

No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
MINISTRY OF AGRICULTURE AND FORESTRY
LAO PEOPLE'S DEMOCRATIC REPUBLIC

**AGRICULTURAL DEVELOPMENT PROJECT
TO
CONTROL SLASH AND BURN CULTIVATION
IN
OUDOMXAY PROVINCE**

**VOLUME II
MASTER PLAN STUDY**

AUGUST 1993

**NIPPON KOEI CO., LTD.
and
CONSTRUCTION PROJECT CONSULTANTS, INC.**

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VOLUME II MASTER PLAN

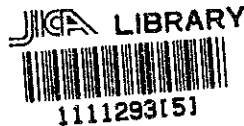
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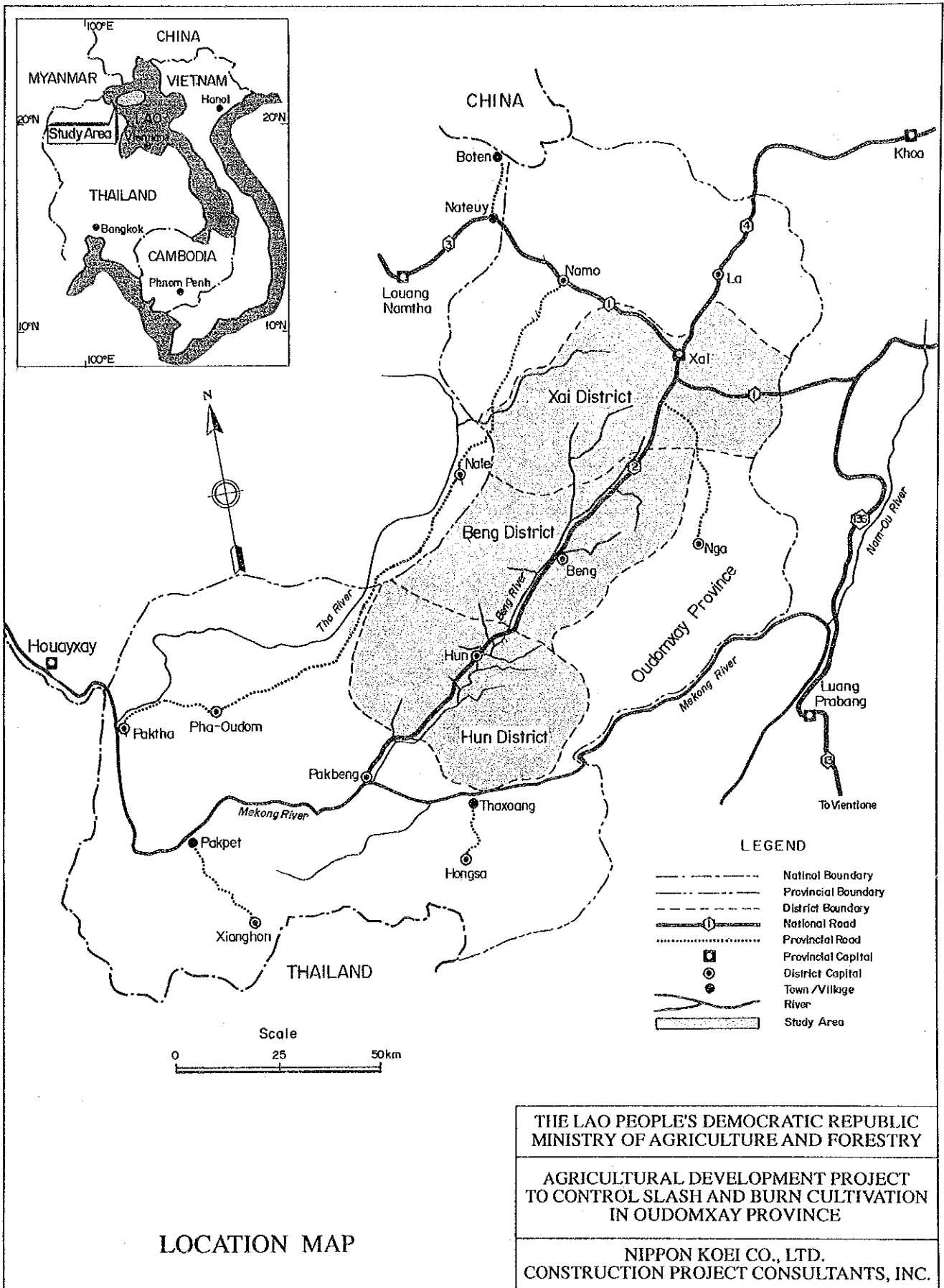


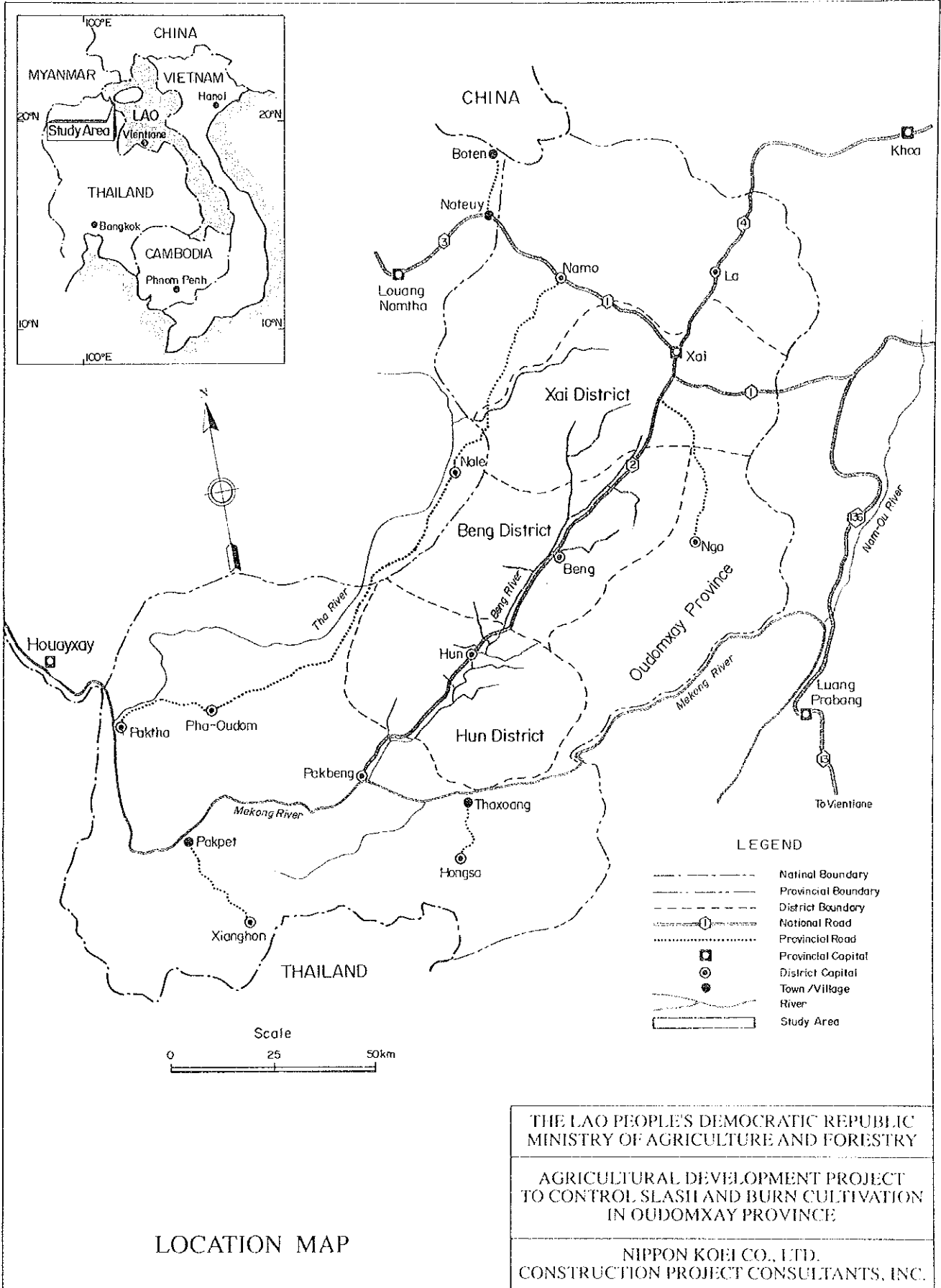
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CONTROL SLASH AND BURN CULTIVATION
IN
OUDOMXAY PROVINCE

Volume II Master Plan Study

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ABBREVIATIONS

ADB	:	Asian Development Bank
CTPC	:	Communication, Transportation, Post and Construction
GDP	:	Gross Domestic Product
EC	:	European Community
FAO	:	Food and Agriculture Organization, UN
FCM	:	Farmer and Community Managed (Irrigation Schemes)
HDP	:	High Density Polyethylene (Pipe)
JICA	:	Japan International Cooperation Agency
Lao PDR	:	Lao People's Democratic Republic
MAF	:	Ministry of Agriculture and Forestry
MCTPC	:	Ministry of Communication, Transportation, Post and Construction
NAEC	:	National Agricultural Extension Centre
NARC	:	National Agricultural Research Centre
NEM	:	New Economic Mechanism
NGO	:	Non-Government Organization
NOEP	:	National Office for Environment Protection
O&M	:	Operation and Maintenance
SIDA	:	Swedish International Development Agency
UNDP	:	United Nation Development Program
UNICEF	:	United Nation Children's Fund

<u>Length</u>	cm	:	Centimeter	
	m	:	Meter	
	km	:	Kilometer	
<u>Area</u>	cm ²	:	sq.cm	: Square centimeter
	m ²	:	sq.m	: Square meter
	km ²	:	sq.km	: Square kilometer
	ha	:	Hectare	
<u>Volume</u>	cm ³	:	cu.cm	: Cubic centimeter
	lit.	:	Litre	
	m ³	:	cu.m	: Cubic meter
<u>Derived Measures</u>	m ³ /sec	:	Cubic meter per second	
	lit./sec	:	Litre per second	
<u>Weight</u>	mg	:	Milligram	
	g	:	Gram	
	kg	:	Kilogram	
	ton	:	Metric ton	
<u>Time</u>	sec	:	Second	
	min	:	Minute	
	hr	:	Hour	
	yr	:	Year	
<u>Electric Measures</u>	W	:	Watt	
	kW	:	Kilowatt	
<u>Other Measures</u>	%	:	Percent	
	°C	:	Degree in Centigrade	
	10 ³	:	Thousand	
	10 ⁶	:	Million	
<u>Exchange Rate</u>	US\$ 1 = Kip 715 = Yen 125			

1. INTRODUCTION

Recently, the Lao People's Democratic Republic (Lao PDR) has serious problems in decrease of forest area in the mountain and hilly zones, especially in the northern and eastern parts of the country, which arise mainly from increase in population and shortage of food supply. In addition, a rapid expansion of shifting agriculture in the forest zones accelerates devastation of vast forest area, serious soil erosion, deterioration of potential water resources and land productivity, and environmental problems, which largely affect the national socio-economic activities and development.

In order to cope with these situations, the Government of Lao PDR has decided to take various measures for control of the shifting agriculture through increase in crop production and farm income of the farmers by introducing and expanding irrigated farming especially in lowland area, improvement and construction of both agricultural and social infrastructures, strengthening of agricultural support services, and improvement of marketing system of farm products.

In order to support such the government's measures also to Oudomxay province, the Master Plan Study on the agricultural development project which covers Xai, Beng and Hun districts of the province (the study area) is carried out, upon request of the Government.

Therefore, the objectives of this Master Plan Study are to formulate the integrated agricultural development in the study area, which will contribute to the control of slash-and-burn cultivation. The purpose of this Master Plan Study is to:

- (1) identify the present conditions in and around the study area;
- (2) make the study on various constraints to profitable agricultural development in the study area;
- (3) make the study on potentials in the study area;
- (4) study the development concept in the study area;
- (5) formulate program for increase and stabilization of agricultural productivity for contributing to alleviation of the present slash-and-burn cultivation in the study area; and
- (6) propose the agricultural development action plan in the study area.

2. BACKGROUND

2.1 National Background

2.1.1 Land and Population

Lao PDR is a landlocked country. It occupies an area of 236,800 km² and is bordered by the People's Republic of China and Myanmar to the northwest, Vietnam to the north and east, Democratic Kampuchea to the south, and Thailand to the west. About 75% of the land surface is mountainous and in these areas only the narrow valleys are suitable for cultivation. About 3,800 km² (1.6% of total national land) are lowland rice field, and about 2,150 km² (0.9%) are for upland rice field including slash-and-burn cultivation areas. About 2,600 km² (1.1%) are for other crops, of which 20% is coffee. Pasture and range land is about 8,000 km² (3.4%).

Traditional slash-and-burn cultivation system was generally in harmony with the environment, when there was no land pressure in the hill to mountainous areas and a family of about 6 persons could have a total area of about 20 ha to 25 ha for adoption of the rice-based slash-and-burn cultivation system under a 10-year fallow cycle. At present, however, slash-and-burn cultivation systems have exerted pressure on the land and some 2,000 km² to 3,000 km² of forest are reportedly destroyed every year, including an estimated 1,000 km² (0.4% of total national land) of primary forest. Conservation of these forest resources is need through a proper measure to control of slash-and-burn cultivation.

