

Abbreviation of Measurement

mm	:	millimeter
cm	:	centimeter
m	:	meter
km	:	kilometer
cm ²	:	square centimeter
m ²	:	square meter
ha	:	hectare
km ²	:	square kilometer
cm ³	:	cubic centimeter
ℓ	:	liter
kℓ	:	kiloliter
m ³	:	cubic meter
MCM	:	million cubic meter
g	:	gram
kg	:	kilogram
t	:	ton
v	:	volt
A	:	ampere
W	:	watt
kW	:	kilowatt
kWh	:	kilowatt hour
MW	:	megawatt
%	:	percent
°C	:	degrees centigrade
s	:	second
min	:	minute
h	:	hour
kip	:	Lao Kip
US\$:	U.S. Dollar
¥	:	Japanese Yen

Abbreviation

Lao PDR	:	Lao People's Democratic Republic
MAF	:	Ministry of Agriculture and Forestry
MCTPC	:	Ministry of Communication, Transport, Post and Construction
DEPFIC	:	Department of Economic Planning, Finance and International Cooperation
DI	:	Department of Irrigation
DAF	:	Department of Agriculture and Forestry
DCTPC	:	Department of Communication, Transport, Post and Construction
IIM	:	Institute of Irrigation and Microhydropower
EOJ	:	Embassy of Japan
JICA	:	Japan International Cooperation Agency
ADB	:	Asian Development Bank
FAO	:	Food and Agriculture Organization
IBRD (WB)	:	International Bank for Reconstruction and Development
MC	:	Mekong Committee
The Team	:	JICA Study Team
NEM	:	New Economic Mechanism
GDP	:	Gross Domestic Product
S/W	:	Scope of Work
M/S	:	Masterplan Study
F/S	:	Feasibility Study
O/M	:	Operation and Maintenance
P.	:	Province
D.	:	District
B.	:	Ban
H.	:	Houay

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CHAPTER 1 INTRODUCTION

1-1 Preface

This Report is prepared base on the 「SCOPE OF WORK FOR THE MASTER PLAN STUDY ON THE INTEGRATED AGRICULTURAL RURAL DEVELOPMENT PROJECT IN SAVANNAKHET PROVINCE」 (S/W) agreed upon between the Ministry of Agriculture and Forestry (MAF) of Lao People's Democratic Republic (Lao PDR) and the Japan International Cooperation Agency (JICA) on August 15, 1990.

The Study is composed of 2 phases, Phase I in which a master plan for the study area is formulated and Phase II in which a feasibility study for the top priority project selected in the Phase I study is carried out. The top priority project was agreed between MAF and the Study Team after presentation and discussion on the Progress Report I submitted at the end of the field survey of the Phase I Study. At the commencement of the Phase II Study, the Interim Report which presented the results of the Phase I Study was submitted, explained, discussed and agreed on the basic concept of the master plan.

This Report is presented the results of the master plan above-mentioned and of the Phase II Study.

1-2 Background of the Study

The area of Lao PDR is 236,800 km². It is an inland country bordered to the east by Vietnam, to the north by Myanmar and China, to the west by Thailand, and to the south by Kampuchea. The population in 1990 is estimated at 4,170,000 persons and the population density is 17.6 persons/km².

Lao PDR established a social democracy system in December 1975, but recently, it tries to keep friendly relations, not only with eastern countries, but also with western developed countries and ASEAN countries, in order to develop its economic situation. It has diplomatic relations with 66 countries and had 24 embassies in 1988.

The economic policy has been reformed to the western system, based on the NEM issued at the Fourth Party Conference held in October of 1988. For example, centralization, subsidy system and bureaucracy are being

excluded from the state enterprises, while independence and activation are being promoted. Every economic sector is being developed according to the methods of national capitalism, in order to improve production. As a result, training and introduction of foreign techniques are being promoted, private ownership of agricultural lands is being permitted according to the farmer's ability and, liberation of the rice market in order to increase productivity, policies preferring cooperative systems are being revised to consider individual rights, and the market shall determine production. A new tax system that will promote production and marketing is being studied, and a law on foreign investment was proclaimed in July 1988.

The GDP per capita of Lao PDR is extremely low at about 180 US\$ (1988). Agriculture covers 60% of the GDP. According to the FAO estimation, it also employs 72% of the population in 1989. The cultivated area was 900,000 ha, pasture area was 800,000 ha and forest area was 13,100,000 ha as of 1986. According to the above statements, agriculture and forestry are the main industries. However, their development is extremely slow.

In the 1980's, rice production in Lao P. D. R. exceeded one million tons. It reached 1.44 million tons in 1986 and self-sufficiency in rice production was declared. Severe drought in 1987, however, caused a 17% decrease from the previous year's production and a shortage of 220 thousand tons of paddy for domestic consumption. Furthermore, decrease in rice production continued in 1988 due to flood and drought. In spite of the Government's efforts to recover the rice production, drought and flood attacked again in 1991, considerable damages are expected.

From these conditions, the Government of Lao strived to improve the agricultural structure so as to exploit agricultural potentials, and worked to change the individual self-sufficient agricultural system to a marketable one.

In the 2nd Five-Year Plan (1986-1990), very important attention was concentrated on the ① achievement of self-sufficiency in food, decrease in imports (excluding food), the promotion of production and export, ② development of transportation and communication, and ③ the development of human resources. In the Plan, 34.7% of the investment plan is allocated to agriculture in which 19% is distributed to irrigation.

The basic policies of the agricultural development of the Lao Government are as follows;

(1) To establish a relationship between government and the farmers by shifting from a bureaucratic system to a supportive and serviceable system, and to make the farmers understand production, marketing and regional characteristics.

(2) To introduce technology

- a) To Shift from a self-sufficient agriculture to marketing agriculture
- b) To solve the problems concerning water (effective use of water resources, protection from flood and erosion)
- c) To introduce bio-technology
- d) To improve the roads, facilities and machineries
- e) To develop forestry
- f) To train the farmers

(3) To promote the production plan and to implement the investment and services necessary to it.

(4) To gain the support of all agricultural development sectors.

(5) To effectively accept international cooperation.

In spite of its ideal location and rice production which contributes to 15-18% of that of the country, Savannakhet Province is still under developed. The Government of Lao PDR has requested the cooperation of the Japanese Government to carry out a master plan study in Sabannakhet Province. In response to the request, the Government of Japan sent the preliminary survey team of JICA to Lao PDR on August 7, 1990. the Scope of Work for the study and the Minutes of the Meeting were agreed upon and signed on August 15, 1990. The Study commenced on November 12, 1990.

1-3 Outline of the S/W

The outline of the S/W agreed between MAF and JICA is as follows;

1-3-1 Objective of the Study

The objective of the Study is to formulate a master plan of the Integrated Agricultural Rural Development Project in the Savannakhet Province, in which comprehensive water resources development programs are to be reviewed and developed with possible agricultural rural development projects be identified and evaluated. The following points will be taken into consideration:

- (1) Effective use of the water resources
- (2) Increase of agricultural production
- (3) Creation of employment opportunities, and
- (4) Increase in per capita income by expanding agricultural land and improving farming systems.

1-3-2 Study Area

The study area covers a part of the Savannakhet Province, which consists of Khantabuli, Champhone, Songkhone, Outhoumphone, Xaybouli, Atsaphangthong districts, the right bank of the Xe Banghiang which is located to the west of the village, Ban Douangmala in the Sone Bouli district, and the catchment area on the right bank of the Xe Bangfai, which is located to the west of route 13.

1-3-3 Scope of the Study

- (1) The study is composed of two (2) phases.

- (i) Phase I

A master plan of the Integrated Agricultural Rural Development Project is formulated, which comprises a study on the agricultural development plan consisting of such items as irrigation, drainage and social infrastructure. The top priority project area is taken up in this Phase.

- (ii) Phase II

A feasibility study on the top priority project area which is selected in the first phase is conducted.

- (2) Study items

- (i) Phase I

- a) Data collection and field survey

Data collection and field survey on the following items are conducted.

- ① Natural conditions

Topography, geography, meteorology, hydrology, water resources (including irrigation water requirement estimation), geology, and soil

② Social conditions

Population, social organization, socio-economy, employment, income level and distribution, education and others

③ Agriculture

Farming, land use/tenure (including farm size distribution), cropping patterns and agricultural organization (support services and extension services)

④ Agro-economy

Farm economy, farmers' organization, farm inputs and productivity, credit, farm machinery and marketing system

⑤ Agricultural infrastructure

Irrigation-drainage systems and diversion schemes, operation and maintenance of the existing irrigation systems, flood control systems and others

⑥ Social infrastructure

Rural roads, electricity, water supply and others

- (b) To study based on the results of the above-mentioned survey
- (c) To identify the projects, putting them in priority order and select the top priority project
- (d) To formulate Integrated Agricultural Rural Development Project
- (e) To estimate the Project cost and benefits
- (f) To evaluate the project
- (g) Recommendation

(ii) Phase II

A feasibility study for the top priority project is conducted.

- (a) To collect and review available data and informations relevant to the top priority project area and carry out a field survey
- (b) To determine the elements of the development plan
- (c) To formulate the development plan
- (d) To formulate a preliminary design of the major structures
- (e) To prepare the implementation schedule
- (f) To estimate the project costs and benefits

(g) To evaluate the project

(h) Recommendation

1-3-4 Study Schedule

Actually, the Phase I Study was carried out from November 26, 1990 to July 30, 1991, and the filed survey of the Phase II was carried out from August 21, 1991 to November 18, 1991. the Phase II finished on January 15, 1992.

1-4 Policy of the Study

Agriculture is a key industry in Lao PDR, and it is very important to raise the economy of Lao PDR. The Lao Government, therefore, has attached importance to agriculture in its last economic development plans which was aimed at self-sufficiency in rice production. As previously stated, the plans succeeded and self-sufficiency was achieved in 1986. Although rice production has decreased in 1987 and 1988 due to drought and flood, but it has almost recovered in 1990. Although the damages are expected due to the drought and flood after May of 1991, the self-sufficiency will be achieved again in the very near future.

Aside from concentrating on the establishment of rice production that will not be easily influenced by natural disasters and one that will correspond with population increase, recently, the Government of Lao aims to improve the marketing, diversified, modernized and integratedly developed agricultural structure. However, the technology used in farming organizations and facilities, marketing, irrigation, post-harvest treatment, livestock and processing of traditionally self-consumptive mono-cultural agriculture, which is dependent on natural conditions, are underdeveloped. For the successful improvement of agricultural structure, therefore, a harmonized development in all fields has to be formulated.

The most serious factor which impedes agricultural development is lack of funds and technology. Lao PDR is concerned, not only with the high economic growth of Japan, but also with the technical developments of agriculture, its key industry, especially, concentrating on the complete development of the marketing structure, organization, irrigation and diversified agricultural structures. In order to discover the technical

methods suitable to Lao PDR through Japanese techniques, it is necessary to open Lao's economy, to establish a free policy, and to train engineers.

The Study Team decided the following approach with due consideration to the above mentioned items.

1) A development harmonized in all fields

As previously mentioned, an integrated agricultural development shall be conducted in all fields, and an agricultural structure, which has not been experience by leaders nor farmers, shall be established.

Development will not be totally effective unless it is applied in all the related fields. For example, the improvement of productivity would be useless unless the marketing systems, transportation systems and farming technology are also developed.

Therefore, a study will be carried out so as to implement harmonious development in all fields (diversified agriculture, marketing systems, increase of productivity, livestock, fishery, etc.)

2) Formulation of a feasible plan

Although the study area is wide, formulation of an unfeasible plan would render it useless. a feasible plan will be formulated taking into consideration the scale of local budget and the actual results of the foreign aids.

A study will be made, therefore, to enable the effective implementation of the plan on a wide area with small investment.

3) Understanding the rural socio-structure

The ties of the village communities in Lao PDR are strong. It is, therefore, important to study and understand the rural socio-structure, government policy, farmers' needs and the past agricultural systems, and to establish a plan which is familiar with the farmers.

4) Irrigation

Many of the irrigation facilities in the study area, with the exception of the pumping systems, are used to supply water during the dry season in a small scale. Therefore, irrigation for a stabilized production during rainy season will be studied as well.

CHAPTER 2 BACKGROUND OF AGRICULTURE

2.1 Agriculture in National Economy

2-1-1 Employment and Production

Agriculture is the backbone of national food security and economy of Lao PDR. Agricultural products contribute to nearly one fourth of the total exports as shown below.

	(unit 10 ⁵ US\$)					
	1984	1985	1986	1987	1988	1989
Import						
Total	1620	1930	1860	2160	1880	2300
Agricultural products	132	66	55	260	123	170
%	8.1	3.4	3.0	12.0	6.5	7.4
Export						
Total	440	540	550	620	580	800
Agricultural products	143	131	204	158	168	199
%	32.5	24.3	37.1	25.5	29.0	24.9

According to the FAO year book, agriculture employs 70% of the total population.

Agricultural production is carried out by small scale farmers and productivity is low. Rice is the staple food and the most important crop. The other main crops are maize, root crops, sugarcane and vegetables. Tobacco, coffee and tea are important and exportable cash crops, while cotton and mulberry are important to the domestic industry.

2-1-2 Rice

Rice is the most important crop and the rainfed cultivation of glutinous rice is mainly carried out. According to the basic statistics issued by the government in 1990, a total of 396,000 ha was cultivated for rainfed paddy, that is, 60.27 % of 657,000 ha of the total area of cultivated land. Production from these rainfed paddy fields amounts to 72.15 % of the total production. On the other hand, the area for irrigated paddy fields amounts to 11,390 ha, that is, 1.76 % of the total paddy fields. Production from these paddy fields amounts to 2.59 % of the total paddy production.

