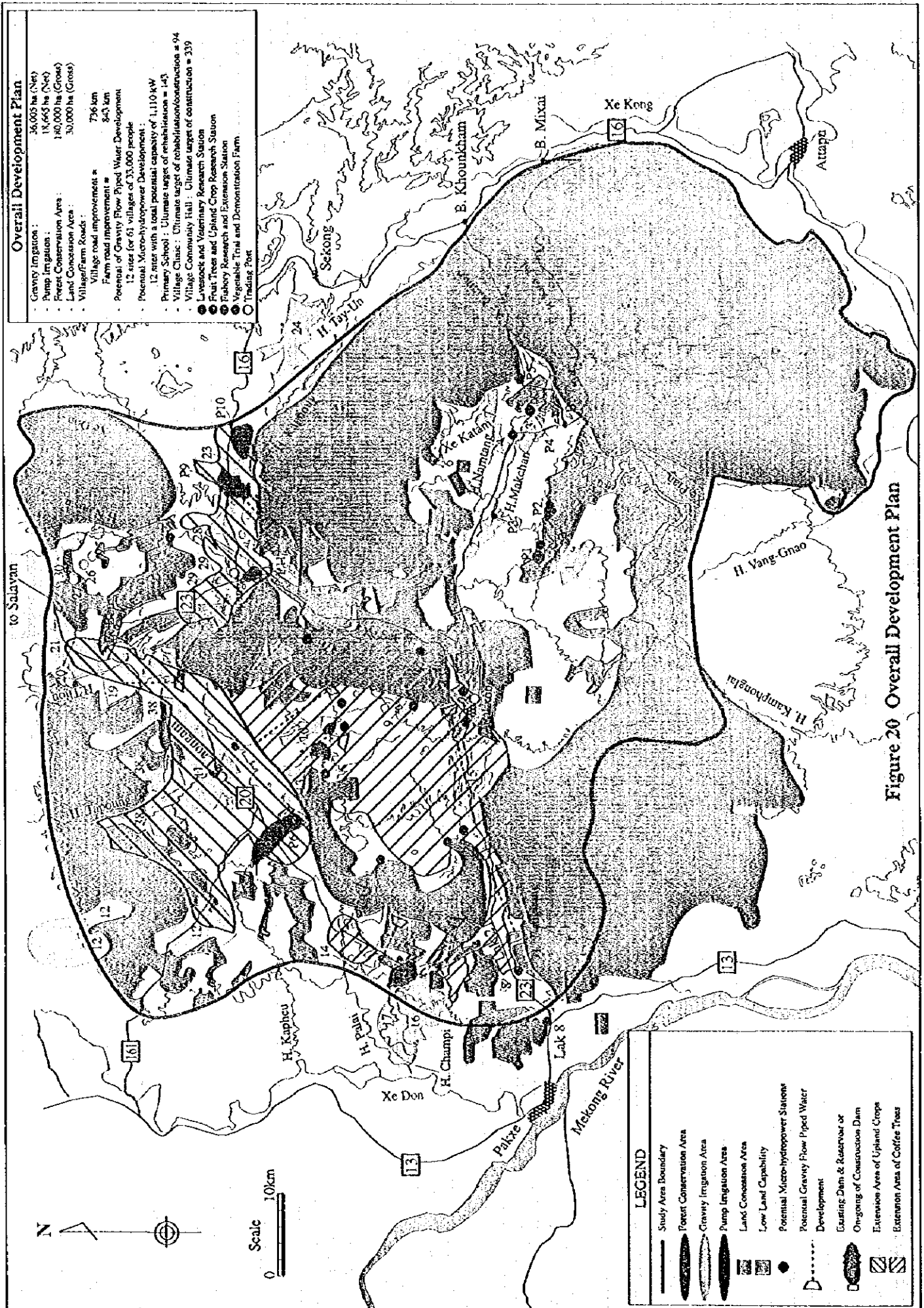


Figure 1.19 Proposed Protected/Conservation Areas



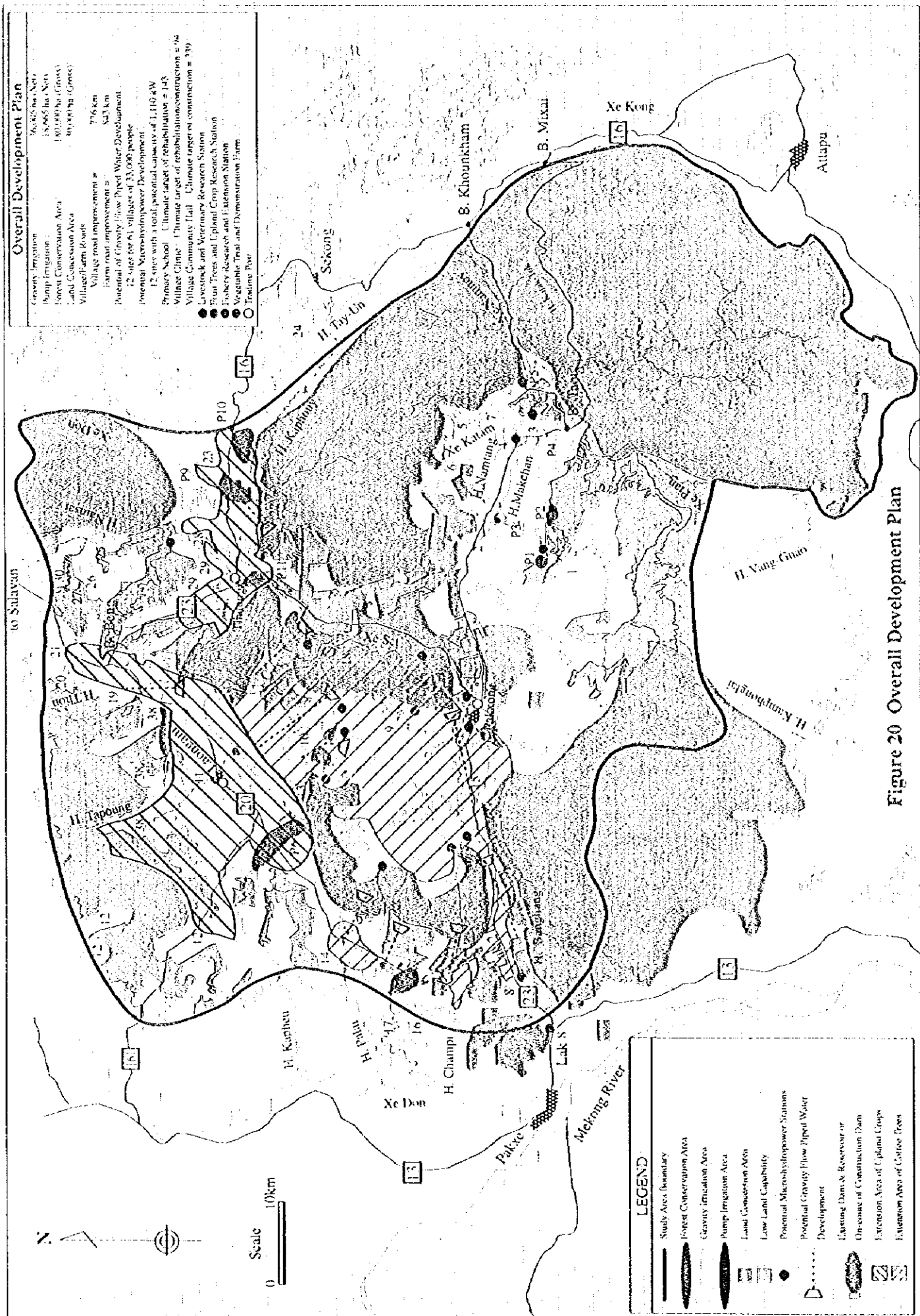
**Overall Development Plan**

- Gravely Irrigation: 36,005 ha (Net)
- Pump Irrigation: 18,665 ha (Net)
- Forest Conservation Area: 140,000 ha (Gross)
- Land Concession Area: 30,000 ha (Gross)
- Village/Farm Roads:
  - Village road improvements = 736 km
  - Farm road improvement = 845 km
- Potential of Gravity Flow Piped Water Development: 12 sites for 61 villages of 33,000 people
- Potential Micro-hydropower Development: 12 sites with a total potential capacity of 1,110 kW
- Primary School: Ultimate target of rehabilitation = 143
- Village Clinic: Ultimate target of rehabilitation/construction = 94
- Village Community Hall: Ultimate target of construction = 239
- Livestock and Veterinary Research Station
- Fruit Trees and Upland Crop Research Station
- Fishery Research and Extension Station
- Vegetable Trial and Demonstration Farm
- Tide Gauge

**LEGEND**

- Study Area Boundary
- Forest Conservation Area
- Gravely Irrigation Area
- Pump Irrigation Area
- Land Concession Area
- Low Land Capability
- Potential Micro-hydropower Stations
- Potential Gravity Flow Piped Water
- Development
- Existing Dam & Reservoir or Ongoing of Construction Dam
- Extension Area of Upland Crops
- Extension Area of Coffee Trees

Figure 20 Overall Development Plan



**Overall Development Plan**

Gravity Irrigation: 36,500 ha (Net)  
 Pump Irrigation: 18,865 ha (Net)  
 Forest Conservation Area: 190,000 ha (Gross)  
 Land Concession Area: 40,000 ha (Gross)  
 Village/ham Roads: 776 km  
 Farm road improvement: 523 km

Potential of Gravity Flow Piped Water Development: 12 sites for 61 villages of 33,000 people  
 Potential Micro-hydro-power Development: 12 sites with a total potential capacity of 1,110 kW  
 Primary School: Climate target of rehabilitation = 143  
 Village Clinic: Climate target of rehabilitation/construction = 94  
 Village Community Hall: Climate target of construction = 379  
 Livestock and Veterinary Research Station  
 Fruit Trees and Upland Crop Research Station  
 Fishery Research and Extension Station  
 Vegetable Trial and Demonstration Farm  
 Trading Post

**LEGEND**

- Study Area boundary
- Forest Conservation Area
- Gravity Irrigation Area
- Pump Irrigation Area
- Land Concession Area
- Low Land Capability
- Potential Micro-hydro-power Stations
- Potential Gravity Flow Piped Water Development
- Existing Dam & Reservoir or Extension of Construction Dam
- Extension Area of Upland Crops
- Extension Area of Coffee Trees

Figure 20 Overall Development Plan



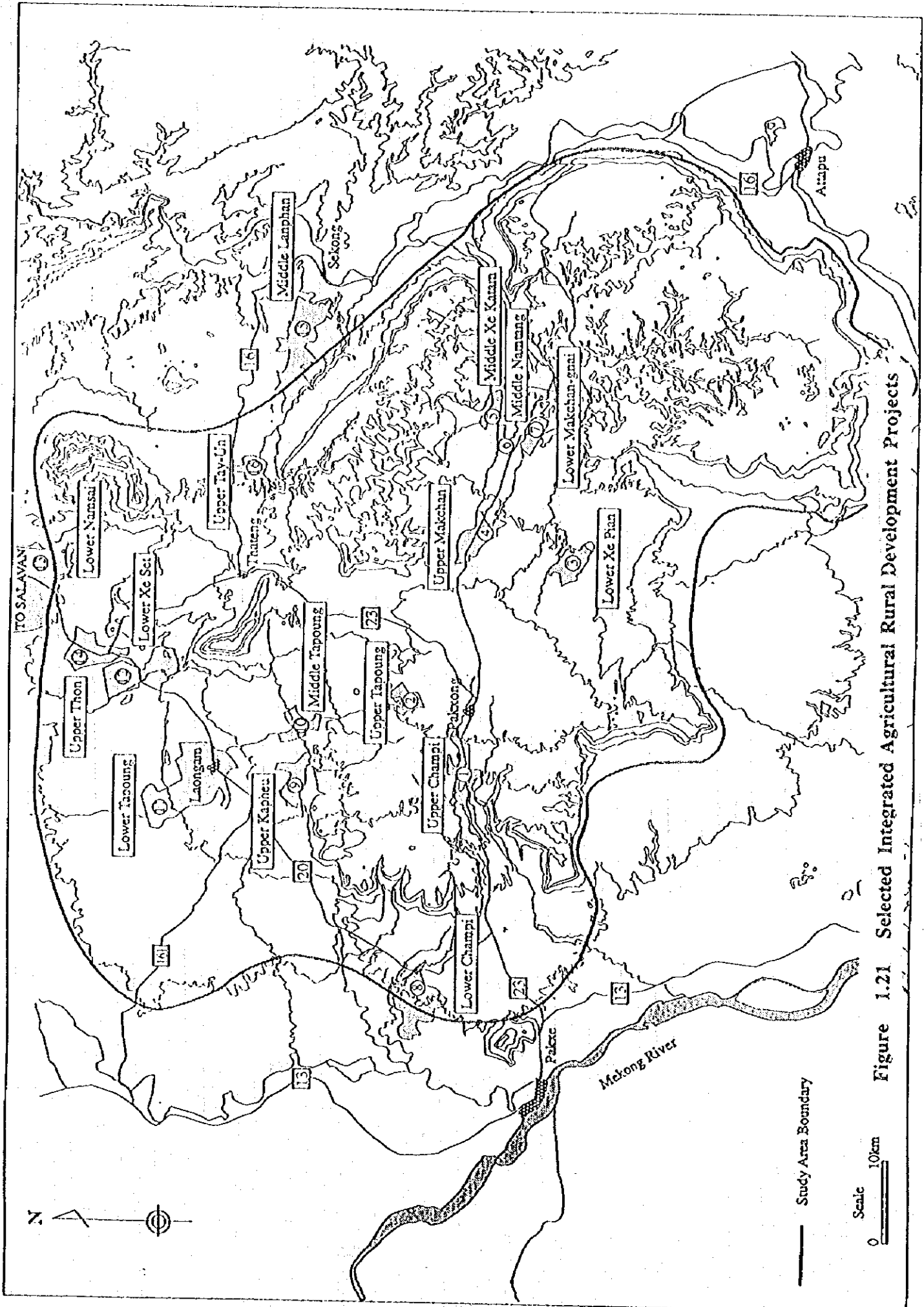


Figure 1.21 Selected Integrated Agricultural Rural Development Projects

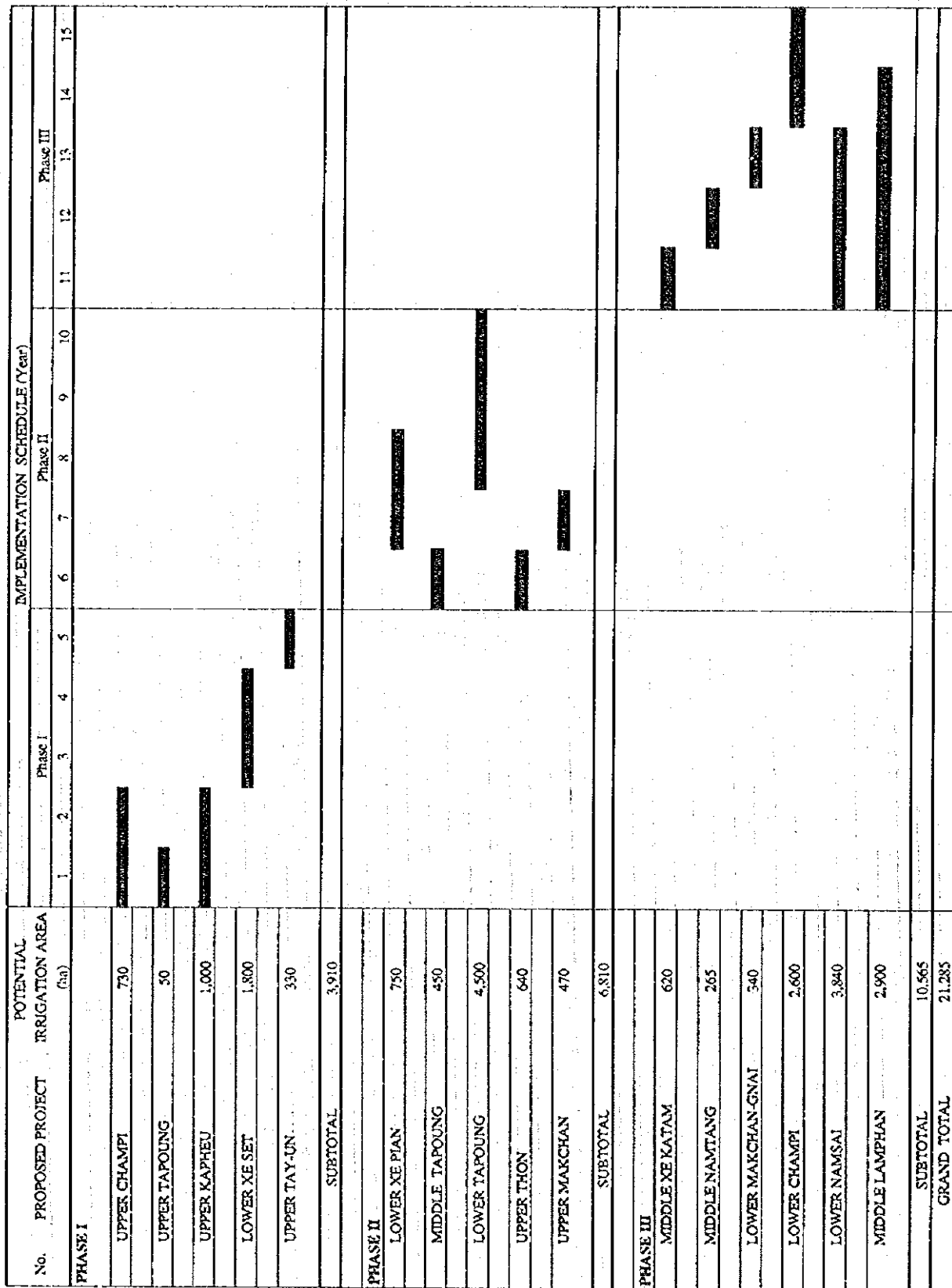
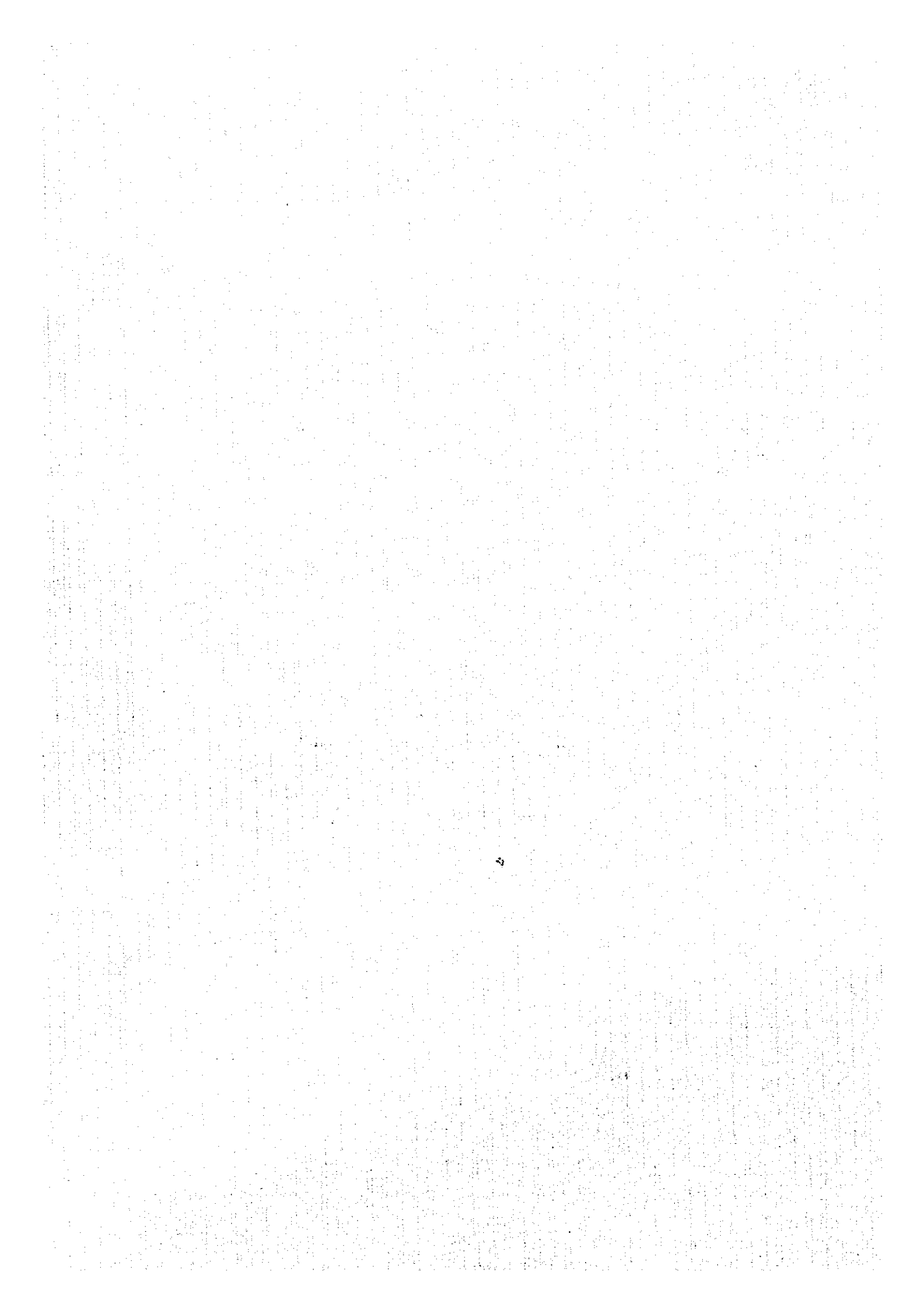


Figure 1.22 Detailed Implementation Program for the Selected Areas

## **Part II    Feasibility Study**





**THE INTEGRATED AGRICULTURAL AND  
RURAL DEVELOPMENT PROJECT  
IN BOLOVEN PLATEAU**

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**FEASIBILITY STUDY**

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## THE FEASIBILITY STUDY

### 1. PRESENT CONDITIONS OF THE PRIORITY SCHEMES

#### 1.1 Natural Resources

##### 1.1.1 Location and Topography

###### (1) Upper Champi Scheme Area

The Scheme area is located around 36 to 47 km east of Pakxe city. The area belongs to Pakxong District of Champasak Province and extends on the left bank of the H. Champi river; the national road No. 23 runs along the southern side of the area. The area is located in the terrace areas. The elevation ranges from approximately 900 m to 1,200 m above mean sea level. It has mostly a flat topography at the higher elevation and an undulating terrace with deep valleys in the lower area. The general slope of the whole area is estimated at about 3%.