According to the 1985 census, the population in Laos was estimated at about 3.62 million in that year with an annual growth rate of 2.8%. The estimated population in 1988 was 3.94 million at an annual growth rate of 2.8%. Based on the same growth rate, the population in the year 2000 is expected to be 5.5 million. About 85% of the population is living in rural areas and widely dispersed in over 11,000 villages, with an average population density of 17 per km². Despite this, about half the population is concentrated in the Vientiane plain and in the Southern Region such as Savannaketh, Champasak and Saravane provinces.

The population comprises the three main ethnic groups, i.e. the lowland Lao or "Lao Loum", the upland Lao or "Lao Theung" and the highland Lao or "Lao Sung". Lao Loum occupies about 50% of the population in Laos, and indigenous and immigrant minority groups make up the remaining 50%. Lao Theung groups are migratory and mostly practice slash-and-burn cultivation in the hilly area and Lao Sung group also practices shifting cultivation at higher elevations.

2.1.2 Economic Background and Policy Development

In 1985, the government initiated a reform of its system of economic management and the New Economic Mechanism (NEM) has been established as a basic foundation for the entire development strategy of Lao PDR. In order to achieve more favourable and faster rate of development, greater reliance will be placed on market-oriented economy. The objectives under NEM are set to improve the public sector enterprise management and increasing the role of the private sector. The measures to be taken under NEM are:

- (1) promotion of private sector business;
- (2) decentralisation of economic planning;
- (3) increased autonomy of state enterprises;
- (4) removal of price control on goods and services;
- (5) revision of tax system;
- (6) restructuring of monetary and banking system;
- (7) adoption of the market exchange rate; and
- (8) liberalisation of domestic and export trade.

Under NEM, Gross Domestic Product (GDP) of Laos has been increased from US\$412 million in 1985 to US\$525 million in 1990 at 1989 constant prices with an annual growth rate of 5.0%. Although this high growth rate, per capita GDP is still remaining low level and is estimated at about US\$126 in 1990. In Lao PDR, agriculture is mainstay of the national economy. Agricultural sector produced about 60% of GDP in 1990 followed by services sector of about 24% and industry sector of about 16%, respectively, and about 85% of the population depends on the agricultural sector. While Lao agriculture is still predominantly subsistence-oriented with less modernized farming practices. Slash-and-burn cultivation systems still account for about 40% of crop production per year.

On the basis of the policies in NEM, a draft of the Third Five Year Plan (1991 to 1995) has been prepared and is under its finalization. The main objectives of the Third Five Year Plan give priority to agricultural sector which will be the engine of economic growth and are to:

- (1) ensure food self-sufficiency and food security;
- (2) reduce the area subject to slash-and-burn cultivation;
- (3) expand the agro-forestry based industrial processing sector;
- (4) improve the balance of payments;

- (5) improve the transport and telecommunication; and
- (6) strengthen the administrative and managerial capability.

2.1.3 Development Strategy for Agricultural Sector

As explained above, the government gives priority to agriculture, and agricultural production should further be expanded as the major share of national production, especially to address the problem of food shortage and inadequate nutrition, while diversifying production through the promotion of cash crops cultivation. To this end, the area under irrigation should further be expanded, and efforts should also be continued to improve crop yields through research, extension services and use of modern farm inputs. For this purpose, the government attention will be focused on the following key areas:

- (1) Land use regulation: clear property right on land is important to enhance the allocation of land resources. A system of land use and land right will be established.
- (2) Subsidies and project intervention: competition will be encouraged in the provision of agricultural inputs. With competition, the farmer is in control since he will have alternative choices, if he is not satisfied with any supplier. The government will concentrate on developing a competitive supply, processing, and marketing network.
- (3) Marketing and trade control: monopoly and trade control and practices in local and foreign trade in agricultural commodities will be avoided by the government or by state enterprises. These include marketing practices such as monopoly trade and processing rights in certain strategic commodities for state enterprises, monopoly supply of agricultural inputs, and use of licenses and quotas to restrict market access. A legal basis for trade transactions will be developed.
- (4) Agricultural taxation: differential agricultural output taxes which causes distortions on the choice of crops to be grown will be eliminated. Agricultural taxation suitable to Lao conditions will be determined and developed. Land taxes based on the classification of land potential, rather than actual production, will be examined, in order to avoid disincentives on choice of crops.

The strategy for irrigation development will be (i) to curtail the flow of resources into high cost larger-scale irrigation systems; (ii) to turn these public sector schemes to the farmers communities as much as possible; and (iii) to concentrate on a much more moderate level of resources on the support of water users associations which control their irrigation systems. In this connection, efforts will be made to improve the efficiency of existing irrigation systems through rehabilitation and maintenance. The government irrigation agencies will be redirected to provide a support function to farmers' associations formed on the irrigation schemes, instead of undertaking direct investment on the development of new schemes.

The productivity, economic returns and export earning of the livestock sector will be maximized by accelerating commercial development of this sector, with the private sector being encouraged to play a dominant role in production, marketing and investment. In order to encourage the livestock export, export taxes on livestock trade will be abolished, with reliance instead of direct level taxes on production in general to generate revenues from the sector.

The government recognizes that fishery is an important and relatively inexpensive form of food source. The development of fishery, especially by the private sector, will further be encouraged through the provision of restocking the lakes, the establishment and expansion of fish farms, the improvement of fishing methods in the rivers, and the provision of adequate transportation and storage facilities for the purpose.

2.2 Regional Background

2.2.1 Regional Socio-economy

Agriculture is the main industry which employs more than 95% of the total population of Oudomxay province. Rice is the staple food and the main agricultural product, followed by sesame and other minor crops such as beans and some vegetables. Rice is cultivated in the lowland rice field with irrigation or under rainfed condition, and also cultivated in the upland rice field by slash-and-burn cultivation. The total area of lowland rice field in 1991 was about 9,800 ha and that of upland rice field was about 31,000 ha. The production of rice in the lowland and upland in the province was about 26,600 ton and 41,000 ton in paddy, respectively.

It is estimated that the population in the province be growing with a rate of about 2.6% per annum. The balance of production and consumption of paddy in the province in six recent years is examined as shown below:

Year	Production (ton)	Population (No.)	Consumption (ton)	Balance (ton)
1986	79,370	254,450	89,100	-9,730
1987	103,890	260,770	91,300	+12,590
1988	68,490	266,260	93,200	- 24,800
1989	96,500	273,910	95,700	+800
1990	99,700	282,140	98,700	+1,000
1991	67,540	290,250	101,600	- 34,060
Total	515,490	-	569,600	- 54,110
Average	85,900	-	94,900	- 9,000

Note: Consumption is estimated based on 350 kg/capita/year in paddy.

The paddy production in the province is not sufficient to fulfil the consumption in the province. About 9,000 tons of paddy are short per year on an average. In the year when the farm production was affected adversely by weather condition, the farmers collect forest products to supplement their food shortage.

Livestock such as buffalo and cattle is important product for export as well as for farm power and local consumption. The number of buffalo and cattle in 1990 was about 80,400 and 57,000, respectively. Beside the products in the farms and of livestock, they collect various kinds of forest products such as cardamom, benzoin, bamboo shoot, mushrooms, and many kinds of animals and fishes.

2.2.2 External Trade

Xai city is the capital of Oudomxay province and the centre for marketing in the province, and occupies important location of transportation routes for transit trade among Thailand, China and Vietnam. The commodities imported from Thailand are passed through Houay Xai, 160 km north from Pakbeng, transported via the Mekong and landed at Pakbeng for road transportation to Xai by National Road No.2 which runs along the Nam Beng river. The goods to Vietnam from Thailand are sent after Xai city via Nam Khoa. Agricultural products in and around Oudomxay province exported to Thailand are mainly shipped at Pakbeng and sent via Houay Xai. Agricultural products exported to China are mainly transported via Xai city and Boten village. Major commodities traded through Oudomxay province and their destinations and origins are as follows :

	Thailand	China	Vietnam
Export	buffalo, cotton, sesame, cardamom, cattle, garlic	iron sheet, plywood, sesame, cardamom	motorcycle, slipper, seasoning, battery
Import	motorcycle, slipper, medical drugs, construction materials	battery, bicycle, sewing machine, cement	cotton, clothes, fabric

Imported items from Thailand are mainly industrial products, such as motorcycles, medicine, and construction materials, while exporting buffalo, sesame, cardamom and cotton. Trading with China is the import of iron sheet and plywood, and the export of agricultural products such as sesame and cardamom. Trading with Vietnam is mostly concentrating on the export of industrial products imported from Thailand and China, and import of cotton to be exported to Thailand.

2.2.3 Administration

The Oudomxay provincial office is administered by the Governor and two Vice-Governors. Five departments and a Bank division are under the control of the Vice-Governor No.1, and the Vice-Governor No.2 governs three departments such as agriculture and forestry services, public and health services, and education services. The military, police and justice divisions and two departments are under the direct control of the Governor (see Fig.M-1). Total number of the provincial office staff is 141, which include 8 high class staff, 53 middle class staff, 55 primary class staff and 25 administrative staff.

3. THE STUDY AREA

3.1 Location and Topography

The study area consists of Xai, Ben and Hun districts, and is located along the Nam Mao and Nam Beng rivers and has a total geographical area of about 5,580 km² as shown in Location Map. The National Road No. 2 connects Xai, Beng and Hun districts from north to south, and reaches Ban Pakbeng located at the river side of the Mekong. The distance from Xai town, which is the administrative and marketing centre of Oudomxay province, to Beng and Hun district centres, and Ban Pakbeng is about 60 km, 100 km and 150 km, respectively, along the National Road No. 2. The Road No. 1 runs further north-westwards from Xai to the border on the People's Republic of China with a distance of about 100 km.

Similar to the whole Oudomxay province, the study area is dominated by hills and mountains areas. Only small part of the study area is composed of the valley flat land and adjacent upland of the tributaries of the Mekong river. Out of 5,580 km², about 19,350 ha (3.5%) are considered arable, of which the annual cropped area is estimated at about 16,000 ha. The slash-and-burn cultivation areas being left fallow are estimated at about 36,980 ha (6.6%), and the remaining 501,800 ha (89.9%) are covered with forests and others.

3.2 Natural Conditions

3.2.1 Meteorology and Hydrology

(1) Meteorology

In the study area, there is only one meteorological station in Xai town which was established by the Ministry of Agriculture and Forestry (MAF) in April 1984 and is managed by the provincial office. Available records are atmospheric pressure, precipitations, temperature, maximum temperature, minimum temperature, relative humidity, cloudiness, sunshine hours and evaporation. Based on the data, the climate in the study area is classified as subtropical characterized by the southwest monsoon which brings rainfall, high humidity and high temperature in the period from May to September. The period from October to March is a dry season and has lower temperature.

Mean annual rainfall is estimated at about 1,220 mm and 81% of it falls in monsoon season from May to September. Mean annual temperature is

23.4°C, which is cooler than those in Vientiane and Luang Prabang. The highest temperature of 36°C to 38°C occurs in April or May. The period from December to February is cool, and the lowest of 4°C to 6°C occurs during this period. No frosts have been reported in the study area. Humidity is high from June to September, 80% of relative humidity is an annual average. Annual sunshine hours is 1,700 hours on an average.

(2) Hydrology

Main water resources in the study area are the Nam Beng river which is a tributary of the Mekong river and the Nam Ko river, a tributary of the Nam Ou river. In addition, there is one perennial spring having a discharge of 30 to 40 liter/sec in the dry season at Ban Phonsavan in Sibounheun sub-district of Hun

- (i) The Nam Beng river is the biggest river in the study area and has a catchment area of 2,140 km² at Pakbeng and 600 km² at Ban Gno, near the confluence with the Nam Phao, in Beng district. This river is perennial watercourse having discharge of about 1 m³/sec, at Muang Hun in the dry season (measured by the study team in March 1992). The discharge of the tributaries of the Nam Beng such as Nam Met, Nam Lo, Nam Phao, Nam Hao in Beng district and Nam Kham, Nam Oun, Nam Heng in Hun district ranges from 50 to 380 liter/sec in the dry season, depending on their catchment areas and vegetation.
- (ii) The Nam Ko river runs northeast direction through Muang Xai and flows into the Nam Phak which is a tributary of the Nam Ou. The Nam Ko is perennial water course with a catchment area of 980 km² at Pakko and 600 km² at the bridge of National Route No.1 in Muang Xai. The Nam Mao and Nam Hin are the main tributaries of Nam Ko and are perennial water courses, having discharges of 340 liter/sec and 150 liter/sec in the dry season (measured by the study team in March 1992).

In August 1985, a big flood occurred in the study area. According to the hearing from officers and villagers, this flood is assumed to be the one with a 40-year return period. Flood discharge at that time is roughly estimated by

the water level which is obtained by hearing, cross section and longitudinal slope of the river, as shown below.