Rice is mainly produced from rainfed paddy fields which are easily effected by natural conditions like flood and drought, and excluding a few irrigated paddy fields, modern farming technology is not introduced.

Although rice production is steadily increasing, rice imports have increased as compared to the early 1980's, and due to population increase,

flood and drought, self-sufficiency in rice production has become difficult to achieve. The volume of rice imports is as shown below.

	(unit 1000 tons)							
	1978- 1980	1983	1984	1985	1986	1987	1988	1989
exported rice	72.3	26.5	38.0	23.0	20.0	29.3	35.4	50.0

source : FAO Trade Yearbook

2-1-3 Other Food Crops

Maize are considered as the next important crop to rice. In 1990, about 48,050 ha of land was cultivated for these crops and although a produce of 81,888 tons was harvested, the yield was low at 1.7 tons/ha. Vegetables, root crops and beans are also cultivated, albeit in a small scale, by the residents for household consumption and feed.

2-1-4 Industrial Crops

The main industrial crops are tobacco, sugarcane, cotton, coffee and tea and 12,025 ha, 4,011 ha, 4,990 ha, 17,277 ha, 383 ha of lands were cultivated in 1990, respectively.

Tobacco is cultivated in the dry season in alluvial plains with good drainage located along the Mekong river and its tributaries. Due to poor farming management, irrigation, seed management and insufficient inputs, the yield and quality of tobacco are low. Cotton is cultivated on small rainfed fields.

2-1-5 Forestry

Laos has 11 million ha of forest land, 4 million ha of which are considered to be developable and are mostly located downstream of the Mekong River. The main trees are mahogany, teak, and pine. Though the forest is declining due to superannuation and felling, it contributes a lot to the national economy in the acquisition of foreign currency.

2-1-6 Marketing and Price

Previously, the rice market was solely controlled by the Food Enterprise. From 1988, however, other private enterprises were authorized & conduct direct buying and selling of rice. The price of rise normally decreases during harvest and increases during the off-crop season.

2-2 Agricultural Development under the New Economic Mechanism (NEM)

The agricultural development policies under the new economic mechanism (NEM) issued in 1986 are as shown below.

2-2-1 Objectives

In order to achieve the agricultural production objectives for 1990-1995, it is necessary to increase GDP at 6.5% every year. The details are as follows:

Annual increase rate by field classification

Agriculture	7.5 %
Livestock	6.6 %
Forestry	2.0 %

Annual increase rate by crops

Paddy	2.3 %	Tobacco	13.0 %
Seasonal Paddy	2.9 %	Root crops	20.0 %
Dry season paddy	8.8 %	Peanuts	15.9 %
Upland paddy	-1.0 %	Mongo beans	4.9 %
Vegetables	10.9 %	Soybeans	15.0 %
Maize	12.2 %	Tea	33.5 %
Cotton	8.7 %	Sugarcane	15.0 %
Coffee	14.9 %		

Annual increase rate by livestock

Buffalo	-1.6 %	Cattle	8.8 %
Pig	9.7 %	Goat and sheep	8.9 %
Poultry	5.9 %		

Annual increase rate by area

Area	(unit %)		
	Agriculture	Livestock	Total
Northern area	7.96	7.0	7.8
Central area	6.0	6.1	6.0
Southern area	8.0	6.2	7.7

The basic policy intends to change the role of the government from investment and direct participation in production to technological services. Moreover, it intends to make farmers more active and professional.

The supply of market information is most important. Including those not related to agriculture, all projects are more or less profitable to the agricultural industry.

2-2-2 Important Policies for the Improvement of the Agricultural Structure

(1) Improvement of the Organization of the MAF

The key to the improvement of the agricultural structure is the strengthening of the systems for suitable services. The abolishment of mediatory organizations and the strengthening of those supplying substantial services will be implemented, too.

(2) Shifting to Marketable Agriculture

In the past, agricultural production was conducted independently by each district area. However, the production of crops other than rice shall be promoted through the NEM. Accordingly, it is most important to determine which crop is most suitable to which land. In such circumstances, the policy must make sure that the use of the market and produce should be effectively carried out. The policy shall therefore, carry out the following ① reformation of land ownership, ② promotion of autonomism among farmers, ③ promotion of international and local private investment, ④ strengthening the competitive powers of state enterprises and privatisation, ⑤ strengthening of investments in communication, traffic, trade and research, ⑥ reformation of the tax system.

(3) Reinforcement of Irrigation by Farmers'

In order to strengthen the farmers' role in irrigation, the government shall refrain from making investments in large/medium scale irrigation projects and instead support medium/small scale irrigation projects implemented by farmers, the O/M of which will be carried out by the farmers themselves.

(4) Livestocks

The tax system and marketing system impede the development of prices and productivity. The government puts emphasis on the ① abolition of export tax and taxes on income, ② abolition of livestock quota, ③ free trade sanctions, and ④ strengthening of the prevention of epidemics and its research.

(5) Forestry

Shifting from governmental direct intervention to participation by regulation and improvement of tax system will be carried out.

A change from direct governmental intervention to participation by regulation and the improvement of the tax system shall be carried out.

CHAPTER 3 MASTER PLAN

3-1 Outline of the Study Area

The study area covers seven districts (Khanthabouly, Champhone, Songkhone, Outhoumphone, Saybouly, Atsaphangthong and Sonbouly) out of the 12 districts of Savannakhet Province, which is located near the center of Lao PDR, and the catchment area on the right bank of Xe Bangfai which is located to the west of route No. 13 in Khammouane Province. It covers approximately 12,000 km², and the population is approximately 525 thousand.

3-1-1 Topography and Soils

The study area is a plain with an elevation of about 200 m stretching between the south-west foot of the Annang Ranges and the Mekong River, and it is 120 km from east to west and 150 km from north to south.

The Xe Bangfai River, Xe Banghiang River, the medium or small rivers meandering in the area, several basins and the valleys complicate the topography of the study area.

The geology of the study area is mesozoic. The parent rocks are composed of shale, siltstone and sandstone. The parent rocks are covered by soil layers several to 10 meters thick. These layers partially include gravel layers of laterite or hard pans. On the other hand, they are covered by alluvium which is rich in clay in the lower Xe Bangfai Plain and middle Xe Banghiang basin.

The clay in the soils are identified as kaolinite. Its movement is physically affected by rain and generally, only few are included in the surface soil layers with medium and high elevation. On the contrary, accumulation of clay is remarkable in areas with low elevation. Humus and organic matters are also in the same situation.

Thus, it is generally difficult to say that the soils in the study area are fertile. However they are physically cultivable, and through adequate soil management, it is possible to raise its productivity.

According to the classification of FAO/UNESCO, the soils are classified into 5 groups, ① Orthic Acrisols ② Ferric Acrisols ③ Distric Gleysols ④ Other low land soils ⑤ High land soils.

3-1-2 Land Use

The study area is traditionally an agricultural area mainly involved in rainfed paddy farming during the rainy season. The elevation of the cultivated rainfed paddy fields in the river fans and basins ranges from 140~170 m. The paddy is planted in the shallow areas of the existing reservoirs and ponds by decreasing water level planting during the dry season. Double cropping paddy is planted on low lands blessed with water by pumping irrigation. In the fields where water can be easily used upland crops are planted in a small scale. Generally, rainfed paddy fields are rarely used during the dry season.

There are forests and villages with orchards and vegetable gardens on the upper land next to the rainfed paddy fields. Slash-and-burn fields are comparatively few. The forest is not man-made and it produces many products such as cardamom, lacquer, resin, rattan, etc.

3-1-3 Meteorology and Hydrology

The study area has a tropical climate which is dominated by the southwest monsoon. The monsoon, carrying moisture from the Indian Ocean, brings heavy rainfall between mid-May and mid-October. The northeast monsoon, between November and mid-February, brings cool air from Siberia and mainland China.

The average annual rainfall in Savannakhet is about 1,400 mm, and 1,700 mm in Xeno. The annual average temperature is about 26°C and the monthly temperature ranges from 21°C to 30°C.

Xe Bangfai and Xe Banghiang, the tributaries of the Mekong river, are the largest rivers in the study area.

Xe Banghiang basin has a catchment area of 19,600 km² and covers most of Savannakhet Province. Champhone River and Xe Xanxoy are the large tributaries of Xe Banghiang. The back-water of Mekong River reaches the middle Champhone river which has an elevation of 130~135 m.

Xe Bangfai has a catchment area of 9,470 km². From Route No. 13, the downstream area of Xe Bangfai lower basin is subject to overflow during the flood season. Flood elevates up to 140 m and continues to do so for more than a month every year.

Main meteorological statistics are shown at the following table.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Savanakhet													
Mean Temperature (°C)	21.6	25.1	27.6	29.5	29.1	28.2	28.4	27.7	27.5	26.4	23.9	20.9	26.3
Mean Relative Humidity (%)	67	68	64	67	74	79	79	82	78	75	71	68	73
Evaporation (mm)	3.3	4.0	4.7	5.0	4.7	4.1	3.9	3.8	3.7	3.8	3.6	3.0	3.8
Rainy days	0	1	2	6	13	16	14	19	13	7	2	0	8
Rainfall (mm)	2	9	33	82	148	266	212	310	229	88	4	1	1,384
Seno Rainfall (mm)	2	17	37	74	222	311	312	370	272	92	4	1	1,713

3-1-4 Society

The population of Savannakhet Province in 1990 is 611,461. 91% (566,645) of the population belongs to the agricultural population.

The number of schools per capita in the province is a little less than the national average of the primary school, and is almost the same with the secondary and higher secondary schools. The entrance rate is 75% for primary schools, 12% for secondary schools and 3% for higher secondary schools.

The medical facilities are insufficient, and the total number of facilities per capita is extremely less than the national average.

The Ministry of Agriculture and Forestry, and the Provincial Department of Agriculture and Forestry provide agricultural support, but due to insufficient budget, facilities and staffs, their efforts are mainly concentrated in some model projects.

The lands are owned by the Government. A permission is necessary for the use of these lands. Cultivating rights, however, are tradable. Taxes are imposed according to the amount of production. A courteous treatment is given to those experiencing decrease in production.

The Government has organized cooperatives. However, almost all of these cooperatives are not functioning at present. The reasons are ① the farmers and the leaders do not sufficiently understand the system ② restricted working time ③ too many regulations ④ complaints on the distribution of benefits. Recently, the Government gives importance to private capacities, has established organizations with a tinge of enterprise and tries to establish the farmers' water use organizations.

There are traditionally firm village organizations. These organizations carry out labor assignments for public work and social events.

3-1-5 Agro-economy

The economy of the study area depends mostly on agriculture, focusing mainly in rice production which is controlled by natural conditions. There were 87,121 ha of paddy fields in 1990 with a paddy production of 236 thousand tons, 15.6% of the total national production.

The farm size per farm-house in the study area ranges from 0.6 to 0.7 ha, 1.0 ha in average. The GDP per capita is 178 US\$, and agriculture covers 87% of the GDP. The cropping section covers 39% of the agricultural section, and livestock covers 57%.

Due to a self-sufficient agricultural system and socialistic economic system, the rural marketing structure is under-developed.

3-1-6 Agriculture

Agriculture in the study area is ① dependent on low funds and production is controlled by natural conditions ② mainly self-consumptive ③ small scale marketing with unstable prices.

Paddy production is damaged by flood or drought almost every year. The yield of the upland paddy or the floating paddy planted on some fields is low. High yield varieties are produced and sold at Thasano Seed Farm, but they are not popular. Inputs such as chemical fertilizers and agricultural chemicals are expensive, because they are imported and their use is only limited to nursery fields and vegetable gardens.

Fruit trees, such as banana and coconuts are planted on 150 m elevation and litchi, sugar apple and jujube tree on 150~200 m elevation. They are, however, planted on an area of less than 10 ha. Fruit tree planting is under-developed in spite of high development potentials, because of ① under-developed planting technology, ② only few improved varieties are introduced, and ③ under-developed market. Vegetable is an important cash crop. There are no farmers' marketing organizations except for watermelon, and the marketing of vegetables is controlled by middlemen. Although cotton, tobacco, sesame, etc. are also planted, their scale equals only that of a family garden.

Animals are not only used in farming, but are also exchanged for cash during emergencies. After large floods or severe droughts, the number of animals decreases. The animals are left in the fields to graze all throughout the year, but due to insufficient feed during the dry season, their number scarcely increases and the death rate of young animals is high. The efforts of the Provincial Governments to prevent epidemic indicate very effective results.

Fish is sold, and they are accorded good prices since they are important sources of protein. However, they are not raised.

3-1-7 Irrigation and Drainage

The Government has made efforts for ① paddy farming during the dry season by pump irrigation, ② paddy irrigation and water preservation for everyday living and animals during the dry season through reservoirs, ③ dissolution of inundation damages during the rainy season, and use of stored water in the river basins during the dry season, through the gates.

There are only few canals for the distribution system, except for large pump irrigation systems constructed along the Mekong river and Xe Bangfai

River. Supplementary irrigation during the rainy season is not implemented.

The existing irrigation systems and the irrigated area are as follows:

Type	Number (no.)	Irrigated area (rainy season)	Flood control area	(unit: ha)
				Irrigated area (dry season)
Reservoir	17	563	—	1,410
Weir	12	510	—	108
Pump	7	1,310	—	1,000
Gate	13	—	1,000	4520
Total	49	2,383	1,000	2,938

Drainage depends on natural rivers. There are no drainage systems.

