

No. 2

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 III

FEASIBILITY STUDY ON MODEL AREAS SCHEME

AUGUST 1993

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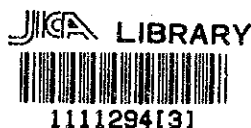
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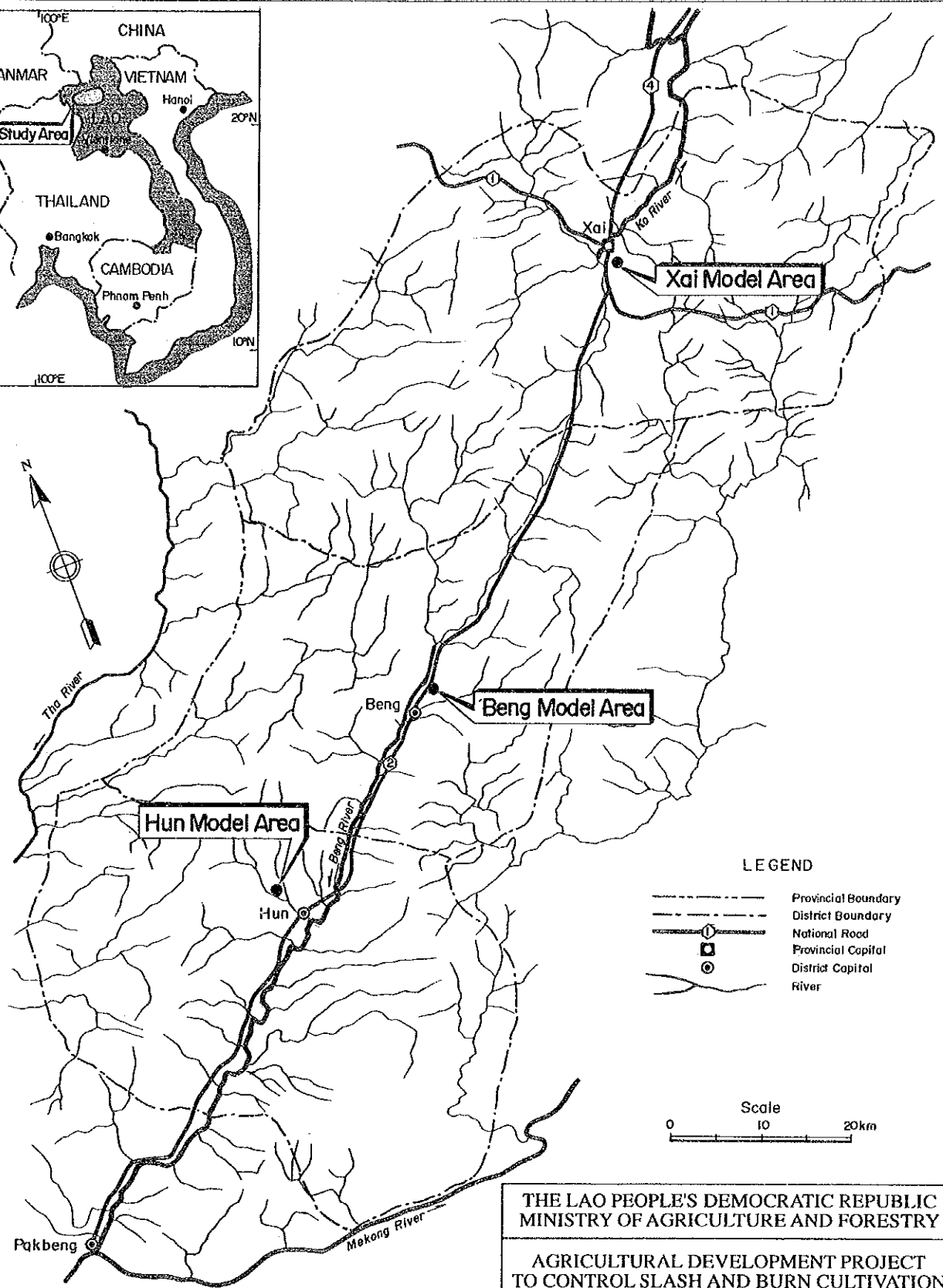
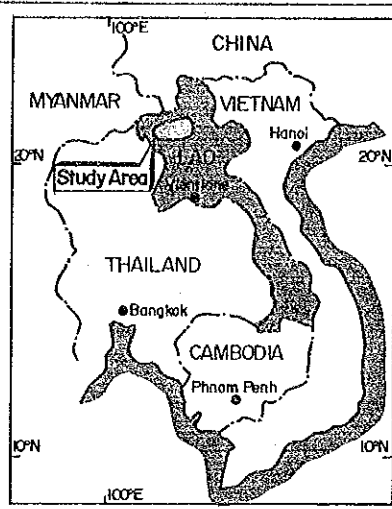


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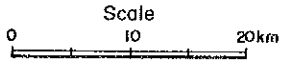
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- LEGEND**
- Provincial Boundary
 - District Boundary
 - ①----- National Road
 - Provincial Capital
 - District Capital
 - ~~~~~ River

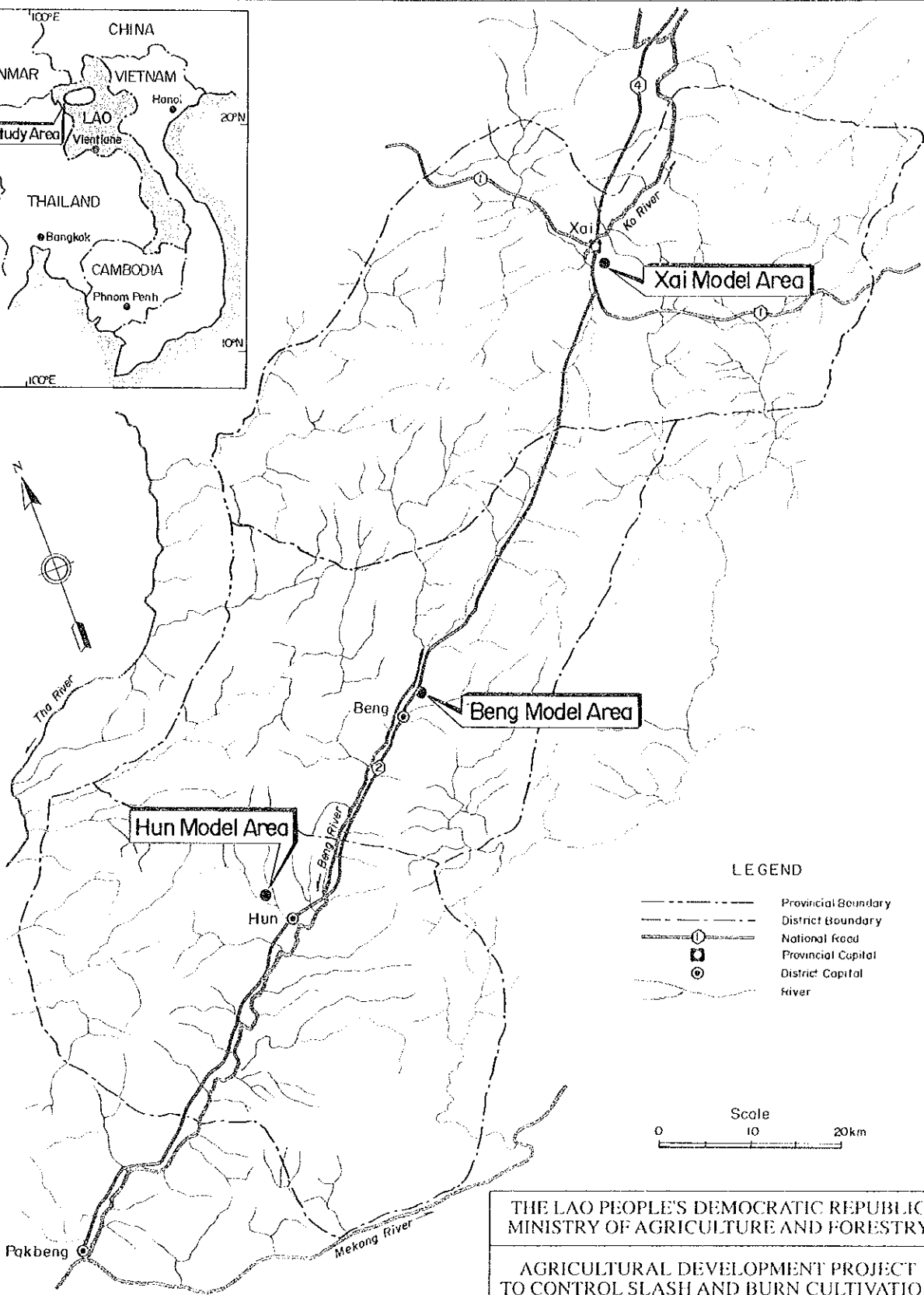


LOCATION MAP

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
 MINISTRY OF AGRICULTURE AND FORESTRY

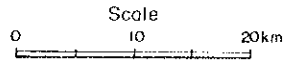
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LEGEND

	Provincial Boundary
	District Boundary
	National Road
	Provincial Capital
	District Capital
	River



LOCATION MAP

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
 MINISTRY OF AGRICULTURE AND FORESTRY

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

NIPPON KOEI CO., LTD.
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Agricultural Development Project
 AGRICULTURAL DEVELOPMENT PROJECT
 TO
 CONTROL SLASH AND BURN CULTIVATION
 IN
 OUDOMXAY PROVINCE

Volume III Feasibility Study on Model Areas Scheme

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ANNEX-FC	AGRICULTURE
ANNEX-FD	IRRIGATION
ANNEX-FE	SOCIAL INFRASTRUCTURE
ANNEX-FF	COST ESTIMATE

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

1.1 Composition of Feasibility Study Report

This Volume III "THE FEASIBILITY STUDY ON MODEL AREAS SCHEME" presents the results of the feasibility study on the integrated agricultural development plan in the selected model areas which is composed of the development programs to be implemented in the short term development phase formulated under the framework of the Master Plan. The various data and information for study of the model areas were collected and analyzed for formulating the proposed development plan in the areas. The data and information, and the results of the survey and studies are presented in ANNEXES attached to this report.

This feasibility study report consists of the main text and the following ANNEXES:

ANNEX - FA	SOIL AND LAND USE
ANNEX - FB	RURAL SOCIOLOGY
ANNEX - FC	AGRICULTURE
ANNEX - FD	IRRIGATION
ANNEX - FE	SOCIAL INFRASTRUCTURES
ANNEX - FF	COST ESTIMATE

1.2 Model Areas Scheme

The model areas development scheme (the Scheme) is proposed to be the first step of the integrated agricultural development in the study area, and to be implemented in the short term development phase formulated under the Master Plan as a model in the development of the whole study area. The Scheme includes three model areas, one in each district of Xai, Beng and Hun. The proposed development programs in the Scheme are summarized as follows:

Scheme component & Action Plan		Development Programs
A	Increase and Stabilization of Agricultural Productivity	
A-1	Strengthening of agricultural support services	- Strengthening extension services - Establishment of rice bank
A-2	Establishment of integrated agricultural station	- Supply of facilities and equipment - Establishment of organization and staffing - Operation of the station
B.	Rehabilitation and Upgrading of Existing Irrigation System	- Irrigation development in Xai, Beng and Hun model area - Improvement and establishment of water users association - Strengthening and improvement of meteorological network
C.	Development and Rehabilitation of Social Infrastructures	- Rehabilitation and upgrading of district road network - Construction of additional rural water supply facilities - Rehabilitation and construction of primary schools
D.	Measure to Environmental Problems	- Study and planning programs in agricultural station
E.	Support Services for Women's Group	- Women's school by extension office - Promotion of participation to rice bank - Extension of sericulture technique

2. CURRENT CONDITION OF MODEL AREAS

Three model areas shown in Location Map were selected for implementation of the short term development programs proposed under the Master Plan. The selected model areas are Tham Nuang area in Xai district, Nam Hao area in Beng district and Nam Kham area in Hun district. The feasibility study (the Study) on the integrated agricultural development plan in the three model areas is presented as follows:

2.1 Location and Topography

(1) Xai Model Area (Tham Nhuang)

This model area extends on both banks of the Nam Mao river, a tributary of Nam Ko, and the National Road No.2 runs in the centre of the area. The far upstream boundary of the area is located at about 4.5 km south from Xai city. Therefore, accessibility to the administrative centre of Oudomxay province and markets in Xai city is very good. In addition, high demonstration effects on pilot rural agricultural development could be expected because of such a good accessibility.

The area has approximately pear-shaped topography, extending from the upstream to the downstream. The area extends within a flat to gentle sloping valley bottom which is surrounded by hills. The approximate elevation of the area is 650 m above sea level. The gross area mapped for the study was 685 ha including some hill areas adjacent to lowland rice field in the valley.

(2) Beng Model Area (Nam Hao)

This model area extends on a narrow valley which elongates along the National Road No.2 and the Nam Beng river. The area is located at administrative centre of Beng district and about 62 km south from Xai city. The approximate elevation of this area is 530 m above sea level. The area has almost flat topography with some micro relief. The gross area including existing lowland rice field mapped for the study was 537 ha.

(3) Hun Model Area (Nam Kham)

This model area is located at about 8 km west from Hun town (capital of Hun district) and about 100 km south from Xai city. The area extends within a narrow valley surrounded by hills and has an approximate elevation of 470 m above sea level. The valley has irregular relief, varying from almost flat to gentle undulating slopes. The area dissected by both Nam Kham and Nam Ngat rivers that join at the centre of this area and flow into the Nam Beng. The total area mapped was 685 ha including part of the adjacent hill areas.