River	Point	Catchment area (km ²)	Discharge (m ³ /sec)	Specific runoff (m ³ /sec/km ²)
Nam Mao	Ban Houaykhoun	200	540	2.7
Nam Ko	Muang Xai at the bridge of Route No.1	600	1,660	2.8
Nam Kham	Ban Nakham-nua	55	132	2.4

3.2.2 Soils and Land Suitability

Up to date, no comprehensive soil survey was carried out in the study area, and specific information on soils of the area is not available. Only existing information that makes some references to the soils of the Northern Region of Lao PDR is the FAO-UNESCO soil map of the world on a scale of 1:5,000,000. A soil and land classification survey was therefore carried out for the purpose of the Master Plan Study.

(1) Soil Classification

Soil classification is made in accordance with the Soil Taxonomy of the US Department of Agriculture, and a correlation is made with the FAO-UNESCO Soil Map of the World Legend. According to the physiographic condition, the soils in the study area are broadly classified into three land units, namely (i) alluvial fans; (ii) lower terraces; and (iii) steeply dissected mountains.

- (i) The alluvial fans developed along the main rivers form mixed local alluvium transported within small basin. In general, the topography of alluvial fans is almost flat to gently sloping. The soils are deep and present good physical conditions. The texture class varies from sandy loam to clay. The internal drainage is moderate in the upper horizons up to approximately 60 cm depth, and it is imperfect for the lower soil horizons. The natural fertility varies from moderate to low, and organic matter contained in the surface horizon is medium. Nitrogen content is low, while phosphorous content is medium. Base saturation percentage is high, being calcium the most largely present cation. Most of the alluvial fan areas are being used as rice field.
- (ii) The lower terraces are mostly located at the foot of hills or mountains, just in slightly higher position than the alluvial fans, and the topography

is gently undulated. The soils present good physical conditions moderately deep, with well to moderate internal drainage. The texture class varies mostly from loam to clay loam, and the natural fertility varies from moderate to low. The lower terraces are mostly used under a slash-and-burn cultivation more intensive than the high mountain. Some are used as rainfed rice fields after the construction of ridges for water retention.

- (iii) The steeply dissected mountain present very rough topographic condition with steep slopes. The soils are shallow to moderately deep with loam to sandy clay texture, and are leached mostly with acidic reaction. The natural fertility is very low. These soils are being used for slash-and-burn cultivation.

(2) Land Classification

The present land suitability classification is made at a reconnaissance level and land suitability rating is made based on the following criteria:

Diagnostic Factors	Unit	S1	S2	S3	Sc	N
Land Slope						
Irrigated	%	<3	3-6	6-9	9-12	>12
Rainfed	%	<12	13-25	26-35	-	>35
Soil Depth	m	>1.5	1.0-1.5	0.5-1.0	-	>0.5
Texture	class	loamy	-	clayey	-	sandy
Note:	S1-S3; suitable		Sc; conditionally suitable.		N; not suitable	

Taking into consideration the land classification criteria described above, the lands in the study area are classified as follows:

Item	Irrigated Agriculture		Rainfed Agriculture	
	(ha)	(%)	(ha)	(%)
Suitable (S1-S3)	3,700	0.7	150,800	27.0
Conditionally Suitable (Sc)	3,500	0.6	-	-
Not Suitable (N1 & N2)	550,800	98.7	407,200	73.0
Total	558,000	100.0	558,000	100.0

The suitable land for irrigated agriculture is estimated at about 3,700 ha or 0.7% of the study area. Even if the lands of conditionally suitable are included, only 7,200 ha or 1.3% of the study area are suitable for irrigated agriculture.

3.3 Ethnic Group

Similar to other provinces of Laos, the people of Oudomxay province as well as the study area are composed of three main ethnic groups of Lao Loum, Lao Theung and Lao Sung. Although Lao Loum is the majority group of the country as a whole, Lao Theung dominates in the study. General characteristics of each ethnic group can be summarized as follows:

(1) Lao Loum

Originally, Lao Loum are people from the lowland areas whose main agricultural activity is the cultivation of irrigated or rainfed lowland rice on terraces or flat valley bottom. During the last decades, however, the population has increased to such an extent that new opening of rice field becomes difficult gradually, mainly because of limited availability of easily terraceable land. Therefore, Lao Loum also started to cultivate upland rice on the adjacent hill slopes by slash-and-burn farming.

(2) Lao Theung

Generally, Lao Theung groups have their shifting agricultural fields and communities on slopes at medium altitude. They are practicing an ecologically much more stable system of shifting cultivation, whereby a large number of fields are cropped for 1 or 2 years in combination with a fallow period of 5 to 15 years, depending on soil conditions and availability of land. Although upland rice is the main crop in general, other crops such as cassava, maize and chillies are also part of their cropping patterns.

There are also Lao Theung groups who moved down from the hill areas and established their villages along the National Road No.2. They are engaged partly in lowland rice cultivation. However, lowland available for these groups is generally limited, because most of lowland rice field is already in use by Lao Loum groups. Therefore, their main farming activities are slash-and-burn cultivation on the adjacent hill slopes with a short fallow period of 3 to 4 years.

(3) Lao Sung

There are also Lao Sung groups who moved down from the higher hills and established their villages along the National Road No.2. These groups are engaged in slash-and-burn cultivation on the hill slopes adjacent to the road. Such hills, especially in the downstream area of Hun district, are completely slashed and burned for upland rice cultivation by these groups. These Lao Sung groups residing on the hill slopes are obliged to be engaged in slash-and-burn cultivation because of no alternatives for their survival at present.

In most cases, an ethnic group is the base to organize a village or community, though there are also villages which are composed of 2 groups or some time 3 groups. The population and number of village by ethnic group, and number of family in each district of the study area are summarized as follows:

Item	Xai	Beng	Hun	Total
Population (Number)	37,446	24,053	39,768	101,267
Lao Loum (%)	35.5	37.9	19.6	30.0
Lao Theung (%)	51.5	54.1	67.2	58.1
Lao Sung (%)	12.9	8.0	13.2	11.9
Number of Villages	172	106	157	435
Lao Loum	23	21	19	63
Lao Theung	108	70	110	288
Lao Sung	25	15	22	62
Ethnic Mix	16	-	6	22
Number of Families	6,169	3,830	6,556	16,558
Member per Family (person)	6.1	6.3	6.1	6.1

Note: Population, number of villages and families are based on the data collected from each district office.

3.4 Basic Economic Conditions

The current economic conditions of the study area are evaluated from the rural economy, farmers' economy and in terms of food balance, as follows:

(1) Rural Economy

The rural economy in the study area is at very small scale and under rather isolated circumstances, due to lack of transportation facilities, lack of timely information on markets as well as due to the subsistence level of the farmers' economic activities. The main economic activities in the rural area are agriculture. About 90% of the total population in the study area seems to be engaged in agriculture.

The agricultural production is, in most of the area, mainly for self-sufficiency and very small portion for marketing purposes. Livestock raising is also important economic activity in the villages. Main livestock raised in the study area is buffalo, cattle, goat, pig and poultry.

(2) Farmers' Economy

The farmers economy is at subsistence farming level, in general, based on rice cultivation both in lowland and upland (slash-and-burn) in the area with some secondary crops such as sesame, tobacco and some vegetables. The livestock is also important element of their economic activities not only for farm power but also for sale to supplement their farm income, especially for emergency cases of like sick or the agricultural production in the field affected adversely by the weather condition.

Their economy also largely depends on the non-wood products collected and hunting in the forest, and fishes from rivers. Many kinds of animals and plants collected from the forest such as cardamom, meat of animals, vegetables, etc. play an important role in the rural economy. Cardamom is the important export product for Thailand and China, and others are mostly consumed by themselves and surplus is sold to the local markets.

(3) Food Balance

The food balance in the study area is examined based on the rice production and population in recent years as shown below:

Year	Production (ton)	Population (No.)	Consumption (ton)	Balance (ton)
1987	24,140	80,230	28,080	-3,980
1988	24,530	81,580	28,550	-4,020
1989	23,700	87,050	30,470	-6,770
1990	24,600	97,480	34,210	-9,610
1991	25,520	101,270	35,440	-9,920
Total	122,490	-	156,750	-34,260
Average	24,500	-	31,350	-6,850

Note: Consumption is estimated based on 350 kg/capita/year in paddy.

The production of rice in the study area is very short to fulfil the people's consumption in the area. The shortage of paddy has increased every year and about 10,000 tons of paddy were short in 1991.

3.5 Present Land Use

Because the scarcity of reliable land use data and the difficult accessibility to most of the area, the present land use and forest maps in the study area are prepared with a kind assistance of the Forest Inventory Project, based on spot images in 1989 and 1990. The present land use in the study area is estimated as follows:

Category	Area	
	(1,000 ha)	(%)
Forest Area	295.5	53.0
Bamboo Area	31.1	5.6
Slash-and-burn Area		
Currently used (Ray)*	54.8	9.8
Fallow (Unstocked)	140.0	25.1
Sub-total	194.9	34.9
Permanent Agriculture Land		
Paddy Field	3.1	0.6
Other agriculture land	3.5	0.6
Sub-total	6.4	1.2
Other Area	29.8	5.3
Total	558.0	100.0

Note: *; This category includes useless burned area. For details, refer to ANNEX-MH ENVIRONMENT.

As seen in the above table, approximately 84% of the land within the study area is under some type of natural vegetation, either forest, bamboo and bush and tall weed (unstocked). The land used for agricultural purpose is only about 11% of the study area. However, the category of slash-and-burn area currently used includes useless enormous burned lands. The physiographic characteristic of the lands is the main constraint for expanding the agricultural land use in the study area. Most of the land consists of extensive rugged mountains and the mountains are rough, sharp-crested with steep, highly dissected slope and narrow V-shaped valleys.

The land under agricultural use in the study area is mainly for subsistence crop production. Based on the statistical data, the total cultivated area in 1991 is estimated at about 19,350 ha. Rice is the crop extensively planted, approximately 15,800 ha are planted of rice; out of this, about 3,050 ha are lowland rice field scattered in many small alluvial fans. About 12,750 ha are upland rice field, and other crops grown are corn, sesame, cotton, tobacco, etc. These crops are mostly inter-cropped with upland rice.

The land use intensity is very low in the study area. Only one harvest is made annually, except for small areas being used for vegetable cultivation. Most of the area is left fallow during the dry season. Physical constraint to more land use intensity is the climate of the region, which presents approximately half of the year with negligible rainfall, causing soil

moisture deficit for rainfed crop growing. The availability of surface water for irrigation purpose is also very scarce and the main limiting factor for more agricultural land use.

3.6 Land Tenure System and Land Holding Size

3.6.1 Land Tenure System

Officially, the basic principle is that land cannot be privately owned; it can only be "the property of the national community represented by the State". This declaration was emphasized in the recent Decree No.117 on Management and Use of Forests and Forested Land, published in 1989. According to this law, the people have the right of usufruct or the right of use of the land, but no right to buy or sell the land. However, this principle operates in urban areas or where the State's presence is felt. In most of the rural and remote areas, the customary land tenure system is apparently still working.

Generally, each village claims the ownership of a well-defined territory, with clear boundaries recognized by all the surrounding people. This right is acquired when families settle and take possession of uninhabited land thus creating a new community. Then, a village can be defined as an aggregate of families, usually forming a lineage or a segment of lineage and established on a territory. This right is acquired by all village families and allows use of land to be passed down from father to son. Strangers to the village can only gain access to the land after asking permission from the Council of Elders.

3.6.2 Land Holding Size

The farmer's economy in the study area is characterized by the holding size and category of farm land. The average land holding size and farming scale of farmers in each district of the study area by ethnic groups is estimated as shown below:

Item	(Unit: ha)								
	Xai			Beng			Hun		
	LL	LT	LS	LL	LT	LS	LL	LT	LS
Lowland	0.48	0.18	0.05	0.42	0.02	0.00	0.45	0.02	0.02
Upland	0.24	0.78	0.59	0.49	1.40	1.20	0.60	0.97	0.93
Total	0.72	0.96	0.64	0.91	1.42	1.20	1.05	0.99	0.95

Note: LL; Lao Loum LT; Lao Theung LS; Lao Sung

Source: District offices

The average holding size of lowland rice field by Lao Loum is about 0.4 to 0.5 ha per farm household, while the area of upland held by one farm household of Lao Loum is about

0.24 to 0.6 ha. The holding size of lowland rice field of Lao Theung and Lao Sung is very small as compared to that of Lao Loum, and the holding size of upland rice field is larger than that of Lao Loum. By these data, it is clear that the farmers economy of Lao Loum largely depends on the lowland rice farming but still needs to cultivate upland rice, while the economic activities of Lao Theung and Lao Sung are mostly dependent on the upland rice farming by slash-and-burn cultivation.

3.7 Present Farming System

3.7.1 Crops and Cropping Patterns

Similar to other districts in Oudomxay province, the main crop grown in the study area is rice, a staple food crop of the people, followed by maize, sesame, cotton and other crops, as shown below:

(1) Rice

Cultivated area of both lowland and upland rice occupies more than 80% of total cropped area mainly for home consumption. The cultivated area of upland rice equals to about 83% of total rice cropped area. The glutinous rice is dominant and non-glutinous rice is cultivated in very limited areas. Most of the upland rice cultivation is practiced in the slash-and-burn field of hilly and mountain areas. On the other hand, lowland rice cultivation is limited in the flat valley bottoms.