The irrigation projects are divided into two scales, the medium scale project and small scale project. The former has more than 300 ha of irrigated land. These lands are constructed by the state or the provincial irrigation construction enterprises under the supervision of the State or the Provincial Government through the use of national or foreign funds.

The latter has less than 300 ha of irrigated areas and they are constructed by the farmers under the supervision of the Provincial Department of Irrigation through the use of provincial or small scale aids of NGO, etc.

There are two state enterprises and two provincial enterprises in Savannakhet Province and Khammouane Province. They construct large and medium scale projects with machineries. There are small scale companies under the districts and they are engaged not only in construction, but also in the O/M of the constructed facilities, supply of materials and collection of water fees.

The O/M of the irrigation systems are transferred to the districts. The O/M of small scale irrigation systems are carried out by the farmers, and the district staffs carry out patrol guidance.

3-1-8 Socio-infrastructure

Route No. 13 is the only road that runs across the country from north to south. It was constructed in the 1930's , and is being widened to 10 m for simple asphalt pavement by the south zone route No. 13 construction enterprise. The average traffic in this road is 300 vehicles per day.

Route No. 9 is an international road connecting Savannakhet and Vietnam. The construction commenced in 1979 and was completed in 1985 with simple asphalt pavement, and the road width is 15 m. The average traffic is 420 vehicles per day.

Route No. 11 connects Savannakhet city to B. Lahanam through B. Kengkok. It is 85 km in length and is under provincial O/M. Although it is partially under improvement, the condition of the road is poor. the average traffic is 50~150 vehicles per day.

The rural roads in the study area are under provincial control and has a total length of 520 km. Due to insufficient funds and the negligence of the users, 80% are impassable during the rainy season. The main carts of the farmers are usually pulled by cows.

Electricity is imported from Thailand across the Mekong river since 1973. It is wired to the districts of Khanthabouly, Champhone, Outhomphone and Atsaphanthong. The majority of the municipalities are not electrified except Savannakhet City where the electrification ratio is 95%. Electricity is wired from Thakhek city to the pump stations in Nongbok for the construction of the pump irrigation facilities in lower Xe Bangfai.

The water supply facilities in Savannakhet city were constructed in 1975. The present supply capacity is about 4 million m³/year and the supply rate is 65%. Savannakhet Water Supply Enterprise supplies water to Xeno, Donghen, Pakxong, Phine and Sepon. Rural areas depend on shallow wells, springs, rivers and ponds for their domestic water supply.

The Savannakhet Riverport and Kengkabao Riverport in Savannakhet Province, and Thakhek Riverport in Khammouane Province contribute to international and domestic transportation. However, due to Mekong River's low water level, traffic is slow during the dry season and the ports are sometimes closed from January to April. The main goods transported from

Vietnam are cement, iron bars, chinaware, daily necessities, foodstuffs, cattle and timber, and oil, while daily necessities, foodstuffs, cement, fertilizer, machineries are transported from Thailand.

There is a daily flight connecting Vientiane and Pakse at Savannakhet Airport.

The communication system of Savannakhet is poor and although its Communication Enterprise engages in telegrams, posts and telephones, the telephones can be used only within the city and the lines are only extended between Vientiane and Pakse.

The buses travel to Vientiane, Pakse and Vietnam more often than the local lines.

3-2 Basic Development Concept

3-2-1 Factors that Impede Agricultural Development

The study area has a self-sufficient agriculture which is mainly focused on rice production. Production, however, is totally controlled by natural conditions. The marketing systems and facilities are very poor, and the farmers' economy and the rural economy are greatly affected by drought or flood. For example, the number of livestock in the study area has extremely decreased in 1989 and 1990 due to the 1987 and 1988 drought and flood. This only shows how weak the farmers' economy is against natural conditions.

The potentials of the study area for agricultural production is high considering that it is blessed with a good location and rich natural resources.

The main factors that impede agricultural development are:

(1) Shortage of Investment

There is very little investment in the area to exploit the abundant natural resources. At present, investment is limited and the agricultural condition is in a vicious circle indicating shortage of investment - low productivity - poverty.

The investment on the following facilities is particularly small.

(a) Insufficient Water Resources Development, Irrigation Facilities and their Maintenance

The ratio of the irrigated area in Savannakhet Province has been crawling sideways since 1985, and is extremely increasing in Khammouane Province since 1988. Both ratios, however, are still within the national average ratio.

With the exception of the pumping systems, the existing irrigation facilities only contribute to the supply of domestic and livestock water during the dry season, and do not supply irrigation water during the rainy season. The knowledge of the operation, water management, canal systems, etc. is limited as well.

(b) Shortage of Agricultural Production Inputs

The study area is blessed with natural resources. However, the soils are sandy and not very fertile, except for areas regularly visited by floods. Productivity, therefore, does not increase without suitable supply of inputs. Chemical fertilizers are expensive because they are not produced in the country and their import is restricted.

(c) Poor Road Conditions

The maintenance of rural roads between villages, villages and highways, and villages and important facilities is inadequate. Transportation is almost impossible during the rainy season. There are many difficult traffic points in the dry season due to broken bridges and the farmers cannot choose the delivery period of the products. The farmers, therefore, complain about poor road conditions because they hinder the free selection of crops, marketing and transportation of necessary agricultural inputs.

(d) Inadequate Post-Harvest Facilities

Paddies are stored in store-houses built in each farmer's house yard. Much loss is gained, therefore, from damages caused by rainfall leaks and rodents. Furthermore, these storehouses do not have enough storage capacity.

(2) Insufficient Marketing System

Due to the past self-supporting agricultural system, the marketing system is poor and its development is hampered by inadequate roads and storage facilities. The farmers lose their volition because the farm-gate prices of the agricultural products are controlled by middlemen.

It is difficult to shift to marketable agriculture and to contribute to the national economy because of the inadequate conditions of the marketing systems, the rural roads, post harvest facilities and the market information.

(3) Inadequate Extension Service System

Owing to the traditional self-supporting agricultural system, the farmers have not experienced an improved agricultural structure such as diversified, marketing and modernized agriculture. In order to achieve the improvement of the agricultural structure, extension service systems, including training of farmers and the supply of inputs and information, will have to be fully strengthened. The average number of farmers commanded by one district extension worker in the study area is 770. There are no agricultural research institutes nor agro-industries. Suitable products for particular lands are also underdeveloped.

3-2-2 The Basic Development Policy

(1) Target Year

The economy of Laos has improved favorably, if not quickly. It is advisable not to aim for a rapid development and a target which is too lofty to realize. Based on this point, feasible medium and small sized projects will be studied, and the foundation of the agricultural development will be established first. Therefore, the year 2010, a medium term development plan, will be the target year of the study.

(2) A Stabilized Rice Production which will Correspond with Population Increase

At present, rice production is greatly influenced by natural conditions. However, it will correspond with the population estimated for the year 2010 by improving the agricultural structures of irrigation, input, farming technology, agricultural land expansion and storage systems.

(3) Improvement of the Agricultural Structure

Shifting from a self-supporting agriculture to a marketable one is the most important agricultural policy in Lao PDR and the most important target of the Study. In order to achieve this target, the diversification of agriculture, the marketing and the service system will have to be improved.

In marketable agriculture, it is necessary to make use of the potential characteristics of each area for the development of diversified agriculture. This will also increase the income of the farmers. Cash crops, industrial crops, livestock, fishery, and agricultural processing are studied according to the potentials of each area.

Diversified agriculture is planned with due consideration of the establishment of a chief producing district. The advantages in establishing a chief producing district are as follows:

a) Improvement of the quality of the agricultural products

The quality of the agricultural products can be improved by selecting the crops suitable to the natural conditions of the area, and by concentrated guidance on farming and cultivation.

b) Economic Production Cost

Cooperative works and reasonable operations are possible through group works.

c) Improvement of Marketing

The market can be easily developed if high quality crops are collected.

(4) A Harmonized Integrated Agricultural Development

The basic structure of marketable agriculture is totally different from self-supporting agriculture. This study, therefore, will equally develop the facilities, technology and the organization for productivity, marketing, farming, extension and living conditions.

It is also important to maintain harmony with the natural environment, social structure and economic structure.

(5) Development of Irrigation and Drainage

The development of the operation and maintenance of the irrigation and drainage systems is important in order to increase agricultural productivity and diversification. By means of a feasible scale, a study on the use of the water resources in the study area can be made.

According to past data, floods brought more damages than droughts. By constructing large flood control dams, drainage pumping stations and dikes, flood control becomes possible for a long term. This study, however, concentrates on a middle term development plan.

(6) Development of Rural Roads

Transportation is the most important element in the improvement of input supply, dispersion, and marketing structure. The rural roads will be developed, therefore, and their operation and maintenance will be studied.

(7) Improvement of the Farmers' Living Environment

A study on transportation and communication, electricity, local water supply, education, health and sanitation and the preservation of the greeneries will be made, because they are essential to the improvement of the farmers' living conditions.

(8) To Propagate the Project by the Construction of the Pilot Project

The study area is very wide and basic improvements on the agricultural structure will be introduced. The propagation of agricultural development will take time and will be costly, and successful results can only be achieved through trial and error. The construction of the pilot project is, therefore, recommendable and will be studied.

3-2-3 The Policy for the Materialization of Agricultural Development

Integrated agricultural development consists of 3 fields. The improvement of the marketing structure, increase of productivity and the improvement of the farmers' living conditions. Each field is developed through hardware and software development. Every field in the study area is underdeveloped and development can only be effective if it is implemented equally in all fields. However, the study area is too wide and has varied conditions to enable the development of a pattern. The following approaches

for the materialization of the agricultural development concept, therefore, are recommendable for an effective development.

(1) Increase of Land Productivity

In order to increase land productivity, investment for irrigation development based on water resources development, extension of agricultural lands by establishment of a chief producing district, intensification of inputs supply and extension works, and improvement of roads will be strengthened.

(2) Establishment of an Agricultural Supporting Center

The development of the hardwares is achieved by increase of investment, however, the development of the softwares, such as marketing systems, farmer's organizations, improvement of technology and living conditions, is achieved by appropriate governmental guidance and farmers' efforts. In order to support the development of the softwares, an agricultural supporting center system will be established. The characteristics and the scale of the center will vary according to area.

Taking into consideration the conditions of the administrative boundaries (district), location, arable land, water resources, farming conditions and communication, the study area is divided into 6 zones. Agricultural supporting centers are established in each zone as a base for softwares development.

(3) Construction of Pilot Projects

The nearest way to an integrated agricultural rural development is the development of increase of productivity parallel to the agricultural supporting center. A pilot project composed of a center with a suitable scale and a few projects which will develop land productivity and agro-infrastructure will be constructed. This pilot project is considered to effect all other zones.

The advantages of zone development are as follows:

(a) Realization of an Integrated Agricultural Development

The study area is too wide to implement an equal agricultural development. An elaborate development can be possible by zone division and the establishment of the centers.

(b) Exploitation of Regional Potentials

The study area is very wide and each area has varied characteristics. By zone division, the exploitation of the potentials of each area and the formulation of development projects can be conducted easily.

(c) Easy Development of the Organizations

The centers will function as the core of the organizations, and it will develop larger organizations by collaborating with other centers.

(d) Strengthening the Effect of Demonstration

Although the development of the hardware in the pilot project is only limited to some parts of the zone, the establishment of a center will affect all zones. It will be accelerated, therefore, to a higher level in the zone. The improvement of a wide area will also affect other zones. This will benefit wide areas with small investments.

(4) Zone Development Concept

(i) Zone Division

There are 6 plains in the study area which are especially important to agricultural development. These plains are the Lower Xebangfai River Plain, Upper Champohn River Plain, Middle Champohn River Plain, Sompoy River Plain, Phoummachedi Plain and Lower Xexangxoy River Plain.

According to the above-mentioned pilot project concept, the study area is divided into 6 zones in consideration of the 6 plains, the administrative boundaries (district), communication, farming and water resources. The location of the centers is mainly determined according to road conditions.

Zone divisions, the location of the centers and their control area are indicated below:

(a) Xe Bangfai Zone

This zone covers the Lower Xe Bangfai River Plain. The water resources are Xe Bangfai River and its tributaries. It partly covers Thakhek District and Nongbok District of Khammouane Province, and Sayboully District of Savannakhet Province.

The centers will be built in Thakhek City, Nongbok Town and Nadeng Town.

(b) Xeno Zone

This zone covers Outhompone District. Xeno center is built in Xeno town, the district capital, and is located at the intersection of route No. 13 and route No. 9. The center controls the whole district.

(c) Savannakhet Zone

This zone covers the northern half of Khanthabouly District, including Sompoy River Plain. The center is built in Savannakhet City, the capital city of Savannakhet Province. This center also functions as the head office of all other centers.

(d) B. Lak 35 Zone

This zone covers the Middle Champhone River Plain and Phoummachedy Plain. It is composed of the southern part of Khanthabouly district, Champhone district and Songboully district. The center is built at B. Lak 35, located at the intersection of route No. 13 and route No. 11, the routes connecting Savannakhet City and Kengkok Town, the capital of Champhone.

(e) Pakxong Zone

This zone covers the Lower Xe Xangxoy River Plain and is composed of Songkhone district. The center is built at Pakxong town, the capital of Songkhone.

(f) Donghen Zone

This zone covers the Upper Champhone River Plain and is composed of Atsaphanthong district. The center is built at Donghen town, the capital of the district.