###### (2) Upper Tapoung Scheme Area

The area is located about 10 km north of Pakxong town and belongs to Pakxong District of Champasak Province. The area extends on the left bank of the H. Tapoung river. The approximate elevation of the area is 1,200 m and exhibits some micro relief. The proposed area for agricultural development is in a flat grassland with slopes of about 2% on the left bank of the river.

###### (3) Upper Kapheu Scheme Area

The area is located about 15 km south of Laongam town, and belongs to the Laongam District of Salavan Province. The area expands in a terrace surrounding between the Kapheu river and the H. Houn river, with elevations ranging from 600 m to 800 m. The terrace area has a topography with gentle slopes of about 3.5% to the north.

###### (4) Lower Xe Set Scheme

The area is located about 15 km east of Laongam town. It is administratively located in Salavan District of Salavan Province. It extends in a terrace surrounding between H. Thon river and the Xe Set river, and has gentle slopes of about 1.5%. The elevation ranges from 300 m to 400 m above mean sea level. However, many small undulations are seen in the whole area.

###### (5) Upper Tay-Un Scheme

The area is located about 12 km east of Thateng town, and belongs to Thateng District of Sekong Province. The approximate elevation ranges from 500 m to 600 m above mean sea level. The topography is mostly flat with minor undulations. General slope of the area is about 1.5%. The Scheme area is bordered by the H. Tay-Un and the H. Thon.

##### 1.1.2 Climate

Through the Master Plan Study of the Project, five (5) priority project areas have been selected to execute the feasibility study on agricultural and rural development. Prior to finalizing the priority areas, a meteorological observation network in and around the Study area was set up; its recording periods were clarified to arrive at representative meteorological observatories for study to provide basic data for each Project.

(1) Application of Meteorological Data for the Selected Priority Area

Meteorological items such as temperature, relative humidity, sunshine hours and wind speed are essential to estimate the potential evapo-transpiration of crops. Rainfall data is also indispensable for estimation of irrigation demand. Taking these basic requirements and data availability into account, representative meteorological stations of the Project area were selected at Pakxe, Salavan and Pakxong, in and around the Study area. For each selected priority area, application of the meteorological data, excluding rainfall data, is made considering elevation, slope direction of the plateau and location in the Thiessen Polygon. Applied meteorological observatory for the priority area is as follows;

Priority Area	Meteorological Observatory
Upper Champi Project area	Pakxong Observatory
Upper Tapoung Project area	Pakxong Observatory
Upper Kapheu Project area	Salavan Observatory
Lower Xe Set Project area	Salavan Observatory
Upper Tay-un project area	Salavan Observatory

General climatic conditions of each selected observatory are shown in the section of the Master Plan Study.

(2) Application of Rainfall Data for the Selected Priority Area

In the calculation of irrigation water requirement, estimated amounts of effective rainfall significantly influences the total irrigation demands of objective areas. Since the selected priority areas are located in the central, north-eastern and northern parts of the plateau, rainfall amounts and its patterns differ with elevation, and slope directions of the plateau, etc. To estimate irrigation demands more accurately, rainfall data should be selected with the extent reflected on the configurations of objective area, because rainfall observation network in and around the plateau is constructed densely compared with the meteorological observation network. Taking these conditions into account, area division delineated by the Thiessen Polygon is applied for the selection of rainfall data on the irrigation of each priority area. Rainfall observatories for the selected priority areas are as follows;

Priority Area	Meteorological Observatory
Upper Champi Project area	Pakxong observatory
Upper Tapoung Project area	Pakxong observatory
Upper Kapheu Project area	Laongam observatory
Lower Xe Set Project area	Laongam observatory
Upper Tay-un project area	Sekong observatory

Average monthly rainfall in recent five years (1991 to 1995) of the selected rainfall stations is as follows;

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Pakxong	13.7	19.9	122.9	210.0	295.3	491.9	790.5	774.7	425.7	139.7	32.8	32.6	3,349.7
Laongam	11.1	4.5	23.4	57.6	208.4	246.9	362.8	393.1	310.7	136.0	4.6	1.1	1,760.0
Sekong	13.9	43.9	135.3	106.1	206.0	225.6	270.3	311.0	242.3	158.2	149.1	82.5	1,620.3

(3) Other Reference Observatories

In connection with the selected priority areas, the following meteorological observatories can be selected as reference observatories taking its location and elevation into account. Observed meteorological parameters of those observatories are limited such as for rainfall, temperature and humidity.

Priority Area	Reference Meteorological Observatory
Upper Champi Project area	KM 42 Observatory
Upper Tapoung Project area	
Upper Kaphou Project area	Laongam Observatory
Lower Xe Set Project area	Laongam & Thateng Observatories
Upper Tay-un project area	Thateng Observatory

### 1.1.3 Soils, Land Use and Land Suitability

#### (1) Historical Review

In the previous Study (Phase I), it has confirmed that the soils in the "Boloven Plateau" are divided into three categories depending mainly on geological origin: 1) alluvial soils, 2) soils derived from sand stone and clay stone and 3) soils derived from basalt rock.

These soils are further subdivided into nine soil units by effective depth, texture, color, consistency, reaction, fertility, etc., (Soil Survey and Land Classification, 1990-1991; by the classification system of FAO/UNESCO). However, among these categories, the most widely used for agriculture and thereby regarded as a representative, is basaltic soils.

In the Study of Phase I, land evaluation of the Study area was done from the point of view of land capability, based on which was legislated by USDA (1961). The results indicate that the land of the Study area can be classified into six capability classes from grade II to grade VII.

The results with regard to present land use in the previous Study are as follows: Plants which are cultivated covering wide or small areas are coffee, tea, sugar cane, cereal crops such as rice and maize, leguminous plants such as mungbean, groundnut and soybean, and spices such as cardamom and chili, etc. It has been observed that bush and grasslands are distributed over wide areas and forest lands extend largely. However, a considerable amount of shifting cultivation has also been found.

As the final outcome of the overall investigation by the study team on the results obtained in the previous Study, priority development areas of sixteen Schemes were selected.

In the present Study (Phase III), soil characteristics and its distribution, land evaluation by suitability classification, and present land use were studied on five priority development Schemes, which were further selected from sixteen areas as above.

#### (2) Soils

The soils spread in five priority development Schemes, namely, Upper Champi, Upper Tapoung, Upper Kaphou, Lower Xe Set, and Upper Tay-un; and they were studied using the same procedures as in the previous Study (Phase I). However, the precision of the survey was more accurate, and analytical procedures such as the test of intake rate and determination of available moisture content were additionally employed. The result obtained is summarized below.

In the Upper Champi Scheme (about 870 ha), soil is derived from basalt rock. Dystric Nitosols (Lithic Nitosols) are found in almost all places. The effective depth is medium to deep, and topography is almost flat to slightly undulant. The texture is generally medium (silty loam) in surface layer and medium to heavy (clay loam to clay) in sub-layer. The intake rate values lie in the range of 23.95 mm/hr to 8.89 mm/hr, and reaction is nearly neutral in most instances. The fertility is relatively high. In the western part of the Scheme, Dystric Nitosols (Lithic Nitosols) are found in a very small size.

In the Upper Tapoung Scheme (about 100 ha), two soil units derived from basalt rock, Dystric Nitosols and Dystric Nitosols (Lithic Nitosols), are found in the area where the effective depth of soil is shallow. The topography is flat to gently sloping with the exception of one site near the saddle in the foothills. The texture is medium (silty loam) in surface layer and medium to heavy (silty clay loam to clay loam) in sub-layer. The intake rate values are on the low level (2.93 mm/hr to 2.18 mm/hr), and reaction is almost neutral. The fertility is generally high.

In the Upper Kaphou Scheme (about 1,240 ha), only one unit of soil (Dystric Nitosols) derived from basalt rock is found in a relatively wide area. The effective depth is deep and is more than 100 cm with sites. The topography is flat or undulating entirely. The texture is medium (silty clay loam) in surface layer and medium to heavy (silty clay loam to clay). The intake rate values lie on the middle level (12.87 mm to 16.04 mm) in comparison with the values determined at other Schemes. The fertility is on the high side.

In the Lower Xe Set Scheme (about 1 250 ha), three units of soils, that is, alluvial soils (Orthic Acrisols or Dystric Cambisols and Fluvisols), soils derived from sand stone and clay stone (Orthic Acrisols or Dystric Cambisols) and soils derived from basalt rock, are found. Alluvial soils are scattered in lowland rice fields and their outskirts that spread at the back slough of both Xe Set and Lanan rivers. The area is about 170 ha in total. The effective depth is generally shallow, and the topography is almost plane. The texture is medium (silty loam). The fertility is on the medium to high side. The soils derived from sandstone and clay stone are also found in lowland rice fields and their outskirts at the back slough of two rivers as above. The area is about 240 ha in total. The effective depth is medium, and topography is almost flat. The texture is moderate between coarse (sandy loam) and medium (silty loam). The reaction is weak acid and the fertility is on the medium side. The soils derived from basalt rocks are found in main areas of the Scheme. The area is about 840 ha in total. The topography is undulating, rolling or gently sloping. The effective depth is shallow and rich in mineral segments such as gravel. The texture is usually medium (silty clay loam). The fertility is on the high level.

In the Upper Tay-Un Scheme (about 420 ha), two units of soils, that is, alluvial soils (Orthic Acrisols or Dystric Fluvisols) and basaltic soils (Dystric Nitosols) are distributed over areas of 50 ha and 370 ha, respectively. Alluvial soils are found in lowland rice fields that spread collectively in the central part and scattered in the north west and southwestern parts. The effective depth is deep and the topography is flat. The texture is medium (silty clay loam to heavy (clay loam)). The intake rate value is moderate (6.85 mm/hr) and fertility is on the high side. Basaltic soils are found in bush and forest areas. The effective depth is shallow to medium and the topography is gently undulating. The texture is medium (Silty Loam) to heavy (clay) and the fertility is on the high side. The intake rate value is moderate (9.41 mm/hr).

Soil maps of all Schemes are shown in Figures 2.1 to 2.5.

### (3) Land Suitability

Land suitability of the five Schemes was examined by the land use capability classes indicating suitable land use intensity for Lowland/Upland/Orchard. A brief description for capability classes is as follows:

- |            |  |
|------------|--|
| Class I.   | Soils have few limitations that restrict their use.  |
| Class II.  | Soils have some limitations that reduce the choice of plants or require moderate conservation.                   |
| Class III. | Soils have severe limitations that reduce the choice of plants, require special conservation practices, or both. |
| Class IV.  | Soils have very severe limitations that restrict the choice of plants, require very careful management, or both. |

The results obtained are as follows:

Scheme	unit : ha(๙)								
	Paddy			Upland			Orchard		
	I - III	IV	Total	I - III	IV	Total	I - III	IV	Total
Upper Champi	-	-	-	865 (88)	115 (12)	980 (100)	870 (89)	110 (11)	980 (100)
Upper Tapoung	-	-	-	100 (91)	10 (9)	110 (100)	100 (50)	100 (50)	200 (50)
Upper Kapheu	1,240 (91)	120 (9)	1,360 (100)	1,240 (91)	120 (9)	1,360 (100)	1,180 (87)	180 (13)	1,360 (100)
Lower Xe Set	1,250 (63)	720 (37)	1,970 (100)	1,250 (63)	720 (37)	1,970 (100)	-	-	-
Upper Tay-Un	410 (91)	40 (9)	450 (100)	410 (91)	40 (9)	450 (100)	410 (91)	40 (9)	450 (100)

The actual state concerning the land suitability of each Scheme is given in Figures 2.1 to 2.5 with the match-markings of soil units and land capability classes.

#### (4) Land Use

Present land use in the priority Schemes was examined using the topographical maps (a scale of 1 to 5,000) from aerophotographs taken by the study team in Phase II. The results obtained are summarized as follows:

- In the Upper Champi Scheme, coffee and tea are cultivated in a wide area covering approximately 72% of the area. Mixed land of bush and grass at borders of this area in the northeast, surrounded by tall trees is promising for agricultural development.
- In the Upper Tapoung Scheme, almost all the area is covered by bush and grass, and trees are scattered.
- In the Upper Kapheu Scheme, coffee is cultivated in the area of about 45% of the Scheme. Upland rice is also cultivated in an area of about 15%, but bush accounts for about 36% of the Scheme.
- In the Lower Xe Set Scheme, lowland rice and upland rice are cultivated in an area of about 8% and 11%, respectively. Upland crops: cotton, groundnuts, chili, etc. are cultivated at approximately 7% of the Scheme. Fruits such as banana are planted in small areas (about 2%), most of the remaining land is covered by bush, grass and tree.
- In the Upper Tay-Un Scheme, slash-and-burn cultivation is practiced in large extent and upland rice is cultivated in the area of about 8%. In the Scheme, several swamps and ponds are scattered. Lowland rice is cultivated where water is available in the wet season, but the area is less than 4%. The remaining land is mainly covered by bush, trees and grasses.
- According to result of the above land suitability classification, present land use, with the exception of unsuitable land, is shown in the following table.

Land Capability Class	(ha)										
	Lowland rice	Upland rice*	Upland Crop vegetable*	Coffee	Tea	Fruit*	Bush*	Grass*	Forest*	Swamp	Total
Upper Champi				490	140		40	80	120		870
Upper Tapoung							90		10		100
Upper Kapheu		190		560			450		40		1,240
Lower Xe Set	100	140	90			20	420	100	380		1,250
Upper Tay-Un	20	30					280	10	70	10	420
Total	120	360	90	1,050	140	20	1,280	190	620	10	3,880

Note: \* These areas presently belong to the category of slash-and-burn system.

Land use maps of all Schemes are shown in Figures 2.6 to 2.10.

### 1.1.4 Water Resources

#### (1) Basic Data

Due to insufficient river flow records in and around the Study area, water resources of specified river basins were evaluated at the beginning, based on the mean monthly flow records of the Xe Set power station during the Master Plan Study of the Project. Taking these data availability and required runoff data for further study into consideration, water level observation and discharge measurement on three rivers in the Study area were started by the study team at the end phase of Master Plan Study of the Project.

During the Feasibility Study stage, observed water level and discharge records were thoroughly checked to construct the H-Q curve, and continuous runoff records for the major rivers were prepared. In addition to the observation records, daily inflow data at the intake site of the Xe Set power station has obtained through analysis of daily power generating records. With these continuous river discharge records available in the Study area, construction and reproduction of the runoff model were made on the respective rivers for project formulation.

#### (2) Runoff Model

The runoff model aims to reproduce the river runoff in the selected priority area. To meet these requirements, Sugawara's Tank Model Method is employed to construct the basic rainfall-runoff model of the Project.

#### (3) Flow Regime of Rivers in the Selected Priority Area

Using the constructed run-off model and the basin areal rainfall, reproduction of river runoff related to the priority area is made on a daily basis. The duration of reproduction is ten (10) years from 1986 to 1995.

The following areal ratio which are determined on the basis of Thiessen Polygon is adopted for the river basin of the priority area;

Priority Area	River	Basin Area (km <sup>2</sup> )	Areal Ratio (%)		
			Pakxong	Laongam	Sekong
Upper Champi	H. Champi (47)	16.0	100	-	-
	H. Champi (43)	36.0	100	-	-
Upper Tapoung	H. Tapoung	4.0	100	-	-
Upper Kapheu	H. Kapheu	24.0	75	25	-
Lower Xe Set	Xe Set (dam)	325.0	68	32	-
	Xe Set (down)	88.0	-	100	-
Upper Tay-Un	H. Tay-Un	21.0	-	57	43
	H. Thong	8.0	-	25	75

Average mean monthly rainfall values are as follows, based on the point rainfall and areal ratio mentioned above;

	Jan	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
H.Champi 47 & 43, H. Tapoung	10.7	23.5	101.0	237.3	343.3	467.0	679.8	757.3	412.2	209.2	31.2	18.4	3,291.0
H. Kapheu	10.4	20.5	86.6	204.9	320.6	415.3	600.9	671.5	375.4	197.1	25.4	14.2	2,942.6
Xe Set	10.1	17.8	74.2	177.0	301.0	370.8	533.2	597.8	343.8	186.7	20.3	10.7	2,643.3
H. Tay-Un	9.5	20.1	66.1	125.0	248.2	264.1	352.5	414.1	264.8	168.7	41.2	19.4	1,993.8
H. Thong	9.7	26.6	83.2	138.0	245.2	267.2	343.7	414.0	264.7	174.7	66.0	32.5	2,065.4

Runoff calculation results for the objective rivers are shown in Table 2.1 with the monthly mean discharge basis. Summary of the calculation results are shown below. In the column, droughty, low-water, and ordinary discharges mean the discharges occurs more than 355, 275 and 185 days in a year, respectively.