(2) Maize

Maize is the important food crop to supplement the shortage of rice. When rice production in the former year is not sufficient due to weather and other conditions, cultivation areas of maize become increase. Maize is generally inter-cropped with upland rice.

(3) Sesame

Cultivation of sesame as one of cash crops mostly for export to Thailand and China, becomes popular, and the planted area is increasing in recent years. Sesame is also inter-cropped with upland rice.

(4) Cotton

Cotton which is also important cash crops, is cultivated mainly by Lao Loum groups in small flat upland adjacent to the villages. Cotton cultivation is gradually increasing which seems to be due to increase in home consumption and in internal trade.

(5) Other Crops

- (i) Garlic and onion are cultivated usually in rice field and flat upland, and these will be prospective cash crop for both internal and external trade which could be grown in lowland rice field with irrigation as a secondary crop in the dry season.
- (ii) Mulberry cultivation for sericulture is seen in the limited undulating lowland in Hun district. It is reported that about 30 households are currently engaged in the traditional sericulture to produce silk mostly for export to Thailand.

Mainly because of the shortage of available water during the dry season, cultivation of crops is concentrated in the wet season from May to September. Most of the agricultural land is left fallow and used for livestock grazing during the dry season, except for very limited area where vegetables are grown. The cropping calendar of main crops is given in the following table and general cropping pattern over the study area is shown in Fig. M-1.

Crops	Seeding	Transplanting	Harvesting
Lowland rice	Jun	Jul-early Aug	Oct-early Dec
Upland rice	May-early Jun	-	mid-Sep-Oct
Maize	Apr-early May	-	Aug
Tobacco	mid-Nov-Dec	-	end-Mar-May
Cotton	May	-	Oct
Sesame	May	-	end Oct

3.7.2 Crop Yields and Production

According to the statistical data obtained from each district office, though there is annual fluctuation of rice production due to drought and other factors, the average yield of both lowland and upland rice in recent 5 years is estimated at about 2.8 ton/ha and 1.4 ton/ha in paddy, respectively.

Year	Harvested Area (ha)			Production (ton)			Yield (ton/ha)		
	Lowland	Upland	Total	Lowland	Upland	Total	Lowland	Upland	Average
1987	2,360	13,460	15,820	5,990	18,150	24,140	2.5	1.4	1.5
1988	2,490	12,900	15,390	6,960	17,570	24,530	2.8	1.4	1.6
1989	2,490	11,990	14,480	7,460	16,240	23,700	3.0	1.4	1.6
1990	2,580	12,220	14,800	7,560	17,040	24,600	2.9	1.4	1.7
1991	3,050	12,750	15,800	8,600	16,620	25,520	2.8	1.3	1.6
Average	2,590	12,670	15,260	7,310	17,120	24,500	2.8	1.4	1.6

In order to check the above present yield level of lowland and upland rice, the yield survey is carried out by the study team. According to the survey results, the average unit yield of lowland rice and upland rice is estimated at 2.6 ton/ha and 1.4 ton/ha, respectively. The results indicate nearly the same figures as in the statistical data. This low crop yields of rice are caused mainly by the (i) no adoption of improved varieties and farming practices; (ii) no use of farm inputs such as fertilizer and agro-chemicals; (iii) limited and unstable supply of wet season irrigation; and (iv) steep slope topography in upland which leads to difficulties in weeding and plowing.

Estimated crop yield and production of the major secondary crops such as maize, sesame and cotton are given in the following table. Reliable data on the crop yield and production of garlic and onion are currently not available.

Year	Harvested Area (ha)			Yield (ton/ha)			Production (ton)		
	Maize	Sesame	Cotton	Maize	Sesame	Cotton	Maize	Sesame	Cotton
1987	-	-	-	-	-	-	-	-	-
1988	490	160	-	2.1	0.9	-	1,030	150	-
1989	-	310	100	-	0.5	0.3	-	160	30
1990	890	1,230	200	1.6	0.6	0.9	1,450	700	170
1991	2,270	3,210	500	1.7	0.9	0.7	3,950	2,990	360
Average	1,220	1,230	270	1.8	0.8	0.7	2,140	1,000	190

Note: Yields are estimated on the basis of district data.

3.7.3 Farming Practices

Because the main crop grown in the study area is rice and cultivation area occupies more than 80%, the present farming practices are mentioned only for upland and lowland rice cultivation.

(1) Upland Rice

The upland rice farming is mostly shifting slash-and-burn cultivation with one year cropping followed by 3 to 5 years fallow. Since the upland farming depends entirely on rainfall in the wet season, crop production under this farming is unstable, varying from year to year. Cropping in upland system is

practiced regardless of the land slope, and protection methods against soil erosion are non-existent. There is no great difference in slash-and-burn cultivation practices between the ethnic groups of Lao Loum and Lao Theung who settled in lowland areas. In recent years, fallow period is becoming shorter due to the population pressure on land and the present policy of the government for forest area. Plowing and fertilizer application are also not practiced, except for only attention to weeding and protection of crops from animals. Inter-cropping method is widely practiced in the upland rice field to minimize the production risks such as drought, pests and diseases.

After cutting bushes during the period from February to early April, the land is set fire in April to May by "Nuay". Then, the land is cleaned of ember stems and branches, and encircled by fencing in April to May by individual farmer. Sowing is done by dibbling at the beginning or middle of May, depending on the first heavy rains. Weeding is the most labour consuming activity and usually done by cooperative work. Two to three times of weeding are practiced during one cropping season. Harvest of rice is done by hand. After the harvest, the fence is dismantled and the wood is brought back to the house to be used for firewood. A series of farming practices for slash-and-burn cultivation are labour consuming practices especially slashing and weeding, in spite of low crop yield. The labour shortage is observed during the peak labour requirement period in the study area.

(2) Lowland Rice

Most of lowland rice receives supplemental irrigation from the brushwood weirs mostly constructed by the farmers themselves. Any fertilizer and agro-chemical are not used. Photosensitivity varieties are widely used. The main varieties of lowland rice are Do, Do kadao, M.tai, Pa, M.naga, M.shing, Fouengkham, Makbeat, etc. All these varieties are local glutinous one with 130 to 150 days of growing period. Farmers choose their varieties, based on their traditional experience in rice cultivation, minimisation of production risks, available family labor and their taste, without any information and technology transfer from the institutes concerned. Seeds are mostly produced by farmers themselves.

Land preparation of lowland rice, which includes plowing, harrowing and puddling, is done by local-made plow and puddler with buffalo after first

heavy rains in June. After land preparation, transplanting is done by cooperative work. One or two times of weeding are practiced by hand during the growing period. However, weeding of lowland rice field looks like rather careless as compared to the upland rice field. Harvest of lowland rice is made by using sickle.

3.8 Livestock and Fishery

3.8.1 Livestock

Livestock sector in the study area has a significant importance to the economy of farmers. The present livestock raising is dominated by small-holders who own small number of livestock as part of the subsistence agriculture. Livestock in the farmer's economy is used to supply animal protein, for farm works, to gain cash income, etc. The livestock production is also one of the main export items, especially to Thailand.

It may be said that almost all the farmers raise some livestock. A farmer keeps on average one buffalo, one or two pigs, and nine poultry. However, the pattern of livestock holding varies between ethnic groups in some degree. The buffalo is important for Lao Loum, because it provides draft power for preparation of lowland field. Lao Sung keeps one horse as pack animal, and is able to raise more number of pig than other ethnic groups, because they grow sufficient maize as fodder crop.

Item	Xai			Beng			Hun		
	LL	LT	LS	LL	LT	LS	LL	LT	LS
Buffalo	1.2	0.8	0.3	2.3	1.2	1.5	2.0	1.1	0.5
Cattle	0.3	1.3	2.1	1.3	0.6	0.8	0.2	0.2	1.5
Horse	-	-	1.1	-	-	0.4	-	-	1.4
Pig	1.0	2.1	2.4	1.8	1.7	2.9	1.7	1.3	3.4
Goat	-	0.2	0.8	0.7	0.9	0.4	-	0.3	0.4
poultry	3.3	17.4	9.2	12.9	8.0	11.0	10.3	6.8	11.1

Source: Each district office.

Note: LL = Lao Loum, LT = Lao Theung, LS = Lao Sung

Usually, livestock is grazing freely in the surrounding lowland rice fields, hills and forests, and there is no attempt on improved ranging. These low input technology for livestock raising results in low returns to the farmers. The vaccination program is currently implemented with the assistance of the Quaker Service in Laos and UNDP/FAO (Management and Operation of Vaccine Production and Distribution Project) to promote and support for vaccination services by the district office with supply of necessary facilities and equipment.

3.8.2 Fishery

The fish culture is not practiced in an intensive way. It is reported that there are about 20 ponds constructed and managed by the provincial office in and around Xai city. The size of a pond is about 0.2 ha in water surface on an average, and the water source is spring water from the surrounding mountains. About 3,000 fish fingerlings are grown in such small ponds at the initial stage, however, marketable product is estimated at 60% of the total number of fingerling.

Fish being raised is "Panei" and "Paninh" in Lao (carp group). The fingerlings were once brought in from the Provincial Fishery Station in Luang Prabang, but they are now self-supplied. The product is sold at Xai market at a price of Kip 800 to Kip 1,000 per fish. Although such a small-scale fish culture is considered as one of effective ways for increase in farmer's cash income, constraints are limited market and difficulties in transporting fresh fishes to the consumers.

3.9 Sericulture

It is said that sericulture (silkworm rearing) had been very common and widely spread for long time in Oudomxay province. Because of internal disturbances and lack of labor force, and more high priority to rice cultivation today, however, a lot of people stopped the silkworm rearing, and it remains only in the limited areas. In the study area, about 30 households in Navang village of Hun district are engaged in sericulture. The cocoon is mainly exported to Thailand or sold to Luang Prabang province through middlemen. The prices of raw silk are Kip 8,000 to Kip 10,000 per kg for white type and Kip 10,000 to Kip 12,000 per kg for yellow type, respectively.

Generally, the spaces under the floor of each house are used for sericulture. The variety of silkworm is local polyvoltine type. Young silkworm is reared in the bamboo basket and covered with cloth. Mulberry, feed of silkworm, is cultivated in terraces with a deep soil layer along the Beng river. Farmers feed chopped mulberry leaf to young silkworm, while they feed chopped mulberry shootlet to silkworm during growing period. Most of sericulture practices such as production of silkworm eggs, feeding and raw silk reeling, are responsible for women, except for harvesting of mulberry.

3.10 Marketing and Processing

3.10.1 Marketing

Main product in the study area is rice, and it is marketed through private channels mostly within Oudomxay province. Other agricultural products such as sesame, cardamom are traded mostly for export to China and Thailand. The main agricultural products exported to Thailand are buffalo, cattle, sesame and cardamom. Main agricultural products exported to China are sesame and cardamom. Cotton is a considerable commodity as the transit trading goods from Vietnam to Thailand. Marketing system of agricultural inputs in the study area has not been established yet, and farmers are not accustomed to apply chemical fertilizers, and the marketing channel and prices of farm inputs such as fertilizers and chemicals have not been formulated yet.

There are common retail markets in Xai city and Hun town. The market facilities were constructed by private investment. The retailers tenant the shop space with payment. The open marketing space for agricultural products in both markets are managed by the government and every local farmer can use the space by some amount of payment, depending on the amount of their sales, usually Kip 10 to Kip 50 per time. Under NEM policy, marketing and prices of farm inputs and outputs are not controlled by the government and market-oriented prices are prevailing. Retail market prices of agricultural products in Xai and Hun markets are listed in Table M-1.

3.10.2 Processing

Most important agro-processing activity in the study area is rice milling. There are privately owned rice mills in the villages and about 20% of villages in number has rice mill in their villages. However, pounding method is still the major part of rice milling for home consumption in many villages. Most of rice mills mainly imported from China and Thailand, are one-pass steel huller type and operated with 12 to 16 horse power of diesel engine. The milling capacity is about 100 kg to 200 kg per hour input, and the milling recovery is about 60% on an average. Milling charge is about Kip 10 per kg in paddy, and rice bran is given to the miller.

Other common agro-processing activities seen in the study area are processing of food. Local liqueur or "Lao Lao" is made from rice mainly in Lao Loum villages and sold at market. It is commonly said that 0.5 to 0.6 litre of Lao Lao is made from 1 kg of rice. Other processed foods sold in market, but not in large scale are; (i) bean card or "Toufu" made from

soybeans; (ii) sausage made from pork; (iii) fermented salt river fish or "Som Pa"; and (iv) fermented bean or "Tua Nao" made from soybeans.

3.11 Agricultural Support Services

3.11.1 Extension Services

At the central government level, Agricultural Extension Agency has been established under the Department of Agriculture and Extension in early 1992. All the provincial and district offices of agriculture and forestry will be centralized into this national system. These provincial and district offices will have a primary function for providing extension services for disseminating agricultural techniques and supplying planting materials improved through research and multiplication activities.