(ii) The Characteristics of Each Zone

(a) Xe Bangfai Zone

Xe Bangfai River runs through the zone dividing it into two provinces, Khammouane on the right and Savannakhet on the left. This area is regularly visited by flood. However, the soil is fertile and the river has an abundant supply of water during the dry season. The paddy production per capita in 1990 was 69 kg, so far the highest in the study area. This area is an important rice producing district. Since 1989, the pumping irrigation from Xe Bangfai River has been rapidly developed and many irrigation projects, concerning the development of the tributaries of Xebangfai river as water resources, were planned. Plenty of upland crops like maize, vegetables and tobacco are planted in the area.

The road conditions of the area, however, are very poor. Except for the road connecting Thakhek City and Nongbok Town, traffic is impossible during the rainy season. There are no roads connecting the area to route No. 13. The only bridge across the Xe Bangfai river is the one in route No. 13. The construction of roads that would connect the area to route No. 13, therefore, is important. There are two methods of irrigation systems, one is medium/small scale pumping irrigation, and another is a large scale weir irrigation.

(b) Xeno Zone

This zone is located at the intersection of route No. 9 and route No. 13. It is an important place for traffic and agricultural trade. The area is not blessed with water resources. Its population density ranks second to that of Savannakhet Zone, the area with the highest population density, while its population increase ratio is the highest. Location wise, the possibility of developing agro-industry and livestock in this area is considered to be high.

(c) Savannakhet Zone

This zone includes Savannakhet City, the second largest city in Lao PDR. This city is the political and commercial center of the area, and has the highest population density. The main agricultural land spreads along the Sompoy River. In spite of a comparatively small catchment

area, the course of this river is unstable, and drought and flood often occur. The other cultivated lands are located along the Mekong river. Pumping irrigation is conducted in some parts of the area.

Lots of vegetables are planted in this zone during the dry season. There is a seed center and a fish farm, too. The fish farm uses the water pumped up from Mekong river. The center in this zone will supply foods to large cities.

Considering its location, this zone will be used as a headquarters after all centers are built.

(d) B. Lak 35 Zone

This zone has the widest plain along the Champhone River. Hence, the rate of the paddy fields of the whole zone, the rate of the irrigated area of the paddy fields, and rice productivity are the highest in the study area. The zone is apt to be flooded, but irrigation exploits the situation.

In addition to a rice supplying base, as in Xe Bangfai Zone, maize, peanuts, cassava, vegetables, livestock, etc., are also cultivated in the upland area. Moreover, the number of cattles, pigs, poultries, etc., raised per family is the highest in the study area.

This zone has many good dam sites, and the development of irrigation and fishery, by using Champhon river, is highly possible.

(e) Pakxong Zone

This zone is located at the southern end of the study area, and it is bounded to the west by Mekong river. There are agricultural lands along Mekong River and its tributaries. In the northern part of the zone, a plain spreads on the lower Xe Xangxoy River. However, there are no facilities in this part of the zone, and it is regularly visited by floods. 80% of the central and western part of the zone is made up of hills and forests, and lots of tobacco, cotton, sesame, maize, vegetables and rootcrops are planted in this area.

(f) Donghen Zone

This zone is the widest in the study area, and it includes the Upper Champhone River Plain. This zone, however, is mostly made up of hills, and the population density is low. There are paddy fields along the Champhone River. However, because of few irrigation facilities, productivity and the farming of upland crops are low.

As it is located in a hilly area, the potential for the development of the water resources is high. The condition of the roads connecting the area to route No. 9, however, is poor.

The development of the roads, therefore, will easily clear the way for agricultural development, including fruit trees, livestock and fishery.

3-2-4 Agro-economic Development Concept

The study area is estimated to have high potentials for agricultural development

It is necessary to achieve rice production increase which will be in accordance with population increase by using this area as a rice supplying base. It is also important to achieve a steady increase in the farmers' income. The project, therefore, aims to achieve self-sufficiency in rice production and aims to more than triple the present agricultural production.

(1) Rice Production Plan

The rice production plan is estimated according to the estimated population and annual consumption per capita.

The population of Lao PDR in 2010 is estimated at 6,240 by means of the widely used logistic curve estimation method.

Referring to the estimation for the southeast countries, individual rice consumption per capita was estimated at 170 kg. Assuming that the amount of polished rice is 60%, the amount of loss is 7.9%, the amount of paddy seed is 7.1% consumption per capita is estimated at 330 kg, and national consumption is estimated at approximately 2,064 tons.

According to the data taken the last 5 years on national rice production ratio, the largest paddy production ratio of the study area is 18%. If production and the marketing structure would be improved in 2010, and if

the study area would produce 20% of the national rice production, the target production of the study area will be 412 thousand tons.

(2) Vegetables and Cereals Production Plan

To improve the farmers' economy in the year 2010, it is necessary to introduce cash crops which will promote the agricultural market. Taking the likes of the neighboring countries into consideration, the following crops will be recommended; peanuts, cassava, mongo beans, vegetables, tobacco, cotton, sugarcane, spices, fruits, etc. An irrigated upland field of 10,000 ha will be constructed in the dry season, and 5,000 ha of land will be reclaimed. Upland crops will be cultivated in these areas.

3-2-5 Land Use Development Concept

(1) Land Resources Potential

The use of the study area for cultivation purposes is sufficiently possible based on the studies on surface geology, soil and vegetation. The 4 types of soil in the study area have more than 1 m of effective soil, and these soils do not contain gravel and pan. Vegetation was also found to be normal.

However, cultivation of areas with more than 200 m E.L. is difficult owing to steep topography. Orthic Acrisols and Ferric Acrisols occupying the middle and highland areas are sandy soils with low water retentivity which is easily affected by drought and erosion. Therefore, the construction of normal upland fields is not suitable for these areas, but suitable to orchard or irrigation paddy fields. The middle and low land areas tend to suffer from flood damages in the rainy season, the development of field crop areas, at present, is therefore, not advisable.

Land Category	Land Use	Land Capability Class ^{*1}	Area (ha)
Dissected isolated hills, erosion surface and mountains	Paddy field	IV gpfn a *2	112,100 (9%)
	Normal upland field	IV gp(W)fnase	
	Land under permanent cultivation	III gp(W)fnase	
High terraces of pleistocene deposit	Paddy field	III 1fn a	194,100 (16%)
	Normal upland field	IV (W) e	
	Land under permanent cultivation	III tw(W)fn e	
High ravine terraces old alluvium	Paddy field	III 1tn a	445,500 (38%)
	Normal upland field	IV (W) e	
	Land under permanent cultivation	III tw(W)fn e	
Lower terraces of semi recent alluvium	Paddy field	III n	340,300 (20%)
	Normal upland field	IV (W)	
	Land under permanent cultivation	III wn	
Lawland plane at recent alluvium	Paddy field	III na	208,000 (17%)
	Normal upland field	IV w(W) a	
	Land under permanent cultivation	IV wa	
			1,200,100

Remarks

*1 Symbol mark 4 is unsuitable land.

*2 gp...etc. is limiting factor. Showed the Table 3-1.

(2) Land Use Strategy

Agriculture in the study area has been developed through rainfed paddy cultivation, the only dominating crop. The rainfed paddy field is one of the effective utilization systems of water resources during the rainy season. However, due to frequent drought and rough management, its producing capacity cannot be improved. The study area, however, is considered as the largest rice producing area in Lao and is also expected to play a role in crop diversification and livestock development for the improvement of trade balance and increase of farmers' income.

The land utilization plan in the study area should be made with due consideration of the natural resources, agricultural production, existing forest development, etc., described below.

① Paddy field: Utilization of alluvial plains, basins and some parts of the hilly areas. Development of double cropping paddy field with suitable water resources.

- Rainy season : Local variety (HYV in hilly area)
- Dry season : Double cropping paddy, field crop with irrigation, fallow land

② Land under permanent cultivation : Utilization of hilly areas, some parts of basins and alluvial plains. Water will be stored for domestic and irrigation use. Development of fruit and industrial (oil, etc.) trees.

③ Normal upland field : Utilization is limited to some parts of the hilly areas with good topographical conditions. Land reclamation with adequate attention for erosion. Crops should have a high coverage of land and rotation should be implemented. Store water for domestic and irrigation use. Recommended crops : forage crops, pulses, millet, maize, cotton, sesame, vegetables.

④ Basins, alluvial plains are mainly used for paddy fields (partly used for upland fields in the dry season).

⑤ Hilly areas are mainly used for orchards or pasture. Paddy fields will be constructed only in areas with enough water resources. The use of the forests and pasture will be considered important.

- ⑥ Mountain areas will be afforested.
- ⑦ The overall cultivation ratio should be less than 30%.

3-2-6 Agricultural Development Concept

(1) Agricultural Support and Marketing Structure Development

Organizations that will enable the smooth implementation of the formulation of the production plan, construction of infrastructure and its O/M, supply of agricultural inputs, marketing of products, collection and analysis of marketing information, rice polishing, storage, livestock, processing, trust and credit, extension, training, improvement of living conditions, etc., will be established. These organizations will easily adapt to rural customs and traditions, will be managed democratically and strengthened by substantial equity capital and the farmers' participation in the project.

The reason why the price of rice is unfavorable to the farmers is their weak organizational ability. It is important to establish a price formation structure so as to uplift the farmers' will to produce.

Repeated trial and error activities are necessary in order to achieve the improvement in the agricultural structure, especially in diversified agriculture. Excellent leaders and farmers' voluntary participation are, therefore, necessary. It is, therefore, desirable that the organization, investments, operation and management will be conducted by the farmers themselves. The excessive protection of the Government ① obstruct farmers' independence and positive participation, ② make accumulation of capital impossible, ③ cause inefficiency and many failures. However, on the other hand, it is difficult to contribute to national economy without the direct or indirect protection of the government and the farmers cannot cope with the drastic changes in the directives given by the Government.

If the management of the organization will be handed over to the farmers in the future, it is advisable to let the Government carry out management in the first stage because, at this time, the farmers are incapable and have no capital of their own. It is also important to strengthen farmers' participation in the project by forming small organizations in every village.

(2) Increase Plan for Rice Production

In order to increase rice production, expansion of the paddy fields and yield increase by strengthening irrigation and supply of inputs will be carried out. From 87,751 ha, the paddy field area will be expanded to 100,801 ha, indicating a 15% increase.

In order to increase the paddy yield, irrigable areas will be considerably increased to 66,853 ha in the rainy season and 33,388 ha during the dry season. Moreover, high-yielding varieties (125 days varieties) will be planted during the dry season. There is a need, therefore, to formulate a seed supply plan and a cheap fertilizer supply plan.

(i) Paddy seed supply plan

10% of the paddy seeds will be renewed, and seed production will be carried out by expanding Thasano Seed Farm and the construction of other seed farms.

(ii) Organic fertilizer production plan

Fertilizers are not produced in Lao PDR, all of them are imported. They are, therefore, expensive and difficult to supply. Therefore, sufficient supply of fertilizer is hopeless if one will rely on chemical fertilizers. The soil in the areas with medium and high elevation are not very fertile. To increase its productivity, the supply of fertilizer is necessary.

In order to curtail fertilizer expenses and to improve the soils, organic fertilizer will be used as basal fertilizer. As organic fertilizers are difficult to transport and are not very effective, chemical fertilizers will be used as additional fertilizer.

(3) Upland Crops and Fruit Development Concept

The development of the upland crops and fruit plays an important role in the increase in farmers' income and the shift to marketing agriculture.

Approximately 2,000 ha of land will be reclaimed to expand the upland fields to 3,893 ha and another 10,000 ha will be irrigated for upland crops during the dry season. The area for the orchards will be 3,600 ha,

indicating an increase of 3,000 ha. In order to achieve these, it is necessary to carry out the supply of the seeds and the saplings smoothly.

The establishment of a farm aid system or financial system is important, as fruit production takes several years.

Considering the future market structure, citrus trees are positively recommendable.

(i) Upland crops seed production plan

If the seeds are to be renewed every 2 years, 80 ha of seed and sapling farms will be necessary. They will be established at Atsaphanthong, Songkhone and Khanthabouly districts where irrigated upland fields are planned.

(ii) As for sapling production, a small scale farm will be established at Songkhone district, the technicians will be trained and orchards will be expanded.

(4) Livestock Development Concept

Livestock covers more than half of the farmers' cash income. There are plenty of under-developed pasture lands with high potential in the study area.

In the project, the present number of animals will be increased by 2.5 times and 4 times for poultry by natural breeding. In order to achieve these, pasturage farms and poultry incubatory farms with a small artificial insemination center and a training center for the prevention of epidemic will be established for technological development.

(5) Fishery Development Concept

Fish is an important source of protein and cash income.

An incubatory pond will be constructed near the newly constructed reservoir, cheap fries will be produced there using surplus irrigation water and then stocked in large reservoirs for 6 months. Afterwards, they are captured and put in the market.

3-2-7 Irrigation and Drainage

(1) Provincial Development Policy

Agricultural policies of the major irrigation provinces including Savannakhet and Khammouane were identified in discussions held by provincial leaders in February 1990 and in Provincial Five Year Plans. Commonly quoted policies were;

- (a) to reduce the role and cost of government
- (b) to diversify cropping
- (c) to develop export trade
- (d) to liberate the private sectors
- (e) to attain self-sufficiency in rice production and
- (f) to reduce shifting cultivation

Based on the above policies, the following aims were pointed out in the irrigation sector.

- ① to promote small-scale irrigation schemes
- ② to introduce irrigation service fees to cover O/M costs
- ③ to intensify cropping
- ④ to rehabilitate in preference to building new schemes
- ⑤ to expand the role of farmers and
- ⑥ to improve water management (improvement of canal system, farmers' training, etc.)