**Upper Champi Project Area**

H. Champi (Lak 47), A= 16.0 km<sup>2</sup> (Unit : m<sup>3</sup>/sec)

Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	0.118	0.117	0.155	0.091	0.104	0.102	0.125	0.093	0.123	0.170	0.120
Low-water	0.243	0.262	0.314	0.230	0.229	0.272	0.226	0.194	0.309	0.277	0.256
Ordinary	0.602	0.528	0.579	0.622	0.546	0.651	0.464	0.357	0.701	0.438	0.549

**Upper Champi Project Area**

H. Champi (Lak 43), A= 36.0 km<sup>2</sup> (Unit : m<sup>3</sup>/sec)

Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	0.266	0.263	0.349	0.205	0.234	0.230	0.281	0.209	0.277	0.382	0.270
Low-water	0.547	0.590	0.706	0.518	0.515	0.612	0.508	0.436	0.695	0.623	0.575
Ordinary	1.354	1.188	1.303	1.400	1.228	1.465	1.044	0.803	1.577	0.986	1.235

**Upper Tapoung Project Area**

H. Tapoung, A= 4.0 km<sup>2</sup> (Unit : m<sup>3</sup>/sec)

Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	0.030	0.029	0.039	0.023	0.026	0.026	0.031	0.023	0.031	0.042	0.030
Low-water	0.061	0.066	0.078	0.058	0.057	0.068	0.056	0.048	0.077	0.069	0.064
Ordinary	0.150	0.132	0.145	0.156	0.136	0.163	0.116	0.089	0.175	0.110	0.137

**Upper Kapheu Project Area**

H. Kapheu, A= 24.0 km<sup>2</sup> (Unit : m<sup>3</sup>/sec)

Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	0.151	0.149	0.197	0.120	0.156	0.101	0.161	0.106	0.146	0.197	0.148
Low-water	0.326	0.346	0.401	0.317	0.343	0.300	0.293	0.242	0.353	0.334	0.325
Ordinary	0.804	0.682	0.770	0.847	0.818	0.770	0.617	0.456	0.857	0.540	0.716

**Lower Xe Set Project Area**

Dam, A= 325.0 km<sup>2</sup>  
Downstream catchment area, A= 88.0 km<sup>2</sup> (Unit : m<sup>3</sup>/sec)

Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	1.916	2.107	2.760	1.831	1.673	2.373	1.916	2.090	1.588	1.894	2.015
Low-water	3.877	4.565	4.756	4.010	3.107	3.798	3.300	3.116	3.487	3.128	3.714
Ordinary	15.850	10.140	12.486	14.451	10.173	10.057	5.886	5.412	9.447	5.990	9.987

**Upper Tay-Un Project Area**

H. Tay-Un, A= 21.0 km<sup>2</sup> (Unit : m<sup>3</sup>/sec)

Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	0.166	0.164	0.176	0.122	0.097	0.153	0.164	0.113	0.099	0.019	0.127
Low-water	0.254	0.284	0.277	0.221	0.170	0.204	0.237	0.170	0.160	0.111	0.209
Ordinary	0.607	0.405	0.470	0.489	0.359	0.386	0.300	0.374	0.260	0.210	0.386

## Upper Tay-Un Project Area

H. Thong, A= 8.0 km <sup>2</sup>		(Unit : m <sup>3</sup> /sec)									
Discharge	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Average
Droughty	0.070	0.070	0.075	0.053	0.050	0.076	0.072	0.046	0.050	0.017	0.058
Low-water	0.106	0.118	0.114	0.092	0.081	0.108	0.091	0.066	0.071	0.048	0.078
Ordinary	0.245	0.166	0.192	0.202	0.150	0.182	0.121	0.201	0.107	0.097	0.166

In accordance with the calculation results, droughty discharge occurs during the transition period from the rainy season to the dry season, such as the months from February to May.

The river basins of H. Champi, H. Tapoung, and H. Kapheu, which includes the huetal region of the Pakxong observatory, show rather stable and high specific discharge during the dry season compared with those in other rivers covered by the other huetal region.

During the course of the field survey, discharge measurements were carried out at each intake site of the priority area. From the comparison between the mean monthly value of estimated discharge by the constructed runoff model, and the observed discharge at each intake site, both discharges can be recognized in the same extent, except the value of H. Tay-Un. To verify such discharge differences of H. Tay-Un, runoff calculation for January and February in 1996 were carried out additionally using the constructed runoff model for the Xe Set basin. As a result, mean monthly discharges were estimated at 0.070 m<sup>3</sup>/sec for January and 0.020 m<sup>3</sup>/sec for February. Thus, the same discharge extent on estimation and observation values were obtained at the intake site of H. Tay-Un, reflecting little rainfall during the last rainy season and no rainfall in the succeeding dry season.

## (4) Flood Discharge at the Intake Site

Flood discharge at the intake site of selected priority areas is estimated by the rational formula. Probable daily rainfall is used for setting up the rainfall intensity during the arrival time of floods. From the point rainfall records and the Thiessen Polygon, daily rainfall of the priority area in each probable year is estimated. Arrival time of flood and rainfall intensity during the flood season are estimated by using Rziha's formula, and the presumed equation quoted from the arrival time of flood and daily rainfall.

Peak flood discharge estimated by the Rational formula is as follows on the basis of the above mentioned rainfall intensity and the basic data shown in the column.

Intake Site	Basic Data		Peak Flood Discharge (m <sup>3</sup> /sec)					
	Area(km <sup>2</sup> )	Runoff Coeffi.	1/5	1/10	1/30	1/50	1/100	1/200
H. Champi(47)	16.0	0.5	102.2	128.9	174.5	197.4	230.7	266.4
H. Champi(43)	36.0	0.5	196.1	247.3	334.8	378.8	442.6	511.2
H. Tapoung	4.0	0.5	33.6	42.4	57.4	64.9	75.9	87.6
H. Kapheu	24.0	0.5	122.0	153.5	206.8	233.5	272.0	313.3
Xe Set (dam)	325.0	0.5	776.2	975.6	1,312.8	1,481.1	1,723.7	1,983.3
Xe Set (down)	88.0	0.5	265.8	330.8	436.8	488.1	560.7	636.9
H. Tay-Un	21.0	0.5	83.2	103.8	138.0	154.7	178.7	204.1
H. Thong	8.0	0.5	27.8	34.8	46.6	52.6	61.1	70.2

## (5) Drainage Requirement

Estimation methodology of the water drainage requirement for the selected priority area is divided into two, paddy and upland fields. For the paddy field, such requirement is estimated to remove the surplus rain water with the drainage period of 3 days by using the probable daily rainfall which has a probability of once in five years. Besides, rational formula



is applied for the upland field to estimate the drainage water requirement with a probability of once in five years. Drainage period of four (4) hours for vegetable fields and one day for other upland crops are considered. Estimated results are as follows;

Priority Project Areas	Probable Daily Rainfall (mm/day)	Upland Field	
		Paddy Field q (lit./sec/ha)	r <sub>1</sub> (mm/hr) q (lit./sec/ha)
Upper Champi	272.1	10.5	27.8
Upper Tapoung	272.1	10.5	27.8
Upper Kapheu	186.0	7.2	7.8
Lower Xe Set	186.0	7.2	7.8
Upper Tay-Un	86.0	3.3	3.6

#### (6) Water Quality

To clarify the water quality at intake sites of priority areas, water samplings for quality analysis have been carried out at the following seven (7) sites in six (6) rivers.

The water quality of the river flow at intake sites of the selected priority areas, can all be basically used for irrigation and drinking purposes. For drinking use, however, removal facilities of iron may be required to suit the standard value of drinking water. To finalize the processing method of river flow, monitoring of the water quality throughout the year is required to clarify the quality transition, since the sampling of analyzed water was made only once at the middle of the dry season.

### 1.2 Social Aspects

According to a result of the Master Plan Study on the integrated agricultural and rural development project in Boloven Plateau, five Schemes were selected as the most priority development Schemes in the plateau. Social aspects of the selected five Scheme areas are described as follows:

#### 1.2.1 Land and Population

##### (1) Land and Administrative Jurisdiction

Each selected Scheme area to be developed covers a net area of: 730 ha in the Upper Champi Scheme, 80 ha in the Upper Tapoung Scheme, 1,000 ha in the Upper Kapheu Scheme, 1,000 ha in the Lower Xe Set Scheme, and 330 ha in the Upper Tay-Un Scheme. The administrative jurisdiction in each Scheme area is shown below.

Priority Scheme Area	Province	District	Net Area (ha)
Upper Champi	Champasak	Pakxong	730
Upper Tapoung	Champasak	Pakxong	80
Upper Kapheu	Salavan	Laongam	1,000
Lower Xe Set	Salavan	Salavan	1,000
Upper Tay-Un	Sekong	Thateng	330

Data source: JICA study Team

##### (2) Population

The population distribution, as of February 1996, of each priority Scheme area is obtained from village administrative committees relating to the Scheme areas, and is tabulated as follows:

Priority Scheme Area	No. of Households	Total Population	Female Households	Size of Households	Farm Households
Upper Champi	828	4,731	2,376	5.7	93
Upper Tapoung	268	1,478	739	5.8	91
Upper Kapheu	456	2,393	1,103	5.2	97
Lower Xe Set	386	2,218	1,066	5.6	92
Upper Tay-Un	108	871	423	7.9	98

Data Source: Village administrative committees related to the Scheme areas

Viewing from the above data, a ratio of male and female in each area is about equal, but the female's ratio is relatively higher. The economically active population of ages 15 to 64, ranges from 42 percent in the Upper Tay-Un Scheme to 56 percent in the Upper Kapheu Scheme, among the total populations. Farm household in the Scheme areas occupies from 91 percent in the Upper Tapoung Scheme to 98 percent in the Upper Tay-Un Scheme. However, the rest of these farm households are also engaged in agricultural activities in addition to their principal.

### 1.2.2 Socio-economic Conditions

The characteristics of five Scheme areas on the socio-economic conditions are presented by agriculture. Coffee and vegetables greatly contribute to regional economy. The socio-economic conditions in five priority Scheme areas are summarized as follows:

#### (1) Upper Champi Scheme Area

The area is situated halfway in gently sloping Boloven Plateau of the southwest part in the Pakxong district, Champasak province. Villages of the area are formed along the national road No. 23 which runs through the area, and extends over coffee gardens surrounding the housing area. Tea plantations also exists in part of this area. The area's economy is represented by coffee as the dominant crop. The national road No. 23 is paved by asphalt and 6m wide.

#### (2) Upper Tapoung Scheme Area

The area extends over the elevated land of the plateau, and is located at about 10 km north from the urban area of Pakxong, the district capital. Coffee feeder road linked with Pakxong and Laongam run through the area. Villages form groups facing the road, but have scattered houses typical of the Phoulankcoo village. Vegetables and coffee are the main staples, and vegetable cultivation is performed by a traditional farming method, such as slash-and-burn cultivation. It is easily accessible to Pakxong from the Project area, but maintenance of the road is still poor.

#### (3) Upper Kapheu Scheme Area

The location of the area is the south of the Laongam district, Salavan province, and in halfway of the plateau. The villages were settled several hundred years ago. All villages form the groups along the coffee feeder road except at Phouak-gnai. The main staple of the area is coffee. Coffee feeder road which run through the area is well-maintained. However Phouak-gnai village is not easily accessible from the coffee feeder road as the path linking them is narrow and poorly maintained.

#### (4) Lower Xe Set Scheme Area

The area extends over the right bank of the Xe Set river, and is situated in the south of the Salavan district, Salavan province. Two villages of the area are located along the national road No. 20, and the rest is scattered and isolated in the area. Main staples of this area are upland crops such as groundnut, soybean, cotton, lowland rice, etc. Traditional farming, such as slash-and-burn cultivation prevails in the area. The roads connecting with the national

road No. 20 with the villages are not well-maintained and not easily accessible. The area is the poorest within the five Scheme areas in the economical view. One drinking water factory exists in the area.

#### (5) Upper Tay-Un Scheme Area

The area is situated in the east of Thateng, district capital, of the Sekong province, and is in the northern part of the plateau. A small number of households form each village, according to its cultural background. The main economy in the area consists of lowland and upland rice and upland crops; and villagers largely practice traditional farming such as the slash-and-burn system. The national road No. 16 passes by villages of this area, and accessible throughout the year for transports.

### 1.2.3 Ethnic Groups

The priority Scheme areas are ethnically diverse societies which are composed of two main ethnic groups; Lao Loum and Lao Thueng. The ethnic groups distributed in five Scheme areas consist of numerous tribes; Lao-Tai and Phouthai of Lao Loum, and Laven, Yahuen, Suay, Taoi, Alak, Nge and Katu of Lao Thueng. Some Vietnamese families live in the Upper Champi Scheme area. The distribution of ethnic groups in the areas is shown below.

Priority Scheme Area	(Unit: %)		
	Lao Loum	Lao Thueng	Vietnamese
Upper Champi	53	45	2
Upper Tapoung	6	94	0
Upper Kapheu	38	62	0
Lower Xe Set	73	27	0
Upper Tay-Un	3	97	0

Data Source: Village administrative committees

The cultural patterns of ethnic groups in the Scheme areas are divided into two patterns; matrilineal and matrilineal in Lao Loum society and patrilineal and patrilineal in Lao Thueng society. Some sub-groups (Laven and Suay) of Lao Thueng acculturate to the Lao Loum's pattern, but their thought and behaviors are still under traditional animistic shamanism. The characteristics of ethnic groups in the Scheme areas are indicated below.

#### Upper Champi Scheme

- Major ethnic groups: Lao Loum (Lao-Tai) and Lao Thueng (Laven)
- Village formation: Grouping type with mixed ethnic groups
- Religion: Buddhist, animist (some small ethnic sub-groups)
- Agricultural system: Coffee and tea are produced in the hilly area
- Organizations: Village administration organizations, religious groups

#### Upper Tapoung Scheme

- Major ethnic groups: Lao Thueng (Laven)
- Village formation: Grouping type and scattered type with single ethnic group
- Religion: Buddhist with traditional animistic thought
- Agricultural system: Vegetable cultivation with slash-and-burn system and coffee growing in the plateau
- Organizations: Village administrative organizations, religious groups, traditional community groups

#### Upper Kapheu Scheme

- Major ethnic groups: Lao Loum (Phouthai) and Lao Thueng (Laven)
- Village formation: Grouping type with single ethnic group

- Religion: Buddhist (Lao Loum), animist (Lao Thueng)
- Agricultural system: Coffee growing and upland rice cultivation with slash-and-burn system
- Organizations: Village administrative organizations, religious groups, traditional community groups

#### Lower Xe Set Scheme

- Major ethnic groups: Lao Loum (Phouthai and Lao-Tai) and Lao Thueng (Taoi, Suay and Nge)
- Village formation: Grouping type with single ethnic group
- Religion: Buddhist (Lao Loum and Lao Thueng-Suay) and animist (Lao Thueng)
- Agricultural system: Upland rice and field crop cultivation with slash-and-burn system and lowland rice cultivation
- Organizations: Village administrative organizations, religious groups, traditional community groups

#### Upper Tay-Un Scheme

- Major ethnic groups: Lao Theung (Nge, Alak and Katu)
- Village formation: Grouping type with single ethnic group (Nge) and mixed ethnic groups (Alak and Katu)
- Religion: Animist
- Agricultural system: Upland rice and field crop cultivation with slash-and-burn system and irrigated lowland rice (some families)
- Organizations: Village administrative organizations, traditional community groups

There are no supporting activities for ethnic groups in the Scheme areas, except for Khonleng village in the Lower Xe Set Scheme area. In this village, the provincial women's union is carrying out supporting programs such as handicraft and weaving for the village women's group to improve family life in collaboration with NGO.

### 1.2.4 Living Conditions

#### (1) Occupation and Labor

Almost all the households in the Scheme areas use family labor in agriculture such as coffee, upland and lowland rice and upland field crop production; and some perform household work as well. In the Upper Tay-Un Scheme area, there is a tendency for female work to take longer than males, due to slash-and-burn farming and customary behavior. The labor exchange system for farming is common to both Lao Loum and Lao Thueng. However, the survey revealed that weeding and harvesting in coffee production are performed by hired labor, particularly in the Upper Champi and Upper Kapheu Scheme areas. Other productive activities such as vegetable gardening, pig and poultry raising are predominantly performed by female members of the family.

#### (2) Income and Home Economy

Cash family income is mainly derived from selling farm products such as coffee, tea, cardamom, vegetables, groundnut, chili and cotton. An additional source of income is the sale of pig and poultry, and bartering of farm products such as between groundnut and white rice, coffee bean and white rice or between farm produce and household commodities.

The household home economy is at a relatively moderate level in most areas of the Schemes, except for the Lower Xe Set and Upper Kapheu. Moderate and better-off groups are estimated at more than 80% of total households in these Scheme areas due to high income derived from coffee and/or vegetable production. But, the poverty group ratio of all households is estimated at about 79 percent in the Lower Xe Set and 39 percent in the Upper Kapheu because of unfavorable physical conditions for farming.

(3) Health Condition

There is a clinic in village Lak 35 of the Upper Champi Scheme and some pharmacies in the Scheme areas, except in the Upper Kapheu and Upper Tay-Un Schemes. The operation of the clinic is poor due to lack of human resources, medical supplies including essential drugs. Most people in the villages use traditional herbal medicine with some drugs purchased from pharmacies. In the villages of certain ethnic groups, spirits and tellers are the way of treating illness.

Diseases such as diarrhea, dysentery and malaria are always found in all the Scheme areas. In the Upper Kapheu, Lower Xe Set and Upper Tay-Un Schemes, goiter (iodine deficiency disease) prevails among girls and women.

(4) Educational Condition

Present primary schools are broadly divided into 2 types such as Class III and Class V referring schooling years. The schooling years are less than 3 years for Class III and 5 years for Class V.

The majority of primary schools are of Class III. The primary schools of Class V are built in four villages of the Upper Champi Scheme area, one (1) in each village of the Upper Tapoung and Upper Kapheu Schemes. However, no school of Class V exists in villages of the Lower Xe Set and Upper Tay-Un Schemes.

School buildings are often made of thatched roof, bamboo walls and earth floors, but the pupil/teacher ratio is relatively high (28 to 40) compared with the national level.

Literacy rate is extremely low ranging from 2 percent to 56 percent. Women's literacy rate is generally lower than that of men, because of drop out and poor attendance due household activities and discrimination against girls. The educational level of all adults is also low; those educated up to three years is estimated at about 95 percent, except in the Upper Champi Scheme.

(5) Living Environments

Domestic water resources are streams and springs in the dry season and rainwater in the rainy season in all Schemes, except for some villages of the Upper Kapheu and Upper Tay-Un Schemes which have wells. Girls and women have the responsibility for fetching water and always undertake two bups a day. About 85 percent of households in the areas use boiled water.

Electricity supply is limited to very few places in the Schemes. It is found in a part of the Upper Champi and Lower Xe Set Schemes due to people sharing 30 percent of the installation costs of the distribution lines. However, most village farmers are using oil lamps and resin for illuminating houses. Firewood collected from the common forest surrounding the housing area is generally used as fuel for cooking. However, coffee growers use cut branches of coffee trees.

Nearly half of the households have radio cassette recorders and bicycles. Seven percent of the households in the Upper Tay-Un and 30 percent in the Upper Champi also have TV sets. Coffee growers and vegetable farmers intend to buy motorcycles and hand tractors in the Upper Champi, Upper Tapoung and Upper Kapheu areas because of high income derived from coffee and vegetables.

Houses are generally constructed of wood and iron roofs, but many bamboo houses are found in the Lower Xe Set Scheme area. No houses have latrines in the three Scheme areas of the Upper Tapoung, Upper Kapheu and Lower Xe Set because of traditional behavior. About 10% of houses in the Upper Tay-Un Scheme have had latrines constructed through a health improvement program conducted by the women's group in association with the LWU. The area has a high incidence of epidemic diseases such as dysentery and cholera.

### 1.3 Agriculture

#### 1.3.1 Land Holding and Tenure System

As mentioned in the Master Plan, land could be inherited, transferred, leased, or sold to a Laotian national, all of which are legitimately recognized by the state at present. Each village is to maintain a land registry for individual holdings, and submit this to the authority concerned.

Most farmers cultivate about 1 to 2 ha of farm land including slash-and-burn fields, but some of them occupy about 5 to 10 ha of farm land for coffee plantations. In addition, some fields in the Upper Champi Scheme have been occupied by investors as land concession areas and these can be found around B. km 45. Tenured farm land from other farmers are hardly found in and around priority Schemes at present. In addition, the slash-and-burn cultivation farmers are assumed to hold additional fields of bush, grassland, and secondary forest for future slash-and-burn cultivation. It is estimated that they have three (3) to five (5) times as much present slash-and-burn cultivating fields. The average cultivating size and estimated holding size of the farms in the priority Schemes are shown below:

	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un
Cultivating size (ha)	3.0	2.5	1.7	1.4	1.9
Holding size (ha)	3.0	3.7	2.5	2.9	3.2

#### 1.3.2 Crops and Cropping Patterns

##### (1) Upper Champi Area

The main crops in the Upper Champi Scheme area are coffee and tea. The present cropping pattern is estimated based on the results of present land use study as follows:

Crops	(Unit: ha)	
	Wet season	Dry season
Coffee	460	460
Tea	130	130
Total	590	590

##### (2) Upper Tapoung Area

Most of the area is covered with elephant grass, and in some areas with bush and secondary forest. Actually the area is not utilized for agricultural purposes at present except grazing of cattle sometimes. The farmers living in the three project villages cultivate coffee, vegetables and upland crops outside the area.