In the study area, agricultural extension services are under the responsibility of the Department of Agriculture and Forestry Services in the provincial office and Agriculture and Forestry Services Section of each district. Actually, no extension services are being provided for agricultural improvement in the study area mainly due to lack of well-organized agricultural extension system and manpower as well as sufficient budget. Only livestock and veterinary services are provided for training of farmers on vaccination of livestock periodically at present.

3.11.2 Farmer's Organization

There are no farmer's organizations established in the study area under the government arrangement other than village committee, village unit (Nuay) and women's union.

- (1) The village committee has a political structure composed of a Village Chief and his Council. The chief is elected by villagers and recognized by the government authorities. His task is to govern the village, to settle conflicts such as irrigation water distribution, crop damage by animals, etc. and to collect government taxes.
- (2) Most of the villages are divided into several Nuay, each consisting of 10 to 15 families in general. The chief of Nuay is appointed by the village chief. The main activities of Nuay are cooperation in farming among farmers of a Nuay and some time between Nuays.

- (3) Every woman who is more than 18 years-old can become the member of the women's union. The activities of the unions are generally low, because the union had more political character in the past. Recently, some new trials are being made by the government with an assistance of Lao Quaker Service, which include the promotion of appropriate technology to lighten workload of the women, cotton cultivation, establishment of rice bank, etc.

3.11.3 Agricultural Credit

There are formal and informal agricultural credit systems covering the study area. The formal credit system is handled by the Lane Xang Bank (LXB), while the informal credit system is operated by villages.

(1) Formal Credit

LXB has the provincial branch office in Xai city and a district branch office in Hun town, and is lending rural credit. Currently individual farmers can receive credit only through group lending arrangements. Farmers within the same village who are interested in receiving credit must form a group which is jointly liable for the loan given to each member. According to LXB, 75 farmers' groups borrowed about Kip 50.2 million in 1991/92 for purchasing of draft animal and livestock, and land clearing. There are 3 categories of terms of loan by the purpose of loans as follows:

Duration	Purpose	Interest Rates
Short term(1month-1 year)	Purchase draft animal, seed, fertilizers etc.	5%/year
Medium term(1 month- 3 year)	Land clearing	4%/year
Long term(1 month - 5 year)	Purchase livestock	2%/year

Source: LXB Oudomxay Branch Office.

(2) Informal Credit System

There are informal credit systems such as rice bank and monetary fund for rural credit. The rice bank is customary system mostly operated by each village, and any family of village who is short in food is allowed to borrow paddy with some interest rates which vary village by village. Some villages have a monetary fund based on disposition of properties formed by the former farmers cooperatives. The member of village can borrow money from

the fund for purchase of food (mainly paddy) or for commercial activities with interest of 3% to 5% per month.

3.12 Role of Women in Agriculture

Lao women are actively involved in every stage of rice production such as transplanting, weeding, threshing and hulling. In addition, women are engaged in other types of agricultural activities, especially the cultivation of subsidiary crops like vegetable, sweet potatoes, cassava, etc., cotton growing and raising of domestic animals. There are some differences in the role of women in agriculture among the ethnic groups. In general, however, women in each group play active part in farming together with men.

- (1) Lao Loum groups have the flexibility of their social organization and the relative equality which characterizes relationship between men and women, where there is less rigid division of tasks between the sexes in comparison with Lao Theung. Occasionally, women are also engaged in land preparation. However, their main activities in farming are transplanting, harvesting and threshing rice, together with men.
- (2) Among Lao Theung, there is a relatively clear division of tasks based on the gender. Slashing and burning the forest, and fencing new fields are the responsibility of men, as well as hunting, whereas women plant and weed upland rice. Women are also responsible for collecting non-wood products from the forest and firewood from swidden fields.
- (3) Among Lao Sung, both men and women are responsible for collecting forest products, weeding, harvesting and threshing. Women sow the seeds of crops after dibbling done by men. Like other ethnic groups, caring of small size livestock such as pig and poultry is women's responsibility.

Even if women are socially equal to men, they nevertheless have many tasks like looking after their children, cooking, carrying water, cleaning and washing clothes. In Lao Loum society, cash is usually kept by the women who take part in the decision-making of its utilization, while those of Lao Theung and Lao Sung seem to have less power in this domain.

3.13 Present Irrigation System and Services

3.13.1 Existing Irrigation System

Most of the existing irrigation schemes in the study area are farmer and community managed scheme (FCM scheme) with a small-scale indigenous brushwood weir constructed by users themselves. These irrigation schemes are used for supplemental irrigation to wet season rice. Since the irrigated area by a scheme is commonly less than 50 ha, only a small group of farmers is involved, and therefore cooperation is not difficult to achieve. The canals and structures being small can be constructed largely by manual labour and the construction cost is generally low. However, the brushwood weirs are easily washed away at flood times. According to the irrigation section of the province, the farmers groups re-construct such weirs two times on an average during the operation period. The re-construction of weirs requires heavy labour input by the water users.

The canal systems in these schemes are also constructed by the farmers and communities themselves, mostly without proper survey and design. Therefore, canal alignment and design are very primitive. Due to lack of canal structures, in addition, flow distribution is erratic and often affected by cross-drainage flows that may lead to canal breaches and/or silting. It can be said that all of these FCM schemes are in a great need of improvement and rehabilitation.

The existing FCM schemes in the study area are 66 schemes in Xai district, 34 schemes in Beng and 22 schemes in Hun, covering 1,360 ha of lowland rice field in total. Among them, seven schemes, two in Beng and five in Hun, have permanent concrete weir constructed by the village community with financial assistance from the provincial and district offices, and the Lao Quaker services. Such an assistance covers a supply of cement, reinforcement bar, tools for earth works, and transportation services. Since water availability in these schemes is limited to very small or nearly nil in the dry season, most of the schemes are not used for dry season farming.

In addition to FCM schemes, there are also medium size irrigation schemes with more than 51 ha of command area. These schemes include those with permanent concrete weir constructed by the province and financial assistance from the Lao Quaker services, and also those with the people's brushwood weir constructed by farmers themselves. The command area of most of these schemes is less than 100 ha. The weirs constructed by the province and other organizations, all of them are concrete permanent weir, are handed over to the village

communities concerned. These medium schemes in Xai, Beng and Hun districts are three, six and four schemes, respectively, with a total irrigation area of 1,302 ha.

The total number of existing small-scale and medium size irrigation schemes in the three districts is 135 with a total irrigation area of 2,662 ha (see Table M-2), which means that an average command area of a scheme is estimated at about 20 ha.

3.13.2 Support Services for Irrigation

The public services for irrigation development in Oudomxay province are provided by the irrigation section in the Department of Agriculture and Forestry of the provincial administration. The irrigation section consists of 3 units for planning, survey/design and irrigation construction company. Fifteen staff which include 2 engineers, 9 assistant engineers and 4 technicians are working with the irrigation section. The activities of the irrigation section are still very limited because of budget problem and of the mountainous province where flat land suitable for irrigation development is also limited. The irrigation section is now constructing only one concrete permanent weir upon request of the village community in Nam Mo district which is outside the study area. The irrigation construction company is constructing two canal systems for two small-scale irrigation schemes financed by UNDP and the Lao Quaker Services in Xai and Beng districts, as a contractor.

The district offices also have irrigation staff. In Xai district, 5 staff, including training staff, are working for irrigation services, among 13 staff in total. Out of 7 staff in Beng district, two are irrigation staff, and in Hun four are irrigation staff, out of 9 office staff. It may be said from these staffing arrangement that the provincial office puts emphasis on providing the irrigation services to the farmers. Practically, however, such services by each district are very limited mainly because of insufficient budget and lack of qualified technical staff.

3.13.3 O&M of Irrigation System and Water Users Organization

It is policy in all provinces that the cost for O&M of the irrigation systems should be born by the water users. All of the existing irrigation systems in the study area are operated and maintained by the farmers and communities themselves. According to the recent information on the water users organization, four organizations are formally established and authorized by the district in the study area.

In the case of Nam Kham irrigation system which has a concrete weir to irrigate 68 ha of rice field, for instance, the organization consists of 4 villages and has the regulation for water distribution management which is prepared through discussions among farmers, irrigation members from each village and the irrigation staff from Hun district office. The regulation is summarized as follows:

- (1) Four irrigation members, one from each village, are elected by all of the farmers concerned, and organize a committee to control the water distribution to each rice field as well as to maintain the whole irrigation facilities.
- (2) Each farm family should participate in repair and maintenance of the weir and canals as labor in accordance with the committee's decision. Such a labor contribution depends on the size of rice land holding of each family.
- (3) In addition, each family should pay Kip 1,000/ha of charge per year to the committee.

The activities and functions of other existing organizations are nearly the same as those of this organization. These water users organizations will have to be strengthened for more efficient O&M of the new irrigation systems to be rehabilitated. Even in the irrigation systems where water users organizations are not yet established, farmers participate in repair and maintenance of the weirs and canals under the leadership of the village community. These traditional system will be the basis for establishing new water users organizations after the existing irrigation systems are improved and up-graded.

3.14 Present Social Infrastructures

3.14.1 Road Network

Oudomxay province is one of the very remote areas like other northern provinces in Laos, with the very limited accessibilities by only 3 times regular flights a week from Vientiane. Although other accessibilities via road and river communications are available, the conditions of these facilities are very poor, requiring 3 to 4 day-traveling from Vientiane to Oudomxay by road and river, and sometimes it is very difficult to utilize such facilities in the wet season.

National roads Route No. 1 to No. 4 and No. 13-B connect Xai city directly and/or indirectly with the main cities in the provinces of the Northern Region. Especially, the Route No.2 (Xai city to Pakbeng town, a total length of 138 km) goes down approximately in the

centre of the study area from north to south-west, and plays a key role in all activities of the people in the study area. These roads are macadam-paved with 6-m carriage way and passable throughout the year, which were constructed during the period of 1973 to 1979 assisted by China. Because of almost no maintenance work, however, the road conditions are very poor, allowing an average travelling speed of 25 km per hour. The rehabilitation project for Routes No. 1 to No. 4 has just started in 1992 with a finance of ADB and will be completed in 1995.

The total length of existing district roads in the study area is 202 km, which are mostly constructed by the farmers' labour force with a technical supervision and some materials and tools from the provincial and district offices. The conditions of existing district roads are very poor. Some parts of these roads are passable by 4-WD vehicle only in the dry season, and some of them are in the conditions that are just opened/cleared the land and excavated by hand without proper route survey and design. The necessity of these roads are very high especially for the remote people, because the road is the only one communication system for economic and other social-welfare activities. In addition to the existing district roads, new construction of district roads with a total length of 298 km is proposed as the future plan by the district offices. These planned roads are presently footpaths and almost are not yet surveyed for proper road alignment.

3.14.2 Water Supply System

There are two types of water supply systems in the study area. One is urban water supply system, so-called "Nam Papa" in Xai city, operated by the water supply section of the Department of MCTPC. The other is rural water supply system managed by the village and district office, which is under the supervision of the Department of Public Health.

Almost all lowland villagers along Route No.2 depend entirely on nearby streams and rivers for their drinking and domestic water. These villages are usually located near the perennial streams and rivers within a few hundred meters walk. Only the limited lowland villages have access to spring sources, and shallow dug wells are also very rare. Most of these sources are facing to fecal pollution and other types of contamination problems from human and animal origins. The villages in hilly and middle mountainous areas are in more poor situation of water availability than those in lowland areas because of limited water sources in general. In addition, the villagers hardly ever boil the water before drinking because of lack of personal hygiene.

There are 5 existing gravity flow pipe water supply systems in the study area, assisted by Lao Quaker Services and UNICEF. During the plan/survey and construction stage,

the provincial authority of the Department of Public Health is a responsible organization and the benefited people participate in the construction work with the provision of materials from the above external organizations. After the construction, operation and management are transferred to the district office and/or villages.

3.14.3 Electricity Supply

Only one public electricity supply system in Xai city is available in the study area. The electricity supply service is operated and managed under the provincial authority of the Department of Industry and Handicraft. The system was established and started the electricity supply service in February 1991. The capacity of generator plant is 100 kW (two units of 50 kW generators), and one unit of the generator is alternately operated at present, because small number of families (218 families) is using the service as of May 1992. The tariff of electricity service is very low, charging Kip 550 per 20-W fluorescent lamp per month.

There are also individual small generators, and they are mostly concentrated in Xai city, Beng town and Hun town. These small generators are used for private purposes such as shops, hotels, restaurants, gas stations, video houses and also some individual houses. The data on the number of private use generator are not available. According to the interviews with district officers, the capacity of those is very small, almost 1.5 kW, and the number is estimated at about 40 units in Xai city, 8 units in Beng town and 8 units in Hun town.

There is only one micro-hydropower plant for rural electricity supply in Beng town. The plant was completed in June 1992 with an economic assistance by China. The total construction cost was Kip 14 million or US\$20,000. The total generating capacity is 6 kW and the plant can supply the electricity to three related villages with 235 lamps. Continuous operation was started from early November 1992. Three staff of the industry section of the district office are responsible for operation of the plant.