2.2 Soils and Land Classification

A soil and land suitability survey was carried out for the purpose of feasibility study on the agricultural development in the model areas. All of the results obtained through the survey is presented in ANNEX FA - SOIL AND LAND USE attached to this report.

2.2.1 Soil Classification

The soil survey in the model areas was carried out at semi-detailed level. Exploratory pits for soil profile observation were opened with an intensity of one pit per every 50 ha and 48 soil samples were collected from representative soil profiles for physical and chemical properties test. The soil test was made at the Soil Survey and Land Classification Centre in Vientiane. The soil classification is made at soil family and soil series based on the Soil Taxonomy of US Department of Agriculture. The general soil characteristics in each model area are summarized as follows :

(1) Xai Model Area

Soils in this model area are classified into two soil orders, Inceptisol and Alfisol which are further sub-divided into three great groups, three sub-groups, three family and 12 series. Soils in the area are formed from mixed fine alluvium transported either by rivers or outwash from the nearby mountains. Most of soil surface is free from rock material. The soil profiles are generally deep. The soil texture is mostly loamy and varies from sandy loam to clay. A hard plow pan at about 20 to 30 cm deep from the surface is found all over the lowland rice field.

(2) Beng Model Area

Soils of this area are classified into a soil order of Alfisol which is further sub-divided into three great groups, three sub-groups, four family and nine series. Soils in the area are formed from mixed fine alluvium. All the soil surface is free from rock material. The soil profiles have at least 150 cm depth without major physical constraints. The soil texture varies from sandy loam to clay. A hard plow pan at about 20 to 30 cm deep from the surface is found all over the lowland rice field, but in some cases it is thin and not very hard.

(3) Hun Model Area

Soils in this model area are classified into two soil orders, Inceptisol and Alfisol which are further sub-divided into two great groups, one sub-group, two family and 13 series. The soils are formed from fine alluvium. The soil surface is mostly free from large size rock material. The soil profiles are moderately deep, and the soil texture is mostly from loam to clay loam. A very hard plow pan is found at a depth between 20 cm and 30 cm. In general, soils in this area are marginally suitable for upland crops and suited for lowland rice because of clayey texture and hard consistence even under wet soil condition.

2.2.2 Land Classification

The land suitability classification is made, based on FAO's Framework for Land Evaluation. For determination of land suitability, the factors of land slope, soil depth, soil texture, rooting condition and soil moisture characteristics are considered in this study. The criteria for suitability rating are set as follows :

Land suitability classification criteria

Diagnostic factors	Unit	S 1	S2	S3	N
Land slope	%	< 3	3 to 6	6 to 9	> 12
Soil depth	m	>1.5	1 to 1.5	0.5 to 1	> 0.5
Texture	class	Loamy	Loamy	Clayey	Sandy
Rooting Condition	class	Very good	Good	Poor	Very poor

Note: S-1 = highly suitable, S-2 = moderately suitable, S-3 = marginally suitable; N = not suitable.

In addition, three land utilization types are considered in the land suitability classification. They are double cropping of rice per year (LUT-1), one cropping of rice and one time of upland crops per year (LUT-2), and two times cropping of upland crops per year (LUT-3). Land suitability class by land utilization type in each model area is summarized as follows :

(Unit : ha)				
Model Area	Class	LUT-1	LUT-2	LUT-3
Xai	S-1	176	176	176
	S-2	217	102	102
	S-3	37	265	166
	Sub-total	430	543	444
Total	N	255	142	241
		<u>685</u>	<u>685</u>	<u>685</u>
Beng	S-1	234	128	128
	S-2	134	208	18
	S-3	13	110	300
	Sub-total	381	446	446
Total	N	156	91	91
		<u>537</u>	<u>537</u>	<u>537</u>
Hun	S-1	197	0	0
	S-2	21	197	0
	S-3	89	114	311
	Sub-total	307	311	311
Total	N	378	374	374
		<u>685</u>	<u>685</u>	<u>685</u>

Note : The total area for each model area is based on the topo-maps prepared for this study.

A general recommendation for effective use of soils in the model areas is the need for deep plowing and incorporation of organic matter to the soil for improving the physical conditions and fertility of soils. Chemical fertilizers, mainly nitrogen, are required for high-yielding crop varieties.

2.3 Socio-Economic Conditions

The rural socio-economic survey in the three model areas was carried out mainly (i) to collect various information on the model areas; and (ii) to know the farmers' opinions, needs and their problems in agricultural and rural development. The data used in this report were obtained through the rural socio-economic survey and from each district office.

2.3.1 Population and Ethnic Groups

The basic socio-economic data on the villages in the model areas such as population, number of families, area of rice cultivation and holding size are shown in Tables F-1 and F-2.

Generally, the population of Oudomxay province is composed of three main ethnic groups, namely, Lao Loum (Lowland Lao), Lao Theung (Midland Lao), and Lao Sung (Highland Lao). As seen in Table F-2, Lao Loum is dominated in Xai and Beng model areas, while Lao Theung is the majority in Hun area. There is no Lao Sung village in the model areas. Lao Loum is generally Buddhist, though some sub-ethnic groups such as Tai Dam are animist. They are usually lowland rice cultivators and settle in the sedentary villages near rivers. Lao Theung is animist and originally lived in the midland of mountain areas. As far as the model areas are concerned, they are engaged in upland rice farming with a limited lowland rice cultivation as well as in hunting and gathering of forest products, and live in the new sedentary villages.

The total population and family number in the model areas are 4,356 and 731 in Xai model area, 3,015 and 508 in Beng model area, and 3,535 and 669 in Hun model area, respectively.

The population structure in the model areas is very young, about 46% of total population is under 15 year-old, while only 5% of the population is above 61 year-old. The male-female ratio is 48 to 52 on an average.

The households consist of either a nuclear family or an extended family. Family size varies from a minimum of 2 to a maximum of 16 persons with an average of 7 persons. Average family size by ethnic group of Lao Loum and Lao Theung is 7.6 and 6.8, respectively.

About 45% of total population can be categorized as labour force. The percentage of labour force who is engaged in agriculture is 83 in Xai area, 90 in Beng and Hun areas.

2.3.2 Settlement of Villages in Model Area

The villages in the model areas are classified into two categories of the settlement history: one is old village which settled before 1970, and the other is new village which was established after 1970 in or near the present place. Lao Loum villages generally have long history more than 100 years, while those of Lao Theung have newly settled within the last 10 to 20 years.

Average holding size of rice field in new and old villages is estimated as shown below:

	(Unit: ha)			
	New Villages		Old Villages	
	Total	per Family	Total	per Family
Lowland rice field	123.1	0.20	727.0	0.57
Upland rice field	503.2	0.80	173.6	0.14

Note: Old : villagers settled in or near present place before 1970
New : villagers settled in or near present place after 1970

The farmer in new villages cultivates smaller area of lowland rice field, and larger area of upland rice field as compared to the farmer in old villages, because old villages already occupied lowland rice field which was easily terraced land before new villages were established.

2.3.3 Slash-and-burn Cultivation

Lao Theung farmers generally cultivate larger area of slash-and-cultivation than Lao Loum. Upland rice field cultivated by Lao Theung farmers exceeds 90% of their total cultivated area on an average, but in contrast Lao Loum relies largely on lowland rice field.

There is no great difference in the practice of slash-and-burn cultivation between Lao Loum and Lao Theung who settled in lowland areas. The fallow forest land is generally cultivated for one crop a year with a fallow period of 3 to 5 years.

2.3.4 Hunting, Fishing and Collecting

The percentage of the farmers in Xai area who never practice hunting, fishing and collecting is higher than those in Beng and Hun areas. Generally, 89%, 73%, and 46% of the farmers is engaged in collecting, fishing, and hunting, respectively. The order of importance among them can be summarized as Collection > Fishing > Hunting. Lao Loum people are found of and familiar with fishing rather than hunting, but for Lao Theung in reverse.

2.3.5 Village Organizations

The basic unit of agricultural production is the small family farm which is operated primarily by family's own labour. Irrigation water is ultimately used by individual farmers, but the operation and maintenance of the whole irrigation system are managed by the water users associations or traditional committees.

There are two types of irrigation systems: one is a small-scale traditional brushwood weir, and the other is a medium-size with permanent concrete weir. Since there are no strict rules to control water distribution management in the case of traditional system, the

conflict of water distribution is apt to occur. However, it is unlikely to take place in the system with permanent concrete weir.

At present, there are no farmers' organizations aiming at economic activities other than village committee and women's union which are part of administrative and political structure.

Labour exchange is carried out among the group of blood ties and neighbours at the peak periods of planting, harvesting, threshing and transportation. Land clearing and fencing are made by their own family labour. Burning of fallow lands is usually carried out by several families together when they have the field in a lot.

2.3.6 Women's Role in Rural Society

There is rigid custom in responsibility on some tasks for men and women. Men's tasks include house building, land clearing, hunting, caring of large size livestock (e.g., buffalo and cattle), and so forth. On the other hand, women have the main responsibility for cooking, child care, milling rice, water fetching, collecting firewood and forest products, and caring of small size livestock (e.g., pig and poultry), though their children often help them.

Women enjoy the right to vote for the election of village head, and also participate in decision-making of village meeting. However, they tend to hesitate to speak out their opinions in the public place.

Women have relatively more works to do and work much longer hours than men. Women's tasks are incessant, because the demands for domestic works continue all year round.

2.3.7 Constraints to Agricultural Development

Pests and diseases of both crop and livestock are the most serious constraints to increase in agricultural production.

Almost all farmers who practice slash-and-burn cultivation are keen to stop this type of agriculture because of hard and incessant work with low yielding. However, it is not easy task for them, because they don't have enough irrigation water and rice field. In other words, the shortage of rice field with lack of irrigation water is the most serious obstacle to stop slash-and-burn cultivation for lowland settlers. It is obvious that irrigation development together with new land clearing is the most important precondition towards this end.

Lowland farmers cultivate small area of rice field, 0.5 ha/family on an average, mainly because the availability of arable land and irrigation water are absolutely limited. On the other hand, the upland rice field is relatively large and its size is mainly depending on the availability of family labour for clearing lands and weeding. Hence, the major constraints to more rice production are land and water in lowland, and labour in upland.

2.3.8 Needs of Farmers and Women

Interviews with 108 farmers in the model areas were carried out to know about their needs for acceleration of the socio-economic activities in rural areas. In such interviews, each farmer was requested to choose three main items with the first, second and third priority that he considers important for generating more income and food through his socio-economic activities. The results of the interviews are summarized in the following table:

		(Unit: Count)			
	Item	Xai	Beng	Hun	Total
1.	Irrigation development	95	100	98	293
2.	Agricultural development	51	48	30	129
3.	Land development	15	20	36	71
4.	Livestock raising	15	10	9	34
5.	Electricity supply	18	14	2	34
6.	Drinking water supply	4	8	13	25
7.	Road development	0	0	18	18
8.	Forest and soil conservation	1	12	4	17
9.	School (education)	10	1	5	16
10.	Health and clinic	4	0	1	5
11.	Cottage industry	0	0	0	0

Note: The above figures were obtained, multiplying the original number of each item by weight factors of 3, 2 and 1 for first, second and third priority, respectively.

As seen in the above table, the farmers give a top priority to the development of productive infrastructures such as irrigation and land rather than social infrastructures.

Interviews with 50 families including both husband and wife in the model areas were carried out to catch their needs separately. The results of interviews are summarized in the following table:

		(Unit: Count)		
	Item	Total	Male	Female
1.	Irrigation development	117	61	56
2.	Agricultural development	117	60	57
3.	Electricity Supply	84	45	39
4.	Rice mill	43	12	31
5.	School (education)	42	26	16
6.	Drinking water supply	38	15	23
7.	Road development	35	23	12
8.	Health and clinic	34	10	24
9.	Livestock raising	28	14	14
10.	Credit	9	9	0
11.	Handicraft development	7	3	4

Note: The above figures were obtained, multiplying the original number of each item by weight factors of 3, 2 and 1 for the first, second and third priority, respectively.

There is the similarity of felt needs between male and female, but it should be noted that the women give relatively high priority to rice mill, health and clinic, and drinking water supply.

2.4 Present Land Use

The present land use in each model area demarcated for the rehabilitation and development of irrigation system is estimated on the basis of topographic maps (scale 1 : 5,000), and field check survey. The present land use in each model area is summarized as follows:

Land Use	Xai		Beng		Hun	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Lowland rice field	310	82	234	70	184	57
Dike, canals etc.	55	14	41	12	33	10
Upland field*	0	0	5	1	19	6
Bush and grass land	13	34	57	17	87	27
Total	378	100	337	100	323	100

Note * includes upland rice by slash-and-burn and other upland crops.

The agricultural land in the model areas is currently used at very low intensity. Only one time of harvest is made annually in almost the entire model areas. Most of the land is left fallow and used for livestock grazing during the dry season, except for very limited areas where vegetable is grown.

2.5 Land Tenure System and Holding Size

Land is officially the property of the state, and the people have the usufruct right of land, but no right of buying and selling the land. However, customary land tenure system still

exists in the model areas, and varies greatly in different categories of land, namely, lowland and upland.

In the case of lowland rice field, purchase and renting of lands are observed in the model areas. The original right of land acquisition becomes a right of property, and such a right is usually transferred by inheritance. Tai Lao family is matrilineal, and the youngest daughter with the husband usually inherits the land and family house. Tai Dam family is essentially patrilineal and the eldest son generally inherits the land.