##### (3) Upper Kapheu Area

The main crops in the Upper Kapheu area are coffee and upland rice. The present cropping pattern is estimated based on the results of present land use study as follows:

Crops	(Unit: ha)	
	Wet season	Dry season
Coffee	540	540
Upland rice	180	0
Total	720	540

**(4) Lower Xe Set Area**

The main crops in the Lower Xe Set Scheme area are lowland rice and upland rice. The present cropping pattern is estimated based on the results of present land use study as follows:

Crops	(Unit : ha)	
	Wet season	Dry season
Lowland rice	100	0
Upland rice	130	0
Upland crops	90	0
Fruits	20	20
Total	340	540

The area of lowland rice, upland rice, upland crops such as groundnut, chili, cotton, and banana is estimated at 100, 130, 90 and 20 ha, respectively. These crops are cultivated only in the wet season and no crops in the dry season except banana which is found in small areas.

**(5) Upper Tay-Un Area**

The main crops in the Upper Tay-Un area is lowland rice and upland rice. Besides these crops, the farmers grow coffee outside the area. The present cropping pattern is estimated based on the results of present land use study as follows:

Crops	(Unit : ha)	
	Wet season	Dry season
Lowland rice	20	0
Upland rice	20	0
Total	40	0

The area of lowland rice and upland rice is estimated at 20 and 20 ha, respectively. These crops are cultivated only in the wet season and no crops in the dry season.

**1.3.3 Farming Practices**

There are no clear differences in the farming practices and cropping seasons among the priority Schemes, and the farming practices prevailing in the areas are almost at the same level technically.

**(1) Coffee**

The main coffee flowering season varies from the end of February to March, and harvested mainly in January to March in the Upper Champi and Upper Tapoung areas; December to February in the Upper Kapheu and Upper Tay-Un areas. Usually no chemical fertilizers are applied and pruning is not appropriately done. In the Upper Kapheu area, the yield of coffee in 1995/96 was very low, about 1/3 of the former year due mainly to water deficiency during the flowering formation.

(2) Cabbage

Cabbage is the main vegetable produced in the Upper Tapping area. The seeding starts in December to January and harvesting in May to June. Farmers also grow cabbage during the rainy season, harvesting in September to October. Usually they use seed from abroad, compound chemical fertilizers such as 16-20-0, and apply insecticides. The main insect is Diamondback moth (Pullet *Xylostella*). Seedlings are raised in nurseries located along streams and watered by can or small pump. Transplanting to the main field usually located far away from the villages is done with rainfall, but presently some farmers have small irrigation pumps to lift water from the streams. Most of the cabbage production is done under slash-and-burn system and some of the fields are planted with coffee trees after the cabbage crop.

(3) Rice

Upland rice is grown under the slash-and-burn system in all Scheme areas, especially in Upper Kapheu, Lower Xe Set and Upper Tay-Un areas. Most of the lowland rice cultivation is found in Lower Xe Set and Upper Tay-Un areas with irrigation water diverted from rivers near the field. Ordinary transplanting method is applied using nursery. Seeding time is around May to June and transplanted after one month of seeding, and harvested during November to December in Lower Xe Set area, and December to January in Upper Tay-Un area. Most rice varieties are glutinous. The farming practices of rice cultivation in the priority Scheme areas have no distinct differences as mentioned in the Master Plan Study.

(4) Upland Crops

Other upland crops such as groundnut, chili and cotton are cultivated in the Lower Xe Set area in addition to rice cultivation. Cotton and chili are sometimes grown as mixed crops. Chili is transplanted at the beginning of the rainy season and harvested in September to October. Cotton is seeded in June and harvested in November to December. Groundnut is seeded in May to June and harvested in August to September. Variety of groundnuts grown in the area is mostly of local type. Usually no chemical fertilizers and pesticides are applied.

(5) Tea

Tea is found only in the Upper Champi area. Harvesting of tea is done twice a month during wet season and once a month in the dry season. The processing method of tea is roasting on a wide iron pan using fire. The tea is sold in the domestic market, but some tea farms are out of production due to low market price.



### 1.3.4 Yield and Production of Crops

The average yield of crops are generally at a low level in all Scheme areas. The average yield of the main crops in each area are as shown below:

Crops	(Unit : yield in ton/ha)				
	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un
Coffee	0.3	0.4	0.3	-	0.23
Tea	0.34	-	-	-	-
Upland rice	0.5	0.6	1.5	2.1	1.4
Lowland rice	-	-	3.0	2.6	1.7
Cabbage	-	10	-	-	-
Groundnut	-	-	-	1.5	-
Chilly	-	-	-	0.08	-
Cotton	-	-	-	0.5	-
CarJamom	0.04	-	-	-	0.04

(Coffee in green beans, rice in paddy, groundnut in shell and chilly in dried conditions)

The average unit yield of coffee is still very low, around 0.2 to 0.4 ton/ha and no distinct differences are found among the areas.

Lowland rice cultivation is done with very little care and management; no weeding or fencing, etc. All farmers use local varieties and generally apply neither chemical fertilizers nor organic manure. The average yield of lowland rice ranges from 1.7 ton/ha in the Upper Tay-Un area to 3 ton/ha in the Upper Kapheu area.

The main vegetable around Upper Tapoung area is cabbage, and the unit yield is estimated at about 10 ton/ha on average. The present low yield is mainly due to lack of proper cultivation techniques by farmers such as application of fertilizers and effective control of insects, and sometimes due to shortage of irrigation water in the dry season.

The production of the main crops in the priority areas are estimated as follows:

Main crops	(Unit : area in ha, production in ton)									
	Upper Champi		Upper Tapoung		Upper Kapheu		Lower Xe Set		Upper Tay-Un	
	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod
Coffee	460	138	-	-	540	162	-	-	-	-
Tea	130	39	-	-	-	-	-	-	-	-
Upland rice	-	-	-	-	180	270	130	273	30	42
Lowland rice	-	-	-	-	-	-	100	260	20	34
Upland crops*	-	-	-	-	-	-	90	135	-	-
Fruits**	-	-	-	-	-	-	20	120	-	-

\* Groundnut, \*\* Banana.

Champi area produces coffee and tea, about 140 and 40 tons respectively. Upper Kapheu produces coffee and upland rice; about 160 and 270 tons, respectively. Lower Xe Set area's main crops are upland rice, lowland rice and upland crops, production is about 270, 260 and 140 tons respectively. Upper Tay-Un Scheme area produces only upland and lowland rice; about 40 and 30 tons respectively.

### 1.3.5 Livestock and Fish Culture

#### (1) Livestock

The main livestock types in each Scheme area is shown in the table below:

Main Livestock	Upper Champi		Upper Tapoung		Upper Kapheu		Lower Xe Set		Upper Tay-Un	
	Total	/Farmer	Total	/Farmer	Total	/Farmer	Total	/Farmer	Total	/Farmer
Buffalo	-	-	-	-	-	-	200	0.7	180	3.6
Cattle	490	2.5	-	2.9	430	1.0	430	1.5	50	0.9
Horse	20	0.1	-	0.7	-	-	-	-	-	-
Pig	240	1.2	-	0.6	820	1.9	490	1.7	70	1.3
Poultry	1,350	6.8	-	6.5	4,300	10.0	2,200	7.8	340	6.7

#### (a) Upper Champi Area

Main livestock in the area are cattle, pig and poultry, and the number of these animals is estimated at 490, 240 and 1,350, respectively. No fish pond is found in the area.

#### (b) Upper Kapheu Area

Most of farmers in the area raise cattle, pig and poultry, and the number of these animals is estimated at 430, 820 and 4,300, respectively. No fish pond is found in the area.

#### (c) Lower Xe Set Area

Most farmers in the area raise cattle, pig and poultry, and buffalo is raised by most lowland rice farmers. The total number of these animals is estimated at 430, 490, 2,200 and 200, respectively.

About 5 ha of fish pond are found in the area according to the results of land use study, but the yield of fish is quite low mostly due to lack of technology and shortage of water especially during the dry season.

#### (d) Upper Tay-Un Area

Buffalo, cattle, pig and poultry are the main livestock types in the area and the total number of these animals is estimated at 180, 50, 70 and 340, respectively.

About 6 ha of fish ponds including natural swamps, are found in the area. These ponds have been constructed recently and the yield of fish is quite low mostly due to lack of techniques and shortage of water especially during the dry season.

### 1.3.6 Post-harvest and Processing of Product

The most important agro-processing activity in and around each Scheme area is rice milling and coffee milling. Most villagers have privately owned rice/coffee mills. The number of rice/coffee mills in each area is obtained from each village office concerned as follows:

Machine	(Capacity : ton/day in output)									
	Upper Champi		Upper Tapoung		Upper Kapheu		Lower Xe Set		Upper Tay-Un	
	No.	Capa.	No.	Capa.	No.	Capa.	No.	Capa.	No.	Capa.
Rice mill	-	-	-	-	9	26	7	4.2	-	-
Coffee mill	27	58	2	5	36	50	4	6	6	5
Total	27	-	2	-	45	-	11	-	6	-

There are no complaints by farmers about milling quality, capacity and recovery rate, etc.; but it was observed that the steel huller type mill is used for milling of rice and coffee, and the recovery rate is about 60-62% for rice, 50 to 60% for coffee on average according to millers. Some villagers pound the rice for home consumption.

Coffee is mostly dried on the ground directly and the quality is very low due mainly to fermentation during the drying process. This is the most important aspect to be improved in the coffee growing areas.

### 1.3.7 Present Agricultural Production Value

Present gross production value in each priority area is estimated based on the farmgate prices in 1995, and the results are summarized below:

	Upper Champi		Upper Kapheu		Lower Xe Set		Upper Tay-Un	
	Prod. (ton)	Value (000kip)	Prod. (ton)	Value (000kip)	Prod. (ton)	Value (000kip)	Prod. (ton)	Value (000kip)
Crops								
Coffee	138	151,800	162	178,200	-	-	-	-
Tea	39	17,550	-	-	-	-	-	-
Upland rice	-	-	270	40,500	273	40,950	42	6,300
Upland crops	-	-	-	-	135	33,750	-	-
Lowland rice	-	-	-	-	260	39,000	34	5,100
Fruit	-	-	-	-	240	13,710	-	-
Total	177	169,350	432	218,700	908	127,410	76	11,400

Remark : Upper Tapoung area is excluded in the above table, because there is no farm land in the Scheme area.

## 1.4 Agricultural Support Services

### 1.4.1 Research

The existing research stations are responsible for agricultural research for crop production of the five priority Scheme areas; Phone Ngam Research Station in Pakxe, which carries out lowland rice research, experimentation and extension under the National Rice Research Program (NRRP) supported by the Lao-IRRI project; The Ban Itou Research Station of the Lao Upland Agricultural Development project (LUADP) financed by the World Bank with technical assistance by the French government conducts research on coffee. At the end of February, 1996, technical assistance for upland crops of the LUADP by the Australian government was terminated.

A new station, Palay Upland Crop Research Station of Champasak province is now under construction at the site of Palay Irrigation project, and will conduct upland field crop research and trial. The new station will contribute to research and extension works for upland field crops in the Scheme area. Besides, the Fishery Research and Extension Station, located at km 8, is now under rehabilitation supported by the Mekong Commission. The freshwater fishery production in the Scheme area will be accelerated by this station.

#### **1.4.2 Agricultural Extension**

The extension activities in the priority Scheme areas do not function well due to shortage of extension staff and insufficient resources. In addition, the low capability of the district AFS staff contribute to the difficulties. The provincial AFSs hold farming technology seminars for village leaders once a year. According to the survey, the extension work as field visit by the extension staff of the district AFSs have been conducted one or two days a year, in some villages. However, most villages in the Scheme area did not receive any extension work from the district AFSs last year. Currently, MAF places emphasis on the strengthening of agricultural extension nation-wide, based on the National Integrated Extension and Research Program (NIERP), and training on extension methodology for staff and extension officers of the provincial AFSs is provided by the Agricultural Extension Agency in Vientiane.

Furthermore, the extension station of the LUADP located at Ban Itou is also carrying out extension activities on coffee production in the target villages of the Scheme area. The extension work at the target village has been conducted two or three days a year. The objective of extension work is mainly for improvement of coffee breeding and management.

In the Lower Xe Set Scheme area, the provincial AFSs is carrying out intensive extension work of upland crop production, particularly groundnut production, in Khonleng village.

#### **1.4.3 Agricultural Credit Services**

The total amount of loans given in 1995 in the priority Scheme area by the Agricultural Promotion Bank (APB) are; 190,831,500 kip in the Upper Champi Scheme area, 89,359,000 kip in the Upper Tapoung Scheme area, 18,988,000 kip in the Upper Kapheu Scheme area and 14,601,000 kip in the Lower Xe Set Scheme area respectively. No loans from the APB have been provided in the Upper Tay-Un Scheme area. According to the survey, the villagers' need for agricultural credit (APB) in the Upper Tay-Un Scheme area is not being met because of complicated procedures.

According to the APB's provincial branches related to the Scheme area, the number of groups and families to be recipients of loans in the Scheme area is; 31 groups with 310 families in the Upper Champi Scheme area, 11 groups with 84 families in the Upper Tapoung Scheme area, 11 groups with 65 families in the Upper Kapheu Scheme area, and 9 groups with 87 families in the Lower Xe Set Scheme area respectively.

In order to promote coffee production in the Boloven Plateau, the APB established its Pakxong Office in 1995. The loans are only for coffee production in the plateau area. In the villages of Lower Xe Set Scheme area, some groups obtain loans for upland field crops and livestock production from the Salavan branch of the APB.

#### 1.4.4 Farmers' Organizations

There are some farmers' organizations established, such as the rice bank, mutual fund, extension group of the LUADP, and production group of the APB, in the priority Scheme areas. The rice bank and mutual fund were established by villagers in 1995. A rice bank exists in each of the Upper Kapheu, Lower Xe Set and Upper Tay-Un Scheme areas; and two mutual funds are in the Upper Champi Scheme area. Existing rice banks were set up under the guidance of the LUADP, and supported by the LWU, particularly in villages of ethnic groups. The interest rate of this bank varies depending on the village, from 20 percent to 50 percent, and borrowed rice returns with interest after harvesting.

With regard to a water user's group in the villages, there are none in the five Scheme areas, including even the Upper Tay-Un Scheme area where irrigation practices currently extend in small paddy field with irrigation facilities such as intake and canal. The beneficiaries maintain these facilities by themselves without any support from the authorities. These activities show the traditional behavior of ethnic minorities.

Most village women's groups in the Scheme area are inactive because of insufficient voluntary participation and sources for operation. Women's Union of Salavan province strives for the promotion of women's development projects in ethnic village groups. In Khonleng village of Lower Xe Set Scheme area. A women's group is working to improve their living condition through projects supported by the provincial women's union and UNICEF. However, the projects do not cover target villages in other Scheme areas.

#### 1.4.5 Women's Role in Agriculture

As mentioned in 1.2.3, Ethnic Groups in the most priority Scheme areas exhibit ethnically diverse societies comprising numerous tribal groups of Lao theung and some groups of Lao Loum. Among the ethnic groups, gender-based division of labor varies with farming patterns. From the village survey, it appears that the women's average working hours on the farm vary substantially as shown in the following table.

Priority Scheme area	Main farming types	No. of village	Ethnic composition of each village	Women's farm working hour		
				Lao Loum	Lao Theung	Average
Upper Champi	Coffee	8	Mix	2-5	6-7	5.4
Upper Tapoung	Coffee, vegetables	3	Single	-	5-6	5.3
Uppaer Kapheu	Coffee, upland rice	5	Single	2-7	5-7	5.4
Lower Xe Set	Up. crops, low. rice	6	Single	4-5	6-8	5.5
Upper Tay-Un	Coffee, up/low. rice	3	Single	-	6-8	6.7

The social organization of Upper Tay-Un Scheme area and some villages of the Lower Xe Set Scheme area is different from the other ethnic societies; and their societies are based on patrilocal and patrilinear cultural patterns.

According to the survey, most women in the ethnic minorities' villages consider husking rice the most exhausting task among domestic activities. Traditional husking and winnowing of rice takes more than one hour per day. Cooking takes two or three hours, water fetching usually requires one to one and half hours per day, and almost all households in the Scheme area have no access to improved sources of water. In addition, the working hours on daily tasks such as pig and poultry raising, taking care of vegetable gardens, are about 2.3 hours on average in the Scheme areas. In total, women in the Scheme area spend approximately 13 hours per day working, seven days a week.

## **1.5 Irrigation and Drainage System**

### **1.5.1 Existing Irrigation and Drainage Facilities**

Small irrigation systems constructed and managed by farmers themselves were found at 5 sites in and around three Scheme areas, namely Upper Kapheu, Lower Xe Set and Upper Tay-Un. Total irrigation area is estimated at about 40 ha. Water offtake systems for the irrigation areas are mainly small brush weirs which are made with stone, wood and bamboo. Irrigation water is conveyed through small earth canals by gravity method. Irrigation water supply is carried out for the rainy season paddy cultivation only.

### **1.5.2 Irrigation Water Management**

Operation and maintenance works of all existing irrigation systems are conducted by the farmers themselves as follows, but irrigation water users' groups are not established. Operation of irrigation water supply is carried out only in the rainy season and no irrigation practices are done in the dry season in the all existing systems. Operation and maintenance works of canals are executed by the farmers themselves.

## 1.6 Rural Infrastructure

### 1.6.1 Rural Road Networks

Two (2) of the selected priority areas, Upper Champi and Lower Xe Set are located along the national roads No.23 or No.20 respectively and have good accessibility. These national roads have a 6.0 m width of asphalt pavement and 1.5 m of shoulders on either side (Lao Standard Class-IV).

Upper Tay-Un area has also good accessibility connected with the national gravel roads No.23 and No.16. The road No.23 in this section is now under rehabilitation and its asphalt pavement work will be completed by 1997. The rehabilitation and asphaltting of road No.16 is also financed by the ADB, and will be completed by 2000.

Upper Tapoung area is about 10 km away from road No.23 at Pakxong. This priority area is connected through a district road (Coffee Feeder Road), with a 4.5 m of laterite paved roadway and 1.0 m shoulders (Lao Standard Class-V). This road was recently improved by the province of Champasak under "Coffee Feeder Road Improvement Program", newly financed by ADB. Coffee feeder road construction under the Upland Agriculture Development project, financed by the World Bank, had been delayed until 1995 because of some engineering problems. All the above coffee feeder road construction programs were transferred to the three (3) respective provinces of Champasak, Salavan and Sekong with new finance from ADB, and are expected to be completed within two (2) years.

Upper Kapheu area is also located about 4 km away from road No.20 at B.On-Beng (the entrance to this priority area). This area is connected with a district road (one of the Laongam Coffee Roads constructed in 1988) with the same width as the above Coffee Feeder Road and well maintained by the province of Salavan.

In addition to the above national and major district roads, village roads (village to village) and farm roads (village to farm) are identified in the areas. These are all earth roads with a 2.0 to 4.0 m of width, mostly constructed by farmers themselves. The condition of these roads is very poor. Only ox-cart or hand tractors can be used on these roads in the dry season. These village and farm roads are maintained by the farmers themselves according to necessity. Besides these farm roads, there are many footpaths mainly for agricultural activities. The total lengths of these roads in the priority areas are summarized below. The road densities are very low, varying from 1.9 to 12.4 km/km<sup>2</sup> in each area and 3.0 km/km<sup>2</sup> on average in all priority areas, even though the farm roads are included in the calculation.