Even though the continuous operation can be made during non-irrigation period, the flow in the canal is not enough to operate the two units at full time. The one unit is being operated for 2 hours every two days, supplying the electricity alternately to 117 lamps in one village and 118 lamps in other two villages. Actual generation was 1.7 kW per unit in November. Whenever excess water is available during the day-time, the water is discharged through the plant not for lighting but for radiating heat.

3.14.4 Other Social Infrastructures

School facilities and education situation are very poor in the study area, especially in mountainous areas. Although the number of primary school seems to be sufficient, about 50% of the existing primary schools has only class I and/ or class II. And 70% of pupils entered the primary schools ceases to learn by class II, though the compulsory education period is five years in Laos. School houses and their equipment are also very poor because of lack of finance. According to the provincial officers of the Department of Education, the reasons for low ratio of entering the schools are as follows:

- (1) Children are considered as important labour force of their family.
- (2) Lack of the number of teachers (no incentive to go mountainous areas).
- (3) Lack of school facilities (lack of teachers, lack of finance, scattered villages distribution).

Community facilities (houses) exist almost in each village along Route No. 2. In the villages which do not have such community facilities for their exclusive use, the villagers utilize a school or village leader's house as community facility, whenever necessary. The facilities are used for important village communications such as discussions about cooperative activities for farming practice, construction and maintenance of irrigation facilities, roads and schools, and transferring official announce from the districts, etc.

3.15 Environment

It is understood that the present major environmental issue in the northern region including Oudomxay province as well as the study area is the destruction of forests mainly due to shifting cultivation and its related activities of rural people. Because of a limited information on the extent of existing forests and shifting cultivation area, the nationwide reconnaissance survey to identify the quantitative extent of existing forests was carried out under the Forest Inventory Project with SIDA financial assistance, using aerial photographs of 1981/82 and Spot images of 1988/89. According to the reconnaissance survey results, the destruction of forest in Oudomxay province seems to be serious as compared with those in other provinces of Northern Region, because the proportion of forest in the region accounts for 36% in 1988/89, but the province accounts only for 29% even in 1981/82.

However, data for assessing the extent of forest and shifting cultivation related to the study area are not available. Therefore, the study team requested the Forest Inventory Project Office in Vientiane to prepare the land use and forest map in the study area. In response to the

request, the Forest Inventory Project produces the land use and forest map (1:50,000) using Spot images of 1989 and 1990. The findings of environmental study through field survey and the analysis of statistical data, the land use and forest map, and aerial photographs, can draw the following:

- (1) It seems that the destruction of forests by the shifting cultivation activities in the study area is currently serious but not critical as seen in Luang Prabang province. However, the forests in Xai and Hun districts will directly be affected by the shifting cultivation activities because of limited extent of bamboo as a buffer. The forests will be considered to put themselves in danger of accelerated destruction without any measures to control the shifting cultivation area.
- (2) Useless burning of enormous lands is practiced annually by the rural people due to uncontrolled slash-and-burn activities, and the lands under such a useless burning are estimated at more than 28,000 ha in 1989/90. This may cause a rotation cycle more shorter in the study area and degradation of soil fertility.
- (3) At present, the rotation cycle in the study area averages 6 to 8 years. However, the rotation cycle in low altitude areas is less than 3 years due to population pressure. The crop yield survey made by the study team indicates that the yield of upland rice in 3 to 5 year-rotation cycle area is 1.4 ton/ha which is the same as the provincial average.
- (4) Establishment of the reserved forest by the provincial government is considered to be one of the effective measures to conservation of water resources even the management of the reserved forest is not appropriate.
- (5) At present, there is only little basic data for evaluation of the slash-and-burn cultivation activities such as the extent of the slash-and-burn cultivation area and its transition, rotation cycle, cultivation method and pattern, relation to the race, land tenure, etc.

4. STRATEGY FOR AGRICULTURAL DEVELOPMENT

4.1 Objective and Policy for Development

The current issues identified in the study area as well as Oudomxay province include (i) improvement of rice shortage, (ii) conservation of forests from slash-and-burn cultivation activities, (iii) betterment of road network, (iv) development of isolated villages, and (v) improvement of water supply and environmental sanitation.

Therefore, the objectives of the agricultural development for the study area are formulated on the basis of the national agricultural development policy notified in NEM and the Third Five Year Development Plan, and the above current issues, as follows:

- (1) Increase in agricultural production especially food crops.
- (2) Improvement of family incomes and living standard of farmers.
- (3) Control of slash-and-burn cultivation activities.

The objectives of agricultural development mentioned above can only be achieved through comprehensive development of not only measures for increase in agricultural productivity but also other measures such as strengthening of the government institutes, improvement of rural socio-economic conditions, direct measures to slash-and-burn cultivation activities, etc. This suggests that the Master Plan be formulated in a form of "the integrated and balanced rural agricultural development". The essential policies to be taken for this purpose will be as follows:

- (1) Increase and stabilization of agricultural productivity.
- (2) Development of agricultural production infrastructures
- (3) Development of social infrastructures
- (4) Measures to environmental problems
- (5) Support for women in development

4.2 Development Strategy

4.2.1 Development Potential

Potential of agricultural development is assessed from land resources, water resources and production of agricultural commodities as follows:

(1) Potential of Land Resources

According to the land classification study mentioned in Sub-section 3.2.2, about 7,200 ha or 1.3% of total study area are classified into both the lands suitable or conditionally suitable for irrigated agriculture. Among these, about 3,700 ha (0.7%) are classified into suitable (flat to almost flat lands with slope less than 9%) for further development of lowland rice field with irrigation. The remaining 3,500 ha (0.6%) are classified into conditionally suitable (gentle sloping lands with slope between 9% to 12%) for irrigated upland fields development.

(i) Potential of irrigated Lowland Rice Field Development

The potential lands for irrigated lowland rice field consist of the following three land categories:

- (a) Existing irrigated rice fields: about 2,660 ha are currently covered by the existing lowland rice fields with wet season irrigation, which extends the flat valley bottoms in the main rivers such as Nam Beng, Nam Mao and Nam Hin, and their tributaries. Such valley bottoms are small in size, less than 50 ha with small catchment areas in most cases, and are nearly in a full use for lowland rice cultivation at present. These areas have a high potential for increase in crop production, especially rice, by rehabilitation or improvement of existing local irrigation system.
- (b) Existing rainfed rice fields: also in the mountain areas, there are some flat valley bottoms being used for lowland rice cultivation. According to the irrigation section of the province, 13 flat valley bottoms with a total irrigable area of about 440 ha are identified in the study area for the future development. However, they are scattered in very wide area, and the access to such valley bottoms is very poor with small footpaths only. In fact, the inventory of existing irrigation schemes shows that only one scheme is constructed and operated by the farmers groups in the remote mountain area of Hun district. These areas could be developed as irrigated rice fields for further increase in crop production.

(c) Lands currently covered with bush or grass: in addition, some lands currently covered with bush or grass in most cases are found in Hun district and are estimated at about 600 ha. These lands could also be developed as irrigated rice fields for crop production in the future, though further investigations should be made to confirm their agricultural potential and water availability for irrigation.

(ii) Potential of irrigated Upland Field Development

About 3,500 ha or 0.6% of total study area currently covered with bush or grass are classified as conditionally suitable for the irrigated agriculture, and could be developed for year-round upland farming with irrigation system. However, these areas require further investigations to confirm their agricultural potential and water availability for irrigation. The uplands especially in gentle-sloping hill areas also have a potential to stabilize their agricultural productivity which could be developed by introducing the improved upland farming and appropriate varieties of crops suitable for physical and vegetative soil conservation.

(2) Potential of Water Resources

Since no hydrological investigation and study even on the main water resources (Nam Beng, Nam Mao and Nam Hin rivers) are carried out so far by the provincial office, appropriate services for the water users such as proper planning and design of the irrigation schemes could not be provided by the office. An analysis of potential water resources in the study area for the year-round irrigation with 80% dependability is made by the study team (details are given in ANNEX-MA "METEOROLOGY AND HYDROLOGY").

According to the results of hydrological study, about 20,900 ha of land could fully be irrigated for cultivation of the wet season rice. This equals to about three times the potential irrigable area (7,200 ha) mentioned above. In the dry season, however, the potential water resources could irrigate only 4% (about 300 ha) of the potential irrigable lands for cultivation of dry season rice. In the case of introducing upland crops such as wheat and onion, the land that

could be irrigated in the dry season will increase to 8% (about 590 ha) as shown in Table M-3.

Even if the potential irrigable lands were developed with rehabilitation and improvement of existing irrigation systems as well as new construction of rehabilitated or improved and newly constructed by permanent irrigation facilities, therefore, most of these schemes could not irrigate the whole command area in the dry season, but stable supply of irrigation water to the wet lowland rice will be made available, especially at the beginning of wet season as well as at the time of peak irrigation requirement usually in July. This means that the availability of water for irrigation purpose especially in the dry season is very low. Consequently, construction of storage dams to store ample river water in the wet season will be required to satisfy the year-round irrigation for the all potential irrigable lands.

(3) Potential of Agricultural Commodity Production

In consideration of marketing, agro-climate conditions, etc., there are much room to produce agricultural commodities currently produced and to be produced in the study area, as follows:

(i) Potential of Agricultural Commodities Currently Produced

- (a) Rice: rice is the most important crop grown in Laos as well as the study area for the main sources of staple food. Rice import in Laos has increased from 24,000 tons in 1986 to 40,000 tons in 1990 with an annual growth rate of 13.6% as shown in Table M-4. Therefore, increase in rice production is encouraged in the agricultural policy and plans of the government to achieve food self-sufficiency and food security.

The study result of food balance in the study area also shows that more production of rice should be made to fulfil the increasing demand for rice. In the study area, the shortage of rice is estimated at about (10,000 tons in paddy) in 1990 as mentioned in Section 3.4. In fact, bagged non-gultinous rice (5 kg or 10 kg) imported from Thailand is sold in Xai and Hun markets. The

price of these rice is about five times the local milled rice. This means that, there is much room to produce rice in the study area.

- (b) Sesame: export of sesame to China and Thailand from the study area increases considerably in recent years and this increase is expected to continue. This suggests that increase in sesame production, as a cash crop, should be encouraged to generate more farm income of the farmers and to promote the use of edible oil by the people in the future.
- (c) Cotton: cotton cultivation, which is important for the study area as well as Laos, is gradually increasing in the study area mainly due to home consumption and internal sale. In addition, a high export potential to Thailand will exist, because import of cotton lint in Thailand increases year by year and reaches about 284,000 tons in 1990 as shown in Table M-4 and this tendency seems to be continued.
- (d) Cattle: livestock production is one of the main export items in the study area, especially to Thailand. Export of livestock (cattle or buffalo) to Thailand is expected to increase, because the import of cattle in Thailand has increased about 10 times the last 5 years as seen in Table M-4.
- (e) Silk: Thailand imports about 1,150 tons of silk in 1990 and imported volume has been increased year by year as shown in Table M-4. Silk produced in the study area is currently exported to Thailand with very small amount, but this is expected to increase in the future.
- (f) Others: garlic and onion are cultivated usually in lowland rice field and flat upland in the dry season, and these will be prospective cash crop for both internal (to Vientiane) and external sale (to Thailand and China) which could be grown in lowland rice field with irrigation as the secondary crop in the dry season.

(ii) Potential of Agricultural Commodities to be Produced

- (a) **Wheat:** Laos also imports about 10,000 tons of wheat flour annually as shown in Table M-4. Cultivation of wheat in the study area is currently not found. However, it is considered that wheat could be grown in the study area from agro-climatic point of view as a secondary crop in irrigated lowland rice fields during the dry season. Wheat would be of high possibility to introduce and to be produced in the study area in terms of the period import substitution of wheat flour.
- (b) **Edible Oil Crops:** currently the people in the study area are not familiar with processing of vegetable oils, but many kinds of vegetable oils are already imported from Thailand and are sold in Xai and Hun markets. In these circumstances, the usage of vegetable oil will become popular in the near future. In view of these situations, there will be a high possibility to produce the edible oil crops such as soybean and rapeseed in the study area as the secondary crops of irrigated lowland rice fields in the dry season for local use as well as internal sale.
- (c) **Others:** some kinds of agricultural commodities which could be produced in the study area are sold in Xai and Hun market. These commodities such as potato, carrot and eggs currently imported from China, and orange from Luang Prabang will also have high potential to produce in the study area.

4.2.2 Constraints to Agricultural Development

There exist various constraints to agricultural development in the study area, and they may be classified into (i) physical constraints, and (ii) technical and institutional constraints. Each of these constraints does not affect the present low agricultural productivity independently, but relates closely each other.

(1) Physical Constraints

Physical constraints directly affect to the increase in crop production of the study area are summarized as follows:

(i) Topography and Land

The mountainous topography of the study area is one of the main physical constraints to further increase in crop production. The lands suitable for lowland rice field with irrigation are only 0.7% (3,700 ha) of the study area and are nearly in a full use for lowland rice cultivation at present. Even including the lands conditionally suitable, which could be developed for upland fields with irrigation, only 1.3% (7,200 ha) of the study area is suitable for intensive farming with irrigation.