The territories of each village are well-defined by the surrounding villages. Most villages have certain rules on the forests concerning cutting trees, grazing livestock, slash-and-burn cultivation, and other activities. For those who break the rules, the village committee gives a warning at first time, but they will be fined, if the violation is continued.

Unlike lowland rice field, slash-and-burn cultivation fields are considered to be village property rather than individual one. The villagers have equal usufruct right for the fallow forest land to be used for slash-and-burn cultivation, but the right on certain place terminates when field is left fallow. Slash-and-burn cultivation fields are allocated to each farmer through negotiation among villagers under the control of the village committee. The land allocation is based on the number of family member of each farmer. In this case, every farmer can propose the location of land where family heads desire to use for cultivation. Individual field is clearly determined, and any dispute is settled before any clearing work takes place.

The average land holding size of lowland and upland field in each model area and by ethnic group is estimated as shown below:

Land Category	Model Area		
	Xai	Beng	Hun
Lowland rice field	0.53	0.50	0.31
Upland rice field	0.07	0.27	0.73
Total	0.60	0.77	1.04

(Unit: ha)

Land Category	Ethnic Group	
	Lao Loum	Lao Theung
Lowland rice field	0.58	0.18
Upland rice field	0.11	0.85
Total	0.69	1.03

The holding size of lowland rice field of Lao Theung is very small as compared to that of Lao Loum, and upland field of Lao Theung family is larger than that of Lao Loum. The

above two tables also show that the total cultivated land per family tends to be larger when the farmers are engaged mainly in upland farming, but to be smaller when they are engaged mainly in lowland rice cultivation.

The area of slash-and-burn cultivation per family is, by and large, inverse relation to that of rice field. The more rice field is available, the less slash-and-burn cultivation is practiced.

According to the village leaders interviewed, there are about 10 to 40% of farmers who have no lowland rice field even in Lao Loum villages. The farmers generally try to avoid the segmentation of their land by inheritance if their land is already so very small that some of their children are not possible to hold lowland rice field at all. As a result, they have to practice slash-and-burn cultivation for surviving.

Limited lowland rice field in Lao Theung villages is shared among the farmers according to their family size, as seen in Hun area. For example, there are 126 families in Somphon village which is divided into 6 Nuay (village unit), and about 9 ha of lowland rice field is shared in farming with one-year cycle. This means that each Nuay can use the lowland rice field once in six years. It may be said from these situations that the farmer in this area have a great need for opening of new rice field whenever and wherever it is possible.

2.6 Present Agriculture

2.6.1 Result of Rice Yield Survey

In order to collect data on the present yield level of lowland and upland rice, the yield survey by representative-hill method was carried out in the rice fields in and around the model areas.

The results of the yield survey on both lowland and upland rice are summarized as follows, and the details are presented in ANNEX FC - AGRICULTURE attached to this report:

	(Unit: ton/ha)			
	Xai	Beng	Hun	Average
Lowland rice	2.4	2.7	2.6	2.6
Upland rice	1.2	1.5	1.6	1.4

The average unit yield of lowland and upland rice is 2.6 and 1.4 tons per ha, respectively. The unit yield of upland rice in the above table is obtained from slash-and-burn cultivation areas.

In order to clarify the reasons for the present low rice yield, the relation between unit yield and each yield component was examined. There is a clear correlation between yield and number of grains per square meter, except lowland rice in Hun area. The yield of lowland rice in Hun area shows high correlation between the ripened grain percentage. It is assumed based on the fact that the rice in Hun area has been affected by some damages such as disease, drought, etc. The neck node blast was observed in very wide area in the model areas and seems to be one of causes of the present low yield. The most important factor for increase of rice yield in the model areas is the number of grains per square meter together with increase in ripened grain percentage.

The most decisive factor is the number of grains per panicle, which is generally determined during the period of 25 days before flowering. This period is included in the stage of panicle formation which is sensitive to lack of irrigation water and nitrogen deficiency of rice plant. The effect of irrigation water and N-fertilizer on rice yield should be considered on water management and fertilizer application practices at the proper time and proper quantities. The varieties cultivated in the model areas are mostly local variety of long culm length, and these are very susceptible to lodging damage and cause the low ripened grain percentage.

2.6.2 Present Cropping Pattern

The present cropping pattern in the model areas is summarized as follows and illustrated in Fig. F-1.

Crop	(Unit: ha)		
	Xai	Beng	Hun
Lowland Rice	310	234	184
Upland Rice	0	5	19
Sesame	0	0.5	2
Tobacco	0	2	0

The present agriculture in the model areas mostly depends on lowland rice cultivation. Besides the lowland rice, about 5 and 19 ha of upland rice are cultivated in Beng and Hun model areas, respectively. Other main crops grown in the upland rice field are sesame and tobacco. Sesame is usually grown mixed with upland rice in about 10% of the area. Tobacco is grown mainly in Beng district after upland rice, and the planted area of tobacco is estimated at about 40% of the upland area.

2.6.3 Present Farming Practices

Most of the farming works are done by manual labour, except only the field preparation by using buffalo. Upland rice and other upland crops are usually planted to a hole made by planting stick without soil preparation such as ploughing.

Sesame is usually planted mixed with upland rice, and the area is assumed at about 10% of the upland rice area. The farmers grow tobacco for self-consumption and also for sale. In Beng area, tobacco is grown commonly after upland rice. Tobacco is usually sun-cured and sold to market.

Pest and diseases such as gall midge, stem borers and neck node blast are found widely in the model areas, but the control measures are not taken at present.

The labour requirements for the lowland and upland rice farming were surveyed through the farmers interview and the result is summarized as follows:

Lowland Rice		Upland Rice	
Work Item	Required Labour (man/day)	Work Item	Required Labour (man/day)
Nursery	10	Fencing	16
Plowing	37	Slashing	38
Transplanting	28	Burning	5
		Sowing	17
Weeding	17	Weeding	56
Reaping	27	Reaping	27
Threshing	24	Threshing	19
Transportation	5	Transportation	20
Total	148	Total	198

Source: Farm survey in 1992 (average of 13 sample farmers).

The labour requirement for weeding in upland rice cultivation is over three times that in the lowland rice cultivation, and also for the transportation of products, 20 man-days, four times that in the lowland rice cultivation. The results show that the upland rice cultivation is very labour consuming farming with very low productivity.

2.6.4 Crop Yield and Production

The average yields, planted area and production of rice and secondary crops such as sesame and tobacco are estimated as follows:

Model Area	Crops	Cultivated Area (ha)	Yield (ha/ton)	Production (ton)
Xai	Lowland rice	310	2.4	744
Beng	Lowland rice	234	2.7	632
	Upland rice	5	1.5	8
	Sesame*	0.5	0.8	0.4
	Tobacco**	2	3.2	6.4
Hun	Lowland rice	184	2.6	478
	Upland rice	19	1.6	30
	Sesame*	1.9	0.8	1.5
Model/Area Total	Lowland rice	728	-	1,854
	Upland rice	24	-	38
	Sesame	2.4	-	1.9
	Tobacco	30	-	96

Note: * means mixed cultivation with upland rice.

** yield is in raw leaf.

The estimated production of rice is 1,854 tons from lowland rice field and 38 tons from upland rice field, and the total 1,892 tons of rice are produced in the entire model area at present. The production of secondary crops is 6.4 tons of tobacco in the dry season upland rice field in Beng and about 2 tons of sesame in total from Beng and Hun, by mixed cultivation with upland rice.

2.7 Livestock and Fishery

2.7.1 Livestock

The present livestock raising in the model areas 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 in the model areas, especially to Thailand. It may be said that almost all the farmers in the area raise some livestock. Buffalo is the main livestock as draft animal for farming and also for sale. Cattle is usually not used for farming, but for sale to get cash for special expenditures in the farmer's livelihood and also for export mostly to Thailand.

A farmer raises three buffalos, two cattle, two pigs and 16 poultry on an average as shown below, though the number of livestock per farmer varies among the villagers and between villages.

(Unit: number)

	Xai	Beng	Hun	Average
Buffalo	2.1	3.7	2.9	2.9
Cattle	1.9	3.1	0.4	1.8
Pig	1.3	3.1	2.0	2.1
Poultry	14.7	21.8	11.1	15.9

Note: Details are in Table FB-5.

Lao Loum farmers generally keep animals more than Lao Theung, as seen in the following table (see Table F-3).

(Unit: number)

	Buffalo	Cattle	Pig	Poultry
Lao Loum	3.3	2.7	2.7	18.4
Lao Theung	2.3	0.3	1.2	8.4

The percentage in number of sold livestock to the total number in the model areas in 1991 is estimated based on the interviews with 158 farmers, and summarized in the following table:

(Unit: %)

	Xai	Beng	Hun
Buffalo	7	8	7
Cattle	8	13	25
Pig	50	48	36
Poultry	24	9	20

Note: Details are in Table FB-8.

As seen in the above table, 7 or 8% of buffalo was sold in the model areas. Sold number of cattle and poultry in the total number is not more than 25%. More than one-thirds of pig was sold in Hun area, while about 50% of pig was sold in Xai and Beng areas.

Usually, buffalo and cattle are grazing freely in the surrounding, harvested lowland rice field, hills and forests. There is no attempt on improved ranging and the only source of supplemental fodder for the animal is rice straw left after the harvesting of lowland and upland rice. Free ranging causes serious problems to cultivated crops 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 stumped on or grazed by the cattle.

These low input technology for livestock raising results in low returns to the farmers (traditional small holder). In addition, such low returns from livestock discourage the adoption of more productive technology and the use of improved breeds. As a result, production methods by the farmers in the model areas are still in low efficiency.

2.7.2 Fishery

The fish culture is not practiced in the demarcated model areas, but around the areas some fish ponds are observed. It is reported that there are about 20 ponds constructed and managed by the provincial office in and around Xai model area. Fish being raised is Panei and Paninh in Lao (carp group). The fingerlings were once brought in from the Provincial Fishery Station in Luan Prabang, but they are now self supplied. The product is sold in Xai market at a price of Kip 800 to 1,600 per kg. Although such a small-scale fish culture is considered as one of effective ways for increase in farmer's cash income, constraints to further development will be small and restricted markets and difficulties in transporting fresh fish to the consumers.

2.8 Marketing and Processing

2.8.1 Market System and Commodities in Model Areas

The selected model areas in Xai and Beng districts are just along the National Road No.2 which is the main route of transporting commodities for both local and international marketing activities. The model area in Hun district is linked to the Road No.2 at Hun town with about 8 km of jeepable road in the dry season. The each model area is recognized as located in the area of marketing centre in the study area. The model areas are supplied with daily consumables, construction materials and etc. from both Thailand and China.

The main commodities produced and marketed are rice, sesame, buffalo, cattle and pigs. Most of buffalo and cattle is sold to Thailand and sesame is sold to Thailand and China. The surplus of rice is sold mainly to the government of Oudomxay province through middlemen appointed by the private company who has a contract with the province. The province pays salary in rice or paddy to the employee. The amount of paddy purchased by the province in 1991 was about 2,500 tons, and 3,000 tons are under contract for 1992 fiscal year.

At present, there is no farmer's organization for marketing activities such as agricultural cooperatives in the model areas. Lao Quaker service is taking approach to some villages in the model areas through the women's unions for establishing a farmer's organization such as "rice bank" which may have the function of saving-cum-rural-credit and marketing.

Sesame is also important product as cash crop in the model areas and collected by the middlemen appointed by private companies in the province. According to the information obtained through companies who are trading sesame, the amount of sesame is not controlled by the government for export to both Thailand and China.

2.8.2 Agro-processing

Most important agro-processing activity of villagers in the model areas is rice milling for daily consumption. Although they mill rice by privately owned small-scale rice mills, the major part is milled by pounding method. The rice pounding work is mainly done by women. The number of rice mills in the model areas is as shown in Table F-4. About 90% of villages in number related to the model areas has privately owned rice mill.

Sesame is usually sold to middlemen at farmgate in each model area. The farmers dry sesame in the field under the sun before threshing, and the middlemen collect threshed sesame. The traders sometimes have troubles with merchants of Thailand or China due to low quality of sesame mainly due to high moisture content and contamination which results in low return to farmers. This is mainly because the farmers have no improved post-harvest equipment and facilities for drying, cleaning and storing sesame before selling to traders.

2.9 Agricultural Support Services

2.9.1 Extension Services

Actually, no extension services by the government institutes are being provided for agricultural improvement in the model areas mainly due to lack of well-organized agricultural extension system and manpower as well as sufficient budget. 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. Agricultural extension services in the model areas are currently under the responsibility of agriculture and forestry section of each district concerning the model areas. The agriculture and forest section of each district consists of technical groups such as irrigation, livestock and veterinary services, forestry, and agriculture. Each group has a little extension activities, but has no qualified extension workers and facilities. Among these sections, livestock and veterinary services are provided for training of farmers on vaccination of livestock periodically at present.

2.9.2 Farmer's Organization

There are no farmer's organizations established in the model areas under the government arrangement other than village committee, village unit (Nuay) and women's union. The farmer's organization aiming at economic or social activities is also not formulated yet in the model areas as well as in the province.

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. Most of villages has Rice Storage (Sang Kao) which has function of storing paddy collected as taxes, supplying food for village guests, and function of rice bank (see section of agricultural credits).

Most of the villages related to the model areas 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.