Road Length and Density

Priority Scheme Area	Net Area (ha)	Road Category				Total Length (km)	Road Density (km/km <sup>2</sup> )
		National	District	Village	Farm		
Upper Champi	730	13.8	3.1	4.5	8.8	30.2	4.1
Upper Tapoung	80	0.0	6.4	0.0	3.5	9.9	12.4
Upper Kapheu	1,000	0.0	6.3	3.7	10.2	20.2	2.0
Lower Xe Set	1,000	4.4	5.6	8.9	0.0	18.9	1.9
Upper Tay-Un	330	1.6	2.8	1.7	7.7	13.8	4.2
(Total)	3,140	19.8	24.2	18.8	30.2	93.0	3.0

### 1.6.2 Rural Water Supply Facility

Almost all villages in the priority areas rely entirely on nearby streams or rivers for drinking and domestic water. These villages are usually located near perennial streams and rivers, not more than few hundred meters away. However, some villagers carry water for more than 1.0 km, particularly in the dry season. In the Upper Champi and Upper Kapheu areas, the people are also facing difficulty in fetching water from deep valleys. These water

sources show mostly fecal pollution and other types of contamination problems of human and animal origins.

Only limited villages have access to other water sources and these are gravity flow piped water systems, springs, dugwells and tube wells with hand pumps. There are two (2) gravity flow piped water systems in B.Lak40 and B. Lak38 of the Upper Champi area. These are supported by the provincial public health service and UNICEF. The number of communal taps are 19 in B.Lak40 and 16 in B.Lak38, with an average ratio of six (6) households per tap. In addition, one (1) private piped water system exists in B.Lak42, which covers seven (7) households with one (1) communal tap. This system consists of a generator, a motor pump, a concrete reservoir tank (8 m<sup>3</sup>) and 500 m of pipe line.

The villagers of B. Lak43 of the Upper Champi area rely on ten (10) dug shallow wells because of the long distance to the stream. These wells are about 13 to 15 m deep and are protected by brick masonry at the ground level. Almost all the wells are contaminated in the rainy season and insufficient in the dry season.

There is one (1) water system developed from a spring in B. Khamkok of the Upper Tay-Un area. This system was constructed in 1995 supported by AICF (an NGO). The system consists of a water collecting facility protected by concrete walls, a washing/bathing platform, and is without distribution pipelines. The pipes are directly installed and the water flows out continuously.

There is one (1) tube well with hand pump with a depth of 30 m in B.Chakam-mai of the Upper Tay-Un area. This well was newly constructed in 1996 supported by the provincial public health service and UNICEF. The village people also shared the cost of installation by providing 100,000 kip. This well is used only for drinking purposes by the people. H. Tit, about 200 m away from the village is the water source for bathing and washing purposes.

Number of villages by main water source are summarized below. The figures in the table below show that 20 villages or 80% of villages in all priority areas rely on nearby streams or rivers for drinking and domestic purposes, with an average distance of 200 m for fetching water.

Priority Areas	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	Total
No. of Villages	8	3	5	6	3	25
Water Source						
(1) Gravity Flow Piped Water System	2	0	0	0	0	2
(2) Spring Development System	0	0	0	0	1	1
(3) Shallow Dug Well	1	0	0	0	0	1
(4) Tubule with Hand Pump	0	0	0	0	1	1
(5) River/Stream/Spring	5	3	5	6	1	20

### 1.6.3 Water Supply Management

The existing village water supply systems in B.Lak40 and B.Lak38 are very simple gravity flow piped systems and the people have insufficient water during the dry season because of limited water source. Both systems are managed by the village committees and no specific water user's association exists. Water charges are not collected regularly and some are collected in case of necessity of repair. In the event of major repair, village people wait for government assistance. According to the interview survey, water supply is not properly distributed to the people. In other words, the people located near the water source get more water than those located far downstream resulting in some complaints about unfair water distribution.



### 1.6.4 Power Supply

Of a total of 25 villages in all priority areas, only one (1) village B.Lak35 in the Upper Champi area, is electrified with two (2) units of transformers (22 kV to 0.4 kV, 100 kVA). The total number of house connections is 111 among 121 households, showing a 92% user ratio in the village. The power rates by categories are summarized below:

Power Rate		
Category	Power Rate (kip/kWH)	
(1) Office, Hotel, Market, Restaurant		47
(2) Residence	0 - 100 kWH	8
	101 - 200 kWH	15
	201 < kWH	25
(3) Irrigation		7
(4) Factory		30

The extension of 22 kV transmission lines is being carried out in and around the priority areas based on the Provincial Grid Integration project (PGI) by MIH and EDL. According to the extension plan above, 8 villages or 32% of total villages in all priority areas will be electrified by the year 2000. In addition, once the above extension plan is realized, twelve more villages can be electrified with an installation of a transformer (22 kV to 0.4 kV) in each village. However, one condition is that the beneficiaries pay 30% of the total cost for extension. The transmission extension plan related to the priority areas is summarized below:

Transmission Extension Plan					
Priority Area	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un
Total No. of Villages in the Priority Area	8	3	5	6	3
Province	Champasak	Champasak	Salavan	Salavan	Sekong
District	Pakxong	Pakxong	Laongam	Salavan	Thateng
(1) PGI Champasak <sup>*1</sup>	4 (8) <sup>*4</sup>	1 (3) <sup>*4</sup>			
(2) PGI Salavan <sup>*2</sup>			3		
(3) PGI Sekong <sup>*3</sup>				(3) <sup>*4</sup>	(3) <sup>*4</sup>

- Note : \*1: PGI of Champasak province (Plan for Pakxong district up to the year 2000):  
A total of ten (10) villages will be electrified, out of which four (4) villages are in the Upper Champi area and one (1) village is Upper Tapoung area. They are B.Lak33, B.Lak38, B.Lak40, B.Lak43 and B.Xetapoun. However, 22 kV transmission line will cover all the villages in the Upper Champi and Upper Tapoung.
- \*2: PGI of Salavan province (Plan for Laongam district in 1997):  
A total of ten (10) villages will be electrified, out of which three (3) villages are in the Upper Kapheu area. They are B.Ong-gnai, B.On-noi and B.Phouak-noi.
- \*3: PGI of Sekong province (Plan for Thateng district in 1998):  
22 kV transmission line with a total length of 37 km will be extended from B.Beng to Thateng district, which may cover the Upper Tay-Un area, because the line will be extended to Sekong in near future by way of the Upper Tay-Un area.
- \*4: The figures in parenthesis show the number of possible electrified villages, if 0.4 kV transformers are installed, with the burden shared by the villagers.

### 1.6.5 Other Rural Infrastructure Facilities

#### (1) Health Care Facilities

There is only one (1) village clinic in all of the priority areas, located in B.Lak35 of the Upper Champi area. This clinic consists of one room, 4.0m by 6.0m with wooden walls and galvanized iron roofing and has no water supply facilities. It is far below the standard requirement of a village clinic building, which is a space of about 42 m<sup>2</sup> (6m x 7m), consisting of a consultation room, examination room, stock room, toilet and dining room. One (1) assistant doctor and two (2) nurses are assigned by the provincial public health department to this village clinic. However, the assistant doctor is mainly working at Pakxong district hospital about 15 km away and the two nurses are generally on-call. This may be because of the poor condition of the clinic and the people prefer to go to the district hospital in Pakxong or the provincial hospital in Pakxe Thence.

The people in the other priority areas also go to the district or provincial hospitals nearby when they get ill. According to the public health department officer in Champasak, government health services are concentrating not only on medical treatment of patients but on rural health care. The rural health service activities are based on such programs as MCH(Mother Child Health-care), vaccination for six (6) diseases in the 0 - 5 year age group, malaria control, environmental sanitation, health education and water supply programs.

However, there are no permanent and established health units in the villages. The government assigned a village midwife "Mae Thamnae" in each village to help the government health services in the rural areas. The village midwives are not supported by the government but voluntarily by the villagers. The personnel from the district usually devote very few days a month or year to visit these areas because of lack of manpower. The village midwives concentrate their efforts in the rural areas. There are no specific permanent buildings for such rural health care services. Instead, these villages use vacant school rooms, or private houses to conduct basic health care services to the people.

The acute lack of facilities and equipment including vehicles, greatly limit rural medical services, both in quality and scope.

#### (2) School Facilities

The situation of school facilities is summarized below:

##### Primary and Secondary School

Priority Area	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	(Total)
Total No. of Villages in the Priority Area	8	3	5	6	3	25
Class-III Primary School	3	2	3	4	1	13
Class-V Primary School	4	1	1	0	0	6
(Total)	7	3	4	4	1	19
Secondary School	2	0	0	0	0	2

Of 25 villages in all the priority areas, five (5) villages have no primary school. Generally, the children in the villages without schools do not go to school because of the long distance to the nearest school. Some of the parents in these villages also are not interested in, or do not understand the importance of their children's education. Poor accessibility to the villages, poor school building facilities and living conditions in the rural areas make it difficult to station school teachers.

Almost all class-III primary schools are constructed and maintained by the villagers themselves. These class-III primary school building facilities are very poor, consisting of one

room, wooden or bamboo walls, galvanized iron roof and an earth floor, with an average floor area of 50 m<sup>2</sup>. The class-V primary schools are in a little better condition because most class-V schools are supported by the provincial education service and UNICEF, providing construction materials such as galvanized roofs, nails and cement. Of 19 class-III and class-V primary schools, only two (2) have concrete floorings.

As for secondary schools, there are two (2) schools in both B.Lak35 and B.Lak43 of the Upper Champi area. Both of these also have poor building facilities, consisting of three (3) rooms, made of wooden walls, galvanized iron roof and earth floor, with an average floor area of 130 m<sup>2</sup>.

Almost all primary schools have no water supply and latrine facilities, which are so essential. Not only school buildings but other school equipment such as desks, benches and blackboards are also in very poor condition. School teachers' rooms are also required for both primary and secondary schools. Both institutional and budgetary support for primary schools are weak.

### (3) Village Community Hall

Among 25 villages of all the priority areas, there are two (2) village community halls; in B.Lak45 and B.Lak42 of the Upper Champi area. Both these have poor facilities, consisting of one (1) room of wooden walls, galvanized iron roof and wooden floor with an average floor area of 50 m<sup>2</sup>. The other villages generally use such facilities as temples, schools, village leader's houses and even open spaces for village level communication.

## 1.7 Agro-economy and Marketing Condition

### 1.7.1 Marketing of Agricultural Products

#### (1) Marketed Crops

The following agricultural products are mainly traded in and around each Scheme area.

Scheme area	Major traded Product	
Upper Champi	Coffee	Tea
Upper Tapoung	Coffee	Cabbage
Upper Kapheu	Coffee	
Lower Xe Set	Groundnut	Chili
Upper Tay-Un	Coffee	

The following table summarizes the present marketing conditions of each traded product in 1995.

Commodities	Selling or Buying	Price	Market	Quality	(Price: kip/kg)
					Problems
Coffee	Selling	950-1100	export	poor	post harvest
Tea	Selling	200-2000	domestic	poor-well	post harvest
Cabbage	Selling	0-250	Thailand & domestic	poor-medium	market is limited (for farmers)
Groundnut	Selling	200-400	Thailand	poor-medium	-
Chili	Selling	2000	domestic	medium	many commodities from Thailand
Rice	Buying	250-300	domestic	poor-medium	-

As mentioned in the Master Plan, the quality of coffee and tea is quite low due to poor processing after harvest. In marketing cabbage, the problem is the unstable market which the farmers have no access to, they simply wait for the buyers to come to the farm.

(2) Farm Input Supply

Most farmers do not use fertilizers and agrochemicals, except for cabbage farmers and some coffee farmers, due to poor knowledge and lack of budget. However, there are also no access to farm inputs in the Scheme areas. At present, they have to go to the Pakxe market to purchase farm inputs.

(3) Post Harvest

(a) Milling of Coffee and Rice

There are no complaints by farmers about milling quality, capacity and recovery rate, etc.; but it was observed that the steel huller type mill is used for the milling of rice and coffee. The recovery rate is about 60-62% for rice, 50-60% for coffee on average according to millers. Some villagers still pound the rice for home consumption.

(b) Drying of Coffee

Presently, the farmers use the "natural drying method" for coffee drying. After harvesting, they sun dry the fresh cherries for about 1 to 2 weeks depending on climatic condition. At this time, most of them dry the cherries on the ground directly. However, some of them use vinyl mats or raised bamboo slats. Therefore, the result is insufficiently dried or fermented cherries, the main reason for low quality Lao coffee.

(c) Tea Processing

Tea is produced by the roasting method using a hot iron pan. The taste of it is close to Chinese tea. After harvesting, the leaves are roasted and dried, and this process is repeated several times. The problems lie in the roasting process. Because they use firewood for roasting, tea has a smoky flavor and its aroma is altered.

### 1.7.2 Agro-economic Condition

(1) Demand and Supply

The demand and supply of food in and around the Schemes in 1995 is analyzed as follows:

Scheme Area	Total Population (person)	Rice demand (Paddy) (ton)	Production of paddy (ton)	Balance	
				Total (ton)	Per capita (kg/person)
Upper Champi	4,731	1,420	10	-1,410	-298
Upper Tapoung	1,478	440	10	-430	-290
Upper Kapheu	2,393	720	400	-320	-174
Lower Xe Set	2,218	670	480	-190	-86
Upper Tay-Un	871	260	190	-70	-80

Remark: Requirement of rice consumption is calculated at 300 kg of paddy/capita/year.

In the Scheme areas, there is a shortage in rice production. Most coffee farmers in the Upper Champi, Upper Tapoung and Upper Kapheu areas have established a trading system and also a consumption style, where farmers buy their food from their cash income. On the other hand, farmers in the Lower Xe Set and Upper Tay-Un produce their rice by themselves. However, presently the amount of rice production is not sufficient.

## (2) Crop Budget

The crop budgets of each Scheme area are analyzed based on the price and cost in 1995 as summarized below:

(Unit : kip)

	Upper Champi		Upper Tapoung			Upper Kapheu	
	Coffee	Tea	Coffee	Cabbage	Up. R	Coffee	Up. R
1. Gross income	297,000	153,000	451,000	950,000	87,000	352,000	225,000
2. Production cost	27,400	0	31,200	250,000	12,000	6,400	12,000
3. Net income	269,600	153,000	419,800	700,000	75,000	345,600	213,000

(Unit : kip)

	Lower Xe Set				Upper Tay-Un		
	Up. R	Low. R	Groundnut	Chili	Up. R	Low. R.	Coffee
1. Gross income	307,500	396,000	367,500	160,000	207,000	250,500	253,000
2. Production cost	16,600	11,900	22,400	14,500	16,600	11,900	8,800
3. Net income	290,900	384,100	345,100	145,500	190,400	238,600	244,200

## (3) Farm Type and Average Holding Size

The main farm types operated in the Scheme areas and the average farm size for each farming type are estimated, based on registration data for land tax. Most farmers except for the Lower Xe Set area depend on coffee cultivation. Besides coffee, they cultivate tea, upland crops or cabbage by the slash-and-burn method, and also lowland rice. The results are summarized as follows :

Scheme area	Farm type	Average holding size	(Breakdown of area)	Number of Household
Upper Champi	1. Coffee	2.7 ha	(coffee 2.7 ha)	12
	2. Coffee + Tea	3.0 ha	(coffee 2.3 ha, tea 0.7 ha)	186
Upper Tapoung	1. Coffee	1.5 ha	(coffee 1.5 ha)	76
	2. Coffee + Cabbage	2.9 ha	(coffee 2.0 ha, cabbage 0.9 ha)	160
	3. Coffee + Upland rice *1	2.8 ha	(coffee 2.1 ha, upland rice 0.7 ha)	26
Upper Kapheu	1. Coffee	1.6 ha	(coffee 1.6 ha)	131
	2. Coffee + Upland rice *1	1.7 ha	(coffee 1.1 ha, upland rice 0.6 ha)	300
Lower Xe Set	1. Lowland rice + Upland crops	1.5 ha	(lowland rice 0.7 ha, upland crops 0.8 ha)	129
	2. Upland rice and other crops	1.3 ha	(upland rice 0.5 ha, upland crops 0.7 ha)	156
Upper Tay-Un	1. Coffee + Lowland rice	2.4 ha	(coffee 1.3 ha, lowland rice 1.2 ha)	17
	2. Coffee + Upland rice *1	1.7 ha	(coffee 0.8 ha, upland rice 0.9 ha)	33

Remarks: \*1 Upland rice is cultivated under slash-and-burn cultivation.

(4) Farm Household Economy

The farm household economics, according to farm types of all the Scheme areas are assessed on the results of the farm interview survey. The average farm economics of typical farmers in the Schemes are summarized as follows:

**Upper Champi & Upper Tapoung**

Project Area	Upper Champi		Upper Tapoung		
	Coffee only	Coffee & Tea	Coffee only	Coffee & Cabbage	Coffee & Upland R.
Holding Size (ha)	2.7	3.0	1.5	2.9	2.8
1. Gross Income	802	796	677	1,762	1,022
(1) Farm Income	802	796	677	1,762	1,022
(2) Non-farm Income	0	0	0	0	0
2. Production Cost	88	78	55	314	90
3. Net Income	713	718	621	1,448	932
3.1 Living Expense	609	612	581	1,145	779
3.2 Net Reserve	105	106	41	303	153

**Upper Kapheu, Lower Xe Set & Upper Tay-Un**

Project Area	Upper Kapheu		Lower Xeset		Upper Tayun	
	Coffee only	Coffee & Upland R.	Lowland R & Upland crops	Lowland R & Upland crops	Coffee & Lowland R.	Coffee & Upland R.
Holding Size (ha)	1.6	1.7	1.5	1.3	2.4	1.7
1. Gross Income	563	522	465	429	612	435
(1) Farm Income	563	522	465	369	612	390
(2) Non-farm Income	0	0	0	60	0	45
2. Production Cost	17	22	20	21	25	22
3. Net Income	546	500	444	408	587	413
3.1 Living Expense	455	437	439	403	536	387
3.2 Net Reserve	92	64	6	5	50	25

Presently the farmers in the Upper Champi and Upper Tapoung areas receive a significant income and live comfortably. On the other hand, farmers in the Lower Xe Set area are somewhat poor. They live at subsistence level and hardly have any savings.

**1.8 Construction Materials**

**(1) Construction Materials**

Current availability of materials and equipment at the local market is as follows;

- Most construction materials have to be supplied from Pakxe to the priority Scheme sites except crushed stones for road pavement, based on present market conditions. Therefore, transportation cost has to be added to each item as the material cost.

- There are several timber suppliers in Pakxe. However, most of the timber is processed for export only. In case of large domestic demand, a shortage of timber will be experienced.
- Reinforced concrete pipes are produced in Pakxe. However, production capacity and quality are not satisfactory to cope with a large demand.
- Availability of labor and operator, especially skilled labor is doubtful for large scale work.
- Special materials such as sheet piles, pumps, valves for a pipe lines and gates etc., are not available in the local market and must be imported.
- Availability of embankment materials for dams or regulation ponds, especially core material is scanty.
- Majority of construction equipment that companies can offer are very old. Therefore, the efficiency of this equipment should be low.

## (2) Market Situation

Numerous types and kinds of materials and equipment are available, but the quantity of materials in the local market is small. The materials have to be imported to deal with a large demand.

## (3) Transportation

Transportation costs were obtained from material suppliers and construction companies. As the result of this survey, transportation costs are estimated at approximately 100 kip per ton per kilometer.

## 1.9 Environmental Aspects

This section discusses forests, wildlife, protected areas, agricultural systems, aquatic systems including water quality, watershed management, urbanization, and cultural aspects.

### 1.9.1 Natural Systems

#### (1) Forests

Forest are found only in small patches. For example, in the Upper Kapheu it is only 3% and bush land is 36%. Bush land is what had earlier been a forest. Cultivated land amounts to 61%. Lower Xe Set has 30% forest cover, 33% bush and 28% agricultural land. Upper Tapoung is 90% bush land. Hence forest land has been gradually taken up by shifting cultivation and subsequently left to fallow.

The land use survey revealed the following forest extents in the priority Schemes.

Scheme	Extent (ha)	%
Upper Champi	115	13.33
Upper Tapoung	9	9.47
Upper Kapheu	34	2.88
Lower Xe Set	379	30.08
Upper Tay-Un	69	16.43

The predominant forest type in the locality is the Upper Mixed Deciduous forest. There are also small extents of the Upper Evergreen, Lower Mixed Evergreen, Lower Mixed Deciduous and Gallery forest types. Much of the available forest land is of poor quality.