Irrigation development policy of Savannakhet Province is based above.

Against drought year and deficiency of water in dry season, the provincial government gives a priority to store or secure water for:

- (i) domestic use in dry season

- (ii) irrigation use in dry season
- (iii) supplementary irrigation use in rainy season by small scale irrigation.

This policy stems from the following reasons.

- to implement as many as possible within limited budget
- to give priority to practical projects in consideration of present technical level
- to expand the role of farmers during construction and O/M stage

(2) Development Strategy

(i) Selection of potential area

The technical basis for evaluating irrigation potential is the combination of land capability, topography and water resources.

The basic policy of the proposed irrigation development in this master plan, following the government agricultural policy, will concentrate on introducing annual irrigation to existing fields with the following objectives.

- (a) Stabilization of rice production (Supplementary irrigation)
- (b) Increase rice production by double cropping (Dry season irrigation)
- (c) Introduction of cash crop for second crop (Crop diversification)

The potential areas were listed by using the following procedures based on the provincial irrigation development plan (1991 ~ 95), the ideas of the study team and the proposals of Mekong Committee, FAO, etc.

- ① Examination of suitability based on the results of soil survey and analysis
- ② Examination of suitable sites through topographical maps with scale of 1/100,000, 1/50,000

③ Estimation of usable water capacity through hydrological analysis and field survey

④ Field reconnaissance to check the present conditions

Priority will be given to the following areas based on the topographical maps and discussions with provincial authorities.

(a) Existing rainfed paddy fields

(b) Sizable plain areas

(c) Topographically suitable areas for irrigation

(ii) Development scale

Both existing and planned irrigation projects are classified by scale into the following 3 scales.

Project Scale	Irrigable Area (ha) ※)	Number of Village	Number of Household
Small Scale Project	~ 200	1 ~ 2	~ 150
Medium Scale Project	200 ~ 2,000	2 ~ 10	150 ~ 1,500
Large Scale Project	2,000 ~	10 ~	1,500 ~

※) Showing supplementary irrigation area in the rainy season for project scale comparison.

One of the important keys to conduct successful irrigation projects is a well-organized O/M system. In the long term, the irrigators have to be responsible for O/M of the utilized irrigation systems. At present, O/M of small irrigation facilities (reservoirs, weirs and canals) is successfully managed by the farmers and it seems to be that these farmers' groups are composed of one member per village. As seen in Tonhen Pump Irrigation Project with 550 ha of irrigable area (medium scale), the Government has just started to organize medium size farmers' groups by training. Considering the above conditions, limited

budget, present technical level and the easiness of O/M, small to medium scale projects shall be proposed for the time being.

(iii) Irrigation system

Both existing and planned irrigation projects are classified by the following type of irrigation system:

- Reservoir
- Weir
- Pump
- Flood gate

There is a type of system suitable to each type of environmental situation, and there are a few or no alternatives in most cases. For example, small weirs are suitable in valleys of the mountainous areas, large or medium weirs in the foothills, and pumps in the plains adjacent to Mekong river. However, there is a possibility to irrigate Xe Bangfai area by gravity considering a large scale project which is difficult to be realized at present due to limited financial sources. Therefore, under the present conditions, there is no choice other than pump irrigation systems even though they are only temporary expedients until the construction of a large scale project and for an execution of which a feasibility study is necessary.

Generally pump irrigation requires a higher O/M cost (power charge, maintenance of pumps, replacement, etc.) than that of gravity irrigation. Due to the above reasons, gravity irrigation will be given priority over all other systems, if the conditions allow it.

However, gravity irrigation by weirs during the dry season is mostly impractical because there are no flows. The value of irrigation will be doubled by irrigation all through the year. Therefore, gravity irrigation with reservoir, which can store adequate water for annual irrigation, will be proposed as a priority project.

(iv) Water requirement

To evaluate an irrigation project, the irrigable area will be determined by the availability of water. Irrigation water requirement varies depending on the conditions of climate, soil, crop, growing stages, etc. In order to compare the planned development projects, tentative water requirements of 600 mm for rainy season paddy and 1,600 mm for dry season paddy are applied with the following assumptions.

Cropping pattern : 100% rainy season paddy + 50% dry season paddy

Rainy season paddy : Jun. ~ Nov. (145 days variety)

Dry season paddy : Dec. ~ May (125 days variety)

Puddling water : 180 mm

Nursery water : $420 \text{ mm} \times 1/20 = 21 \text{ mm}$

Percolation : 3 mm/day (dry season),
1.5 mm/day (rainy season)

Efficiency : 60 %

Evapotranspiration : Modified Penman Method

Effective rainfall : Effective rainfall curve by Mekong Committee,
10-year return period of drought year

Water requirement of 1,200 mm (about 75 % of the dry season paddy) is applied for dry season field crops with the following assumptions:

Representative crop : Groundnut

Growing period : Jan. ~ May (130 days variety)

Efficiency : 47 %

(3) Flood Control Concept

(i) Xe Bangfai basin

As mentioned above, there are 15 planned projects besides the 7 existing flood gates, 4 of which are under construction. According to the

survey results by the Institute of Irrigation and Hydropower, about 7,000 ha of paddy field will be protected by dikes of about 50 km in length, 1 ~ 2 m in height and 1 ~ 2 m in width. A floodway at the downstream area of B. Xay Soung will also be effective to decrease the water level of the Xe Bangfai river.

(ii) Xe Banghiang basin

For flood control in this area, the proposal of "Flood Mitigation and Irrigation Development" was submitted by Mekong Committee, suggesting the following measures.

① Floodway

Construction of a floodway from the Xe Banghiang river to the Mekong river at 8 km downstream from the present junction.

② Improvement of Xe Champhon river

The Xe Champhone river is a natural river meandering near Kengkog allowing the area to flood easily because of the insufficient capacity of water passage.

③ Regulating reservoir

Construction of reservoirs for both irrigation and flood regulation purposes at the upstream area of the Xe Champhone river to reduce flood volume.

(4) Irrigation Development Program

(i) Potential project (small to medium scale, medium term)

83 small to medium scale potential projects are selected with the procedure mentioned above, and 8 projects are presently under construction. There are 40 projects, with only survey works completed, 17 projects with survey and design works completed by 1990, and no works have been started yet for the other 18 projects. Out of 83 projects, about 65 % is gravity irrigation by reservoirs and weirs (refer below).

Development Project by Type

Irrigation	No. of Project	Percentage (%)	Under Const.	Survey Completed	Survey/Design Completed
1 Reservoir	38	46	0	29	2
2 Weir	16	19	1	4	11
3 Pump	14	17	3	2	4
4 Flood Gate	15	18	4	5	0
Total	83	100	8	40	16

(ii) Reservoir

The 38 reservoir projects are divided into 3 types by the scale of the irrigable area (refer below).

Project Scale	No. of Project	Survey/Design Completed	Survey Completed	Examination on Maps
1 Small Scale (~ 200 ha)	15	0	12	3
2 Medium Scale (200 ~ 2,000 ha)	23	2	17	4
Total	38	2	29	7

Survey and design works were finished for the following 2 projects.

Project Scale	District	Irrigable Area (ha)		Total
		Rainy Season	Dry Season	
1 Nhyod H. Bak	Champhone	630	320	950
2 H. Khambou	Atsaphanthong	90	50	140

The total irrigable areas by the above 38 reservoirs are shown below according to scale.

Project Scale	No. of Project	Irrigable Area (ha)		Total
		Rainy Season	Dry Season	
1 Small (~ 200 ha)	15	1,720	890	2,610
2 Medium (200 ~ 2,000 ha)	23	11,290	5,990	17,280
Total	38	13,010	6,880	19,890

(iii) Weir

Most of the 16 planned weir projects are small with an irrigable area of about 50 ha in the rainy season and 10 ha in the dry season. The design works of 12 out of 16 projects have been completed and will be implemented one by one on receipt of the provincial budget. The construction method is in the same way as mentioned before. With the provision of materials and technical supervision from the province, farmers will carry out the construction work of the weir cooperatively. At present, H. Xay weir in Saybouly district is under construction. The weir has an intake structure, however, canal systems have to be constructed by the farmers themselves. After the completion of all 16 weirs, a total of 680 ha during the rainy season and 240 ha during the dry season can be irrigated. Pump irrigation is, however, necessary for dry season irrigation.

(iv) Pump

Except for Vanghouang Khonh Project in Atsaphanthong district where the irrigable area totals 50 ha, all 14 pump irrigation projects are medium scale with about 500 ha of irrigable area. Design works were completed for 7 projects and the 3 in Xe Bangfai area are under construction with budgets from MAF and the external assistance of FAO. With the completion of all 14 projects, 9,010 ha of paddy fields during the rainy season and 8,990 ha during the dry season will be irrigated.

(v) Flood gate

There are 15 flood gate projects planned in all, and 4 projects (3 projects in Nongbok district and 1 in Saybouly district) are under construction. One flood gate can protect about 100 ha of paddy field from flooding during the rainy season and store water for about 50 ha of dry season irrigation. With the completion of 15 flood gates, 1,420 ha of paddy fields will be protected from flooding and 720 ha will be irrigated during the dry season.

(vi) Long term large scale projects

This master plan gives priorities to small to medium scale projects for a medium term program with 2010 as target year.

The following 8 potential projects are proposed for a long term program, all of which are gravity irrigation projects by reservoir or weir. For the implementation of the above projects, a detailed investigation and study about the natural and social effects caused by the projects will be required because of large submerged areas by reservoir.

Irrigable areas of each large scale project are as follows.

Long Term Large Scale Projects

Project	District	Irrigable Area (ha)		
		Rainy Season	Dry Season	Total
1. H. Somпой Reservoir	Khantabouly	3,350	1,680	5,030
2. H. Xevan Reservoir	Champhone	2,550	1,280	3,830
3. Xe Champhone (1) Reservoir	Atsaphanthon	4,780	2,390	7,170
4. Xe Xangxoy (1) Reservoir	Atsaphanthon	5,600	2,800	8,400
5. Xe Champhone (2) Reservoir	Atsaphanthon	11,780	5,890	17,670
6. H. Sikhai Reservoir	Saybouly	2,290	1,150	3,440
7. Xe Bangfai Weir	Saybouly/Nongbok	11,400	11,400	22,800
8. Xe Xangxoy (2) Reservoir	Sonebouly	9,020	4,510	13,530
Total		50,770	31,100	81,870

(5) Irrigation Development Area

The list and location of the 83 small to medium scale and 8 large scale development projects are shown in Table 3-7 and Fig. 3-6.

Total irrigable area is:

- Dry season : 16,830 ha
(47,930 ha including large projects)
- Rainy season : 22,700 ha
(73,470 ha including large projects)
- Flood protected area: 1,420 ha

They are summarized below by irrigation type.

Irrigation Development Area

Irrigation System	No. of Project	Rainy Season Irrigable Area (ha)	Flood Protect Area (ha)	Dry season Irrigable Area (ha)	Total Area (ha)
Reservoir (Small to Medium)	38	13,010	--	6,880	19,890
Reservoir (Large)	(8)	(50,770)	--	(31,100)	(81,870)
Weir	16	680	--	240	920
Pump	14	9,010	--	8,990	18,000
Flood Gate	15	--	1,420	720	2,140
Total	83	22,700	1,420	16,830	40,950
(Including Large Project)	(91)	(73,470)		(47,930)	(122,820)

(6) Rehabilitation Program

The Provincial Development Policy, 'Rehabilitation in preference to new schemes' is one of the important policies. It is proposed that many effective rehabilitation works should be promoted as much as possible. Out of 83 projects, the following 3 projects are rehabilitation or improvement projects.

Project	District	Purpose
(1) H. Salung Gate	Saybouly	Improvement of gate
(2) Thongxakun Pump	Champhone	Utilization of existing H. Souy Reservoir
(3) Thongbak Pump	Champhone	Utilization of existing H. Bak Reservoir

(7) Provincial Development Budget and Implementation

Out of the 83 development projects, survey works were completed for 65 projects and design works for 24 projects.

When the plan becomes concrete, design work will be carried out by the design section with a budget for the coming year. Construction work will be divided into the following 2 methods by scale.

- (i) Small scale : Construction by farmers' labour with provision of materials and technical advice
- (ii) Medium to large scale : Construction by heavy equipment contracting with an enterprise

The 83 projects are classified by construction methods below.

Project	Manual Work by Farmers	Equipment Work by Enterprise	Total
Reservoir	5	33	38
Weir	16	-	16
Pump	1	13	14
Flood Gate	4	11	15
Total	26	57	83

Realized provincial budget in 1991 is for the following 8 projects.

Project	District	Budget (1,000 kip)	Construction Method
(1) H. Kalang Weir	Champhone	6,777	Farmer
(2) H. Thahao (2) Weir	Outhomphone	4,283	Farmer
(3) H. Kasine Weir	Atsaphanthong	6,390	Farmer
(4) H. Phiphut gate	Saybouly	35,030	Enterprise
(5) Thongxakun Pump	Champhone	214,125*	Enterprise
(6) Thongbak Pump	Champhone	117,032*	Enterprise
(7) Phakha Pump	Khanthabouly	201,256**	Enterprise
(8) Thapho Pump	Khanthabouly	246,889**	Enterprise

Note: * Excluding pump cost, using existing pump

** Excluding pump cost, pumps from FAO

(8) Operation and Maintenance

Success of irrigation project depends on a well-organized operation and maintenance system. This will ultimately depend on the farmers' understanding and cooperation. Without the farmers' cooperation, all efforts by the Government will be in vain. At present, a farmers' group for small weir or pump project is composed of one member per village and their activities are successful. According to the expansion of the project scale, the organization of farmers' groups will extend over more than 2 villages. The key point of the farmers' organization is to start from a smaller unit. To unite the farmers' group in the village, for example, a total of 50 farmers will be divided into 5 groups of 10 farmers each and 5 leaders of each group will be trained first. The success of the unification will lead to cooperation among villages for the second stage. The operation and maintenance of irrigation facilities are finally the responsibilities of the benefiting farmers, though, considering that "water management cooperation" in Lao has not yet been established completely, the provincial technicians should also be trained to level up their technique and knowledge of management.