Every woman who is more than 18 years-old (in the case of woman who already married, more than 16 years-old) can become the member of the women's union. The member fee is Kip five/month for women who are getting salary and Kip one/month for women of farm family. In the case of Beng district, population of women who can be the member is 5,194 in total. However, actual number of women with membership is only 286. The activities of the unions are generally low, because the union had more political character in the past. Therefore, re-organization of the union is requested so as to promote more economic and social activities of the women under the introduction of the New Economic Mechanism (NEM). 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 village rice bank, etc.

2.9.3 Agricultural Credit

There are formal and informal agricultural credit systems covering the model areas. 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 Oudomxay provincial branch office located in Xai city and a district branch office in Hun town, and is lending rural credit covering the model areas. 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. There are three categories of terms of loan by the purpose of loans as follows:

Duration	Purpose	Interest Rate
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.

The Oudomxay branch has started its operations in mid-March 1991, and the amount of rural credit lent during one year of 1991-1992 was as follows :

Items	(Unit : 1,000 kip)		
	Xai	Beng	Hun
1. Purchase draft animals			
Amount	13,313	3,060	3,400
No. of village	8		
No. of family	82	17	22
No. of groups	20	4	7
2. Land clearing			
Amount	8,578	7,103	7,772
No. of village	7	5	5
No. of family	67	40	57
No. of groups	19	7	11
3. Purchase livestock			
Amount	6,930	0	0
No. of village		0	0
No. of family	26	0	0
No. of groups	7	0	0

Data source: LXB Oudomxay Branch Office.

(2) Informal Credit System

There are informal credit systems in the model areas 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 possible 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

is allowed to borrow money from the fund for purchase of food (mainly paddy) or for commercial activities with interest rate of 3 - 5%/month.

2.10 Present Irrigation System

2.10.1 Existing Irrigation System

Lowland rice field in each model area is currently used for cultivation of wet season lowland rice with irrigation water from some existing irrigation systems. The existing irrigation systems related to each model area are summarized in Table F-5.

Lowland rice field in Xai model area is estimated at 310 ha in net. To irrigate the rice field, there exist two irrigation systems on the Nam Mao river. One is irrigating rice field on the left bank of the Nam Mao, and the other is supplying irrigation water to rice field on the right bank area. The intake weirs of both systems are of brushwood type constructed by farmers groups, using bamboo, wood, stone and clay soil. The main canals are also constructed by farmers groups. Total rice field irrigated by these two systems in the wet season is estimated at 197 ha. The remaining 113 ha of rice field are irrigated by using excess water from small streams in the adjacent hill area. The two irrigation systems could be integrated into one system by constructing a permanent weir on the Nam Mao near Houay Khoum village. In addition, the whole lowland rice field in this model area could be irrigated by such a permanent weir and new canal network to be constructed to serve the whole rice field.

The farmers open some upland on the hills located at the eastern side of the model area, and are growing wide varieties of vegetable with irrigation by bucket, using excess water from two streams, Houay Hippi and Houay Phuk, which are the source of the Xai urban water supply system. In order to improve the irrigated upland agriculture on these hills, a simple pipe system may be considered for more effective use of the limited water from these two streams for both irrigation and domestic use.

The existing lowland rice field in Beng model area is estimated at 234 ha in net, most of which is irrigated by five existing irrigation systems. The intake weirs of these systems are of brushwood type constructed by farmers groups on the Nam Hao river, a tributary of the Nam Beng. Two main canals are also constructed by farmers groups with an assistance from the provincial office. One canal goes towards north, and the other runs to the south along the National Road No.2. Total irrigation area by these existing systems in the wet season is estimated at 221 ha, including 188 ha by two irrigation systems and the remaining 33 ha by other three systems. Topographically, the whole rice field in this model area could be

irrigated by one weir to be constructed on the Nam Hao, instead of five existing weirs. At the same time, the existing main canals should be improved, together with the construction of new distribution network such as secondary and tertiary canals which cover the whole model area.

The existing irrigation systems related to Hun model area are six with two water sources, Nam Kham and Nam Ngat, of which four systems already have concrete permanent weir constructed by farmers groups with the financial assistance from the provincial office (one weir), district office (two weirs) and Lao Quaker service (NGO, one weir). These permanent weirs are maintained in good condition, except for some parts for which small repair works will be required. The remaining two brushwood weirs should be replaced by new permanent weir to be constructed, one on the Nam Kham river and the other on the Nam Ngat. Total irrigation area by these existing systems in the wet season is estimated at 199 ha in net. Irrigation canal networks are also constructed by farmers groups. However, the alignment and design of canals are still primitive to meet the requirements for effective use of available river water in both wet and dry seasons. In fact, only 164 ha of rice field received irrigation water in the wet season of 1992. The beneficiary of the five irrigation systems are farmers in eight villages, consisting of two Lao Loum, four Lao Theung, one Lao Sung and one mixed. Because of a lack of irrigation water in this model area, conflict of water distribution happens sometimes.

2.10.2 O&M of Irrigation System and Water Users Organization

The cost for O&M of irrigation systems should be born by users, say farmers. All of the existing irrigation systems related to the model areas are therefore operated and maintained by farmers and communities.

According to the recent information on the water users organization, four organizations are formally established and authorized by the district in the study area, of which two are related to the model areas. One is the Nam Hao irrigation system in Beng model area, and the other is the Nam Kham irrigation system in Hun model area.

In the case of Nam Kham irrigation system which has a concrete weir to irrigate 68 ha of rice field, the organization consists of four 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. According to the regulation, 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. Each farm family should participate in repair and maintenance of the weir and canals as labour in accordance with the committee's decision.

Such a labour contribution depends on the size of rice land holding of each family. 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 system in the model areas. The regulation for management of this irrigation system is shown in Annex II as an example.

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 committee. These traditional system will be the basis for establishing new water users organizations after the existing irrigation systems are improved and up-graded under the model area scheme.

2.11 Social Infrastructures

2.11.1 District Road Network

There are two district roads related to the model areas. One is in Xai model area, which connects Nasao and Nale villages to the National Road No.2 with a total length of about 1.9 km, and the other runs from Hun town to Somphon village with a total length of 7.5 km in Hun model area. The former extends further to Kavang, Tangkok and Chomong, connecting five sub-districts to the Road No.2. The latter also connects three sub-districts to Hun town through Kang and Phouthong villages in the remote area.

In spite of the fact that these roads play an important role in connecting the remote areas with the district centres for the people's socio-economic activities, the road conditions are very poor, passable only in the dry season by 4-WD vehicles or trucks because of the lack of drainage facilities.

2.11.2 Rural Water Supply System

Out of 22 villages relevant to the model areas, the people in eight villages can use domestic water from the urban water supply system in Xai city and rural water supply systems in Beng and Hun district centres, though there are some problems such as insufficient discharge and low water quality.

Usually, the people in the remaining villages are doing washing and bathing in the streams nearby the villages. As for the drinking water, almost all the villages depend on only one or two shallow wells or dug holes beside the streams.

During the late dry season, April to June, the villagers have to fetch water directly from the streams even for drinking purpose, because the wells dry up.

2.11.3 Primary School

There exist 17 primary schools in the villages and four Thaohom schools in and around the model areas. Because of the limited education budget of the province, the conditions of school house are very poor. Out of 17 villages related to the model areas, nine villages have no school house and utilize the village community house, village office or sub-district clinic.

2.12 Environment

2.12.1 Destruction of Forests by the Shifting Cultivation Activities

In the proposed model areas, the destruction or degradation of the forests by the slash-and-burn cultivation activities is not the environmental problem, because the proposed model areas are all located in the lowland and mostly covered by lowland rice field. However, most of the families in the related villages have both rice field and slash-and-burn cultivation area and probably give rise to a destruction or degradation of forests by slash-and-burn activities outside the model area.

2.12.2 Living Environment

At present, the serious environmental issues in the model areas are concentrated on the living environment such as poor road condition, poor rural water supply system, poor electric supply system both in quality and in quantity, and poor sanitary condition mainly due to the life style of rural people. These issues cause the inconvenience and disadvantage to the people in the model areas such as transportation of agricultural products and fuel wood by hand, carrying water from the river, water born diseases, high infant mortality rate, etc.

3. DEVELOPMENT PROGRAMS

3.1 Strengthening of Agricultural Extension Services

3.1.1 Objectives of Program

(1) Long Term Objectives

In line with the nation-wide program, extension services for farmers in the model areas will be provided by the existing agriculture sections of Xai, Beng and Hun district offices. The package of improved farming techniques and superior varieties of crops to be developed in the agricultural station will be extended to the farmers in the model areas. The present agricultural extension services for the farmers in the model areas are still not sufficient mainly due to shortage of extension staff, lack of superior varieties of crops and improved farming techniques suitable to the model areas, and of sufficient facilities for extension activities as well. The objectives of the program are to strengthen the capacity of agricultural office in each district to promote improvement and stabilization of agricultural productivity in the model areas as a model in the agricultural development for the whole study area.

(2) Immediate Objectives

The immediate objective of the program is to provide the following facilities and equipment required to provide more effective agricultural extension services by each district office:

Item	Quantities
- Assignment of extension worker	: for each model area 1-Rice farming expert x 3 districts 1-Upland farming expert x 3 districts 2-clerks x 3 districts
- Construction of office building*	: for Beng and Hun districts 3-office room x 24 m ² x 2 districts 1-conference room x 48 m ² x 2 districts 1-storage x 32 m ² x 2 districts
- Construction of staff quarter	: 2-140 m ² for Hun district
- Supply of office and extension equipment, including motorcycles	: 1-lot x 3 districts 2-motorcycles x 3 districts
- Establishment of pilot demonstration farm	: Part of leading farmer's field is used as pilot demonstration farm in each model area on contract basis

Note: Office space for Xai extension office is included in the agricultural station.

3.1.2 Main Extension Work

The main extension work to be carried out in the agricultural extension offices will be as follows:

- (1) Extension of improved rice cultivation farming through distribution of certified seeds, demonstration of pest-disease control and soil improvement techniques, and training of farmers' groups.
- (2) Extension of improved sericulture in collaboration with the Hatxyphong Silk Pilot Station in Vientiane. The expert will be requested periodically from the station to the model areas to conduct technical extension on sericulture.
- (3) Services for improvement of people's living standard, promotion of health education and basic literacy education through periodical opening of women's school at the agricultural extension office. The lecturer or trainers for the women's school will be invited by the extension office, depending on the subject in the school, through the outside collaborators such as Women's Union of Vientiane or other authorities of Ministries, etc.

3.1.3 Training of Extension Workers

Besides the supply of the above facilities, the training of the extension workers will be carried out at the agricultural station in collaboration and strong linkage with the Naphok Agricultural Extension Centre, National Agricultural Research Centre, and other authorities concerned. The extension workers will be trained not only to improve their special matters but also to identify the farm production problems as well as problems in rural life of the farmers in and around the model areas. The training curriculum will be prepared through various trials in the agricultural station

3.2 Establishment of Rice Bank

3.2.1 Project Objectives

The immediate objective of the proposed program for this component is to establish a rice bank in each model area with necessary building and facilities not only for the rice bank activities (saving and credit) but also for marketing and processing of rice and sesame produced in and around the model areas, and for supply of farm inputs to the farmers.

Such a rice bank has a purpose of prototype of the farmers' cooperatives in the short term development phase as the initial step of the marketing system development, and for further promotion of establishing farmers' cooperatives in the medium and long term development phases so as to help farmers get reasonable return from farm products as well as to promote supply of farm inputs.

3.2.2 Production of Rice and Sesame in Model Areas

The amount of rice and sesame to be produced in the model areas under with-project condition in the future and in the study area under the present condition is estimated as shown in Table F-6, and summarized as follows:

Items	Xai	Beng	Hun	Total
I. Model areas total				
Total rice production(ton)	1,594	1,112	1,532	4,238
Total sesame production(ton)	3.5	6.3	35	44.8
II. Study area total(three districts):				
Total rice production(ton)	9,520	8,100	11,100	28,720
Total sesame production(ton)	250	270	400	920

The total production of paddy (lowland and upland rice) in the study area is estimated at about 9,520, 8,100, 11,100 tons in Xai, Beng and Hun districts, respectively. The total amount of sesame produced in the study area is estimated at about 250, 270, 400 tons in Xai, Beng and Hun districts, respectively. The production of paddy in the model areas will be about 1,594, 1,112, and 1,532 tons in Xai, Beng and Hun model areas, respectively.

3.2.3 Capacity of Rice Mill and Sesame Cleaner

(1) Rice Mill

The amount of surplus rice (in paddy) for marketing is very limited in the model areas at present, however most of the surplus rice in the study area as well as in the province is sold to the province and to be paid in kind as salary for employees of the province. The amount purchased by the province was about 2,500 tons in 1991, and 3,000 tons in 1992. The paddy purchased by the province is milled mostly by the private millers in Xai city at present.

The amount of paddy to be processed in the villages in the model areas would be mostly for home consumption by the villagers, and paddy collected as land taxes is allocated to the villages and districts. The amount of paddy to be

processed in the villages is assumed to be almost all production in the villages. The total rice milling capacity of the existing small-scale rice mills is estimated at about 2 tons/hr in Xai and Hun model areas, and 3 tons/hr in Beng model area (see Table F-4). The capacity of the existing rice mills will be sufficient for milling the paddy produced at present in each model area.

Because of the present low milling recovery and quality, however, the performance of the existing mills seems to be not satisfactory. In fact, the milled rice imported from Thailand is sold in Xai and Hun markets at a price of about five times the locally milled rice. This means that there is a possibility of selling even local rice with a more attractive prices, if it is milled with a good quality. The amount of paddy milled by the rice bank is assumed to be 10 to 20% of total production in the model areas. Based on the assumption, the capacity of rice mill proposed for a new rice bank will be 500 kg/hr, also taking into account available marketed rice mills with economical size to obtain higher recovery and good milling quality.