At the present time forest harvesting is a state-controlled operation with annual logging quotas being determined on the basis of annual allowable cut. There is restricted logging taking place presently, unlike in the period after 1991, when a ban on logging was in force. For 1995/96 ending September, 637,000 m<sup>3</sup> has been decided upon by the government. Not all quotas are logged however. Most of the time cuttings of previous years have not been collected due to various logistic problems. The current provincial allocations are as follows: Champasak -20,000 m<sup>3</sup>, collection from previous cuttings; Salavan -10,000 m<sup>3</sup>, part collection and part cutting; and Sekong -80,000 m<sup>3</sup>, collection from previous cuttings.

The land use classes of bush and secondary forest are actually deforested land that is not properly utilized. Sometimes land from this class is allocated for shifting cultivation. Extension of this land area vary from 5% in the Upper Champi to 91% in the Upper Tapoung. The area in the Upper Tay-Un is also particularly high, being about 66%.

Forest land is assigned to village administrative authorities for management, including reforestation. According to the decree on Provisions on the Rights and Duties in Forestry Resources Management at Village Level issued by the Minister for Agriculture and Forestry, a wide ranging list of functions is the responsibility of village administrative authorities. They have authority to effectively manage and preserve forests, develop plans, educate people, monitor changes, organize forest protection and management, draw up rules to suit village needs and work towards eliminating shifting cultivation. In the recent reorganization of the Forest Department, it has reported that a village forester is being appointed to manage forestry work in the village under the direction of the village administrative committee.

People may collect non-timber forest produce from protected areas and, with appropriate permission, extract limited quantities of timber from village forests for personal needs. Some of the non-timber forest products are cardamom, bamboo, rattan, leaves, nuts, mushrooms and a wide variety of wildlife which bring in a small income to families but most are put to household use.

Customary rights over forest land and produce have a long history and are said to have legal obligations. These are generally unwritten, very old and repeated time and again, having roots in tradition. The rights regarding the use of forest land and forest produce are to be exercised freely by their holders within bounds set by custom. These rights however, can vary between ethnic groups and locations.

## (2) Wildlife

The larger species of wildlife are extremely rare in and around the village areas in spite of the rich diversity of species reported in the Lao PDR. They are confined to well forested areas due to hunting pressure. The Minister for Agriculture and Forestry, has by decree, prohibited the killing or capturing of 21 species of mammals, 14 species of birds and six species of reptiles. There are also 64 additional species protected during the close season of hunting from July to November and these regulations apply in the priority Schemes.

## (3) Wetlands

Wetlands of the Boloven Plateau are found in the area around Pakxong and are of great ecological value. Most of the major rivers in Southern Laos originate in these wetlands. Part of the Upper Tapoung Scheme falls within the Pakxong wetland area. The wetland makes up a small catchment of 4 km<sup>2</sup>. Similarly, it also forms the catchment of the Xe Set Scheme but in this instance, the extent is much larger, being 325 km<sup>2</sup>.

Wetlands are also economically important. The people harvest varieties of fish, amphibians, reptiles and molluscs on a regular basis. Wild birds are also trapped or hunted. These are either sold or used for domestic consumption. In some of the larger waterbodies, around Pakxong, aquaculture, using tilapia and common carp, is practiced.



#### (4) Protected Areas/Conservation Areas

There are no protected or conservation areas within the priority Schemes as designated either by the provincial or central administrations. However, there are those land areas having varying densities of forest canopy, looked after by village administration committees and somewhat loosely referred to as protection and conservation forests.

### 1.9.2 Agricultural Systems

The most important crop is paddy because of its place in the Lao diet. Coffee brings in much cash to most farmers in areas other than Xe Set. Cabbage cultivation is predominant in the Upper Tapoung. A variety of other crops are grown under upland conditions.

#### (1) Shifting Cultivation

Shifting cultivation is considered undesirable in the present time but nevertheless provides the basis for the maintenance of cultural values of a large number of ethnic groups. The system as practiced with a long fallow, had some good features such as nutrient cycling and crop diversity. The long fallow also helped in the suppression of weeds and pests. It is most extensive in the Upper Kapheu - 412 ha, but the average holding size is highest in the Upper Tayun, with each family having an 1-ha holding. The fallow cycles are as short as one year in certain Upper Kapheu villages and rise to a little over five years in some other villages of the same Scheme.

Of the eight villages in the Upper Champi Scheme, only the people of one village practice shifting cultivation. On an average each family has a 0.4-ha holding which is the lowest extent in all the Schemes. Perhaps the reason for this low incidence of shifting cultivation in this Scheme is the financial success of the farmers who mostly own coffee holdings.

#### (2) Soil Erosion

Management of agricultural systems is generally poor. A number of factors determine rates of erosion. Coffee is a major export-oriented crop in the Boloven Plateau. It is often grown on steep land without erosion control of any kind. It has been reported that the coffee yield is on the decline. Contributing factors could well be the loss of top soil along with plant nutrients and the lack of fertilizer application.

Tea is another crop that causes concern in resource management. It is randomly planted, so widely spaced and poorly managed, that open spaces between bushes which are already clean are weeded. It will continue to be a source of sediment generation.

#### (3) Agrochemical Use

The use of pesticides is extremely low in all priority areas. However, an environmental concern is pesticides used in cabbage cultivation in the Upper Tapoung. Here, highly toxic chemicals are used. Two of those used, folidol or methyl parathion are classified by WHO as "extremely hazardous" and DDT as "moderately hazardous".

Fertilizer use is also limited. While permanent crops are hardly ever fertilized, seasonal crops such as cabbage receive fair doses of inorganic fertilizers.

### 1.9.3 Aquatic Systems

#### (1) Fish Habitat

In the Upper Kapheu and Upper Champi, rivers flow in deep valleys. The river beds are rocky over long stretches which do not make fishing attractive as the fish habitat is confined to small pools found at intervals along the river. Species are limited to the smaller indigenous types which are not of much commercial value. However, some of the family protein needs are met by this means. The daily catch averages 0.5 - 1.0 kg, which may be somewhat more during the rainy season.

In the Upper Tapoung and Upper Tay-Un, rivers flows through relatively flat areas and the banks are marshy in many places. Presently aquaculture is being introduced here and the construction of ponds is taking place along the river. The people appear to like this idea as it should bring in extra family income and is also well suited to be an occupation for family women. Organized aquaculture is practiced to some extent in the lakes around Paxong.

#### (2) Water Quality

The low intensity of agricultural land use, being only 12.8, 6.8 and 1.1% of the land area in Champasak, Salavan and Sekong provinces respectively, is largely responsible for the relative freedom from pollution of the land and soil. The absence of pollution is further influenced by the extremely low use of agricultural inputs such as fertilizer, aspesticides and the lack of industrial growth. Low population densities and a predominantly rural lifestyle are also contributing factors. Even the larger town centers are quite rural in outlook.

A suspect non-point source however, is in H. Tapoung below B. Xetapung, where agrochemical residues are likely to show up after draining from the cabbage cultivation further upstream.

#### (3) Environmental Health

The Priority Scheme areas have problems of health. The water-related, vector-borne diseases are discussed here.

Malaria is considered the most important public health problem. It also causes high mortality among children under one year of age. Other health problems are reported to be diarrhea and acute respiratory infections. Some basic malaria control measures have been carried out by the provincial health authorities. These include spraying of mosquito breeding sites and houses, drainage of ponded water and promoting the use of mosquito nets.

### 1.9.4 Watershed Management

The siltation on Hoary Xe Don and the difficulties experienced in power generation during the dry season particularly, at the Selaban hydropower facility, which is a run-of-river operation on the Hoary Xe Don, is a good example of watershed problems in southern Laos. Due to insufficient water, the power generation at the present time is only 50% of what was anticipated in the feasibility study. Shifting cultivation and irrigation projects in the basin of the river are attributed as the causes for low water availability at the power facility.

### **1.9.5 Urbanization**

Urbanization has not affected any of the priority areas. There are only poorly developed villages, often with difficult access. The amenities are quite primitive in most instances. There is very little ongoing trade in the villages. Towns outside the priority Schemes cater to the needs of the people. For example, Laongam serves Upper Kapheu and Lower Xe Set. Pakxong serves Upper Tapoung and Upper Champi. Thateng serves Upper Tay-Un. However, it is quite common for people to even go far to the largest town of Pakxe to look for their needs.

### **1.9.6 Cultural and Aesthetic Aspects**

There are no reported sites of archaeological interest. However, a large number of ethnic groups is part of the country's national cultural diversity. There is some effort to improve the educational standards of ethnic groups. Unfortunately there is no attempt to preserve the cultural identity of each group by promoting the folk arts such as music, dancing, and handicrafts.

Of aesthetic interest are the Pakxong wetlands, a part of which falls within the Upper Tapoung priority Scheme. There are also a number of waterfalls; some inaccessible, but others such as on the Houay Xe Set, provide the basis for limited tourist development.

## **2. DEVELOPMENT CONSTRAINTS OF THE PRIORITY SCHEMES**

### **2.1 Agriculture**

Where coffee is grown and also in general for all other crops, management and post-harvest practices are very poor, causing low yield and poor quality produce. Certain coffee plantations suffer from frost, and also moisture stress during flowering and fruiting. Generally, the dry season brings about water deficits in all areas and for all crops water is the limiting factor. In upland crop culture, low yielding varieties, poor cultivation and post-harvest practices contribute to low yield and poor quality. Pests such as crabs, wild boar and rodents are major problems in certain areas. The Xe Set hydropower facility has created unstable river flow and difficulty of taking water for irrigation. Uncertain rainfall in the beginning of rainy season has also created soil moisture problems for all crops.

### **2.2 Agricultural Support Services**

A remarkable feature is that the extension services are almost non-functional. Apart from severe staff shortages, the existing staff have had poor basic training and are not quite adroit with modern technology. Research is also inadequate and research-extension links are weak. Credit facilities are not easily available and farmers do not have appropriate organizations. In all the districts there are no programs of extension work and coffee is about the only crop where some service is available, under the LUADP.

### **2.3 Irrigation and Drainage**

Some river valleys are deep and this makes access to intake sites difficult. A High intake dam-up is therefore required. In the dry season water resources are restricted due to limited watershed management area. Water availability may also be reduced depending on human activities in the watershed which can lead to erosion from forests, bushes and grasslands after shifting cultivation. The watersheds for off-taking water irrigation are limited to be quite small due to topographic conditions in some instances, as in the Upper Champi, Upper Tapoung and Upper Kaphou.

### **2.4 Rural Infrastructure**

Poor facilities are characteristic of all Schemes. Water has to be fetched from deep valleys and some sources of water are inadequate during certain months. Village roads are in very poor condition; some are almost impossible to be used by motor vehicle. Most are only dry weather roads and there are no bridges in many places. Health facilities are very poor and non-functional in some villages, due to insufficient staff, medicines and finances. Primary education lacks basic needs. Some villages do not have primary schools. Even when 22 kV transmission lines are available, certain villages cannot afford the 30% share of the transformer cost.

### **2.5 Socio-economy**

A low literacy rate is a major drawback in all Schemes. Educational services are poor and general resources are lacking for socio-economic development. The many ethnic groups do not appear to co-operate with each other. Incomes are very low from traditional farming systems. Incidence of malaria and diarrhea are high, and health services are poor. The women have inferior status. Water supply is poor and piped water is not available except in few cases. Roads are poorly maintained. Rural electrification is not available. The inadequacy of technical and financial support are serious shortcomings to better community development.

## 2.6 Institutions

Institutional weaknesses play a major part in retarding development progress. Most of these are common to all government institutions and all project areas. Education can be ranked as the single most important shortcoming as it is basic to all other activities, at the grassroots level. Primary health care is also extremely weak. Village institutions are not well established and issues relate to village boundaries, land title, administration and finances. The lack of competent village leaders is also a setback to economic progress of the village. At the district level also, there is administrative and planning incompetency in project appraisal and subsequent follow-up. Resources, both human and financial, are severely lacking to undertake existing programs. Even the available staff is very short of managerial skills.

## 2.7 Agro-economy and Marketing

Coffee, which should have a good market, does not, because of poor quality due to incorrect harvesting and drying. There is also no grading by the producers. Although some extension work has been carried out by LUADP, most farmers have not changed their old practices. Vegetables, particularly cabbage, do not receive the benefit of good prices as market linkages are not well established. Market information does not reach farmers, who are at the mercy of buyers visiting farms. Trade barriers in Thailand, such as a high import duty, also deprive farmers of the benefit of good prices. The absence of quality control and poor post-harvest technology prevents obtaining good prices. The supply of farm inputs is not well organized and some items required in Tapoung can only be obtained by farmers visiting Pakxe.

## 2.8 Environment

The environmental constraints to the development of priority Schemes are clearly seen in section 1.9. Some of these are common to all Schemes while others are more specific. Briefly these relate to:

- Deforestation
- Loss of wildlife
- Soil erosion on agricultural land
- Loss of plant nutrients
- Lack of application of fertilizers and manure
- Destruction of gallery forest and river bank erosion

There are technical constraints peculiar to certain areas such as the destruction of wetland vegetation in the Upper Tapoung and the use of extremely toxic pesticides for the control of cabbage caterpillars, also in the Upper Tapoung.

Besides, there are many constraints of a non-technical nature, which also play an important role in preventing sustainable resource management. A weak institutional capability is one constraint, which despite of having more staff in provincial and district offices, has an inadequate presence at grassroots level; resulting in poor technology transfer to farmers. The capacity of staff to implement government programs is also weak.

Another serious constraint is inadequate budget to train farmers in extension. Farmer training is also constrained by the educational level of the trainers. Experimental stations are not geared to applied research and do not actively participate in the training of farmers. Public awareness of environmental issues is very poor.

### 3. DEVELOPMENT CONCEPT

The ultimate objectives of the integrated agricultural and rural development plan in the Study area are to increase agricultural output in the area through improvement/development of irrigation, drainage and rural infrastructure together with appropriate support services, and to achieve substantial and sustainable improvement in the living conditions of the inhabitants and their quality of life, taking into account the Government policy; namely, i) food security and self sufficiency, ii) promotion of export-oriented crops and livestock, and iii) farming stabilization and reduction of slash-and-burn cultivation.

The basic agricultural development concept is to intensify diversified agriculture in the existing agricultural areas of the five priority Schemes, which vary with altitude, climate conditions, current social needs, etc. It seeks to improve suitable and profitable crops such as coffee, tea, vegetables and fruit and stabilize agricultural management by providing irrigation and drainage facilities and extension of agricultural support services. Furthermore, based on the introduction of suitable farming technology and farm management, the agriculture area is expanded and intensified. The existing slash-and-burn cultivation practices are to be reduced and converted to stabilized farming, lowland rice and upland crops. It finally aims to increase agricultural income and have demonstrations on diversified agriculture even to farmers in the adjacent areas in the respective Scheme areas. Depending on social needs, the production of food is expected to increase in the lowlands through the provision of irrigation and drainage facilities and extending agricultural support services. In addition, the concept propose to adopt sustainable production methods to maintain a sound environment.

Rural development aims for community involvement voluntarily, of participating beneficiaries of management, from planning to the O&M stages in environment, agricultural and rural infrastructures, taking into consideration current social and cultural conditions of ethnic groups.

Considering the development aims mentioned above, the following detailed concept and practical development approach are to be taken in order to achieve designed goals.

#### (1) Agriculture

Crops are selected on the basis of natural conditions such as altitude and land capability. Farmers' background, market conditions, and social conditions are also pre-conditions for stable production of coffee, increase of upland crops and paddy production, and extension of highland vegetable production. These are to be intensified through strengthening agricultural support services and providing irrigation management.

Vegetable cultivation is introduced in the highlands where elevation is above 1,000 m and coffee cultivation is not suitable due to frost. The highlands are also near vegetable trial and demonstration stations and to wholesale market centers a facilitating easy access of technical extension and marketing. Coffee cultivation is proposed to be developed in line with intensive farming practices with irrigation under the present condition, with guidance and technical cooperation from LUADP. Tea cultivation is intensified from the viewpoints of farming and processing technology. Rice and upland crops are grown to satisfy the need of food production in the Schemes.

Furthermore, inland fish culture is introduced to increase protein resources, using water reservoirs which will be constructed for irrigation.

(2) Irrigation and Drainage

Aims of irrigation and drainage development are

- (i) Irrigation development for high land vegetable cultivation,
- (ii) Supplementary irrigation for rainy season paddy and irrigation for dry season paddy cultivation
- (iii) Irrigation for coffee and
- (iv) Inland fishery development using irrigation ponds to be constructed.

Simple and economic irrigation facilities are provided for vegetable cultivation areas to get high yield, particularly in the dry season. Supplementary irrigation is conducted for rainy season paddy and, irrigation for dry season paddy depending on water availability. Although no irrigation for coffee has been practiced so far on the Plateau, it is known that irrigation for coffee during the period of flowering to fruiting will bring about better yield and quality. Hence, irrigation is proposed to be provided for coffee cultivation for about 3 months, from the flowering to fruiting stage.

(3) Agriculture Support Services

Agricultural support services of the following 5 components are strengthened in line with current the National Integrated Extension and Research Program (NIERP).

- (i) agriculture research,
- (ii) agricultural extension,
- (iii) agricultural input supply, agricultural credit and insurance system,
- (iv) farmers' organizations, and
- (v) operation and maintenance of irrigation facilities

(4) Rural Society

Rural development aims to improve the quality of rural life by raising the living standard through the provision of rural as well as agricultural infrastructures. In order to successfully implement those aims, it is essential to strengthen support services in agriculture and social aspects, with the voluntary participation of beneficiaries. These services are to be carried out in close cooperation with AHS and with the involvement of beneficiaries.

(5) Agro-economy and Marketing

For market development of vegetables and rice, a wholesale market system of vegetables is to be established through the provision of market facilities at Pakxong, under local government management. The existing rice bank systems will be improved to intensify the existing system and to enlarge its function.

#### 4. DEVELOPMENT PLAN

##### 4.1 Agriculture

##### 4.1.1 Proposed Cropping Pattern

The proposed cropping patterns for the Scheme areas were formulated taking into account present agricultural land use, crop suitability by altitude, familiarity to the farmers, present agro/socio-economical conditions, availability of irrigation water as well as expected future development in and around the areas which are in line with the above development concept. The crops selected for each area are as follows:

##### (1) Upper Champi Area (920~1,220m)

##### (a) Selection of Crops

Coffee	500 ha	Existing area, plus some expansion of Arabica varieties is expected.
Tea	120 ha	Existing area.
Vegetables, upland crops	110 ha	Highland vegetables (cabbages, peas, strawberries, asparagus, etc.) and some upland crops (maize, sweet corns, soybeans, potato, etc.)

##### (b) Cropping Pattern

The proposed cropping pattern is summarized as follows:

Crops	(Unit : ha)	
	Wet season	Dry season
Coffee	500	500
Tea	120	120
Upland crops	110	0
Vegetables	0	110
Total	730	730

Upland crops and vegetables are proposed to be grown in rotation to maintain soil fertility and to prevent soil born diseases and pests.

##### (2) Upper Tapoung Area (1,200~1,220m)

##### (a) Selection of Crops

Vegetables, upland crops	80 ha	Highland vegetables (cabbages, potatoes, carrots, cauliflowers, etc.) and some upland crops (maize, sweet corns, soybeans, etc.)
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##### (b) Cropping Pattern

The proposed cropping pattern is summarized as follows:

Crops	(Unit : ha)	
	Wet season	Dry season
Upland crops	40	40
Vegetables	40	40
Total	80	80

Upland crops and vegetables are proposed to be grown in rotation to improve soil fertility and to prevent soil born diseases and pests, etc.



## (3) Upper Kapheui Scheme (570~790m)

## (a) Selection of Crops

Coffee	900 ha	About half is the existing area, and the other half is expected for expansion of Arabica varieties.
Lowland rice	100 ha	Lowland rice of 135 days growth duration in the wet season.
Upland crops	100 ha	Upland crops (maize, groundnuts, soybeans, etc.)

