	517	1,162	3.09	2.44	2.76
65 -	292	250	542	1.40	1.18	1.29
Total	20,898 (49.64%)	21,202 (50.36%)	42,100 (100.00%)	100.00	100.00	100.00

Note: Population distribution data are based on the result of demographic survey of the project schemes in Lhuntshi District. Total population in the project schemes is 4,756 which is around 11% of the total population of 42,100 in Lhuntshi District.

Table IV.2.2 POPULATION DISTRIBUTION BY AGE AND SEX IN THE STUDY AREA (2/2) (MONGAR DISTRICT)

Age Group	Population			Percentage Distribution (%)		
	Male	Female	Total	Male	Female	Total
0 - 4	5,212	5,388	10,600	13.60	13.86	13.73
5 - 9	5,262	6,017	11,279	13.73	15.48	14.61
10 - 14	3,886	4,482	8,368	10.14	11.53	10.84
15 - 19	3,790	3,691	7,481	9.89	9.49	9.69
20 - 24	2,840	2,641	5,481	7.41	6.79	7.10
25 - 29	2,912	2,654	5,566	7.60	6.83	7.21
30 - 34	2,571	2,671	5,242	6.71	6.87	6.79
35 - 39	1,862	2,399	4,261	4.86	6.17	5.52
40 - 44	1,951	1,508	3,459	5.09	3.88	4.48
45 - 49	2,292	2,278	4,570	5.98	5.86	5.92
50 - 54	1,610	1,548	3,158	4.20	3.98	4.09
55 - 59	1,498	1,659	3,157	3.91	4.27	4.09
60 - 64	1,023	706	1,729	2.67	1.82	2.24
65 -	1,613	1,236	2,849	4.21	3.18	3.69
Total	38,322 (49.64%)	38,878 (50.36%)	77,200 (100.00%)	100.00	100.00	100.00

Note: Population distribution data are based on the result of demographic survey of the project schemes in Mongar District. Total population in the project schemes is 6,337 which is around 8 % of the total population of 77,200 in Mongar District.