(ii) Water Resources

There are many rivers in the study area. Among them, however, only the Nam Beng, the Nam Mao and the Nam Hin rivers are perennial river. Even in these rivers, only the limited amount of river water flows during the dry season. Many of their tributaries mostly dry up in the dry season since most of them have small catchment area. Therefore, the availability of water in the dry season especially for irrigation purpose is very low, without water resources development by construction of storage dams to store ample river water in the wet season.

(iii) Irrigation System

Most of the existing lowland rice field is served by traditional irrigation facilities constructed by farmers themselves, except for very limited number of schemes with concrete permanent weir. The conditions of traditional irrigation facilities are very poor. The weirs are constructed using wood, bamboo and soils which are easily washed away at flood times, and the canal system constructed by farmers group is also very poor. In addition, most of the schemes has no secondary and tertiary canals. These poor conditions of the existing facilities are the constraints to stable, timely and sufficient supply of irrigation water.

(iv) Social Infrastructures

Lack of good transport and communication systems is a constraint especially to the increase in crop production as well as in farm income

of the farmers. In the study area, only the National Road No. 2, all-weather type of paved road, is available for transportation of commodities, farm inputs and outputs, as well as for the people's moving from village to village by vehicles. The lack of good transport will also restrain the introduction and expansion of crop diversification by the farmers, especially cultivation of cash crops, in the study area. In addition, the lack of good communication system prevents the farmers from responding quickly to the market signals and being able to transport their products to the markets in order to meet a shortfall or to obtain favourable prices.

Apart from the agricultural development, there exist the constraints to the extension of education and health control, and development of other human needs for the people such as (i) lack and poor condition of domestic water supply system, and (ii) lack and poor condition of such public service facilities as primary schools, clinics and community houses.

(2) Technical and Institutional Constraints

Most of these constraints which are crucial to profitable agricultural development in the study area are due to insufficient agricultural services for the farmers that should be provided by the government offices concerned.

(i) Information and Technology Transfer

Despite the fact that the existing farm lands in the study area have a potential of increasing crop yields, no packages of farming techniques have been developed, based on field trials of improved varieties of crops, appropriate planting time and fertilizer practices suited to the differences in the physical conditions.

Almost all the farmers in the study area do not show their interest in the dry season cropping. It is considered that the following negative factors give the farmers less incentive and they may think that dry season cultivation would be risky with a low economy of production.

- (a) Low reliability of available water supply from both rainfall and irrigation as compared with the wet season.
- (b) Difficulty in control of the crop damage from free grazing of livestock, especially in small scale irrigation scheme.
- (c) Traditional attitude of farmers to work during dry season.

Inter-cropping method is widely practiced in the upland rice field to minimize the production risks due to heavy damage such as drought, pests and diseases. This method also provides long harvesting period of food crops and high cropping intensities in a limited field area. On the other hand, this method causes low yield and quality of products mainly due to difficulties in proper crop management.

Since there is no basis of researched techniques, credible extension services for increase in crop production by farmers could not be provided sufficiently by the offices concerned for good and profitable farm management. In fact, almost all the farmers in the study area are presently isolated from receiving information and technology useful for increase of their crop production.

The main constraint to increased livestock production is the high mortality rate arising from a high incidence of diseases. Even though most livestock are not vaccinated and at considerable risk, there appears to be a largely unsatisfied demand for credit for livestock purchases.

Free ranging of the livestock causes serious problems to cultivated crops especially in the dry season which have to be protected by labour consuming fences. A lot of damage is also caused to forest plantations where the young seedlings are often stamped on or grazed by the cattle.

(ii) **Agricultural Input Supply**

Availability of certified seeds is very limited and farmers are using their own seeds of local varieties. Continue to be used as these varieties are adapted to local micro-environments and held alleviate risk due to their tolerance to adverse conditions such as drought, but there is no room to improve their low yielding characteristics.

The dominant varieties used in the lowland rice fields are photosensitivity varieties which promise the regular farming practice to the farmers, because the timing of flowering stage is fixed annually. But it is difficult to disperse the labor intensive period and this may cause the labor shortage. Further, these varieties can not be adapted to the double cropping, even if irrigation water is available throughout the year.

In Laos, agricultural technicians and farmers are becoming aware of the benefits of fertilizer and agro-chemicals. Demand for these farm inputs has increased and is expected to continue to increase. In the study area, however, such fertilizers and agro-chemicals are not used even for lowland rice as well as for upland crops, because actually no services for supply of these materials are provided by the government institutes.

(iii) Marketing System

Farmers presently consider that they are suffering from the unstable market needs. In the past, they failed to sell their crop products which were requested by the traders. The main reason for the failure was due to inferior quality and very small quantity for international trade. In addition, no organization has been established to trade farm inputs especially fertilizers and agricultural chemicals in the study area.

Farmers are kept without relation with the markets due to lack of roads, communication facilities and organizations in order to disseminate accurate information on the market needs. Farmers live under very isolated conditions and are not willing to introduce crop diversification because of poor access to markets due to poor road and transportation facilities especially for villages in the hilly areas.

The farmers usually sell their products directly to middlemen who are visiting the villages mainly along the main road, and they have custom to sell their products when they need cash, not depending on the request of the markets. Then, the individual farmer has no power to negotiate with the middlemen on the attractive prices of commodities.

(iv) Weakness in Credit Services

The farmers need effective credit services to become more readily available for all fields of agriculture, not only for crop production but also for marketing activities, procurement of farm inputs, etc.

4.2.3 Farmers' Intention

According to the results of rural socio-economic survey, the practice of slash-and-burn cultivation is closely related to the availability of rice field in lowland area. The more lowland rice field is available, the less slash-and-burn cultivation is practiced. The area of slash-and-burn cultivation per farm family has an inverse relation to that of lowland rice field. In other words, slash-and-burn cultivation becomes less important in the farmers economy as lowland rice field is enough for supply of their staple food.

Regardless of ethnic groups, most of farmers interviewed who practice slash-and-burn cultivation are keen to stop this type of cultivation because of hard work with low yielding. However, scarcity of rice field and lack of irrigation water have hindered the above farmers' intention. Their efforts toward opening of lowland rice field are minimal because of the heavy over-head labor requirement and scarcity of easily terrraceable land. Therefore, farmers give a top priority to the development of agricultural production infrastructures rather than social infrastructures.

4.2.5 Development Strategy

The development strategies for the integrated agricultural development to achieve the overall development objectives and policies mentioned above, the proposed development is formulated in consideration of the exploitation of potentials, the elimination or alleviation of various constraints, and farmers' intention in the study area, as follows:

(1) Increase and Stabilization of Agricultural Productivity

The increase and stabilization of agricultural productivity through elimination or alleviation of various technical and institutional constraints that currently exist in the study area is considered to be the single most important factor in contributing to the control of slash-and-burn cultivation. The basic concept for the development plan to achieve this purpose is (i) intensification of farming in both lowland rice field and upland field for increase in crop

production, (ii) extension of improved farming, and (iii) diversification of cropping system. In line with the concept, the following strategies are considered to formulate the proposed agricultural development plan:

- (i) Improvement and Strengthening of Agricultural Support Services
 - (a) Strengthening of Extension Services: especially for transfer of packaged farming information and technology, necessary actions on how to encourage the farmers for increase in crop production, and on how to promote the farmers' participation in crop diversification.
 - (b) Strengthening of Veterinary Services: increase in livestock productivity with improvement and strengthening of livestock grazing techniques as well as of public services for disease control and marketing system.
 - (c) Establishment of Efficient Marketing System: establishment of efficient marketing system is one of the important factors to vitalize the regional economy as well as to develop agriculture for increasing productivity of the main crops and also by promoting crop diversification. Expansion and improvement of the existing marketing system with establishment and development of organization and facilities will be essential for the market improvement in the study area.

- (ii) Establishment and Operation of Integrated Agricultural Station

Confirmation of the adaptability of crops both in lowland rice field and sloping land, of year-round farming system in the gentle slope lands, and of alley cropping system in the steep slope lands is essential for increase and stabilization of agricultural productivity and will have to be made through various field trials at a well-designed agricultural station. In addition, the station will prepare concrete action plans for further development in cooperation with the provincial and district staff. This will contribute to improve their technical and managerial capability for continuous agricultural development in the study area and Oudomxay province as well.

(2) Development of Agricultural Production Infrastructures

The development of agricultural production infrastructures should also have a high priority. The rehabilitation and upgrading of the existing traditional irrigation system including replacement of the existing brushwood weir by a permanent one and construction of canal network, and new construction of well-designed irrigation system are the basic requisite for increase and stabilization of crop production.

(3) Development of Social Infrastructures

Further development of social infrastructures, especially the facilities for people's welfare, education and for promotion of farmers' progressive activities related to the increase in agricultural productivity, should also be taken into consideration in connection with the proposed rural agricultural development. Such a development will be the rehabilitation and grade-up of existing district road network, construction of additional rural water supply system, and improvement and construction of primary schools and village community facilities.

(4) Measures to Environmental Problems

The most serious environmental problem in the study area is destruction or degradation of forests due to the slash-and-burn cultivation activities by rural people. Two strategies, direct and indirect, are considered to formulate necessary measures to environment problem as follows:

- (i) Direct control to the slash-and-burn cultivation activities through establishment and/or development of appropriate technologies and measures, and their extension and implementation.
- (ii) Indirect control to the slash-and-burn cultivation activities through diversification of the cropping system, and agro- and socio-economy of the rural people.

The latter strategy could be achieved by the integrated agricultural development. Therefore, the former strategy (direct control) is selected as a strategy for measures to environmental problem in this Master Plan.

(5) Support for Women in Development

Women especially in rural areas play an important role in farming and in some cases they are working harder than men. Because the government services to support the women's activities are still limited, more effective services will have to be provided for acceleration of their socio-economic activities.

5. ACTION PLANS FOR AGRICULTURAL DEVELOPMENT

The proposed action plans and programs for implementation of the Master Plan are formulated on the basis of the objectives, policies and strategies for the integrated rural agricultural development mentioned in Chapter 4.

5.1 Increase and Stabilization of Agricultural Productivity

The scheme component for increase and stabilization of agricultural productivity includes two action plans such as (i) improvement and strengthening of agricultural support services, and (ii) establishment and operation of integrated agricultural station. The programs in each action plan are summarized as shown below.

5.1.1 Improvement and Strengthening of Agricultural Support Services

In order to provide more agricultural support services for farmers, this component will provide various programs (i) to strengthen the extension services; (ii) to strengthen the veterinary services; and (iii) to establish efficient marketing system. The work items of each program mentioned above will be as follows:

(1) Strengthening of Extension Services

This program will provide various support (i) to strengthen extension service sections of each district office; (ii) to station additional extension workers at such sections; (iii) to extend and settle the improved farming techniques for more crop production in lowland rice field, gentle sloping upland fields and steep slope land; (iv) to arrange programs for women's group; and (v) to promote sericulture.

The present technical and managerial capability, staffing and facilities of the provincial and district offices are weak to provide appropriate extension services for the farmers that are inevitable to achieve the increase in agricultural productivity. A nation-wide plan for the institutional improvement has been studied by the international institutes in Laos. In line with such a nation-wide plan, this program will provide the following facilities and equipment to support their activities:

- (i) Office buildings including storage and garage.
- (ii) Staff quarter, if necessary.
- (iii) Supply of necessary equipment for each office.
- (iv) Station of additional extension workers to provide more extension services, especially for lowland rice and second crops production.
- (v) Training of extension workers at the "integrated agricultural station" to be established.

Activities under this program to be carried out in these extension offices will be as follows:

- (i) Extension of improved farming system in the lowland irrigated rice field, gentle sloping upland field and steep slope areas through introduction and distribution of improved crop varieties, demonstration of pest-disease control and soil improvement techniques, and training of farmers groups.
- (ii) Extension of improved sericulture.
- (iii) Periodical opening of women's school for improvement of people's life standard, promotion of health education and basic literacy education.

(2) Strengthening of Veterinary Services

In the study area, vaccination promoting activities are on-going supported by Quaker Services in Laos and UNDP/FAO. Therefore, this program will be proposed for further extension of vaccine injection for disease control of livestock and promotion of veterinary services to the farmers. However, the program will be necessary to subject ad hoc study at the implementation stage in connection with the progress of these current activities, and will be prepared at the integrated agricultural station.

(3) Establishment of Efficient Marketing System

This program will support (i) to establish the farmers organization, and (ii) to strengthen the governmental institution.

- (i) Establishment of Farmers Organization: under the free market system, it is essential to produce the commodities with good quality and appropriate quantity to meet the market requirements, and to ship

constantly and/or timely every year according to the market situations. For these purposes, a well-rationalized marketing system will have to be established by organizing the farmers groups to control quality and quantity of products so that the farmers can negotiate with traders on the appropriate prices of products as well as of inputs through the organization. Establishment of the "rice bank" will be the first step to organize the "farmers' organization" in the next stage. The program will support to:

- (a) construct office building, storage and drying yard, and
- (b) supply rice mill, sesame cleaner and office equipment.

The activities of the rice bank will be processing and selling of rice, and collection, selection and selling of sesame as well as to provide more local credit services. The concrete action plan for establishment of the farmers organization in the future will be prepared at the integrated agricultural station on the basis of the information to be provided by the rice bank.

- (ii) **Strengthening of Governmental Institution:** the improvement of organization and system for marketing of farm inputs and outputs is one of the important factors for increase in agricultural productivity and for promotion of crop diversification. Actually, however, the province and district supporting sections are not functioning efficiently because of the limited budget and low managerial capability. Therefore, this program will include:

- (a) training of the staff in the offices concerned, and
- (b) improvement of the office facilities with supply of necessary equipment and instruments.

5.1.2 Establishment and Operation of Integrated Agricultural Station

It is essential to establish and operate an integrated agricultural station in order to develop packaged farming techniques or system for lowland irrigated rice field, gentle sloping upland field and sloping areas, based on various field trials of crop varieties, appropriate planting time, fertilizer practices, weeding, etc. suited to the differences in the physical

conditions of the study area. For this purpose, the following works will be carried out under this action plan:

- (1) Construction of main office with storage and garage
- (2) Construction of research and training house
- (3) Construction of staff quarters
- (4) Construction of workshop
- (5) Development of trial plots including lowland rice and gentle sloping fields
- (6) Supply of machinery and equipment necessary for O&M of the station
- (7) Supply of O&M equipment for the model areas to be developed

The station will carry out the following programs in collaboration with national research institutes, international organizations and other economic cooperation organizations:

- (1) Development and extension of intensified farming in lowland rice field
- (2) Development and demonstration of year-round farming in gentle sloping upland field
- (3) Development of farming system in sloping areas for the future
- (4) Introduction and extension of improved sericulture in collaboration with the sericulture centre in Vientiane
- (5) Selection of improved varieties and multiplication of seeds for distribution farmers through the extension office
- (6) Training of extension workers in the district extension offices and the staff of the rice banks
- (7) Post evaluation of the model areas development will be made, which will be useful for preparation of concrete plans and programs to be executed in the future development stage in cooperation with the province and districts. The plans and programs will include further improvement and strengthening of marketing system, veterinary services, preparation of measures to environmental problems, and further rehabilitation of existing irrigation system and social infrastructures, etc. During the preparation, the staff of the provincial and district offices will be trained to improve their technical and

managerial capability for continuous rural agricultural development by their own effort in the future.

5.2 Development of Agricultural Production Infrastructures

The action plans for the purpose of developing agricultural production infrastructures will include (i) rehabilitation and upgrading of the existing traditional irrigation systems; (ii) establishment and improvement of water users associations; (iii) improvement and strengthening of meteo-hydrological network; and (iv) development of new irrigation system. The work items of each action plan mentioned above are proposed as follows:

5.2.1 Rehabilitation and Upgrading of the Existing Traditional Irrigation Systems

In the study area, there are 135 schemes with a total irrigation area of about 2,660 ha. However, these systems are very primitive without proper investigation and design. Especially, the intake weirs are easily washed away at flood times because of indigenous brushwood weir. Therefore, the first priority should be given to the rehabilitation and upgrading of these existing irrigation systems by constructing permanent weir together with well-designed canal network down to the tertiary irrigation block. In addition, consideration should also be paid for opening of new lowland rice field in the potential areas adjacent to the existing system, including the construction of new irrigation system or expansion of the existing canal network.

The rehabilitation and upgrading of the existing systems will have to be carried out, through packaging of a number of the systems and package-wise implementation schedule with priority ranking which will be made, based on the topography, potentials for opening new rice fields in and around the existing systems, available water resources, the number of water users, and accessibility. The package-wise implementation program for rehabilitation and upgrading of the existing irrigation systems is summarized as follows:

Development Priority	Xai District		Beng District		Hun District		Study Area	
	Scheme (N.o)	Area (ha)	Scheme (N.o)	Area (ha)	Scheme (N.o)	Area (ha)	Scheme (N.o)	Area (ha)
High	1	196	5	221	6	266	12	683
Medium	4	210	5	179	6	364	15	753
Low	48	334	30	439	14	195	92	968
Under UNDP	16	258	-	-	-	-	16	258
Total	69	998	40	839	26	825	135	2,662

5.2.2 Establishment and Improvement of Water Users Associations

Almost all the existing irrigation systems are operated and maintained by the farmers group(s) organised on the basis of one village or several villages concerned, except for four existing water users association authorized by the government institutes. It is essential to establish the efficient water users associations by organising the existing farmers groups in connection with the proposed irrigation development which is the basic agricultural production infrastructures. The following programs will be required to achieve this purpose.

- (1) Improvement and strengthening of existing water users associations.
- (2) Development of laws and regulations related to establishment and management of the association.
- (3) Training of farmers who will be the staff of the association.
- (4) Demonstration and training of farmers groups for extension of proper farm water management and O&M of the irrigation facilities.

5.2.3 Improvement and Strengthening of Meteo-hydrological Network

In order to strengthen the existing meteo-hydrological observation networks for supporting the implementation of the proposed agricultural development as well as for further acceleration of socio-economic development in the future, the following programs will be conducted under the Master Plan.

- (1) Supply of additional equipment and instruments to Xai meteorological observation station.
- (2) Construction of additional meteorological yard in Beng district.
- (3) Installation of additional rainfall recorders, one in 250 km² of catchment area.
- (4) Installation of additional water level gauge staff in the main rivers.

5.2.4 Construction of New Irrigation System

As mentioned in Sub-section 4.2.1, about 4,540 ha are classified into suitable land for construction of new irrigation system, which include 1,040 ha suitable for development of irrigated lowland rice field and 3,500 ha to be proposed for irrigated upland field development. The construction of new irrigation system in these suitable lands could be divided further into three (3) groups mainly in terms of their location, the present land use and topography.

The first group will include 438 ha in total of that lowland being used for rice cultivation mostly under the rainfed condition in 13 flat valley bottoms. Since they are scattered in very wide area, the lowland in this group is divided further into two groups: one includes seven (7) valley bottoms with a total irrigable area of 257 ha where access to each bottom could be secured by constructing a relatively short distance road, less than 10 km from the National Road No.2 and the other includes six (6) bottom sites covering 181 ha of lowland which would require the construction of long distance road. Then, it is proposed to implement the former group in the medium term development phase for which further investigations and study will be required to be carried out at the short term stage. The implementation of the latter group is planned to be executed at the long term stage.

The second group will include 600 ha of currently bush and/or grass land and the irrigation development in these lands would require the construction of medium size storage dams together with new diversion weirs and canal networks as well as opening of new farmland. According to the available topographic maps on a scale of both 1:100,000 and 1:50,000, in addition, there are narrow gorges suitable for construction of medium size storage than (10 to 15 m in height) schemes mostly on the tributaries of the Nam Beng river. Since various investigations and study, especially for dam foundation, will be required to formulate the schemes for their implementation, the irrigation development in such lands will have to be included in the long term development programs after further study on technical and economic feasibility of these dam schemes including the construction of new irrigation facilities and opening of farmland is made.

The third group will include 3,500 ha in local of potential upland in gentle sloping hills, which would require construction of small-scale storage ponds on the foot of the hills to utilize available river water and rainfall as well to a maximum extent mainly in terms of their topography. In addition, a simple piped irrigation system may be considered for more effective use of limited water available from either the rivers or springs. Since data and information useful for preparation of concrete plan for the development are very limited, it is proposed that detailed investigations and studies be carried out at the medium stage development and that the implementation of the development be made gradually during the long term development taking into account the progress of such investigations and studies.

5.3 Development of Social Infrastructures

Action plans required for development of social infrastructures will include those for (i) rehabilitation and upgrading of district road network; (ii) construction of rural water supply facilities; (iii) rehabilitation and construction of primary schools and community

facilities; and (iv) development of rural electrification system. The programs for each plan will be as follows:

5.3.1 Rehabilitation and Upgrading of District Road Network

In the study area, there are 33 routes of district roads with a total length of 500 km, including 202 km of roads which are currently passable by 4-WD vehicles in the dry season only and 298 km of footpath-level roads. Up-grading and improvement of these district roads will be carried out under the stage-wise development program, taking into consideration the priority of each route. The improved district roads will provide not only permanent access from the National Route No.2 to each sub-district as well as for local traffic services to accelerate agricultural and socio-economic activities of the people, but also access to the potential areas for future irrigation development.

Considering these functions of district roads, selection criteria for phasing of the road improvement to be proposed are studied, taking into account the factors of (i) potential areas for irrigation development, and (ii) beneficial population. The development programs by phase of the district road network are summarized as follows:

Development Priority	Total Length (km)
High Development Priority	10
Medium Development Priority	211
Low Development Priority	279
Total	500

5.3.2 Construction of Rural Water Supply Facilities

Rural water supply facility is one of the basic human needs for the people, which also contributes to the people's health control, and lightening of workload of children and women to transport the water for domestic use as well as to acceleration of socio-economic activities by the people. For practical implementation of water supply system development under the Master Plan, phasing of the development should be taken into account, selecting the priority villages in the study area.

Group	(Unit: village)			
	Xai	Beng	Hun	Total
First group	3	4	5	12
Second group	22	7	11	40
Third group	22	31	61	114
Fourth group	100	59	74	233

The factors to be included in the selection criteria would be (i) availability of water sources; (ii) prospective population of beneficiary; (iii) quality of water from available sources;

(iv) conditions of existing water supply facilities; (v) distance from and access to the available water sources; and (vi) construction cost per capita of the supply system.

5.3.3 Rehabilitation and Construction of Primary Schools and Community Facilities

The Department of Education of the Province has a plan to construct the Class I & II primary school in each village and the Class III, IV & V primary school in each sub-district. In the study area, on the other hand, there are 195 schools for Class I & II against the total of 435 villages and 29 schools for Class III, IV & V, out of 41 sub-districts. The rehabilitation of existing schools and construction of additional primary schools, especially for Class I & II education, will be included in the integrated agricultural development to contribute to such a plan of the provincial office. For the priority ranking in the development of primary schools and community facilities, consideration is given to the population of each village as shown below:

District	High Priority	Medium Priority	Low Priority	Beyond the Master Plan
Xai	5	14	37	116
Beng	3	4	38	61
Hun	6	12	65	74
Total	14	30	140	251

5.3.4 Development of Rural Electrification System

Although rural electrification is one of the main requisites for the people as well as for development of rural socio-economic activities in the study area, the main constraints to the rural electrification are lack of data and information on the availability of water sources and the location. Some perennial rivers in the study area will have the potential for micro-power development. Investigations and feasibility study of the micro hydro-power schemes in such rivers will be proposed as one of the components of the Master Plan. Perennial rivers which are considered to have the potential for micro-power development are listed below:

District	Village	Water Source
Xai	B. Kho-noi	Nam Kho
	B. Nammiang	Nam Miang
Beng	B. Nammet	Nam Met
	B. Napa-tai	Nam Xat
	B. Xengle	Nam Lo
Hun	B. Nanguen	Hoay Xat
	B. Donkham	H. Kao
	B. Fen	Nam Oun

5.4 Measures to Environmental Problems

Based on the findings mentioned in Section 3.15, the following programs for the measures to environmental problem, which seem to be "Quick Response and Low Input" program, are proposed to the study area.

- (1) Program for Evaluation of the Slash-and-burn Cultivation: there is only little basic data for evaluation of the slash-and-burn cultivation activities as already mentioned. Therefore, in order to contribute to formulation of a proper control and management plan for the slash-and-burn cultivation activities, collection and evaluation of the basic data will be carried out under this program.
- (2) Reserved Forest Establishment Program: establishment of the reserved forest is considered to be one of the effective measures to conservation of water resources. Therefore, the new reserved forests in the critical watersheds based on the discharge measurement of rivers during the dry season will be established under this program.
- (3) Management Program for Uncontrolled Fire: useless enormous lands are burned annually due to uncontrolled slash-and-burn activities. In order to reduce the useless burning lands and forests, the training of the fire control technique to the rural people will be carried out under this program.
- (4) Program for Analysis of the Minimum Rotation Cycle: the results of crop yield survey show that crop yield in 3 to 5 year-rotation cycle area is the same as in the 6 to 8 year-rotation cycle area at present. If this can be kept at it is and sustainable, the total slash-and-burn cultivation area could be reduced more than 40% in area to produce the same amount of rice. To clarify the minimum rotation cycle under several conditions, therefore, analysis of a relation between rotation cycle and yield by soil type and slope class will be carried out under this program.

These programs will be carried out mainly by the integrated agricultural station in collaboration with the offices concerned.

5.5 Support Services for Women's Group

In order to accelerate and support the activities by the existing women's groups, the following plans and programs will be required in connection with the implementation of the integrated rural agricultural development, and will be carried out through more efficient activities by the existing Women's Unions:

- (1) Training of extension workers for improvement of people's life standard.
- (2) Support services for promotion of health education to women.
- (3) Support services for promotion of basic literacy education to women.
- (4) Support services for encouraging women to participate and utilize the rice bank system.
- (5) Demonstration and extension of sericulture.

The programs mentioned above will be implemented mainly by the extension offices under the action plan of "Improvement and Strengthening of Agricultural Support Services" as mentioned in Sub-section 5.1.1.