(2) Sesame Cleaner

All production of sesame is exported to Thailand and China at present. The amount of sesame marketed is assumed to be 250, 270 and 400 tons in Xai, Beng and Hun districts. The marketing of sesame is made through the market centres in Xai, Beng and Hun where the model areas are located. Therefore, the proposed new rice bank in each model area will have an opportunity to market some amount of sesame. It is expected that the amount of sesame to be marketed by a rice bank would be 10 to 20% of total production in each district at the initial stage. Based on these assumptions, the capacity of sesame cleaner proposed for each rice bank will be 300 kg/hr as shown below:

District	Xai	Beng	Hun
Annual production(ton)	250	270	400
Amount to be handled by rice bank(ton)*	25~50	25~54	40~80
Operation period(days)**	60	60	60
Workable days(days)***	30	30	30
Amount cleaned(kg/day)	830~1,700	900~1,800	1,300~2,700
Operation hour(hr/day)****	5	5	5
Amount to be cleaned(kg/hr)	166~340	180~360	260~540
Required capacity(kg/hr)*****	210~425	225~450	325~675

Notes: * The amount to be handled by each bank is assumed to be 10-20 % of total production in each district.

** It is assumed to be about two months after harvesting season.

*** Workable days are assumed to be 50% of the operation period.

**** Assumed actual operation hour per day.

***** Operation efficiency of equipment is to be estimated at 80%.

3.2.4 Proposed Organization and Staffing of Rice Bank

(1) Rice Bank

A new rice bank will be established as an initial step in each model area under the Scheme. The women's union will operate the rice bank. All women's unions at the village level in and around the model areas will be the member of the rice bank. The board of director will be organized with the responsibility for operations of the rice bank. In the future, the rice bank will be transferred to the farmers' organization that will be established along with the progress of organizing farmers' groups.

(2) Staffing

(i) Managing director

One managing director will be assigned by the general meeting. Other necessary staffing will be assigned by the board of directors of each bank.

(ii) Other staff

The staff will be employed, depending on the work volume to be expected for the rice bank. At the initial stage, some staff to be dispatched from the province or Vientiane will be necessary for training and guidance to the staff of new rice bank, especially for operation and management of the rice bank. Clerks and accountant will also be

necessary for daily routine work. Operators of rice mill and sesame cleaner and store keepers will also be necessary to be employed. Some casual labours at peak operation time will be employed besides these permanent staff.

The proposed organization of a rice bank is illustrated in Fig. F-2 and summarized as follows:

Position	Number
Managing director	1
Clerk	2
Assistant clerk	3
Equipment operator	2
Assistant operator	2
Store keeper	2

3.2.5 Design of Building

The buildings required for the proposed rice bank will be office, storage, drying yard and milling house for rice and sesame.

(1) Office

The office building required for the bank should have a space enough for routine work of managing the bank by clerk, accountant, etc. The required floor space is estimated at 104 m² with 54 m² of garage.

(2) Storage

The storage is inevitable for the work of the bank, and the floor space is estimated at 200 m² to store paddy for long period, and sesame and milled rice for temporary storing.

(3) Drying yard

The concrete yard with a floor space of 200 m² is designed for drying sesame and paddy collected from farmers.

(4) Building for rice mill and sesame cleaner

Building for rice mill and sesame cleaner will be constructed for effective operation and maintenance of the equipment. The building will be partitioned with a wall to separate operation room for rice milling and sesame cleaning. The required floor space will be 100 m² for both equipment.

The size of buildings for each rice bank is summarized as follows:

Building	Size (m ²)
Office	100
Storage	200
Drying yard	200
Mill house (rice and sesame)	100
Garage	100

3.2.6 Operation of Rice Bank

(1) Milling charge of rice

Milling charge of rice in and around the model areas is estimated at about Kip 10/kg of paddy. It is assumed that the amount of rice to be milled by the rice bank is 10~20% of the total production in each model area, about 150 tons of paddy per year for each bank. The annual gross income of milling charge will be Kip 1.5 million.

(2) Marketing of sesame

The amount of sesame to be handled by the rice bank is estimated at about 40 tons a year on an average. The present prices of sesame in and around the model areas are as follows:

Market level	(Unit: Kip)	
	Present price	Recommendable price*
Farmgate	280	300*
Company gate	300~350	400*
Export price	440~470	550*

Note: * The prices in assumption.
The recommendable price of 400/kg is at the bank gate.

The farmers sell sesame at farmgate in Kip 280/kg usually to middle man, and the middle man sells to the company at trader's gate in Kip 300-350/kg. Then the trader exports in Kip 440-470/kg to China or Thailand.

It is recommended to buy sesame with a farmgate price of Kip 300/kg by the rice bank, and to sell it after drying and cleaning at the bank. The recommended price for selling at the store gate of the bank may be Kip 400/kg. Based on these assumptions, the gross income of the bank would be Kip 4 million by marketing 40 tons of sesame a year.

The cost for and benefit from operations of the rice bank are estimated as follows:

(Unit: Kip)	
Items	Amount
I. Gross income:	5,500,000
Rice milling	1,500,000
Sesame marketing	4,000,000
II. Cost:	4,566,000
Personnel expenses	1,840,000
Operation cost(fuels)	269,000
Maintenance cost	2,148,000
Management cost	150,000
III. Net income	934,000

The above estimates show that annual net income of the bank would be Kip 934 thousand without deducting the depreciation costs for buildings and equipment. The income to be expected from the credit services is not included in these estimates. The depreciation costs for buildings and equipment will have to be subsidised by the government at the initial stage to promote the further establishment of farmers' organizations in the future.

3.2.7 Guidance and Training

The guidance and training of the staff of the rice bank by the province as well as the district offices concerned are essential for effective operations of the bank. The district agricultural extension office will have the direct responsibility for providing technical and managerial support services to the rice bank in collaboration with the province as well as the integrated agricultural station to be established under the Scheme. In this connection, it is recommended to send some of the key staff in the women's unions to Vientiane for training on how to manage the rice bank and to promote further establishment of the farmers' organizations. The agencies concerned and the cooperation line among them are illustrated in Fig. F-2.

3.3 Establishment and Operation of Integrated Agricultural Station

The establishment of integrated agricultural station is one of the proposed development programs in the action plan for strengthening of agricultural support services in the Scheme component of improvement and stabilization of agricultural productivity formulated in the Master Plan.

3.3.1 Objectives

As a long term objective for implementation of the proposed rural agricultural development in the study area, it is essential to establish and operate an integrated agricultural station in order to develop packaged farming techniques for both lowland rice and upland crops, 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 such an agricultural station, the proposed program is to construct the necessary buildings and supply farm plots facilities and equipment, and to establish the organization including the staffing required for the activities to be executed by the station for the model areas at the short term development stage. This station will be opened in the suburbs of Xai city and near to Xai Model area, through re-organization of a project office to be established for the purpose of implementing the proposed model areas.

3.3.2 Main Work Items

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

(1) Research and Trials

Research and field trials will be carried out to develop the improved farming techniques for intensified lowland rice cultivation, which will include:

- selection of superior varieties of rice and other crops, and collection and introduction of crop varieties inside the study area as well as other areas of the country and outside the country;

- soil fertility improvement for increase in unit yield of crops by applying fertilizers, green manure, compost, etc.;
- crop protection technology improvement such as pests and disease control and weed control, etc.;
- improvement of cultivation method in combination with the variety trials, such as planting timing, nursery preparation method, planting density, etc. not only for the lowland rice cultivation but also for secondary crops in the lowland rice field such as wheat, rapeseed, potato, dry onion, etc.;
- harvesting, post-harvesting and quality control technology improvement;
- establishment and standardization of cultivation technology and preparation of materials for extension to farmers;
- demonstration of the improved farming method in the model areas through district agricultural extension offices;
- improvement of farming practices with introducing and improving farm tools and equipment such as plough, harrow, weeder-wheel, etc.; and
- training of farmers on the improved farming technology.

Research and field trials for developing year-round upland farming system in gentle sloping area will include:

- introduction and selection of superior varieties of upland rice and other secondary crops such as sesame, maize, etc.;
- introduction of irrigation farming in the upland where irrigation water is available;
- improvement of crop cultivation system for proper management of each kind of crop by applying pure standing method in a separated field plot for each crop;

- establishment of crop rotation system including alley cropping to maintain and improve soil fertility, weed control and crop productivity for sustainable agriculture;
- introduction and establishment of soil fertility management technology by applying green manure and mulching, etc.;
- diversification of the existing monoculture of rice by growing such crops as sesame, cotton, ground nuts, spice crops, vegetables, fodder crops, tree crops, etc.; and
- cooperation to demonstration, extension and training of extension workers and farmers on the above farming technology.

Research and trial works will also be carried out for extension of improved sericulture technique, including introduction of improved variety of silk worm and mulberry tree.

(2) Training and Guidance for Extension Workers and Farmers

- Training of extension workers in both lowland rice and upland crop farming techniques.
- Training of farmers in both lowland rice and upland crop farming.
- Direct guidance to agricultural extension offices for demonstration of lowland rice and upland crop farming in the model areas.
- Training of farmers for extension of improved sericulture technique in collaboration with the Hatxyphong Sericulture Pilot Station centre in Vientiane (Hatxyphong).
- Training of staff of the proposed rice bank.

(3) Seed and Seedling Multiplication

- Introduction and selection of superior varieties of rice and other crops.

- Multiplication and distribution of improved seeds and seedlings to farmers through the extension office in each district.

(4) Operation and Maintenance

- Operation and maintenance of the project facilities in the model areas such as irrigation system and road network.
- Repair and maintenance of machinery and equipment for the operation and maintenance.

(5) Study, Planing, Monitoring and Evaluation

- Study and preparation of concrete action plans and programs to be executed at the medium and long term development stages for further improvement and strengthening of marketing system, veterinary services, preparation of measures to environmental problems, and further rehabilitation of existing irrigation systems, new irrigation development, and rehabilitation of social infrastructures. 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.
- Monitoring and evaluation of the agricultural development scheme in the model areas.

3.3.3 Proposed Organization and Staffing

The proposed agricultural station will consist of six (6) sections to carry out the activities categorized above and also for general management of the station. The proposed organization is illustrated in Fig.F-3, and staffing of the agricultural station is summarized as follows:

Section	Staffing
Administration	1-General manager 1-Section chief 1-Clerk 1-Accountant 1-Typist 3-Vehicle Drivers 6-Office Boys
Research and Trial	1-Section chief 1-Incharge of Rice Farming 1-Incharge of Upland Farming 5-Fieldman
Extension and Training	1-Section chief 3-Training expert
Seed Multiplication	1-Section chief 1-Incharge of Food crops 1-Incharge of Horticulture crops 1-Incharge of Tree crops 5-Fieldman
Operation and Maintenance	1-Section chief 1-Chief Mechanic 2-Ass. Mechanic 5-Operators 3-Fieldman
Study, Planing and Monitoring	1-Section chief 1-Irrigation Eng. 1-Agro-economist 2-Surveyor -Temporary study teams

3.3.4 Proposed Facilities and Equipment

The facilities and equipment required for the effective operations of the agricultural station are summarized as follows:

- Administration Section
 - Office space and equipment
- Research and Trial Section
 - Office space and laboratory with equipment
 - Trial farm and farm machinery for lowland rice and upland crops
- Extension and Training Section
 - Office space, training room, training equipment and lodging facilities for training of extension workers and farmers
 - Training and demonstration farm and farm machinery for extension workers and farmers on lowland rice and upland crop farming practices
 - Transportation facilities for training tour of extension workers and farmers
 - Transportation facilities (motor cycles) for extension workers

- Seed Multiplication Section
 - Office space
 - Seed farm and nursery for lowland rice, upland and tree crops
 - Seed storage and machinery for seed production
 - Transportation facilities for introduction and distribution of seed and seedlings

- Operation and Maintenance Section
 - Machinery for operation and maintenance of the project facilities such as irrigation system and road network in the model areas
 - Workshop, tools and spare parts for repair and maintenance of the machinery for operation and maintenance and farm machinery

- Study Planing and Monitoring Section
 - Office space
 - Equipment for study, survey, planing, evaluation and monitoring of agricultural development projects

Buildings and Facilities

The items and specifications for the proposed buildings and facilities are summarized as follows:

Item	Facility and Equipment	
Office buildings	Office	650 m ²
	Storage	200 m ²
	Garage	200 m ²
	Site office with storage	150 m ²
Research and Trials	Lowland rice field	5 ha
	Net house for trial work	100 m ²
	Upland trial field of gentle sloping	10 ha
	Laboratory, study, training room	650 m ²
	Working room	105 m ²
Residence	Storage	100 m ²
	Residence for staff with family	6 units, each 140 m ²
	Dormitory for bachelor staff	425 m ²
	Dormitory for trainee	560 m ²
Workshop	Workshop	300 m ²
	Garage (Farm machinery)	200 m ²

Vehicles and Equipment

The items and specifications of the proposed vehicles and equipment are summarized as follows:

Item	Specification	Number
Vehicles	Pickup truck (1.5 ton-capacity)	2
	Jeep	2
	Minibus (for 15 persons)	2
	Motorcycle	5
Workshop equipment	S.L.	1 lot
Research & Trial equipment	Experimental rice mill (Capacity: 500 kg/hr)	1 set
	Laboratory equipment	1 lot
	Equipment for water requirement test	1 lot
	Farm machinery	1 lot
Training equipment	Audio visual aids	1 lot
	Training materials	1 lot
Seed multiplication	Farm machinery for seed production	1 lot
	Storage for seed	1 lot
O&M equipment	Bulldozer, grader, buck hoe, etc.	1 lot
Survey and design equipment	Geographical survey equipment	1 lot
	Hydrological survey equipment	1 lot

3.3.5 Study, Planning and Monitoring Programs

It is recommended to carry out the following study, planning and monitoring programs at the short term development stage not only to achieve the targets of this development plan effectively but also to expect the continuous and self-reliant development activities in the study area by collecting and analyzing the basic data required for the future development, and to improve the plan implementation capacity of the province as well as districts through these proposed activities described as follows:

- In-depth sociological and agricultural study to contribute to control of slash-and-burn cultivation in the study area.
- Preparation of detailed stage-wise implementation program of existing irrigation systems in the study area, and investigation and study of new irrigation development.
- Preparation of concrete action programs for improvement of existing marketing system and services.
- Preparation of concrete programs for rehabilitation and construction of primary schools and village community houses.

- Preparation of monitoring and evaluation program and establishment of monitoring unit in the agricultural station.

(1) In-depth Sociological and Agricultural Study to Contribute to Control of Slash-and-burn Cultivation in Study area

For in-depth study on agriculture and socio-economy to identify the effective solution to control slash-and-burn cultivation, a multidisciplinary study team consisting of the experts for rural sociology, agriculture including soils, crops, agro-ecology and farming systems, agro-economy, forestry, and any expert as required should be formulated. To implement this study, the national research system such as NARC, and any other international research institutes, and some institutes of universities, should be considered.

(2) Preparation of Detailed Stage-wise Implementation Program of Existing Irrigation Systems and New Irrigation Development in Study Area

At the short term development stage, a detailed stage-wise implementation study for further rehabilitation and upgrading of the existing irrigation systems in the study area is carried out in the agricultural station. In addition, additional investigations and study on the new irrigation development in the currently rainfed lowland, unused lowland and upland in gentle sloping hills will also be required. Appropriate engineers will take the leadership to such survey and design of the study at the initial stage and will train the local engineers and transfer technology on study and design and engineering work to prepare further irrigation development over the study area.

(3) Preparation of Concrete Action Programs for Improvement of Existing Marketing System and Services

At the short term development stage, an overall marketing development action programs to establish effective marketing system in the study area should be prepared along with the development of agriculture in the area. The main commodities for marketing may be paddy and rice, sesame, cattle and buffaloes, garlic, dry onion etc. and some diversified crops. Improvement and strengthening of support institutes for marketing should also be incorporated in this program.

- (4) Preparation of Concrete Rehabilitation and Construction Plan for Primary School and Village Community House

During the short term development stage, a concrete rehabilitation and construction plan of the primary schools and village community houses in the study area should be prepared in the agricultural station in cooperation with the province and district offices concerned.

- (5) Preparation of Monitoring and Evaluation Program and Establishment of Monitoring Unit in Agricultural Station.

It is inevitable to establish a unit in the agricultural station to monitor and evaluate the implemented projects. The unit is established in the section of planning and study which deals with the preparation of design and construction of irrigation, schools, community houses, etc. The monitoring and evaluation unit is required to be started at the initial stage of the short term development stage to conduct bench-mark survey in the model areas at first and then for the whole study area.

3.4 Agricultural Development Program in Model Areas

In line with the agricultural development strategy to increase and stabilize food production at first, the study on the proposed agricultural development program in the model areas scheme is made, also based on both local socio-economic and natural conditions in and around the model areas. Details of the program are presented in ANNEX-FC attached to this report.

The proposed program is for short term development phase with the main purpose of increase in lowland rice production under the irrigated condition in the areas. The lowland rice cultivation has been widely applied in the areas, and the practical level of farmers for further improvement of farming technique has been established already.

- (1) Change in Agricultural Land Use

In Xai, Beng and Hun model areas, 378, 337 and 323 ha in gross of land are demarcated for the irrigation development purpose, respectively. After completion of the construction works of the Scheme, these land areas would be changed into the new proportion in terms of land use categories as follows:

Land Use	(Unit: ha)					
	Present			With Project		
	Xai	Beng	Hun	Xai	Beng	Hun
Lowland rice field	310	234	199	302	270	258
Dike, canals etc.	55	41	35	76	67	65
Upland field	0	5	19	0	0	0
Bush and grass land	13	57	70	0	0	0
Total	378	337	323	378	337	323

As seen above, lowland rice field in Xai model area will decrease from 310 ha to 302 ha in net mainly due to the construction of new irrigation facilities, while those in Beng and Hun model areas will increase to 270 ha and 258 ha in net, respectively, by opening 36 ha and 74 ha in net of new rice field in the currently bush and grass land.

(2) Proposed Cropping Pattern

(i) Selection of Crops

For study on the optimum cropping patterns to be proposed in the model areas, physical conditions such as climate, availability of seasonal irrigation water and social conditions such as familiarity of crops to the farmers, custom and dietary preference of farmers, economic base of the farmers, etc. are firstly studied.

The principal policy of the government's national development plan is to increase food crops and to control slash-and-burn cultivation.

Most of rice varieties grown in the model areas are glutinous. However, some farmers grow non-glutinous rice with acceptable crop yields, using a small quantity of yard manure. The crop yield of non-glutinous rice varieties are usually higher than that of glutinous varieties. Therefore, it is proposed to introduce non-glutinous rice in about 30 % of the total lowland rice field to raise production in the model areas under future with-project conditions, because the farmers prefer also glutinous rice.

Taking into account the basic requirements for crop cultivation and the government's policy mentioned above, the wet season lowland rice and dry season lowland rice are selected as the main crop. Recommendable

glutinous rice varieties will be IR-43069-UBN-507-3-1-2-2, SK2-9-1 and RD-16, and rice SPTLR82022-PRE-26-2-3-GM-18 and SPTLR82074-PRE-6-2-3-GM-6 for non-glutinous rice. Other varieties will also be introduced through the proposed agricultural station.

(ii) Proposed Cropping Pattern and Cropping Intensity

The adequate supply of irrigation water after the completion of the Scheme will lead to certain change in crops and cropping patterns within the model areas. The following basic principles which govern the cropping pattern under the Scheme are considered:

- (a) The crops and cropping pattern must create maximum benefits for the farmers, and be familiar to the farmers.
- (b) The crops and cropping pattern must make optimum utilization of water to be supplied by the Scheme.
- (c) The crops and cropping pattern should be practical with the limited number of family labour, etc.

In due consideration of the above basic principles, double cropping of rice in Xai area, and single cropping of lowland rice in wet season in Ben and Hun model areas due to limitation of irrigation water are proposed.

The proposed cropping patterns in the model areas are summarized below and illustrated in Fig. F-4..

Crops	(Unit: ha)			
	Xai	Beng	Hun	Total
Lowland rice field	302	270	258	830
Wet season crop	302	270	258	830
Dry season crop	125	0	0	125
Total cropping area	427	270	258	955
Cropping intensity (%)	141	100	100	115

The area to be planted with lowland rice in the wet season will be 302, 270, 258 ha for Xai, Beng and Hun areas, respectively. While the dry season rice is planted in 125 ha of rice field only in Xai model area. The overall cropping intensity in the model areas will thus increase to 115%.

(3) Proposed Farming Practices

The proposed farming practices are described on the lowland rice cultivation both in the dry and wet seasons.

- (i) Farm inputs and labour requirements per ha for the proposed farming practices will be as follows:

Inputs	Unit	Quantity
Seed	kg	40
Fertilizer		
N:	kg	30
P:	kg	15
Agro chemicals:		
Pesticides	kg	1
Fungicides	kg	1
Labour inputs	man/day	165

The total requirement of farm inputs and incremental amount in the model areas are calculated as follows:

Inputs	(Unit: tons)			
	Xai	Beng	Hun	Total
Extension seed				
Glutinous	12.0	7.6	7.2	26.8
No-glutinous	5.2	3.2	3.1	11.52
N. Fertilizer	13.0	8.1	7.7	28.8
P. Fertilizer	6.4	4.1	3.9	14.4
Pesticides	0.40	0.3	0.3	1.0
Fungicides	0.40	0.3	0.3	1.0

Since the extension seeds, chemical fertilizers and agro-chemicals are not used in the model areas at present, extension seeds of both glutinous and non-glutinous varieties, chemical fertilizers of N and P and agro-chemicals will have to be introduced newly into the model areas.

- (ii) Labour requirement

The labour requirements per ha for lowland rice in both wet and dry seasons under the proposed farming practices will increase to 165 man-day (see Table F-7). The peak labour requirements are estimated to analyze the possibility for carrying out the proposed cropping pattern with the proposed farming practices together with cultivation of the

related upland rice field. The total labour force required at the peak time during the first 10 days in August for each model area is estimated as shown below:

Conditions	(Unit: man/day)		
	Xai	Beng	Hun
Proposed lowland rice	563	504	532
Traditional upland rice	44	109	38
Peak requirement	604	613	913
Available labour a day	1,140	850	1,000

The total labour requirement at the peak time in each model area will be 604, 613 and 913 labours per day in Xai, Beng and Hun areas, respectively. On the other hand, total available labour force in each model area is estimated at 1,140, 850 and 1,000 labours per day in Xai, Beng and Hun areas. These estimates show that the available labour force in each area would be enough for the proposed farming operations even at the peak time.

(5) Anticipated Crop Yield and Production

After completion of the Scheme, the yield of rice will be stabilized and increased through stable supply of irrigation water, improvement of farming practices and water management and further expansion of agricultural supporting services. The anticipated unit yield of lowland rice is estimated as follows:

Present yield Model Area	Present Lowland	(Unit: tons/ha)	
		Target yield of lowland rice	
		Glutinous	Non-glutinous
Xai Model area	2.4	4.0	4.0
Beng Model area	2.7	4.0	4.0
Hun Model area	2.6	4.0	4.0

Rice production under with-project conditions will be expected as follows:

Model Area	Variety	Wet Season		Dry Season		Total	
		Planted Area	Prod. (ton)	Planted Area (ha)	Prod. (ton)	Planted Area (ha)	Prod. (ton)
Xai (302 ha)	Glutinous	211	844	88	352	299	1,196
	Non-glutinous	91	364	38	150	129	514
	Total	302	1,208	125	502	427	1,710
Beng (270 ha)	Glutinous	189	756	0	0	189	756
	Non-glutinous	81	324	0	0	81	324
	Total	270	1,080	0	0	270	1,080
Hun (258 ha)	Glutinous	181	724	0	0	181	724
	Non-glutinous	77	308	0	0	77	308
	Total	258	1,032	0	0	258	1,032
Total	Glutinous	581	2,324	88	352	669	2,676
	Non-glutinous	249	996	38	150	286.5	1,146
	Total	830	3,320	125	502	955	3,822

Note: The planted area for glutinous and non-glutinous rice is about 70% and 30% of the total planted area in each model area.

The present rice production in the model areas is estimated at 1,892 tons in total. After the completion of the Scheme, total rice production from the three model areas would increase to 3,822 tons at full development stage of the Scheme, with 1,930 tons of increment.

3.5 Rehabilitation and Grade-up of Existing Irrigation System

As mentioned in Section 2.10, there exist 12 traditional irrigation systems related to the model areas, including two (2) systems in Xai, five (5) in Beng and six (5) in Hun model areas. Most of them, except for four (4) systems in Hun model area that have concrete permanent weirs, are farmer and community managed scheme with small-scale indigenous brushwood weir and primitive canal network constructed by farmers and communities themselves. They are in a great need for rehabilitation and upgrading of the weirs as well as canal network which are the basic requisite for increase and stabilization of crop production, especially rice, in lowland rice field in each model area.

3.5.1 Basic Concept

The main purpose of rehabilitation and upgrading program for these traditional irrigation systems is the stable supply of irrigation water to wet season rice, especially in the beginning of rainy season as well as at the time of peak water requirement usually in July, because river water available for dry season irrigation is limited. The basic concept for planning and design of the program is summarized as follows :

- (1) The traditional brushwood weir will be replaced by a concrete permanent weir.

- (2) Dual function of the present canal for both irrigation and drainage should be separated completely.
- (3) The water distribution network in each model area will be constructed newly, except for the main canals in Beng area which will be rehabilitated. The network will consist of the main and secondary canals. On-farm canals to small irrigation blocks will be constructed by farmers' groups under technical guidance from the project office. To facilitate irrigation supply to such small blocks, offtakes will be provided on the secondary canal so as to command 4 to 5 ha of rice field by an offtake.
- (4) The main canal will be of stone masonry lining type.
- (5) An O&M road will be provided basically along a main canal.
- (6) New drains will be constructed, where required topographically.

3.5.2 Xai Model Area

In order to irrigate the whole 302 ha in net (378 ha in gross) of existing lowland rice field in this model area, a new concrete weir will be constructed on the Nam Mao, integrating the existing two brushwood weirs into one. The new weir is located near Houaykhum village, about 4.5 km south from the Xai town center. The crest length and height of the new weir would be 60 m and 4.2 m, respectively. In the dry season, it will be able to irrigate 125 ha of rice field, utilizing the natural runoff from the Nam Mao.

Two main irrigation canals will be constructed to irrigate rice field on both banks of the Nam Mao. The right main canal with a total length of 4.6 km will run along the foot of the hill which serves 194 ha of rice field, and the left main canal with a total length of 2.3 km will run through Nasao village to irrigate 108 ha of rice field.