Contract business's such as O/M and procurement of agricultural input materials by the small irrigation company in Tonhen (Sayabouly district) should be observed and evaluated.

3-2-8 Agro-infrastructural Development Plan

(1) Basic Approach

In the agro-infrastructural development, the development of the roads, post-harvest facilities and the living conditions in the rural area (water supply, electrification, hospitals) will be given importance.

(1) Rural Road Improvement

The total length of the rural roads in the study area is about 520 km. 55% (290 km) of these roads and 55 bridges have to be improved, and 21 bridges shall be constructed immediately.

The total cost of the improvement works is estimated at 5,700 million kips (8.5 million US\$).

The construction cost and the social and living conditions of the rural area will be taken into consideration, and improvement methods that enable passage even during the rainy season will be studied for the improvement of the rural roads. An improvement plan will be also formulated for the lateral roads connecting the irrigation facilities and the paddy fields, and the main roads connecting the villages and the markets.

The development of the rural roads is very important in order to successfully promote Zone development.

First of all, the main farm road networks have to be improved and constructed.

The improvement schemes are as follows:

(i) 5 Year Road Improvement Plan

The simultaneous improvement of all roads is difficult because of shortage of funds, engineering and construction equipment. Therefore, the improvement of the routes considered to be very important to agricultural development will be given priority.

(ii) The Consolidation of the O/M Executive Body

The development of agro-infrastructures will support and further the Project. The improvement of the roads, especially those in need of

immediate repair, will take precedence of other rural development works.

The main O/M executive agency is DCTPC. However, due to limited O/M budget and superannuated equipment, operation and maintenance has not been conducted efficiently. It is important, therefore, to consolidate the executive agency (DCTPC). Consolidation can be achieved according to the following measures.

- To increase the O/M budget
- To give technological support to the division of road and bridge planning
- To provide machineries to the State Enterprise of road and bridge Construction and to help in the improvement of the workshop.

(iii) To Establish the Farmers' Supporting System

At present, there are no supporting systems for the O/M of the rural roads in the villages, and the roads are left to dilapidate further.

A manual on road O/M has to be framed and established for the Farmers' O/M supporting system.

The responsibilities of the farmers concerning the O/M of the roads are as follows:

- To assist road maintenance and the redredging of ditches
- To fill up the road surface holes
- To offer materials for the repair of the farm roads and bridges and to offer one's services to DCTPC

(iv) Formulation of road construction and O/M specifications

At present, the specifications on the O/M works of the rural roads are imperfect. Moreover, these roads are not classified and defined. It is, therefore, necessary to distinguish the main and lateral roads, formulate suitable road specifications and to conduct economically feasible construction and O/M works.

The following methods should be considered.

- Surface course grading methods,
- The intensity of road crossing conduit and banking depth,
- Road embankment materials, embankment intensity (California bearing ratio), road cross grade,
- Road width, longitudinal slope, traffic drainage,
- Road bridge grade and design load,
- Road pavement method and others.

(v) Road surface improvement scheme

Improvement will be carried out on roads with completely damaged road body by erosion during the rainy season. Consequently, the improvement of the roads becomes very hard and complicated because it will entail big volumes of road body embankment, replacement of drainage facilities and the upper course of the laterite soil embankment.

Therefore, it is necessary to conduct road surface grading and side ditch cleaning twice a year (after and before the rainy season). The conditions of the surface course should be maintained to avoid serious damages and in order to limit the construction cost to 1/3~1/10 of the heavy improvement works.

(3) Post-harvest

There are large rice mill facilities (3~4 ton/hour polishing capacity, 5,000 ton storage capacity) in Savannakhet city, while mortars and small rice-polishing machines are still used in rural areas. The farmers store the paddies in their respective warehouses. The amount of loss resulting from damages caused by rodents is 3~8%.

The post harvest facilities (vehicles for collection and distribution, store house and rice-polishing machines) necessary to marketing will be included in the development plan.

(4) Stabilization of Rural Life

(i) Domestic water supply

The Savannakhet city water supply has already achieved the water supply volume intended for 1995, and after 2~3 years, it is foreseen to achieve the maximum water supply volume (1,200 m³/day) intended for the year 2000.

Furthermore, the ground water supply in the cities of Xeno, Donghen and Pakxong is almost drained.

Therefore, there is a need to construct new water supply systems and to repair the old ones. The source of the rural areas domestic water supply are shallow wells, rivers and swamps. It is, however, difficult to secure domestic water in the dry season.

The following will be considered for the rural area domestic water supply.

— Groundwater resources

It is necessary to conduct aerial groundwater survey to grasp the available volume of groundwater, and to be able to identify the most suitable locations for the wells. The study area has 1,158 villages and the estimated number of places in need of new wells is about 250. The new wells will be 15~30 m deep (hand pump), and the farmers will be trained on how to operate and maintain these wells.

— Rainwater use

Rain water is considered as a safe source of water supply. It can also be used as drinking water. Water tanks and jars can be easily and economically produced and they are popular especially in the northeast of Thailand. The production of water jars can possibly develop into a domestic industry in the rural area.

— Construction of Small Reservoirs

The farmers will construct small reservoirs near small rivers or the farming area. The bed embankment of the small reservoirs will be made of clay and dikes will be constructed to ward off coarse water.

The reservoirs filled with rain water will become clear after 2~3 years. By then, it can be used for drinking.

(ii) Electricity

There are 22 kv transmission lines around the study area (see Fig. 2-16). Electrification was only conducted in the cities located along route No. 9 and the Mekong River. The other cities (Pakxong and Pin) rely on diesel generators for electricity.

The electrification plan of the Electric Company is stated below.

- B. Thasano to Keng kabao : 18 km, to be completed in 1992
- Route No.13 Junction to Pakxong : 24 km, to be completed in 1992
- Route No.13 Junction to B. Houay : 33 km, to be completed in 1993
- B. Napan to B. Nongbouatha : 36 km, to be completed in 1995
- Xeno to B. Phondua : 15 km, to be completed in 1995
- B. Nokoykhok to B. Laosuligna : 9 km, to be completed in 1995

3-3 Agricultural Development Plan

3-3-1 Organization of Agricultural Supporting Center

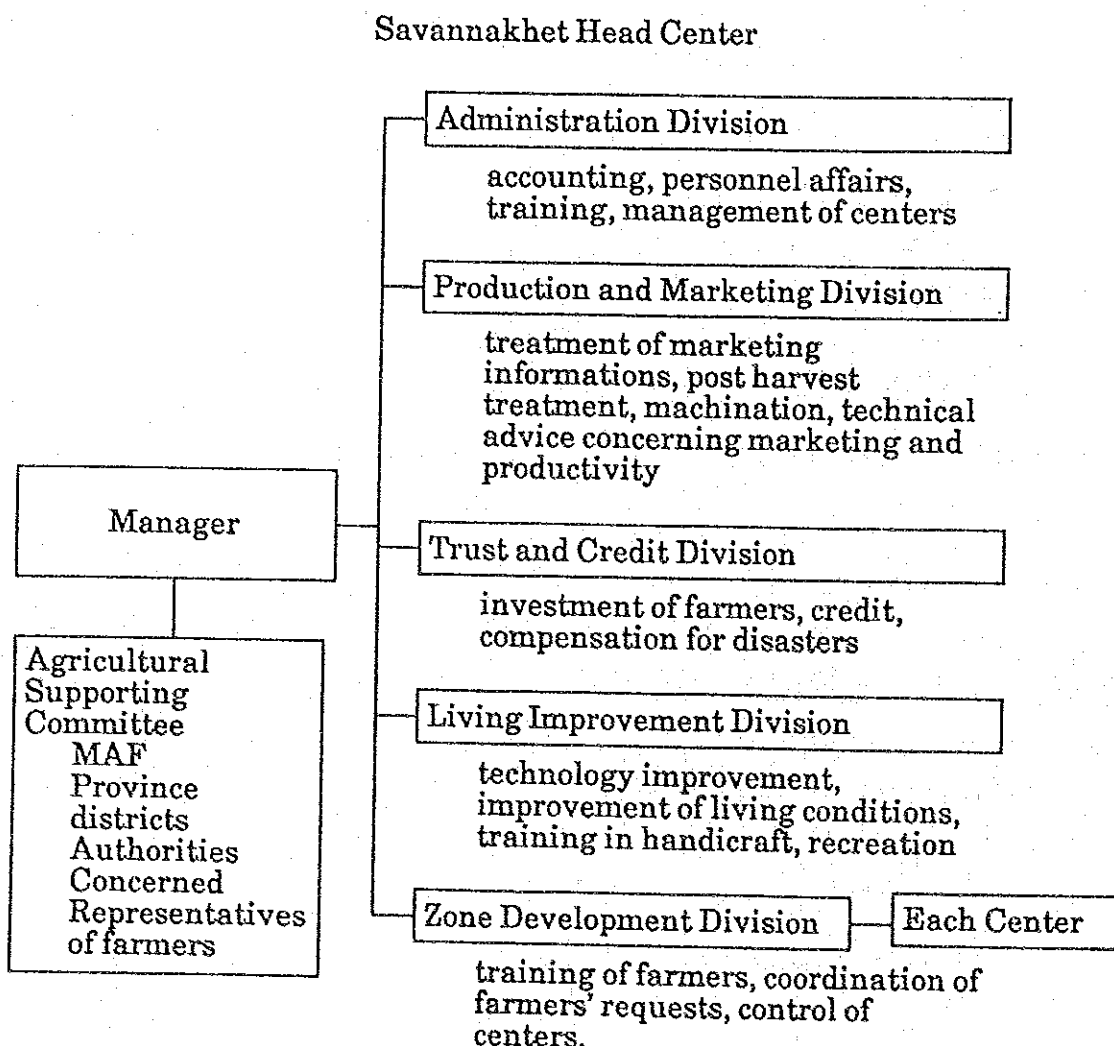
Agricultural supporting centers are built in each zone to mainly support software development. The centers will be controlled by MAF, Savannakhet Province and Khammouane Province with the cooperation of the district government and authorities concerned.

The functions of the center are as follows:

- Post-harvest functions (collection of paddy, rice mill, storage, rice bank, etc.)
- Collection, analysis and transmission of information concerning marketing and marketing development.
- Formulation of production planning, supply of inputs and training of farmers.

- Operation and maintenance of constructed facilities.
- To promote the development of the agricultural structure.
- Promotion of rural industries
- Improvement of the farmers' standard of living

It is important that agricultural supporting centers are basically organized, managed, utilized by farmers, and that every farmer has equal right to the centers as a means of the improvement of his way of living. In the first stage, however, it is necessary to establish such organization with guidance from the Government in terms of funds and able staff. The organization of the Savannakhet Head Center is shown below.



3-3-2 Proposed Land Use

The land use plan of the study area was made according to the following.

(1) Paddy field:

- Stable and increased production with supplementary irrigation
- Increased production with double cropping paddy
- Land reclamation (open new paddy fields) in case of shortage of rice production
- New lands were selected from the areas with suitable water resources for gravity irrigation

(2) Upland field:

- upland field use:
 - + Orchard with a sizable area
 - + Normal upland fields with vegetables (highly profitable), beans and sesame (wide demand), and maize (various uses)

- Orchard:

There are plenty of suitable areas for orchards. However, considering the demand and supply of fruits and other tree crops, and the shortage of labor, the area for orchards was limited.

- Normal upland field:

Suitable areas for normal upland fields are limited in the study area. The cropping use for the dry season paddy fields in favourable conditions will be planned.

The proposed land use is summarized below.

No.	Kind of Land Use	Proposed Land Use		Present Land Use		Disparity	
		(ha)	(%)	(ha)	(%)	(ha)	(%)
1	Rainfed paddy field	33,948	33.7	85,645	97.6	▲51,597	▲63.9
2	Irrigated paddy field	66,853	66.3	2,106	2.4	51,597	63.9
2-1	Rainy paddy field	23,465	23.3	0	-	23,465	23.3
2-2	Paddy, double cropping field	33,388	33.1	1,679	1.9	31,709	31.3
2-3	Rainy paddy, dry upland field crops	10,000	9.9	427	0.5	9,573	9.4
3	Total paddy field	100,801	100.0	87,751	100.0	13,050	-
4	Rice field	0	-	143	5.7	▲143	▲5.7
5	Normal upland field	3,893	52.0	1,750	70.2	2,143	▲18.2
6	Land under permanent cultivation	3,600	48.0	600	24.1	3,000	23.9
7	Total upland field	7,493	100.0	2,493	100.0	5,000	-
8	Total cultivated land	108,294	9.0	90,244	7.5	18,050	1.5
9	Forest and other lands	1,091,806	91.0	1,109,854	92.5	▲18,050	▲1.5
10	Total	1,200,100	100.0	1,200,100	100.0	-	-
11	Ratio 3/8 (%)	-	93.1	-	97.2	-	▲4.2
12	Ratio 7/8 (%)	-	6.9	-	2.8	-	4.1

3-3-3 Agricultural Development Plan

(1) Rice Production Plan

(i) Rice Production

As shown in Table 3-9, the irrigated area will be expanded to 66,853 ha, 40 times more than the present area, in the rainy season and 33,388 ha during the dry season. The paddy fields will be increased to 100,801 ha, 15% more than the present area.

The paddy production for the target year is estimated at 450 thousand tons, about 2.5 times more than the present production (about 180 thousand t). The production target will be achieved and approximately 10% of the produced paddy can be stored.

(ii) Paddy seed production plan

The necessary volume of paddy seed is 40 kg/ha. It is necessary to have 100 ha of irrigated paddy fields if 10% of the paddy seeds will be renewed. The Thasano Seed Farm will be expanded up to 50 ha. Although the drying facilities have enough capacity, it is necessary to install additional pumps and farm machines.

Other seed farms measuring 50 ha will be established at Donghen zone and Xe Bangfai Zone where plenty of water resources can be found.

(iii) Organic fertilizer production plan

① Production

The organic matters in the soil are insufficient and they impede the growth of the crops. Organic fertilizer will be produced by mixing chaffs, straws and animal composts. A lot of chaffs, about 25% of the paddy amount, will be produced in the rice mills which will be constructed in the centers. The farmers burn the chaffs because they do not decompose naturally.

The amount of nitrogen in the soils of the study area is insufficient and organic fertilizers are used to supply nitrogen. Chemical fertilizers are very effective, however, they are expensive and causes soil

infertility. The use of organic fertilizers as basal fertilizer, will curtail expenses and improve the soils.

As organic fertilizers are not very effective and as their transportation is difficult, chemical fertilizers will be used as additional fertilizers.

The price of the chemical fertilizer is 17.1US\$ per 50kg for urea fertilizer, 15US\$ per 50 kg for mixed chemical fertilizer, and 34US\$ per 50 kg for potash fertilizer, while the production cost of the organic fertilizer is about 1US\$.

② Fertilization standard

The organic fertilizer will be produced during the rainy season and it will be plowed into the soils before paddling. The standard volume of fertilization is estimated according to the standard of the Thasano Seed Farm. The fertilization standard of Thasano Seed Farm for basal fertilizer (N-16%) is 100kg/ha and 50 kg/ha for additional fertilizer. Approximately 2 t/ha of organic fertilizer is sufficient for basal fertilizer.

(2) Upland Crops and Fruit Production Plan

(i) Expansion of upland fields and irrigable areas

The upland fields will be 7,493 ha and 10,000 ha for the second crops of irrigated paddy fields, while the present area is 2,493 ha and 427 ha respectively. The upland rice fields included in the present area will be annihilated. These areas are largely distributed in Pakxong Zone, where lots of upland crops are planted at present, and in Donghen Zone, a mountainous area. Moreover, the irrigable paddy fields which will be used for upland crop cultivation during the dry season, are largely distributed in Donghen Zone, B. Lak 35 Zone and Xe Bangfai Zone, the areas rich in water resources.

(ii) Formation of Chief Producing Area

The formation of a chief producing area is desirable to production, marketing and farming. The recommendable main upland crops are as follows:

Xe Bangfai Zone : mongo beans

Xeno Zone	: Feed crops with high resistance against drought such as maize and sorghum
Savannakhet Zone	: vegetables and fruits because it is located near large consumptive cities
B. Lak 35 Zone	: watermelon, melon, peanuts and fruits
Pakxong Zone	: sesame and peanuts which are highly resistant to drought, tobacco, fruits. As the population density and elevation is comparatively high, cultivation of the upland crops is favorable.
Donghen Zone	: cotton, sesame, peanuts and citrus trees

(iii) Sapling farms

As previously mentioned, 80 ha of sapling farms will be constructed in Pakxong Zone, Donghen Zone and B. Lak 35 Zone, the key areas for upland crop production.

(3) Livestock Development Plan

The objective of the Livestock Development Plan is to increase the number of livestock. It is, therefore, necessary to reinforce the prevention of epidemic and to disperse technology. The following facilities which are necessary to this plan will be installed.

(i) Pastureland

Pasture in the study area thickens rapidly in the rainy season and gives a maximum yield after the said season. The yield, however, considerably declines during the dry season.

Calves born during the dry season suffer from malnutrition. The death rate of young animals is high due to feed shortage. This plan, therefore, will construct a special place where pregnant cows will be transferred whenever feed shortage occurs. In this place, these cows will be fed with rice straws, and through careful management, accidental deaths can be prevented.

This plan will also build fences to prevent excessive grazing. A plan for the development or reclamation of grasslands will not be made.

a) Construction of Fences

Brahmin dairy and beef breed cattles will be raised. The management of the pastureland will entail the removal of toxic grass, implementation of long-term seeding, and the maintenance of the water field. The pastureland will be divided into 12 areas and a 15 day rotation will be conducted in each area to maintain growth.

b) Water Resources Securement Plan

The standard amount of water required is 30 liters/head/day. Rain-fed water is used during the rainy season, and water is secured from groundwaters and small ponds in the dry season when water shortage occurs.

c) Breeding Plan

At present, 21% of the animals are pregnant. These animals will be given nourishment, and through artificial insemination, the pregnancy rate can be increased to at least 50%.

d) Management System

The pastureland will be managed by the Livestock Bureau, and the children of the farmers will be trained for a year in order to learn stock farming management. They will be given lectures in the mornings by the staff of the Livestock Bureau, and will work in the fields in the afternoons.

The bureau will be in charge of the enlisting of the students. These students will not be remunerated for their efforts, but they will be given free board and lodging. As a result, the O/M cost will be slightly curtailed.

(ii) Hatchery Plan

Poultry (chickens, guinea fowls, ducks, etc.) is marketable and it contributes to the development of the region.

This plan will establish a small hatchery and the facilities necessary to it (facilities for breeding fowls and for manufacturing feeds).

a) The Scale of Poultry Facilities and the Kinds of Fowls

- Small Cambell Ducks
- Chickens from Rhode Island
- African Guinea Fowls

b) Production Scale

If there are 80 ducks, each duck can produce 400 eggs per month, and 85% of the 300 eggs will hatch and breed approximately 255 ducks.

If there are 80 hens, each hen can produce 840 eggs per month, and 85% of the 700 eggs will hatch and breed 590 chickens.

If there are 40 guinea fowls, each fowl can produce 280 eggs per month, and 85% of the 200 eggs will hatch and breed 170 guinea fowls.

An incubator will be established, and it will be big enough to accommodate 950 birds a month.

c) Feed Production Scale

A factory for the production of livestock feed will be necessary in the future plan.

The minimum annual production amount of feeds is 6,400 kg and the required amount of feed per head is 50g a day. Feeds, except for fish meals, will be produced in the area. A hammer mill and one generator will be installed.

d) Rough Estimate of Management Cost

Expenses on feeds and electricity consume 70% of the management cost, and labor cost covers 20%.

The operation and management of this project will be placed under the commercial enterprise section of the Livestock Bureau.

e) Development Foothold

The selection of Champhone and Nongbok as development footholds is considered effective due to the following reasons.

- ① Easy acquisition of raw feeds
- ② They are located near districts where chicks can be sold
- ③ Favorable traffic conditions

(iii) Facility plan

The breeding methods will change in the future and seed improvement propagation, group breeding and expansion of livestock trade will materialize. It is, therefore, important to train the farmers on breeding management and epidemic prevention. This plan will therefore, construct small artificial insemination centers and training centers to improve the techniques used by the livestock department and to train the farmers.

Facility Scale

A small refrigerator, a laboratory, and management facilities will be installed in the artificial insemination center.

A video, hall and a practice room will be installed in the training center.

(4) Fishery Development Plan

(i) Incubatory pond

An incubatory pond will be included in the irrigation dam construction plan. This facility will be made up of a breeding pond and a fry pond. The surplus water of the reservoir will be used and fresh water can be always supplied to the breeding pond. As a result, diseases can be prevented and production cost can be curtailed.

Ponds will be established to produce fries, and these fries will be kept in large reservoirs. Tilapia, and catfish will be raised and the number of fries are estimated at approximately 2,000~2,500.

(ii) Fishing plan

It is possible to breed tilapia 3 times a year through artificial breeding. As there are no problem in water quality and feeds in the reservoirs, natural breeding is possible.

(iii) Breeding capacity of reservoirs

Tilapia and catfish prefer high temperature. The weight of the tilapia ranges from 250 to 300 g for adult fish, and the breeding capacity is 7~9 per 1 are of the pond's surface area. The weight of the adult catfish is 200~250 g and the breeding capacity is 10 per 1 are.

(5) Agricultural Gross Earnings

The estimated agricultural gross earning for the target year will be 116,726 US\$, 3.2 times more than the present earning of 36,685 US\$. The data are shown in Table 3-3.

3-3-4 Irrigation and Drainage Development Plan

(1) Xe Bangfai Zone

(i) Target plan and background

The rivers with adequate flow all through the year in the study area are the Xe Bangfai and Xe Banghiang rivers. The Xe Bangfai river runs westwards in the central part of the zone. The development of this zone aims to fully utilize the water of the Xe Bangfai river. The average flow of the Xe Bangfai river is about 30 m³/sec in April, and about 1,260 m³/sec in August. If half of the dry season flow (15 m³/sec) is used for irrigation, about 8,000 ha can be irrigated and if 20 m³/sec of flow is used, about 10,000 ha can be irrigated.

Nam Theun No. 2 Dam Project is now taking effect. The feasibility study of the project has just finished and the implementation stage is expected to start in the near future, with a planned construction period from 1994 to 1997. After the completion of the dam, the water for generating electricity will be discharged to the Xe Bangfai river with an average flow of 200 m³/sec through the year. In the long term plan, a multipurpose utilization of the water resource from Nam Theun No. 2 Dam should be considered.

On the other hand, there are more than 30,000 ha of flooding areas with less than 145 m E.L. in this zone. Half of the flooding areas (16,000 ha) is an agricultural land; 10,000 ha of which are rainfed paddy fields.

The flood control programs are now underway, based on the study by Mekong Committee "The Se Bang Fai Plain, Lao PDR, Pre-feasibility Study of Floodway and Small Structure, 1984", with measures such as:

- i) Gate (Flood regulating gate at the mouth of tributary)
- ii) Dike (Flood protection dike on banks of the Xe Bangfai river and the Mekong river)
- iii) Floodway (Floodway from B. Sokbo to the Mekong river)

For the medium term plan, a priority is placed upon flood gate constructions.

(ii) Project

- (a) Reservoir

Below are the three gravity irrigation reservoir projects with a total irrigable area of 370 ha in rainy season and 190 ha in dry season.

Reservoir Project

Project	Catchment Area (km ²)	Annual Flow (10 ⁶ m ³)	Gross Storage (10 ⁶ m ³)	Net Storage (10 ⁶ m ³)	Reservoir Area (ha)	High W.L. (m)	Low W.L. (m)
1) H. Gngang	5.8	2.4	2.2	1.5	60	158.0	153.0
2) H. Xeng	4.2	1.8	1.8	1.3	40	160.0	153.0
3) H. Tung	13.0	5.4	4.9	2.5	160	154.0	150.0

Earth Dam			Main Canal	Irrigable Area (ha)		
Height (m)	Length (m)	Volume (10 ³ m ³)	Length (km)	Rainy Season	Dry Season	Total
12.0	320	77	1.5	100	50	150
14.0	200	63	2.0	90	50	140
10.0	700	121	2.5	180	90	270
(Total)				370	190	560

(b) Weir

There is only one weir project under construction in the zone.

Project	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
H. Xay	50	10	60

(c) Pump

The main irrigation development on the medium term is a series of pump stations along the Xe Bangfai river. These pump stations have 2 to 4 inclined type pumps with a capacity of 33 m³/min., 500 mm diameter and 130 kW of motor each, according to irrigation areas. There are 3 pump stations under construction in Bungxe, Kengphosi in Saybouly district and Namphou in Nonbok district. The pump irrigation projects, including the above 3 stations, are shown in the following table with a total irrigation area of 8,000 ha in both rainy and dry season.

Pump Project

Project	Dry Season Irrigable Area (ha)	Nos. of Pump ¹⁾	Motor Capacity (kW)	Main Canal Length (km)
1) Dangtai	600	3	390	6.0
2) Naphoktha	1,100	4	530	11.0
3) Gnangkham	450	2	260	4.5
4) Namphou ²⁾	300	2	260	3.0
5) Dongkasin	400	2	260	4.0
6) Hatxiandi	850	4	530	8.5
7) Dongsangam	300	2	260	3.0
8) Phakitou	500	2	260	5.0
9) Left Bank Xe Bangfai	(Total 3,500 ha)			
9-1) Bungxe ²⁾	500	2	260	5.0
-2) Xaysoung ³⁾	400	2	260	4.0
-3) Kangpa ³⁾	500	2	260	5.0
-4) Kengphosi ²⁾	300	2	260	3.0
-5) Phakphua ³⁾	400	2	260	4.0
-6) Tabo ³⁾	300	2	260	3.0
-7) Donggnay ³⁾	300	2	260	3.0
-8) Somsaai ³⁾	500	2	260	5.0
-9) Naxengkham ³⁾	300	2	260	3.0
Total	8,000			

Note 1) Pump: Inclined type, 33 m³/min. D=500 mm
 2) Under construction
 3) Tentative area (not yet identified)

(d) Gate

There are 15 gate construction plans shown below, one of which is H. Phiphut gate in Saybouly district is under construction, with a total of 1,420 ha of flood protection area in the rainy season and 720 ha of irrigation area in the dry season.

Gate Project		
Project	Flood Protection Area in Rainy Season (ha)	Dry Season Irrigable Area (ha)
1) H. Xay	50	20
2) H. Phe	70	30
3) H. Salung	100	50
4) H. Sikhai	100	50
5) H. Thamhiang	100	50
6) H. Phiphut	100	70
7) H. Sadu	100	50
8) H. Bangkak	100	50
9) H. Sokbo	100	50
10) H. Vay	100	50
11) H. Sayphay	100	50
12) H. Lo	100	50
13) H. Memang	100	50
14) H. Naphok	100	50
15) H. Boum	100	50
(Total)	1,420	720

(iii) Proposed Irrigable Area

Proposed irrigable areas by irrigation type are as follows.

(iv) Long term large scale project

Planned Irrigable Area (Xe Bangfai Zone)

Type	Irrigable Area Rainy Season (ha)	Flood Protection Area Rainy Season (ha)	Irrigable Area Dry Season (ha)
Reservoir	370	--	190
Weir	50	--	10
Pump	8,000	--	8,000
Gate	--	1,420	720
(Total)	8,420	1,420	8,920

(a) Background

As mentioned above, a series of pump stations along the Xe Bangfai river is proposed in the medium term plan. It is planned suitably to irrigate about 8,000 ha by these suitable pump stations in the dry season which fully uses Xe Bangfai's average dry season flow (30 m³/sec).

On the other hand, Nam Theun No. 2 Dam project has just finished the feasibility study. After the completion of the dam, it is possible to generate electricity of 300 to 600 MW and an average flow of 200 m³/sec is planned to be discharged to the Xe Bangfai river through out the year. The feasibility study on the multipurpose utilization of the water resources from Nam Theun No. 2 Dam, compared with a series of pump stations and flood protection projects, is proposed for the future long term plan.

The technical and economical results of operation and maintenance of the pump irrigation projects along the Xe Bangfai river will be made clear according to the progress of implementation and operation stages. It is important to compare these results with the alternative gravity irrigation by Xe Bangfai Weir.

Moreover, the utilization of Sikhai river, with a 100 km² of catchment area, is very effective for irrigation development.

(b) Xe Bangfai weir

[Planning policy]

- Net utilization water: 230 m³/sec (30 m³/sec of dry season average flow plus 200 m³/sec of discharged flow from Nam Theun No. 2 Dam)
- 11,400 ha of suitable irrigable area with an elevation of lower than 150 m for gravity irrigation (See Fig. 4-4)
- 22 m³/sec of irrigation water requirement for 11,400 ha (1.9 l/sec/ha × 11,400 ha) and about 200 m³/sec of remaining flow for generating electricity.

[Intake facilities]

- Structure: reinforced concrete weir with gates
- High Water Level: 149 m E.L. (kept by closing gates during the dry season)
- A passage through the section of the river should be maintained for 1,200 m³/sec of rainy season flow.
- In the rainy season, the gates should control the flooding discharge and maintain high water level for supplementary irrigation.

[Generating electricity facilities]

- The capacity of generating power facilities should be adjusted to 200 m³/sec of net utilization water flow with 12 MW of possible generating electricity throughout the year.

[Irrigation facilities]

Irrigable areas and quantities of main irrigation facilities area shown below.

Dimension of Xe Bangfai Weir

	Left Bank (Saybouly district)	Right Bank (Nongbok district)	Total
Irrigable Area (ha)	3,710	7,690	11,400
Main Canal (km)	18.8	25.3	44.1
Secondary Canal (km)	15.1	23.5	38.6
Bridge (Nos)	5	3	8
Syphon (Nos)	2	3	5
Diversion Works (Nos)	4	6	10
Check Gate (Nos)	3	4	7

(c) H. Sikhai reservoir

The design work of H. Sikhai reservoir project was completed by IIM under the department of irrigation and MAF in 1990, and it is looking for an external financial source. The dimension of H. Sikhai reservoir is as follows.

H. Sikhai Project

Catchment Area (km ²)	100.0	Earth Dam	Height (m)	14.5
Annual Flow (10 ⁶ m ³)	42.0		Length (m)	500
Gross Storage (10 ⁶ m ³)	38.8		Volume (10 ³ m ³)	169
Net Storage (10 ⁶ m ³)	32.1	Main Canal	Length (km)	22.0
Reservoir Area (ha)	740	Irrigable Area	(ha)	
High Water Level (m)	161.5		Rainy Season	2,290
Low Water Level (m)	153.0		Dry Season	1,150
			Total	3,440

(2) Xeno Zone

(i) Target plan and background

This zone is located at an area with 170 to 200 m E.L. Therefore, all the rivers dry up in the dry season showing very poor water

resource. Thus, pumping irrigation is not suitable and reservoir projects become the main irrigation development projects in the area.

Drainability is good owing to the topographical conditions of the area, and the construction of flood gates will not be required.

(ii) Project

(a) Reservoir

There are 6 reservoir projects with a total irrigable area of 2,160 ha in the rainy season and 1,090 ha in the dry season.

Reservoir Project

Project	Catchment Area (km ²)	Annual Flow (10 ⁶ m ³)	Gross Storage (10 ⁶ m ³)	Net Storage (10 ⁶ m ³)	Reservoir Area (ha)	High W.L. (m)	Low W.L. (m)
1) H. Hinelat	5.0	2.1	3.0	1.4	90	177.0	174.0
2) H. Kipma	28.0	15.0	2.9	2.0	60	162.0	158.0
3) H. Xay	17.7	7.4	7.4	5.5	160	195.5	188.0
4) H. Xeno	38.0	15.9	12.7	6.8	460	174.0	170.5
5) H. Paname	41.0	17.0	16.3	9.7	570	176.5	173.0
6) H. Thahao (1)	16.6	6.9	6.9	5.0	200	198.5	193.5

Height (m)	Earth Dam		Main Canal Length (km)	Irrigable Area (ha)		
	Length (m)	Volume (10 ³ m ³)		Rainy Season	Dry Season	Total
11.0	200	41	0.7	100	50	150
9.0	1,200	173	1.0	140	70	210
13.5	1,400	416	3.0	400	200	600
9.5	1,100	174	7.0	480	240	720
9.5	1,600	253	7.0	690	350	1,040
11.0	400	82	2.5	350	180	530
			(Total)	2,160	1,090	3,250

(b) Weir

There is only one weir project in this zone as shown below.

Project	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
H. Thahao (2)	50	10	60

(iii) Planned Irrigable Area

The locations of irrigation projects in Xeno zone are shown in Fig. 4-5 and planned irrigable areas by irrigation type are as follows.

Planned Irrigable Area (Xeno Zone)

Type	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
Reservoir	2,160	1,090	3,250
Weir	50	10	60
(Total)	2,210	1,100	3,310

(3) Savannakhet Zone

(i) Target plan and background

The Sompoy river is a main river running westwards in the central part of the zone with a sizable existing paddy field of about 10,000 ha. This river dries up in the dry season. However, the effective utilization of this water resource will be a main irrigation project in the long term development plan due to a large catchment area of 208 km². For the medium term plan, 2 reservoirs in the northern area, 2 weirs in the southern area and 2 pump stations with the Mekong river water resource are proposed and shown below.

(ii) Project

(a) Reservoir

There are 2 reservoir projects listed below with a total irrigable area of 1,070 ha in the rainy season and 540 ha in the dry season.

Reservoir Project

Project	Catchment Area (km ²)	Annual Flow (10 ⁶ m ³)	Gross Storage (10 ⁶ m ³)	Net Storage (10 ⁶ m ³)	Reservoir Area (ha)	High W.L. (m)	Low W.L. (m)
1) H. Nambo	28.4	11.9	14.4	9.1	360	160.0	155.5
2) H. Kasen	18.1	7.6	8.6	5.9	220	159.5	155.0

Earth Dam			Main Canal	Irrigable Area (ha)		
Height (m)	Length (m)	Volume (10 ³ m ³)	Length (km)	Rainy Season	Dry Season	Total
12.0	300	72	4.2	650	330	980
11.5	400	89	2.7	420	210	630
(Total)				1,070	540	1,610

(b) Weir

There are 2 weir projects listed below with a total irrigable areas of 20 ha in the rainy season and 10 ha in the dry season.

Weir Project

Project	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
1) Sopchiang	10	5	15
2) H. Thapho	10	5	15
(Total)	20	10	30

(c) Pump

There are 2 pump irrigation projects under construction with the water resource from the Mekong river. The type of pumps is an inclined type with a capacity of 33 m³/min., a diameter of 500 mm and a motor capacity of 130 kW. Total irrigable areas are 450 ha in both rainy and dry season as shown below.

Pump Project

Project	Irrigable Area (ha)			Main Canal (km)
	Rainy Season	Dry Season	Total	
1) Phakkha	250	250	500	2.5
2) Thapho	200	200	400	2.0
(Total)	450	450	900	

(iii) Planned irrigable area

The location of irrigation projects in Savannakhet zone is shown in Fig. 4-6 and planned irrigable areas by irrigation type are as follows.

Planned Irrigable Area (Savannakhet)

Type	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
Reservoir	1,070	540	1,610
Weir	20	10	30
Pump	450	450	900
(Total)	1,540	1,000	2,540

(iv) Large scale long term project

[H. Sompoy Reservoir]

H. Sompoy Reservoir will enable the irrigation of 3,000 ha of paddy field in the rainy season and more than 1,500 ha in the dry season. However, the reservoir will submerge more than 500 ha of existing paddy fields. Before the implementation of the project, an adequate feasibility study is required considering both social and economical effects.

General information of H. Sompoy reservoir is as follows.

H. Sompoy Reservoir

Catchment Area (km ²)	208.0	Earth Dam	Height (m)	11
Annual Flow (10 ⁶ m ³)	87.3		Length (m)	1,200
Gross Storage (10 ⁶ m ³)	76.8		Volume (10 ³ m ³)	246
Net Storage (10 ⁶ m ³)	47.0	Main Canal	Length (km)	13.0
Reservoir Area (ha)	2,200	Irrigable Area (ha)		
High Water Level (m)	151		Rainy Season	3,350
Low Water Level (m)	147		Dry Season	1,680
			Total	5,030

(4) B. Lak 35 Zone

(i) Target plan and background

There are 2 big paddy fields in the zone, one is Phummachedy basin (3,000 ha) with water resources from H. Xay, H. Phou, and H. Somhong, and the other is Xe Champhone basin, some parts of which are flooded by the Xe Champhone river in the rainy season. Tributaries of the Xe Champhone river have a lot of suitable sites for reservoir and weir, showing a big irrigation potential. The topographical characteristics of each site should be considered for the specific utilization plan. For example, proposed reservoirs in the eastern higher area with 160 to 180 m E.L. do not have sizable existing paddy fields near the dam sites which are suitable for livestock project.

(ii) Project

(a) Reservoir

There are 15 reservoir projects shown below with a total irrigable area of 5,320 ha in the rainy season and 2,980 ha in the dry season.

Reservoir Project

Project	Catchment Area (km ²)	Annual Flow (10 ⁶ m ³)	Gross Storage (10 ⁶ m ³)	Net Storage (10 ⁶ m ³)	Reservoir Area (ha)	High W.L. (m)	Low W.L. (m)
1) Namphou	15.8	6.6	1.9	0.8	100	170.0	168.0
2) H. Sakhen	2.2	0.9	1.2	0.6	40	148.0	145.0
3) Koutapo (2)	10.5	4.4	4.7	2.8	150	155.5	153.0
4) Phummachedy	61.7	25.9	105.2	15.2	1,650	154.5	153.0
5) H. Cheao	-	-	22.0	7.0	550	133.0	131.0
6) H. Khamsyda	9.7	4.1	4.2	2.9	110	157.5	152.0
7) Sokkambalay	8.7	3.7	4.2	3.0	90	149.5	143.0
8) H. Bong	4.0	1.7	2.3	0.7	120	144.0	136.0
9) H. Phangvu	10.0	4.2	4.7	3.0	130	150.5	146.0
10) Nhyod H. Bak	31.0	13.0	20.7	13.4	570	168.0	163.0
11) H. Louang	13.9	5.8	7.8	4.5	160	156.5	150.0
12) H. Thouat	33.3	14.0	14.1	6.4	500	150.0	147.0
13) H. Phaleng	35.5	14.9	15.5	11.1	500	144.5	138.0
14) H. Patdeng	2.2	0.9	1.3	0.8	10	148.0	146.5
15) H. Xom	4.2	1.7	2.0	1.2	40	147.0	140.0

Earth Dam			Main Canal	Irrigable Area (ha)		
Height (m)	Length (m)	Volume (10 ³ m ³)	Length (km)	Rainy Season	Dry Season	Total
9.0	500	72	6.5	600	150	750
10.0	500	87	0.3	400	20	60
10.5	400	76	2.4	200	100	300
17.5	900	431	15.0	1,080	540	1,620
7.0	2,500	233	-	0	440	440
13.5	550	163	3.0	210	110	320
14.0	650	206	2.0	210	110	320
8.0	450	53	0.6	50	30	80
11.5	550	122	1.4	210	110	320
16.5	1,200	515	13.0	1,000	500	1,500
14.0	450	143	2.5	320	160	480
10.5	350	66	5.0	460	230	690
13.5	350	104	6.0	790	400	1,190
7.0	200	19	0.3	60	30	90
15.0	400	144	0.5	90	50	140
(Total)				5,320	2,980	8,300