## (b) Cropping Pattern

The proposed cropping pattern is summarized as follows:

Crops	(Unit : ha)	
	Wet season	Dry season
Coffee	900	900
Lowland rice	100	0
Upland crops	0	100
Total	1000	1000

The upland crops are grown in the dry season after lowland rice in the wet season.

## (4) Lower Xe Set Area (300~400m)

## (a) Selection of Crops

Lowland rice	1,000 ha	Lowland rice (150 days in wet season, 135 days in dry season).
Upland crops	800 ha	Upland crops (groundnuts, chili, cotton, maize, soybeans, etc.) Some cool dry season vegetables (cabbages, peas, etc.), and water melons, etc. as hot dry season crops.

## (b) Cropping Pattern

The proposed cropping pattern is summarized as follows:

Crops	(Unit : ha)	
	Wet season	Dry season
Lowland rice	200	200
Lowland rice	800	0
Upland crops	0	800
Total	1000	1000

Lowland rice is grown in the wet season in 1,000 ha, while it is limited to 200 ha in the dry season due to shortage of irrigation water. Upland crops are grown in the rest of the 800 ha in the dry season under irrigated condition.

(5) Upper Tay-Un Area

(a) Selection of Crops

Lowland rice	330 ha	Lowland rice (135 days in wet season, 120 days in dry season).
Upland crops	80 ha	Upland crops (maize, soybeans, groundnuts, etc.), cool season vegetables (cabbages, peas, sweet corns), etc.

(Unit : ha)

Crops	Wet season	Dry season
Lowland rice	70	70
Lowland rice	80	0
Lowland rice	180	0
Upland crops	0	80
Total	330	150

Lowland rice is grown in 330 ha in the wet season, and 70 ha in the dry season. Upland crops are grown in 80 ha irrigated condition, and the rest of the 180 ha is fallow without crops in the dry season.

(6) Control of Slash-and-Burn Cultivation

According to the implementation of proposed cropping patterns, almost all of grass, bush and secondary forest lands belonging to the category of slash-and-burn cultivation system would be converted to the permanent cropping system, such as for lowland rice fields, tree crops, vegetables and upland crop fields. The extent of change in land use in each area concerning the control of slash-and-burn cultivation is summarized as follows:

(a) Upper Champi Area

(Unit; ha in gross)

Crop/land use	Present	Proposed	Increment
Coffee	490	590	100
Tea	140	140	0
Bush	40	0	-40
Grass	80	0	-80
Secondary forest	120	0	-120
Vegetables/upland crops	0	140	140
Total	870	870	0

The area converted from slash-and-burn cultivation system is estimated at 240 ha.

(b) Upper Tapoung Area

(Unit; ha in gross)

Crop/land use	Present	Proposed	Increment
Bush	90	0	-90
Secondary forest	10	0	-10
Vegetables/upland crops	0	100	100
Total	100	100	0

The area converted from slash-and-burn cultivation system is estimated at 100 ha.

(c) Upper Kaphou Area

Crop/land use	(Unit; ha in gross)		
	Present	Proposed	Increment
Coffee	560	1,100	540
Upland rice	190	0	-190
Bush	450	0	-450
Secondary forest	40	0	-40
Lowland rice	0	140	140
Total	1,240	1,240	0

The area converted from slash-and-burn cultivation system is estimated at 680 ha.

(d) Lower Xe Set Area

Crop/land use	(Unit; ha in gross)		
	Present	Proposed	Increment
Lowland rice	100	1,250	1,150
Upland rice	140	0	-140
Upland crops	90	0	-90
Fruits*	20	0	-20
Bush	420	0	-420
Grass	100	0	-100
Secondary forest	380	0	-380
Total	1,250	1,250	0

\* Mostly bananas in this area.

The area converted from slash-and-burn cultivation system is estimated at 1,150 ha.

(e) Upper Tay-Un Area

Crop/land use	(Unit; ha in gross)		
	Present	Proposed	Increment
Lowland rice	20	420	400
Upland rice	30	0	-30
Bush	280	0	-280
Grass	10	0	-10
Secondary forest	70	0	-70
Swamp	10	0	-10
Total	420	420	0

The area converted from slash-and-burn cultivation system is estimated at 390 ha.

#### 4.1.2 Proposed Farming Practices

As mentioned also in the Master Plan, no precise data was available on research results of the farming practices of crops and animal husbandry in the areas. The proposed farming practices for the priority Scheme areas are based mostly on the general experiences in the tropics, as well as the results of present field studies. It is strongly recommended that a

variety of on-farm trials and research be carried out to establish appropriate farming practices, to verify the possibility of agricultural development and to promote agricultural production in the areas.

The farmers have much experience with cabbages, Chinese cabbages etc. but only little reliable experience with new kinds of highland vegetables. The farmers are also very familiar in producing the local variety of rice, but are unaccustomed to the improved varieties and the double cropping of rice. It is necessary to introduce new varieties of lowland rice, upland crops as well as new kinds of vegetables to improve quality and yield, to meet market requirement of products, to establish trial and demonstration stations in order to show the effective cultivation techniques of these crops, and to train extension officers and farmers in the area.

The present small holding farming practices prevailing in and around the Scheme areas will be applied basically, such as animal power for land preparation and transportation, manual operation for transplanting and harvesting, etc. Although farm mechanization is now gradually introduced in the areas, rapid farm mechanization is not recommended in the proposed farming practices in due consideration of the large amount of investment needed at once for the individual farmer.

Regarding plant protection, proper application of chemicals will become necessary for the safe and effective control of insects and diseases, taking into account selection of attractive and non-harmful agro-chemicals. The minimum use of pesticides is recommended if necessary, to avoid disastrous damage by pests, together with the introduction of environmentally sound practices that use selected chemicals such as Fenitrothion, Buprofezin, Dithiocarbamate, and Benomyl, under proper guidance of agricultural services. To minimize pesticide application and to ensure the effective control of pests and diseases, as well as to protect the environment, biological methods of control are recommended such as sex pheromone traps, utilization of predators and natural enemies, etc. which will be promoted under the IPM program by MAF.

The farming practices to be paid attention are management and improvement of soil fertility in the area. The soils need intensive management to maintain fertility to continue a proper level of production in the fields converted from the slash-and-burn system to the permanent cropping system. Mulching practices with leguminous crops or covering with cut and dried grass as well as the application of organic materials as compost etc. are recommended.

The proper management of livestock is essential in promoting livestock production as well as preventing damage to the crops, and keep a clean living environment in the Scheme areas. The development of managed grazing land is recommended by improving fodder, which could be done with minor modification of the traditional grazing system, and not to depend only on natural grass. It is also essential to promote disease control of the animals by an extension of veterinary services and the breeding of healthy animals.

Fish culture is presently practiced sporadically in the Study areas by few farmers. It is recommended to introduce modernized culture techniques for the effective use of reservoirs to be constructed for irrigation water. However clarification is necessary in the possibility of fish culture using these reservoirs, especially in terms of quality and temperature, diseases and parasites, etc. in the reserved water. At the initial stage, common carp, catfish, mural and climbing perch etc. are recommended because of their adaptability to a wide range of water conditions. Tilapia is also recommended to the area of low altitude. Intensive fish culture system will not be applicable by utilizing reservoirs for irrigation, mainly due to large seasonal fluctuations of the water level, but a extensive system will be adopted.

### 4.1.3 Anticipated Crop Yield and Production

The present yield of crops in the Study area is rather low due mainly to the lack of irrigation water, a shortage of farm inputs, and the low level of supporting services. By implementation of the Project, the yield of crops would be substantially increased and stabilized after introduction of the irrigation farming practices supported by the agricultural services. The increase of yield without the Project is considered to be insignificant. The estimated yield of crops at the full development stage is shown below:

Crops	Present (ton/ha)	With Project (ton/ha)
Coffee	0.3	1.5
Tea	0.26	1.0
Upland rice	1.5	3.0
Lowland rice		
Local variety	2.6	3.0
Improved variety		4.0
Vegetables:		
Cabbage	8.0	20
Chinese cabbage	6.0	20
Potato	10.0	20
Upland crops		
Groundnuts	1.5	2.0
Soybeans	1.0	2.0
Maize	1.0	3.0

Note: The estimated yield of each crop is assumed at average production conditions under irrigation in the tropics, since there is no reliable data on the ultimate crop yield in and around the Scheme areas. The present yield is the average of the Scheme areas. The anticipated yield of coffee is assumed at a rather conservative level referred to 5 t/ha of potential yield under irrigation (Gordon Wrigley, 1988. Netherlands MAF, 1989).

Most farmers in the Study area are not yet familiar with new varieties of crops and farming practices to be introduced, such as proper fertilization, plant protection, and water management. In order to attain the projected yield as early as possible, it is essential to improve and strengthen the present agricultural supporting services to keep pace with the implementation of infrastructure development. It would take a long time for farmers to successfully manage operation of the irrigation facilities and attain the projected targets, because the supporting systems and research institutes are still not well organized. There is also a lack of qualified manpower and it will also take some time to train extension officers capable of working effectively. It is necessary to start research and training work prior to starting construction work. The build-up period is assumed to be 5 years after completion of the Project work and the starting of proper support services.

The anticipated crop production by the Project in each area at the full target stage is summarized as follows:

(Unit: ton)

Scheme	Condition	Coffee	Tea	Lowland rice	Upland rice	Field crops	Vegetables	Fruits
Upper Champi	With	750	120			330	2,200	
	Without	138	39			0	0	
	Increment	612	81			330	2,200	
Upper Tapoung	With					240	1,600	
	Without					0	0	
	Increment					240	1,600	
Upper Kapheu	With	1,350		400	0	200		
	Without	162		0	270	0		
	Increment	1,188		400	-270	200		
Lower Xe Set	With			4,800	0	1,600		0
	Without			260	273	135		240
	Increment			4,540	-273	1,465		-240
Upper Tay-Un	With			1,600	0	160		
	Without			34	42	0		
	Increment			1,566	-42	160		

\* The production of coffee is of hulled dried beans (green beans).

\*\* Upland crops is represented by maize, groundnuts, soybeans, etc.

\*\*\* Vegetables are represented by cabbages.

\*\*\*\* Fruits are represented by bananas.

#### (1) Upper Champi Scheme

The expected production of coffee with Project condition is estimated at about 750 tons, from the present 140 tons; an increment of 600 tons. Tea production will be increased to about 120 tons per annum, 3 times the present production. More than 2,000 tons of highland vegetables, and some 300 tons of upland crops such as maize will be produced besides increases in coffee and tea.

#### (2) Upper Tapoung Scheme

About 200 tons of upland crops and 1,600 tons of vegetables will be expected annually.

#### (3) Upper Kapheu Scheme

A large increase of annual coffee production will be achieved; from 160 tons to about 1,200 tons. In the field converted from the slash-and-burn system, lowland rice and upland crops will be grown; the incremental paddy production is about 130 tons, and about 200 tons of upland crops are expected under irrigated conditions.

#### (4) Lower Xe Set Scheme

Lowland rice under irrigation will be the main crop in this Scheme, and about 4,800 tons of paddy production will be expected annually. Upland crops will be grown under irrigation in the dry season, and the expected production is about 1,600 tons.

#### (5) Upper Tay-Un Scheme

Lowland rice will be the main crop in this area, and the expected annual production is about 1,600 tons of paddy, and 160 tons of upland crops.

#### 4.1.4 Anticipated Livestock and Fishery Production

##### (1) Livestock Raising

Natural grasslands, bushes and secondary forests in most of the schemes where cattle and buffaloes sometimes graze, will be converted to permanent cropping areas. Along with the conversion of land use, cattle raising would also be improved. It is also recommended to establish communal grazing lands with pens and improved grasses and fodder trees. These lands would be utilized in rotation to allow for growth of the fodder.

In the Lower Xe Set area, there is presently a short supply of buffaloes (about 200) for the cultivation of 1,000 ha of lowland rice. It will be necessary to introduce more than 300 head of buffalo from outside the Scheme area to manage the total rice fields. In the Upper Kapheu area, introduction of 50 head of buffalo will be necessary to manage 100 ha of newly created lowland rice fields. For proper breeding and better health care of the buffaloes, veterinary services such as artificial insemination and vaccination would be inevitable.

##### (2) Fish Culture

The estimated production of fish using ponds constructed for irrigation based on the effective area for fish culture of each pond is as follows:

Schemes	Effective area (ha)	Production (kg)
Upper Champi	0.3	200
Upper Tapoung	16	8,000
Upper Kapheu	2	1,000
Lower Xe Set	0	0
Upper Tay-Un	2	1,000

Note: Yield of fish applied is 500kg/ha by extensive techniques.

#### 4.2 Agricultural Support Services

The objectives of the agricultural support services in the five selected Scheme areas are to provide necessary assistance to the farmers to achieve the agricultural development. Currently, the support system is based on the National Integrated Extension and Research Program (NIERP) composed of extension planning, conducting, monitoring and evaluation, and training. Therefore, the support services in the Scheme areas will be made taking into consideration the NIERP.

The proposed agricultural services comprise (i) agricultural research, (ii) agricultural extension, (iii) agricultural input supply, agriculture credit and insurance system, (iv) farmers' organizations, and (v) operation and maintenance of irrigation facilities. The support services also extend to the field of rural life improvement. Furthermore, for the purpose of promotion and extension of vegetable production, which could greatly improve the farm household economy and the regional economy, a highland vegetable trial and demonstration station is proposed.

##### 4.2.1 Agricultural Research

Although the Boloven Plateau has high potential and favorable conditions for vegetable production, there is no experimental station. Hence, establishment of the highland vegetable trial and demonstration station is proposed. The station will carry out trial and demonstrations to support extension work for farmers on the plateau. In the short-term, extension activities of this station will be carry out for the Upper Tapoung Scheme as a nuclear area and the surrounding areas in the Pakxong district where vegetables will mainly be produced. The details of this station are described in sections 4.2.8 and 4.8.

The main crops in the priority Schemes, are coffee in the Upper Champi, vegetable and upland field crops in the Upper Tapoung, coffee and rice in the Upper Kapheu, lowland rice and upland field crops in the Lower Xe Set and lowland and upland rice in the Upper Tay-Un. In the Champasak province, lowland rice in the Phone Ngam station and upland field crops in the Palay station will provide research to support agricultural production in the Scheme areas. The stations will conduct joint research with the extension staff of district AFSs to appropriately resolve farm level production constraints; and to improve the extension staff's techniques through on-farm research and trials.

Research and extension of coffee and carried out by the LUADP, and thus excluded from this plan.

#### 4.2.2 Agricultural Extension

The proposed agricultural extension services will be provided mainly for the mentioned crops, through provision of trained extension staff, vehicles, equipment and office buildings. With implementation of the scheme, irrigated farming will be introduced in the schemes. In order to achieve the scheme goal and improve agriculture, strengthening of extension services for irrigated farming is particularly essential.

##### (1) Extension Activities:

- Introduction of improved varieties;
- Supply of planting materials;
- Demonstration and guidance on cultivation techniques with irrigation;
- Information of marketing and distribution;
- Guidance of fish farming techniques;
- Introduction and guidance of agricultural credit and insurance;
- Guidance on agro-processing activities;
- Consultation and guidance on rural life improvement; and
- Monitoring and evaluation of extension activities.

##### (2) Strengthening of Extension Services:

- Establishment of agricultural extension offices at district AFSs;
- Augmentation of extension staff and stationing of extension staff to take charge of Scheme areas at district AFSs;
- Training of extension staff to raise their capabilities in farming techniques;
- Formation of farmers' working groups at the village level comprised of volunteer progressive farmers, based on NIERP;
- Establishment of on-farm demonstrations at the village level, with the co-operation of progressive farmers;
- Conducting periodical farmers' training in villages;
- Provision of extension materials and vehicles for the transportation of extension staff; and
- Collaboration with the LUADP, and existing stations in Champasak province.

##### (3) Proposed Organization for Agricultural Extension

A new agricultural extension section will be set up in the district AFSs, in order to concentrate in the schemes. This section staff will consist of the head (one) and two officers in charge of the main crops to be developed in the area, and rural life improvement. They will also be assigned field work. The specialties to be assigned for the field extension staff are; tea for the Upper Champi, vegetables for the Upper Tapoung, upland rice for the Upper Kapheu, lowland rice and upland crops for the Lower Xe Set and lowland and upland rice for the Upper Tay-Un.



#### (4) Facilities and Equipment

Facilities and equipment for agricultural extension work are required for both field and office. Office space will be provided in the initial development stage. The community hall constructed in each village of the areas will serve as a field office for the field extension staff, and for training farmers. The extension materials and vehicles for transport will be provided at the office.

#### (5) O&M Facilities

O&M facilities of irrigation and drainage systems also need to be provided for in the water association and local government offices. O&M facilities are broadly divided into two groups: facilities of operation and monitoring, and facilities for maintenance works. The facilities of operation and monitoring are radio communication equipment, vehicles, motor cycles and office equipment which are maintained by the water association and water users' group. The facilities of maintenance work are construction equipment such as bulldozers, backhoes, motor graders, dump trucks, generators, pumps, etc. which are maintained by local government and water associations.

### 4.2.3 Supply of Agricultural Inputs

As mentioned in section 1.3.6, small amounts of agricultural inputs such as fertilizers and agro-chemicals, are used in the priority Scheme areas. Actually, almost all the inputs are supplied by the private sector. No credit system of the APB exists for upland field crops and vegetables. Accordingly, the proposed supply system of agricultural inputs required such as fertilizers and agro-chemicals will strengthen the existing supply system for both the state and private channels.

The proposed supply systems are to supply inputs required in the Scheme areas, to be developed by the state company and private traders through strengthening of the sources of the APB's loan. In particular, restructuring the APB credit system will lead to expanded projects, such as new fields for upland crops and vegetables, and financial support for private traders. The distribution of these inputs will be done wholly by the private sector, focusing only on safety regulations of input application, in line with national policies.

On the other hand, the village farmers' organization is proposing to construct the required storages in each village of the Scheme areas. Improved seeds and planting materials of rice, upland field crops and vegetables will be distributed to farmers by related research stations through the extension staff of the district AFSs (under control of the provincial AFSs).

### 4.2.4 Agricultural Credit and Insurance

#### (1) Agricultural Credit

The proposed credit system is to strengthen the source and expand the lending credit of APB, in addition to expanding its sub-branch network in the Scheme areas. In the initial development stage, establishment of an APB sub-branch will be proposed in the Laongam district. Furthermore, at the village level, establishment of a saving bank (mutual financing) as well as Grameen-style operations will be proposed. The bank should be operated autonomously by involving and incorporating village women's groups. The establishment and training for these associations will be collaborated with the NGOs.

There are two mutual financing groups in the Upper Champi area, but their credit systems cover only group members due to limited funds. In these cases, restructuring their credit system to that of the proposed bank is desirable. In particular, such a credit system should be introduced urgently in the villages of the Lower Xe Set area where there are many poor families.

## (2) Agricultural Insurance

No agricultural insurance system has been established so far in Lao PDR in order to relieve the income losses caused by natural disasters and pests which reduce agricultural production. Therefore, it is recommended to implement an agricultural insurance system by the government as a public policy measure to promote general welfare among the people in rural areas, as a kind of social insurance.

### 4.2.5 Farmers' Organization

As mentioned in the socio-economy section, villages in the priority Schemes are formed by ethnically diverse societies. Consequently, the village farmers' organization will be set up with due respect for the farmers' autonomy and then awareness of community developments, taking into consideration the different ethnic cultures. Formation of the farmers' organizations in the schemes will be based on existing farmer's groups such as extension groups of coffee, production groups of APB, rice banks and mutual funding groups in villages. Group formation will be promoted through community activities in villages where no such group exists at present. Viewing the farmers' group formations as a basis, the village agricultural association will be established. Considering the farmers' expectations from village interviews and farm household surveys, the following methods are proposed for their organization:

- (1) Extension officers and provincial and district AFS staff propose that a forum be arranged whereby common problems can be discussed between existing farmers' groups.
- (2) The problems will be recognized by the farmers themselves; and they will work out a solution at the forum, led by the extension staff.
- (3) In order to solve problems, reorganization of existing groups and formation of new groups will be made. The group formations will be made autonomously by farmers themselves, under the guidance of the extension staff. Leadership of the progressive farmers will be expected to form village groups. In addition, training the farmers on autonomous group operation will be conducted by the extension staff at the village level.
- (4) To raise the farmers awareness on the need to establish a village agricultural association, the village leaders will use a direct approach. With a view to promoting this organization, support from relevant authorities will be conducted through subsidies for farming materials and operating funds for the association, and preferential treatment of APB's loans.
- (5) The farmers' groups will be consolidated into the village agricultural association. The association will be open to voluntary membership, having a democratic administration. Members of the association and/or groups will contribute equitably to it, sharing the same risks and benefits.