3.5.3 Beng Model Area

Three alternatives are considered for study on the most suitable rehabilitation and upgrading of the five existing irrigation systems in this model area. As a result, Alternative-2 is recommended for its implementation (for details, refer to ANNEX-FD "IRRIGATION").

The Alternative-2 proposes that a new concrete weir will be constructed on the Nam Hao, integrating the two existing brushwood weirs into one. The new weir will be located at the upstream end of the fan of the Nam Hao. The crest length and height of the weir would be 40 m and 1.6 m, respectively. Total irrigation area to be served by the new weir will increase to 270 ha in net of lowland rice field from the existing 234 ha by opening rice field in the present bush, grass and upland areas. The existing right canal with a total length of 5.3 km will be improved to irrigate 167 ha on the right bank area, and the existing left canal will be improved as the left main canal with a total length of 4.1 km which covers 103 ha of rice field. In connection with the weir construction, the river improvement will be required for a total length of 0.9 km along the Nam Hao to control floods.

3.5.4 Hun Model Area

Out of the five existing irrigation systems, three (3) systems will be rehabilitated with concrete weirs and new canal networks. These are the Nam Kham No.1 system (mainly for Nakhm-tai village), the Nam Ngat No.1 system (mainly for Na village) and Nam Ngat No.4 system (mainly for Phonsavath village). Two existing brushwood weirs for Nam Kham No.1 system on the Nam Kham and Nam Ngat No.1 system on the Nam Ngat will be replaced by concrete one. The crest length and height of the new Nam Kham No.1 weir would be 40 m and 2.1 m, and those of the Nam Ngat No.1 weir would be 22 m and 1.8 m, respectively. The existing two irrigation systems of Nam Ngat No.2 and No.3 (mainly for Somxai village) will be integrated into Nam Ngat No.2 system with minor repair of existing concrete weir and construction of new canal network. The new irrigation area to be served by these rehabilitated systems will increase to 258 ha in net of lowland rice field from the present 199ha, and the command area by each irrigation system will be as follows:

Canal system	Water source	Irrigation area in net (ha)
Nam Ngat No.1	Nam Ngat	70
Nam Ngat No.2	Nam Ngat	74
Nam Ngat No.4	Nam Ngat	57
Nam Kham No.1	Nam Kham	57
Total		258

Since the runoff from the Nam Kham and Nam Ngat is very limited in the dry season, possibility of constructing a small reservoir is studied to utilize the runoff effectively for increase in irrigation area in the dry season. The dam site is located on the Nam Kham in between Nakhm-nua and Somphon village as shown in Fig. F-5. Since the maximum height of the dam is limited to 12 m to avoid submergence of Somphon village, the maximum storage capacity is estimated at 348,000 m³. The dam will be of earth-fill type with 160 m of crest length, 12 m of dam height and dam volume of 31,300 m³. Even if the dam were

constructed, the increase in irrigation area in the dry season will be 18 ha only. In addition, there exists limestone area near the dam site for which detailed investigation of the foundation is required. As a result, this dam construction is not recommended at the short-term development stage because of very small effect by the dam construction and lack of detailed information on the dam foundation.

3.5.5 Design of Irrigation Facility

Design of the proposed irrigation facility such as diversion weir, canal network and related structures in the model areas is made at the feasibility study level, and summarized as follows (for details, refer to ANNEX-FD) :

(1) Irrigation Water Requirements

A unit irrigation requirement is estimated on the basis of the proposed cropping pattern and meteorological data. Consumptive use of water by crops is calculated by multiplying evapo-transpiration (ET_o) by crop coefficient (K_c) which varies with the growth stages of crops. Effective rainfall with 80 % probability used in this calculation is estimated using available rainfall records. The evapo-transpiration is calculated by using the Modified Penman method and summarized as follows:

(Unit: mm/day)											
Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2.56	3.39	4.32	4.98	5.02	3.56	3.49	4.03	3.69	3.20	2.58	2.27

The consumptive use of water by crops calculated on monthly basis is shown in Table F-8. Percolation rate in rice field is determined at 2 mm/day, taking into account loam to clay texture of soils prevailing over the model areas. Water requirement for puddling of rice field is estimated at 150 mm on the basis of soil depth to be saturated and farmer's farming practices. Overall irrigation efficiency in flooding irrigation for lowland rice and furrow irrigation for upland crops is determined as follows:

	<u>Rice field</u>	<u>Upland</u>
1. Conveyance efficiency	90%	90%
2. Operation efficiency	80%	80%
3. Field application efficiency	70%	60%
Overall efficiency	50%	43%

The gross irrigation requirements for rice and upland crops are calculated on the basis of the above basic parameters and summarized as follows (refer to ANNEX-FD for details) :

(Unit: lit/sec/ha)												
Crop	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rainy season rice	-	-	-	-	-	0.00	0.33	0.36	0.82	0.68	0.28	-
Dry season rice	0.77	1.37	1.42	1.21	0.48	0.00	-	-	-	-	-	-
Onion	0.48	0.76	0.36	-	-	-	-	-	-	-	-	0.31
Tobacco	0.58	0.83	0.50	0.00	-	-	-	-	-	-	0.00	0.24

(2) Water Balance Study

The water balance study of diversion requirement and available river runoff is made to determine the appropriate scale of proposed irrigation development in each model area. Details of the study are shown in Tables F-9 and F-10. The study shows that all of the rivers can irrigate fully the proposed cropping area in the wet season, and only 125 ha in Xai model area can be irrigated in the dry season, as summarized below:

Area	(Unit: ha)				Water Source
	Wet Season		Dry Season		
	Net	Gross	Net	Gross	
Xai model area	302	(378)	125	(156)	Nam Mao
Beng model area	270	(338)	0	(0)	Nam Hao
Hun model area					
- Nam Ngat area	201	(252)	0	(0)	Nam Ngat
- Nam Kham area	57	(71)	0	(0)	Nam Kham
Trial farm					
- Rice	4	(5)	4	(5)	Nam Ko
- Sloped area	8	(10)	0.8	(1)	Houay Phuk

(3) Diversion Weir

The proposed concrete weir will be of fixed type. The slide type of scouring sluices will be provided for each weir to flush out sediments in front of the intake structure. The weir is designed to flow down the peak flood discharge with a 40-year return period. The principal features of the weir for each model area are summarized as follows:

	Xai Tham Nhuang	Beng Nam Hao	Hun Nam Ngat No.1	Hun Nam Kham No.1
Fixed weir				
- Crest elevation (m)	EL 294.60	EL 324.60	EL 337.80	EL 322.10
- Crest length (m)	60	40	22	40
- Height of weir (m)	4.2	1.6	1.8	2.1
Apron and riprap				
- Length of apron (m)	12.0	7.0	7.5	8.0
- Length of riprap (m)	23.5	9.0	10.0	8.0
Scouring sluice				
- Gate size & nos. (m)	2.0 x 2.3 x 2	1.7 x 1.7 x 1	1.5 x 1.7 x 1	1.7 x 1.7 x 1
Intake				
- Intake water level (m)	EL 294.50	EL 324.50	EL 337.70	EL 322.00

Note: The elevation shown above is the tentative elevation used by JICA study team for mapping of the model areas.

(4) Canal Network

The new irrigation canal network in the model areas will consist of the main and secondary canals. The service area of a main canal varies from 50 ha to 300 ha, depending on the topography and its command area. The secondary canal will be aligned for each irrigation block that will covers 10 to 30 ha and will be a unit for water management. On-farm canal which will serve 4 to 5 ha of small irrigation block will be constructed by farmers groups under technical guidance from the project office.

The main canal will be lined with wet stone masonry in order to minimize the canal width and maintenance works as well as to utilize the limited water effectively. The secondary canal will be of earthen type. The canals will be open channel with trapezoidal flow section. The typical cross section of canals is shown in Fig. F-6. Irrigation flow diagrams for each model area are shown in Figs. F-7 to F-9. A list of the required irrigation canals is shown in Table F-11 and summarized as follows:

Canal	(Unit: m)		
	Xai model Area	Beng model Area	Hun model Area
Main canal	6,900	9,345	5,690
Secondary canal	12,855	13,915	13,560

(5) Related Structures

Various kinds of canal structures will be required to distribute irrigation water properly as well as to convey it safely. These structures include bifurcation structure, turnout, check, culvert, aqueduct, drop, spillway and division box.

All of them will be reinforced concrete structure. A list of structures for each model area is given in Table F-12.

3.5.6 Drainage Facility

The drainage facility required for the model areas will have two purposes: one is to drain excess water from rice field, and the other is to evacuate rain water from the outside of the model areas to protect the facilities from flood damage.

(1) Drainage Requirement

Drainage requirements are calculated separately to drain excess water from rice field and to evacuate rain water from the outside of the model areas, on the basis of storm runoff estimated by using the daily maximum rainfall with a 10-year return period. The drainage requirement for rice field is estimated at 3.1 lit/sec/ha, and the drainage requirement to evacuate the rain water is calculated based on the drainage area required for each model area (for details, refer to ANNEX-FD).

(2) Drain and Related Structures

The required drains will be of earthen type with a trapezoidal flow section. The drainage flow diagrams for each model area are shown in Figs. F-10 to F-12. A list of drains is given in Table F-13 and summarized as follows:

	Xai model Area	Beng model Area	Hun model Area
Total length (m)	7,000	6,345	9,160

The structures related to the drainage network will be drop, culvert and junction protection as shown in Table F-14.

3.5.7 River Improvement

In Beng model area, the land located at eastern side of National Road No.2 is part of flood plain of the Nam Hao river. To settle the river course of the Nam Hao, improvement of the river section will be required for a length of 900 m along the river. The design discharge in the Nam Hao is estimated at 186 m³/sec of flood runoff with a 40-year return period. The proposed river bed width will be 15 m with an inside slope of 1 : 1.5 for the cross section in the improved portion.

3.6 Establishment of Water Users' Association

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 model areas are operated and maintained by the farmers and communities themselves. There exist two water users' associations formally established and authorized by the district. One is for the Nam Hao irrigation system in Beng model area, and the other is for the Nam Kham irrigation system in Hun model area. These associations have the regulation for water distribution management which is prepared through discussions among farmers (water users), irrigation members from each village concerned and the irrigation staff from the district offices. The irrigation members are elected by all of the water users, and organize a committee to control the water distribution to each rice field as well as to maintain the whole irrigation facilities. Each water user should participate in repair and maintenance of the weir and canal as labour in accordance with the committee's decision. In addition, each water user should pay some amount of charge per year to the committee.

Even in the irrigation systems where the authorized water users' associations are not yet established, they have the traditional water users' committees organized by the villages concerned. Such committees consist normally of a village chief and/or persons in charge of water use who are elected from each village. The member of the committee inspects the conditions of the weirs and canals, and prepares the maintenance program. In addition, the committee holds a meeting for O&M of the irrigation system at the beginning of rainy season to decide the contribution for maintenance works from each village concerned. All of the farmers who receive the service from the irrigation system have to participate in the maintenance works, depending on the size of their own rice field. These committees are not authorized by the district, but traditional ones. Under these traditional systems, it is still rare case to collect water charge. However, farmers contribute to O&M of the irrigation system in kind such as wood, bamboo, etc. In the case of Xai model area, even traditional one is not organized yet, and the district office arranges the meetings to settle the conflicts of water distribution among water users and/or villages.

The existing irrigation systems in Xai and Beng model areas will be integrated into one system in each area. The existing canal networks in Hun model area will be integrated into four (4) new canal system, using six (6) weirs. Since the new irrigation system will be well-designed and functional, it is essential to establish more efficient water users' association for proper water distribution to each water use's rice field as well as for O&M of all the facilities of the system. For these purposes, the existing water users' associations in Beng and Hun model areas should be re-organized, including all farmers and villages to be the beneficiary of the new

system. The traditional water users' committees should also be integrated into one association that should be established newly. For Xai model area, a new water users' association should be established by organizing all the farmers groups and village communities who will be the beneficiary of the new irrigation system. In connection with the re-organization of the existing associations and establishment of new one, the following programs should be carried out by the province and district offices in collaboration with the integrated agricultural station :

- (1) Development of laws and regulations related to establishment and management of the association.
- (2) Preparation of regulations for proper water distribution management and O&M of the irrigation system.
- (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 in each model area.

3.7 Improvement of Meteo-Hydrological Observation Network

The present meteo-hydrological observation network in the province and the study area as well is still not sufficient with only one meteorological station at Xai city and one rain gauge at Pakbeng located outside the study area. In connection with the irrigation development in the model areas as well as in the study area in the future, the meteo-hydrological observation network will have to be strengthened also for supporting the implementation of the proposed rural agricultural development and also for further acceleration of rural socio-economic development in the future. The following programs will be carried out under the model areas development scheme :

- (1) Supply of additional equipment and instruments to Xai meteorological observation station. The additional equipment and instruments to be supplied will include automatic rain gauge, recording anemometer and A-class evaporation pan.
- (2) Construction of additional meteorological yard in Beng district. As for Hun district, the meteorological station established by UNDP can be used for this purpose.

- (3) Installation of additional rainfall recorders, one in 250 km² of catchment area, nine (9) sites in total.
- (4) Installation of additional water level gauge staff in the five (5) main rivers.

It is proposed that the new meteo-hydrological observation network including the above facilities should be operated and maintained by the Department of Agriculture and Forestry of the province in collaboration with the district offices concerned.

3.8 Development of Social Infrastructures

3.8.1 District Road Network

It is proposed that two district roads in Xai and Hun model areas be rehabilitated as a model in improving the district road network in the future. The proposed roads will be of all weather type paved by gravel with appropriate number of drainage facilities and three (3) causeways on the Nam Mao, Nam Ngat and Nam Kham rivers, respectively. The development plan of these roads is summarized as follows:

Item	Unit	Xai Model Area (H. Khoum to Nale)	Hun Model Area (Hun to Somphon)
Road Length	km	1.9	7.5
Causeway	Nos.	1	2
Cross Drain			
- Pipe Culvert	Nos.	4	28
- Box Culvert	Nos.	3	5

3.8.2 Rural Water Supply System

Three (3) rural water supply schemes, one in each district, will be included in the model areas development scheme, taking into consideration the availability of water sources, population of beneficiary and urgency of supplying clean water to 12 villages in and around the model areas. These villages are located three (3) in Xai model area, four (4) around Beng model area and five (5) in Hun area, respectively, as shown below:

Model Scheme	Nos. of Village	Village
Xai	3	Nasao, Nale, Houay Khoum
Beng	4	Phokeo, Pangdua, Nalai, Gnjo
Hun	5	Somphon, Nakham-nua, Nakham-tai, Na Mai

3.8.3 Primary School

It is proposed to construct four (4) Thaohom schools and eight (8) primary schools in total, five (5) schools in Xai, three (3) in Beng and four (4) in Hun, respectively, as shown below :

Model Area	Nos. of School	Nos. of Village	Village
Xai	5	5	Nalao, Nasao, H. Khoum, Cheng, Nale
Beng	3	3	Phokeo, Thakat, Benglouang
Hun	4	6	Somphon, Nakham-nua, Nakham-tai, Na, Mai, Somxai

3.9 Environmental Conservation

Based on the findings mentioned in Section 2.12, 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 are only little basic data for evaluation of the slash-and-burn cultivation activities as already mentioned. In order to contribute to formulation of a proper control and management plan for the slash-and-burn cultivation activities, therefore, 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 will have to be established in the critical watersheds under this program, based on the discharge measurement of rivers during the dry season .
- (3) Management Program for Uncontrolled Fire: useless burning of enormous lands are practiced annually due to uncontrolled slash-and-burn activities. In order to reduce the useless burning lands and forests as well, 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 crop yield by soil type and slope class will be carried out under this program.

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

3.10 Support Services for Women in Development

In order to accelerate and support the activities of the existing women's groups, the following plans and programs are proposed to be carried out in connection with the implementation of the integrated rural agricultural development mainly through reactivate the existing Women's Unions:

- (1) Training of extension workers who will be engaged in extension work for improvement of people's living standard.
- (2) Agricultural extension office will organize periodical women's school for hygiene, health and basic literacy education. The trainer or lecturer for the school will be invited by the extension office, depending on the subject in the school, through the outside collaborators such as Women's Union in Vientiane or other authorities of Ministries etc.
- (3) Support services for encouraging women to participate in and utilize the rice bank system.
- (4) Demonstration and extension of sericulture technique.

The programs mentioned above will be implemented mainly by the agricultural extension offices which will be strengthened through the proposed development programs such as "Strengthening of Agricultural Extension Services", "Establishment of Integrated Agricultural Station" and "Establishment of Rice Bank".

4. PROJECT IMPLEMENTATION

4.1 Organization for Implementation

4.1.1 Project Coordination Committee

The proposed development programs to be implemented in the Scheme fall under the jurisdiction of different departments and ministries not only at the national level but also at the provincial level. For successful implementation of the Scheme, close cooperation among the ministries, departments, agencies and institutes concerned at the national and provincial level will be essential. The Project Coordination Committee is proposed to be organized under the MAF with its leadership. The committee coordinates among the concerned authorities and make recommendations and assistance to the Project Office for smooth and successful implementation of the scheme.

4.1.2 The Project Office

For managing implementation of the Scheme, it is proposed to establish an execution organization tentatively called "the Project Office" under the control of MAF. The proposed organization of the Project Office and the coordination lines among the authorities are illustrated in Fig. F-13. The Project Office will be fully responsible for executing the construction of civil works in the Scheme, and will work in close cooperation with the provincial services such as agriculture, forestry, irrigation, public health, roads, marketing, education, and with other foreign-assisted or NGO-assisted projects in the Province in the same subsectors.

The Project Office building will be constructed in the Provincial land at the suburbs of Xai city. In addition to the office in Xai city, one site office with a staff quarter will be constructed in Hun district to facilitate the implementation of various construction works in Hun model area, because Hun model area is located about 100 km far from Xai city.

After completion of the civil works in the Scheme, the Project Office will be re-organized to establish the proposed integrated agricultural station aiming at execution of various development programs proposed to be implemented in the Scheme as well as in the medium and long term development phases. The site office to be constructed in Hun district will be utilized as the proposed extension office in Hun model area.

4.2 Project Implementation Schedule

The implementation schedule of construction works of the Scheme is prepared on the following basic conditions:

- (1) All the construction works will be executed by contractor(s) selected through international bidding.
- (2) Mechanized construction methods will be employed in major construction works.
- (3) Competent foreign consultant(s) will be engaged in detailed design, preparation of tender documents, technical guidance for prequalification and tendering, and supervision of the construction works.
- (4) Annual workable days for the construction works are estimated at 278 days excluding suspension days due to rainfall, national holidays and Sundays.

Orderly implementation of the Scheme is essential for obtaining the project benefit as early as possible. In this view and also taking into account the scale of construction works of the Scheme, it is proposed to implement the construction works in two phases. The construction works related to Xai district will be mainly implemented in Phase-1 and the works related to Beng and Hun district will be implemented in Phase-2. Proposed construction schedule of the construction works is presented in Fig. F-14. Main items of the construction works to be implemented in each phase are tabulated as follows:

Work Items	Phase-1	Phase-2
1. Irrigation and Drainage		
- Xai area	X	
- Beng area		X
- Hun area		X
2. Social Infrastructure		
(1) District road		
B.Nasao to B.Nale (Xai)	X	
Hun centre to B.Somphon (Hun)		X
(2) Rural water supply system		
Houay Khoun system (Xai)	X	
Houay Lai system (Beng)		X
Houay Phon system (Hun)		X
(3) Primary school		
Xai area	X	
Beng area		X
Hun area		X
3. Agricultural Station	X	
4. Extension Office		
(1) Beng extension office	X	
(2) Hun extension office	X	
5. Rice Bank		
(1) Xai rice bank	X	
(2) Beng rice bank		X
(3) Hun rice bank		X

4.3 Operation and Maintenance

The implementation of construction works will be executed by the Project Office under control of MAF. After completion of the construction works, all of the constructed facilities will be handed over to the Province for actual operation and maintenance.

The Phase-1 works consists of the construction of irrigation and drainage facilities of Xai area, social infrastructure facilities of Xai area, buildings and trial farms of agricultural station, Xai rice bank and extension offices will be completed by the end of October in 1977. According to the completion, all the facilities will be transferred to actual operation. All organizations proposed or concerned will have to be ready to start their work prior to this time. The rice bank in Beng and Hun area will be constructed in Phase-2, and completed by the end of October 1998. Establishment of organization of these banks will be one year later than that of Xai area. During the Project implementation as well as operation stage, close cooperation among the provincial services as well as national level ministries, agencies and offices concerned, especially with Agricultural Extension Agency, NAEC, NARC, Sericulture Pilot Station in Vientiane, foreign-assisted and NGO projects, should be kept at all times under the control of the Province with a guidance from the ministries concerned.

5. COST ESTIMATE

5.1 General

The costs for implementation of the Scheme are estimated based on the feasibility-level design of the Scheme and the following assumptions:

- (1) All the costs are estimated at December 1992 price level. The exchange rates applied are Kip 715 = Yen 125 = US\$1.
- (2) The construction works will be carried out by contractor(s) selected through competitive bidding.
- (3) Taxes on construction materials, machinery and plants to be imported from abroad shall be exempted from the cost estimates.
- (4) The costs are divide into foreign and local currencies.
- (5) Physical contingency related to construction quantity is assumed to be 5%.
- (6) Price contingency is assumed to be 2% for foreign currency and 5% for local currency, provided that the implementation period is four (4) years.

The details of prices of basic materials and labour wages and unit cost for major work items are presented in Table FF-6 and Table FF-7, respectively in ANNEX FF attached to this report.

5.2 Work Quantities

The details of main construction work items, work quality and quantities, and construction method to be applied are described in ANNEX FF attached to this report. The main work items and quantities are summarized as follows:

- (1) Irrigation and Drainage Facilities

Major construction work items for irrigation and drainage development are weir, main irrigation canal, secondary irrigation canal, drainage canal and river improvement as shown below for each model area:

Model Area	Weir (nos.)	Main canal (km)	Secondary canal (km)	Drainage canal (km)	River improvement (km)
Xai	1	6.9	12.9	7.0	-
Beng	1	9.4	13.9	6.3	0.9
Hun	2	5.7	13.4	9.2	-

(2) Social Infrastructures Facilities

The works implemented under the Scheme on social infrastructure are as follows:

(i) District Road

The district roads of 1.9 km from Nasao village to Nale village in Xai area and 7.5 km from Hun centre to Somphon village in Hun area will be improved to all-weather type with three river crossing structures of causeway (see Table FF-2, ANNEX FF).

(ii) Rural Water Supply

The main facilities to be constructed for rural water supply are as follows(see Table FF-3, ANNEX FF).

Area	Intake (nos.)	Reservoir Tank (nos.)	Filter Tank (nos.)	Tap Stand (nos.)	Trunk Pipe Line (m)	Distribution Pipe Line (m)
Xai	1	2	1	26	4,910	3,515
Beng	1	2	1	35	4,178	5,600
Hun	1	3	1	46	7,300	4,320

(iii) Primary School

Ten primary schools are the rehabilitation of existing building and two (2) in Hun area will be newly constructed (see Table FF-4, ANNEX FF). The number of schools to be constructed in each model area are as follows:

Model area	Xai	Beng	Hun
Nos. of schools	5	3	4

(3) Agricultural Station

An agricultural station with trial farms will be constructed in Xai area. It is composed of main office, building of research and trials, workshop, quarters and 15 ha of trial farm. The construction works related to the agricultural station are as follows:

Item	Unit	Quantity
1. Main office		
- Main office	m ²	650
- Storage	m ²	200
- Garage	m ²	200
2. Research and trial building		
- Laboratory	m ²	650
- Working room	m ²	105
- Storage	m ²	100
3. Workshop		
- Workshop	m ²	300
- Garage for farm machinery	m ²	200
4. Quarters		
- Residence for staff with family	m ²	140 x 6 = 840
- Dormitory for bachelor staff	m ²	425
- Dormitory for trainee	m ²	560
5. Trial farms		
- Trial farm for lowland rice	ha	5
- Trial farm for upland crops	ha	10

(4) Extension Office

One extension office will be constructed in Beng and Hun areas, respectively. Extension office space for Xai model area will be considered in the agricultural station. The size of buildings for each extension office is as follows:

Area	Office (m ²)	Garage (m ²)	Quarters (m ²)
Beng	208	54	-
Hun	208	54	140 x 2

(5) Rice Bank

One rice bank will be established in each model area. The size of buildings for each rice bank is as follows:

Building	Size (m ²)
Office	104
Storage	200
Mill house for rice	50
Sesame separator room	50
Drying yard	200
Garage	54

5.3 Cost Estimate

Total project cost is estimated at US\$15.54 million consisting of US\$5.27 million of local currency portion and US\$10.27 million of foreign currency portion, as follows:

Items	Unit: US\$1,000		
	FC	LC	Total
1. Preparatory Works	578	334	912
2. Irrigation and Drainage	3,766	2,161	5,927
(1) Xai area	1,498	858	2,356
(2) Beng area	1,298	730	2,028
(3) Hun area	970	573	1,543
3. Social Infrastructures	951	490	1,441
(1) District road	416	169	585
(2) Rural water supply	371	78	449
(3) Primary school	164	243	407
4. Agricultural Station	754	479	1,233
5. Extension Office	139	90	229
(1) Beng area	43	28	71
(2) Hun area	96	62	158
6. Rice Bank	168	120	288
(1) Xai area	56	40	96
(2) Beng area	56	40	96
(3) Hun area	56	40	96
Sub-total (1 - 6)	6,356	3,674	10,030
7. Equipment	1,559	0	1,559
8. Administration Cost	0	232	232
9. Engineering Services	927	0	927
Sub-total (1-9)	8,842	3,906	12,748
10. Physical Contingency	442	195	637
Sub-total (1-10)	9,284	4,101	13,385
11. Price Contingency	984	1,167	2,151
Total (1 -11)	10,268	5,268	15,536

The breakdown of the costs and the annual disbursement schedule according to the construction schedule are as shown in Table F-15.

5.4 Operation, Maintenance and Replacement Cost

(1) Operation and maintenance cost

The annual O&M cost of irrigation and drainage facilities, district road and rural water supply systems constructed by the Scheme is estimated at US\$176,600. The personnel expense of O&M is estimated at US\$12,900 per year. The details are presented in Table FF-20 and Table FF-19, ANNEX FF attached to this report. These cost does not include O&M costs for other facilities such as agricultural station, extension offices, rice banks.

(2) Replacement Cost

Some of mechanical and metal facilities have a shorter life than civil works and have to be replaced periodically. The useful life and cost of replacement of such facilities are listed in Table FF-21, ANNEX FF attached to this report.