On the basis of the proposals mentioned above, village agricultural associations, having the leading role in agricultural production, all the villages of the Scheme area. These associations not only support agricultural production, but act as rice banks and offer credit as mutual financing to further contribute to the lives of the farmers. Extension staff of the district AFSs will indirectly support the managing of the association. Furthermore, grass root support and the guidance of experienced experts of international organizations and NGOs will be proposed.

The association will set up a leader, who will be elected by members of the association. The leader will take responsibility for managing the association's activities. An executive organ of the association will consist of the leader, a deputy leader, secretary and

accountant; it will also organize the managing committee comprising the representatives of the groups. The groups are: production groups (recipients of APB's loan), extension groups (working groups for the improvement of farming), marketing groups (marketing of farm products and inputs), and rice banks and saving banks (mutual financing and village credit). The association will effectively promote agricultural production, as well as irrigation, in close teamwork with the village water users groups. Members will finance the association through annual fees. At the initial establishment stage of the association, contributions and annual fees will be set low, then increase along with the farmers' income through introduction of irrigated agriculture. Formation of farmers' organizations in the Scheme areas will be proposed, taking into account the characteristics of each Scheme area, as follows:

- (1) Upper Champi Scheme Area:
  - Establishment of the association by the village leaders.
  - Strengthen and establish the association through community activities.
- (2) Upper Tapoung Scheme Area:
  - Establishment of the association with due respect of the farmers' consensus.
  - Associations' activities based on the consensus of farmers.
- (3) Upper Kapheu Scheme Area:
  - Establishment of the association with due respect of the farmers' consensus, and by the village leaders in some villages.
  - Associations' activities based on the consensus of farmers.
- (4) Lower Xe Set Scheme Area:
  - Establishment of the association with due respect of the farmers' consensus, and by the village leaders in some villages.
  - Associations' activities based on the consensus of farmers.
- (5) Upper Tay-Un Scheme Area:
  - Establishment of the association with due respect of the farmers' consensus.
  - Associations' activities based on the consensus of farmers.

#### 4.2.6 Water Users' Organizations

The operation and maintenance of both the irrigation and water supply facilities, will be transferred to the beneficiaries in line with national policies. Both the water users' groups/associations for irrigation and water supply will be organized by the beneficiaries, under the guidance of provincial agricultural and health authorities, just before setting up the construction works. The proposals for the formation of water users' organizations, considering the interests of farmers expressed in village interviews and farm house household surveys are as follows:

- (i) From the implementation of the scheme, official notices will immediately be sent to the related district authorities from the provincial authorities. An explanation on the scheme to the village committee (administration) will be done by the provincial and district authorities concerned.
- (ii) Following the explanation, a villager's meeting will be held; and the personnel of the provincial and district authorities, the village leader and members of the village committee will explain to the villagers issues regarding the present water situation, i.e., irrigation water and drinking and domestic water, the scheme components to be solved for these issues, merits and benefits from the scheme, and a formation of a water users' association.

- (iii) At the second step, villagers and/or beneficiaries will hold an autonomous meeting at the village, and discuss the formation of these organizations and cooperation to the scheme implementation. The officers who take charge of the scheme will be consulted and cooperate with villagers and/or beneficiaries indirectly.
- (iv) In order for the farmers to form these organizations autonomously, provincial and district authorities will give them (farmers and/or beneficiaries) incentives such as: subsidies for farming materials, and construction costs of tertiary and quaternary canals, reduction and/or exemption from taxes, and special favor for APB loans for five years after the completion of construction works due to stable production resulting from irrigated agriculture. If some farmers appear who could not get benefits from the schemes, the authorities could give them some benefits such as subsidies for farming materials, and reduction and/or exemption from taxes. For beneficiaries of the water supply, a low water fee for five years will also be considered.
- (v) Through these steps, it is possible for these organizations to be autonomously managed and operated by farmers and/or beneficiaries themselves.
- (vi) It is expected that the involvement of women in the groups will contribute to their recognition in the long term, and enhance the awareness of their role in irrigation among males as well as females.
- (vii) In establishing water users' groups/associations, it seems sufficient support from the authorities concerned on group formation is rather difficult to obtain, because such staff and officers in provinces and districts are less experienced in such activities. Therefore, it is proposed that the establishment and subsequent operation and maintenance be carried out by the beneficiary farmers in close cooperation and collaboration with international agencies and NGOs.

The groups/associations will collaborate on the implementation of the schemes. After completion of the schemes, the administrative authorities shall hand over the irrigation and water supply facilities to the groups/associations for operation and maintenance. There will be a legal agreement between water users' groups/associations and relevant authorities on technical and managerial assistance. For this purpose, the formation of these organizations is proposed as follows:

(1) Water Users' Groups/Associations for Irrigation

In accordance with the regulations, the water users' groups/associations are organized as follows:

(i) Village Water Users' Group for Irrigation (VWUG-Irrigation)

The VWUG-Irrigation will be organized in each village of the irrigation scheme area by the beneficiaries under the guidance of the provincial AFSs. The group will set up an office comprising a leader, a deputy leader, a water-man and water fee collector (holding the post of accounting), and also organize the village water users' committee. The leader will be elected by members of the group and take responsibility for managing the group's activities. The water-man will operate water distribution to farm fields, and the water fee collector will collect the fees for operation and maintenance of the irrigation facilities. The water users' committee consists of a leader, a deputy leader, representatives of sub-groups (irrigation units) and of a women's group.

(ii) Water Users' Association in the Irrigation Scheme Area (WUA-Irrigation)

The WUA-Irrigation will be established consisting of the VWUG-Irrigation which belongs to the same scheme. They will be organized in order to the entire scheme area smoothly and effectively manage. The association will carry out water distribution and control; operation and maintenance of irrigation facilities; calculation of O/M costs as water fee; collection of water fees and the responsibility of operation costs. The managing board of the association consists of the leaders of VWUG-Irrigation, a chief, deputy chief, secretary, accountant, and a water-man. The chief of the association will take the responsibility of managing the entire scheme area. The secretary and accountant will be assigned by the managing board. A woman selected among the women's groups in the scheme area will participate as a board member. The provincial AFSs will support the technical part, such as water control, operation and maintenance of the irrigation facilities; and an irrigation engineer will be assigned to the scheme.

(2) Water Users' Group for Water Supply (VWUG-Water Supply)

(i) The VWUG-Water Supply will be organized in each village of the scheme area by the beneficiaries under the guidance of the provincial health services. The group will set up a managing staff and a group committee in the same way as the VWUG-Irrigation. A water-man assigned will operate the controls for water distribution within the village; and a water fee collector assigned will collect the water fees for operation and maintenance of water supply facilities. The committee consists of a leader, a deputy leader, representatives of sub-groups (water supply units) and of a women's group. The involvement of women in the groups will contribute to the success of rural water programs as for water, sanitation and hygiene. The role of women and girls in this respect is essential since they are the ones who draw and haul water, and are engaged in sanitation and activities.

(ii) Water Users' Association for Water Supply (WUA-Water Supply)

In order to smoothly and effectively manage the entire area, the WUA-Water Supply will be established consisting of the VWUG-Water Supply which belong to the same water supply system. The association will operate in the same way as the WUA-Irrigation, and also be run by the managing board. A representative of the women's groups in the system will participate as a board member. The provincial health services will provide technical support, such as water control, operation and maintenance of the water supply facilities. A technician will be assigned to the system.

(3) Board for Coordination of the Water Users' Associations

A board will be established in order to coordinate both the associations for irrigation and for water supply. The board will comprise of representatives of the central authorities, MAF and MOH, and provincial authorities and both associations. This board will coordinate water distribution between irrigation and water supply, at the highest level.

#### 4.2.7 Establishment of Highland Vegetable Trial and Demonstration Stations

The Boloven Plateau, exceeding an elevation of 1,000 m has proved to be favorable for vegetable production for physical features as well as climatic conditions. For the purpose of promotion and extension of vegetable production which could greatly improve the farm household economy and the development of regional economy, the establishment of highland vegetable trial and demonstration stations is proposed. The station aims to improve production methods, conduct extension activities and distribute improved seeds. In addition, the station will conduct research on tea cultivation and its processing for the purpose of upgrading the quality of products.

The proposed station will be operated under the agricultural authorities (AFSSs) of Champasak province, collaborating with the Department of Agriculture and Extension, MAF and the Hatdokeo agricultural research station. The organization is composed of the cultivation section, extension and training section, farm facilities section, laboratory of tea processing and administrative section, with the necessary staff for smooth and effective operation.

The station will prepare a definite plan for development and extension of vegetable farming techniques, and will carry out research and extension programs in cooperation with the MAF's DAE and international organizations. In order to successfully achieve vegetable production, training of extension staff of the provincial and district AFSSs, and also farmers of the production areas will be conducted at the station.

The station with 50 ha will be located at Lak 45, where irrigation water is available from the Upper Champi Scheme, and has convenient road access. Accordingly, it could be expected that extension would cover the entire plateau. This development plan comprises construction of necessary buildings, provision of farm plots with facilities and equipment. Details of this plan are described in section 4.8.

In the long-term, vegetable seed multiplication at the station will be considered for the purpose of selecting and introducing superior varieties to farmers through the district AFSSs.

### 4.3 Water Resource Development

#### 4.3.1 Irrigation Water Requirement

Based on the rainfall data for the past ten years, from 1986 to 1995, and the proposed cropping patterns, irrigation water requirement is estimated using the following formula.

$$IWR = (ETc + Pr + Pd + Nr - ER) / Ei$$

where :	IWR	:	gross irrigation water requirement
	Ei	:	overall irrigation efficiency
	ETc	:	crop consumptive use of water
	Pr	:	percolation for paddy
	Pd	:	puddling requirement for paddy
	Nr	:	nursery requirement for paddy
	ER	:	effective rainfall

Basic data for this calculation such as potential evapo-transpiration (To), crop coefficient (Kc), effective rainfall (ER), percolation (Pr), puddling requirement (Pd), nursery requirement (Nr) and overall irrigation efficiency (Ei) are the same figures presented in Part I, the Master Plan Study. Seasonal irrigation requirement for each cropping pattern is estimated as shown below, adopting rainfall data for the past ten years.

Type-A	(double paddy cultivation) Lower Xe Set Scheme Upper Tay-Un Scheme	1,627 - 2,299 mm 1,222 - 2,291 mm
Type-B1	(upland crop-paddy) Upper Kapheu Scheme	911 - 1,360 mm
Type-B2	(upland crop-paddy) Lower Xe Set Scheme Upper Tay-Un Scheme	1,170 - 1,649 mm 778 - 1,707 mm
Type-C	(vegetables-upland crop) Upper Champi & Upper Tapoung Schemes	305 - 729 mm
Type-D	(coffee) Upper Champi Scheme Upper Kapheu Scheme	79 - 160 mm 123 - 205 mm

#### 4.3.2 Irrigation Areas and Irrigation Methods

In accordance with the test results on field intake rates and evaluation of land capability, it is clear that any irrigation method can be adopted for upland crops in all the Schemes. The following three (3) methods are adopted for the irrigation of the each crop.

- (i) Furrow irrigation method for upland crops including vegetables,
- (ii) Border irrigation method for coffee and
- (iii) Surface irrigation method for paddy.

#### 4.3.3 Small Impounding Water Management

In order to supply irrigation water properly in the rainy season and to expand irrigation areas as much as possible based on land suitability in each Scheme area, small impounding ponds are provided, taking into consideration topographical conditions and location of irrigation areas.

Except for the Lower Xe Set Scheme, eight (8) small impounding ponds are provided to construct small scale earthfill dams with dam height ranging from 8 m to 20 m or concrete weirs in the four (4) Scheme areas such as one (1) site in the Upper Champi Scheme, one (1) site in the Upper Tapoung Scheme, four (4) sites in the Upper Kapheu Scheme and two (2) sites in the Upper Tay-Un Scheme.

Water management of all impounding ponds is to be carried out throughout all the seasons to store as much river water in the rainy season as possible for irrigation use in the dry season. Storage capacity of reservoirs is determined by supply water in all irrigation areas during a drought year of 80% probability based on water balance calculation, and the storage capacity of respective reservoirs ranging from about 60,000 m<sup>3</sup> to 240,000 m<sup>3</sup>.

#### 4.3.4 Water Balance and Irrigation Potential

Water resources for development are estimated based on monthly water balance calculation between river runoffs at proposed dam sites and water demands consisting of irrigation water, domestic water supplies, water losses in the reservoirs and maintenance of river flows for ten (10) years, from 1986 to 1995.

Concept of water balance is presented in the following formula:

$$(R - (L1 + L2 + M + D)) = C + SP$$

Where,

R : Seasonal runoff	L1 : Evaporation loss
L2 : Seepage loss	M : Maintenance flow
SP : Spill out discharge	C : Reservoir capacity
D : Irrigation demand and domestic water supply	

Water resources for irrigation in each Scheme is estimated to sustain full water supply during a drought year of 80% probability, based on proposed cropping patterns; and irrigation areas of all the schemes are determined taking into consideration land suitability and results of water balance in each Scheme as shown below.

(1) Upper Champi Scheme	Coffee & Type-C	730 ha
(2) Upper Tapoung Scheme	Type-C	80 ha
(3) Upper Kapheu Scheme	Coffee & Type-B 1	1,000 ha
(4) Lower Xe Set Scheme	Type-A & Type-B 1	1,000 ha
(5) Upper Tay-Un Scheme	Type-A, Type-A 1 & Type-B 1	330 ha
Total		3,140 ha

#### 4.3.5 Water Demand for Domestic Water Supplies

The following design assumption is applied for gravity flow piped water systems based on the discussion with provincial health service officers and information on similar types of rural water systems in other parts of Lao PDR, constructed by UNDP and UNICEF.

- Daily water consumption : 60 lit./day/capita
- Population design : Year 2010 with 1.7% to 3.6% (\*) of growth rate
- Users' loss and pipe transmission loss : 30% of design requirement

Note: (\*) Annual population growth rates are applied based on the censuses in 1985 and 1995, 1.7% for the Upper Champi and Upper Tapoung areas, 2.7% for the Lower Xe Set and Upper Tay-Un areas and 3.6% for the Upper Kapheu area, respectively.

Based on the above assumption, total daily water demand for each priority Scheme area is estimated, varying from 359 m<sup>3</sup> to 77 m<sup>3</sup>, and requiring from 5.41 lit./sec. to 1.14 lit./sec. of flows, as shown below. The proposed water source is determined in combination with the proposed irrigation development plans, considering water availability and topographical conditions.

Priority Scheme Area	No. of villages	Total population	Population design	Daily demand (m <sup>3</sup> )	Required flow* (lit./s)	Water source
(1) Upper Champi	8	4,731	5,990	359	5.41	H. Champi
(2) Upper Tapoung	3	1,478	1,871	113	1.68	H. Kapheu, H. Tapoung
(3) Upper Kapheu	5	2,393	3,926	236	3.54	H. Kapheu
(4) Lower Xe Set	6	2,218	3,221	193	2.91	Xe Set
(5) Upper Tay-Un	3	871	1,264	77	1.14	H. Thon, H. Tit
Total	25	11,691	16,272	978	14.68	

Note: \* with 30% of pipe transportation loss



#### 4.4 Agro-economy and Marketing

##### 4.4.1 Market and Price Forecast

Future marketing conditions are estimated of the following crops:

###### (1) Coffee

As mentioned in the previous chapter, the present high price is a result of the decrease in coffee production in Brazil; the price is assumed as an exceptional case. The price will be in decline, at half the present price according to the IBRD forecasting (Commodity Market and the Developing Countries, IBRD, Feb. 1996). The following table shows future international market prices and anticipated farmgate prices of coffee.

	(Unit US\$/kg, Kip/kg)		
	1995	2000	2005
New York (US\$)	2.77	1.54	1.50
Farmgate (Kip)	950-1,100	700	670

Remarks: Price is for robusta coffee.

Price is indicated at 1995 constant price.

Farmgate price is the floor price calculated from the formulation of LCEA.

Source: IBRD, Commodity Market and the Developing Countries, FEB. 1996

###### (2) Tea

High quality teas are presently traded in the domestic Chinese and Vietnamese markets at high prices. Therefore, if the quality of tea improves, it could be sold at a reasonable price. The market is not broad, however if high quality tea can be produced; but it will be possible to export it to Thailand, China and other international markets.

###### (3) Vegetables

Vegetables produced in the priority areas are presently traded at domestic markets at Pakxe, Vientiane, and at Thailand. Due to poor road conditions and the present diet of eating no vegetables in Lao PDR, it is considered that the expansion of the vegetable market is quite difficult at present. However, the diet style will change in the future as the country develops; and road conditions also will be improve under the existing plan.

One of the main limitations to exportation is the high duty barrier in Thailand. In this connection, most vegetables are traded at the border, hence the amount of vegetables exported to Thailand is not stable. In the future, the duty barrier will disappear under the advice of WTO (World Trade Organization). Therefore, it is considered that there is a high market potential during the off crop season in Thailand. The future marketable vegetables and them marketable seasons are considered as follows :

Proposed vegetables	Domestic	Thailand
Potato	Dry season	Rainy season
Cabbage	Dry season	Rainy season
Chinese Cabbage	Dry season	Rainy season
Ginger	Dry season	All season
Carrot	Dry season	Rainy season

###### (4) Upland Crops

Presently, a significant amount of groundnuts are exported to Thailand, where there is a processing factory of groundnuts. This trend for groundnuts will be continue, and the market of peanuts will be stable. It is estimated that the demand for livestock feed will increase in the future along with an increase in demand for livestock. In addition to these conditions,

since the improvement of the Tha Ngon processing factory is expected under the LUADP activities, the markets for soybean, and maize, should also expand in the future.

(5) Rice

There is quite a shortage in the total rice production of the plateau area as mentioned in the Master plan report. In addition, production in Xekong province did not cover the demand of the province as shown in the table below. There was a shortage of 6,000 tons of paddy in 1995. The shortage is covered by aid every year. Therefore, the rice produced in the priority area along the Project is traded at two (2) markets; plateau area and Sekong province. The price of rice at the domestic market will rise if the quality of rice improves.

Population (1994)	Demand (Th. tons)	Production(Th tons)	Balance (Th tons)
63,800	19.2	13.1	- 6.1

4.4.2 Marketing Development Plan

The market development plan is formulated taking into consideration the basic development concepts. The following institutional development of marketing is proposed, which includes the construction of market facilities (including warehouses), the strengthening of agricultural support and extension, promotion of farmers' organizations, women's development and agricultural development.

(1) Establishment of Wholesale Market in Pakxong

The establishment of a wholesale market for vegetables in the Pakxong area is vital in promoting vegetable cultivation, not only in the Study area but also for other producing areas. The introduction of a grading system will create a smooth and competitive market.

(a) Proposed Site

It is recommended that a wholesale market shall be established at Pakxong town; because it has main commercial activities, it is at the center of the plateau, and has easy accessibility to producers and traders. Most vegetables produced in the Pakxong area are presently transported through Pakxong town to Pakxe or another town. In addition, the two (2) Schemes with potential for vegetable production, namely the Upper Champi and Upper Tapoung Schemes are located near Pakxong town. It is recommended that the free land space adjacent to the existing Pakxong market be used for the proposed wholesale market.

(b) Activities and Facilities

This wholesale market shall have the following activities.

- i) operating the wholesale market,
- ii) introducing a grading system and quality control,
- iii) supply market information,
- iv) assistance in transporting,
- v) training of farmers, and
- vi) agro-input supply (by private sector)

The facilities to be constructed are planned as follows: