Note) *) H. Xay reservoir and 5 weirs in the downstream area of the reservoir.

(b) Weir

There are 7 weir projects shown below with a total irrigable area of 330 ha in the rainy season and 130 ha in the dry season.

Weir Project

Project	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
1) H. Kadane	50	20	70
2) H. Xiangxoum	25	10	35
3) H. Takiang	25	10	35
4) H. Taleo	70	30	100
5) H. Kalang (1)	50	20	70
6) H. Kalang (2)	50	20	70
7) H. Khe	60	20	80
(Total)	330	130	460

(c) Pump

The proposed pump irrigation projects are the following 2 projects with a total irrigable area of 510 ha both in the rainy and dry seasons. The water resources are existing reservoirs, H. Souy and H. Bak where flood recession cultivation is carried out in the dry season. It is expected that irrigation in the higher land will be possible by these pump projects.

Pump Project

Project	Irrigable Area (ha)			Main Canal (km)
	Rainy Season	Dry Season	Total	
1) Thongxakun	300	300	600	3.0
2) Tongbak	210	210	420	2.1
(Total)	510	510	1,020	

(iii) Planned irrigable area

The location of the irrigation projects in B. Lak 35 zone is shown in Fig. 4-7 and the planned irrigable areas by irrigation type are as follows.

Planned Irrigable Area (B. Lak 35 Zone)

Type	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
Reservoir	5,320	2,980	8,300
Weir	330	130	460
Pump	510	510	1,020
(Total)	6,160	3,620	9,780

(iv) Large scale long term project

(a) Xevan reservoir

Xevan reservoir will enable irrigation of 2,550 ha of paddy field in the rainy season and 1,280 ha in the dry season. However, the planned reservoir is located in the highland forest area with no sizable fields near the downstream area of the dam site and suitable for a cattle grazing project. Dimension of the project is as follows.

Xevan Reservoir

Catchment Area (km^2)	147.0	Earth Dam	Height (m)	11.0
Annual Flow ($10^6 m^3$)	61.7		Length (m)	700
Gross Storage ($10^6 m^3$)	50.2		Volume ($10^3 m^3$)	144
Net Storage ($10^6 m^3$)	35.7	Main Canal Length (km)		-
Reservoir Area (ha)	1,440	Irrigable Area (ha)		
High Water Level (m)	142.0		Rainy Season	2,550
Low Water Level (m)	137.0		Dry Season	1,280
			Total	3,830

(b) Xe Xangxoy (2) Reservoir

Xe Xangxoy (2) reservoir will enable irrigation of 9,020 ha of paddy field in the rainy season and 4,510 ha in the dry season. The reservoir with a high water level is 5,100 ha extending more than 60 km along the Xe Xangxoy river. Thus, small pump irrigation is possible along the river in the dry season in addition to the gravity irrigation downstream. Furthermore, it is possible to control flooding by the gate operation of the reservoir. Dimension of the project is as follows.

Xe Xangxoy (2) Reservoir

Catchment Area (km^2)	1,730	Earth Dam	Height (m)	14
Annual Flow ($10^6 m^3$)	726		Length (m)	700
Gross Storage ($10^6 m^3$)	255		Volume ($10^3 m^3$)	222
Net Storage ($10^6 m^3$)	126.3	Main Canal Length (km)		10.0
Reservoir Area (ha)	5,100	Irrigable Area (ha)		
High Water Level (m)	140		Rainy Season	9,020
Low Water Level (m)	136		Dry Season	4,510
			Total	13,530

(5) Paksong Zone

(i) Target plan and background

This zone is located in the middle and highland areas with 150 to 160 m E.L. Almost all rivers flow into the Mekong river directly, and their sizes range from small to medium. All these rivers have small catchment areas and a few suitable places for dam site due to topographical conditions. They always dry up in the dry season, too. Paddy fields are scattered along these small rivers. These conditions above show a low potential for irrigation development. The main purpose of the development plan is to store water in the rivers for the dry season through the weirs.

There are no flooding problems owing to topography in this zone.

(ii) Project

(a) Reservoir

There is only one proposed reservoir project shown below.

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)
H. Tamleum	30	12.6	20.0	10.1	310	142.0	137.0

Earth Dam			Main Canal Length (km)	Irrigable Area (ha)		
Height (m)	Length (m)	Volume (10^3 m^3)		Rainy Season	Dry Season	Total
17.0	700	317	5.0	720	360	1,080

(b) Weir

Proposed weir projects in this zone are the following 3 projects with a total irrigable area of 130 ha in rainy season and 50 ha in dry season.

Weir Project

Project	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
1) H. Kok (2)	50	20	70
2) H. Vay	20	10	30
3) H. Nonghy	60	20	80
(Total)	130	50	180

(iii) Planned irrigable area

The location of irrigation projects in Paksong zone is shown in Fig. 4-8 and planned irrigable areas by irrigation type are as follows.

Planned Irrigable Area (Paksong Zone)

Type	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
Reservoir	720	360	1,080
Weir	130	50	180
(Total)	850	410	1,260

(6) Donghen Zone

(i) Target plan and background

The Xe Champhone river runs southwards in the central part of this zone. The development of the Xe Champhone river and its tributaries is the main target for irrigation development in this zone. The Xe Champhone river has a catchment area of 2,640 km^2 at Kengkok with a total annual flow of 1,600 million m^3. However, this flow concentrates in the rainy season and the average flow in the dry season (January to April) is 0.3 m^3/sec.

Therefore, the main target, in this zone, is the construction of reservoir to store water for the dry season. For the medium term plan, 11 reservoir projects, 2 weir projects and 1 pump project are proposed and described below. 3 large scale reservoir projects are proposed for the long term plan in this zone.

(ii) Project

(a) Reservoir

The following 11 projects are the proposed reservoir projects with a total irrigable area of 3,370 ha in the rainy season and 1,720 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. Toumpang	18.4	7.7	3.7	2.2	110	142.0	137.0
2) H. Khambou	27.5	11.5	11.4	7.1	380	139.0	135.0
3) H. Nga	5.6	2.4	2.1	1.0	100	141.5	139.0
4) H. Ka	7.6	3.2	3.0	1.8	80	146.5	142.0
5) H. Tabonghak	20.0	8.4	12.8	5.6	430	156.5	154.0
6) H. Nalai	16.7	7.0	6.7	3.3	270	144.0	141.0
7) H. Pongdeng	25.0	10.5	11.7	8.0	290	160.0	155.0
8) H. Sokkathoum	3.6	2.0	2.3	1.6	50	149.0	143.0
9) H. Klong	29.8	12.5	13.0	9.6	290	161.0	155.0
10) H. Ngut	16.0	6.7	7.0	4.4	270	153.5	149.0
11) H. Khene	11.8	4.9	4.5	2.6	110	141.0	137.0

Earth Dam			Main Canal Length (km)	Irrigable Area (ha)		
Height (m)	Length (m)	Volume ($10^3 m^3$)		Rainy Season	Dry Season	Total
11.0	250	51	2.5	160	80	240
10.0	700	122	2.0	500	250	750
8.5	450	59	2.0	70	40	110
11.5	700	156	2.0	130	70	200
8.5	1,400	182	5.0	400	200	600
9.0	1,400	202	2.8	230	120	350
12.0	700	168	3.6	570	290	860
13.0	400	111	0.7	120	60	180
13.0	1,200	333	4.2	690	350	1,040
11.5	1,200	267	–	310	160	470
12.0	600	144	1.2	190	100	290
			(Total)	3,370	1,720	5,090

(b) Weir

Proposed weir projects are the following 2 projects with a total irrigable area of 100 ha in the rainy season and 30 ha in the dry season.

Weir Project

Project	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
1) H. Na	50	10	60
2) H. Kasine	50	20	70
(Total)	100	30	130

(c) Pump

There is one pump project proposed with Xe Cahmphone river as the water resource.

Pump Project

Project	Irrigable Area (ha)			Main Canal (km)
	Rainy Season	Dry Season	Total	
1) Vanghouang Khonh	50	30	80	1.0

(iii) Planned Irrigable Area

The location of irrigation projects in Donghen zone is shown in Fig. 4-9 and planned irrigable areas by irrigation type are as follows.

Planned Irrigable Area (Donghen Zone)

Type	Irrigable Area (ha)		
	Rainy Season	Dry Season	Total
Reservoir	3,370	1,720	5,090
Weir	100	30	130
Pump	50	30	80
(Total)	3,520	1,780	5,300

(iv) Long term large scale project

(a) Xe Champhone (No. 1) Reservoir

This reservoir will enable irrigation of 4,780 ha paddy fields in the rainy season and 2,390 ha in the dry season. However, pumping facilities are required for the effective use of the stored water due to the low level intake of 134 to 140 m E.L.

Irrigation areas should be sizable existing fields along the Panam river (branch of the Xe Champhone river, 6 km westwards from the reservoir). Though about 1,000 ha of existing paddy fields will be submerged by the reservoir, this area can be possibly utilized in flood recession cultivation in the dry season. General information on this project is described below.

Xe Champhone (No. 1) Reservoir Project

Catchment Area (km^2)	1,065	Earth Dam	Height (m)	14
Annual Flow ($10^6 m^3$)	447		Length (m)	400
Gross Storage ($10^6 m^3$)	97		Volume ($10^3 m^3$)	127
Net Storage ($10^6 m^3$)	67	Main Canal Length (km)		12.0
Reservoir Area (ha)	1,950	Irrigable Area (ha)		
High Water Level (m)	140		Rainy Season	4,780
Low Water Level (m)	134		Dry Season	2,390
			Total	7,170

(b) Xe Xangxoy (No. 1) Reservoir

This reservoir can store enough water to irrigate 5,600 ha of land in the rainy season and 2,800 ha in the dry season. However, a suitable and sizable existing field of about 800 ha is located 14 km downstream from the reservoir. On the other hand, the big difference in the water level of this reservoir is enough to generate 300 kW of electricity. For the implementation of the project, a feasibility study on the combination of irrigation and generating electricity is required for the effective use of water resources. General information on this project is described below.

Xe Xangxoy (No. 1) Reservoir Project

Catchment Area (km^2)	320	Earth Dam	Height (m)	19
Annual Flow (10^6 m^3)	134		Length (m)	900
Gross Storage (10^6 m^3)	99		Volume (10^3 m^3)	502
Net Storage (10^6 m^3)	78.4	Main Canal Length (km)		16.0
Reservoir Area (ha)	1,330	Irrigable Area (ha)		
High Water Level (m)	160		Rainy Season	5,600
Low Water Level (m)	150		Dry Season	2,800
			Total	8,400

(c) Xe Champhone (No. 2) Reservoir

This reservoir can store enough water to irrigate 11,780 ha of land in the rainy season and 5,980 ha in the dry season. However, pumping facilities are required for the effective use of the stored water due to the low level intake of 135 to 138 m E.L. There is a sizable existing paddy field to be irrigated downstream and the reservoir extends 30 km farther in the upper reaches of the Xe Champhone river making irrigation possible along the river through pumps and flood recession cultivation. It is also possible to control flooding by gate operations in the rainy season. General information on this project is given below.

Xe Champhone (No. 2) Reservoir Project

Catchment Area (km^2)	1,785	Earth Dam	Height (m)	12
Annual Flow (10^6 m^3)	750		Length (m)	1,500
Gross Storage (10^6 m^3)	384		Volume (10^3 m^3)	360
Net Storage (10^6 m^3)	164.9	Main Canal Length (km)		10.0
Reservoir Area (ha)	9,600	Irrigable Area (ha)		
High Water Level (m)	138		Rainy Season	11,780
Low Water Level (m)	135		Dry Season	5,890
			Total	17,670

3-3-5 Agro-infrastructural Development Plan

(1) Xe Bangfai Zone

(i) Rural road improvement plan

The improvement of the rural roads will be given priority over other improvement works, and a rural road improvement plan will be formulated.

The scope of the improvement work is stated below.

a. Road width (passage) is 4~6 m, upper course is 30~40 cm, and laterite pavement is 5~10 cm,

b. Traffic drainage (road ditches), road cross culvert is ϕ40~60 cm,

c. Width of the wooden farm bridge is 4 m, and the pier and abutment are made of reinforced concrete.

The scope of the improvement work for roads and bridges is the same in each zone.

The roads to be improved are as follows:

–	B. Pakxebangtai ~ B. Sadu	: 12 km
	Bridge improvement	: 3 places
–	B. Phonxai ~ B. Dangnua	: 10 km (newly-established)
	New bridge construction	: 3 places
–	B. Bangxe ~ B. Somsaat	: 28 km
	Bridge improvement	: 4 places
–	B. Ghangkham ~ Route No. 13	: 5 km
	Road cross culvert	: 5 places

(ii) Village water supply

The existing sources for the village's domestic water supply are shallow wells, rivers, swamps and rainwater. However, these water resources are drained in the dry season, and it is difficult to secure domestic water in the rainy season. It is, therefore, necessary to have sufficient amounts of water supply to stabilize rural life. A well construction plan will be made for the villages with limited water

resources to enable the villagers to secure enough water supply even in the dry season, to reduce labor and for safe and clean domestic water. The water quality, depth and the water volume of the existing wells should be studied through electric prospecting and boring tests, and the conditions of the water resources should be understood.

The scope of the wells is as follows:

- Taking into account the existing wells and water resources, one well will be constructed per 80~100 houses.
  The total number of new wells will be 40.
- The average depth of the wells will be 30~60 m.
- The strainer will be ϕ15~20 cm, and the wells will be manual in type.
  The construction methods of the well will be the same in each zone.

(2) Xeno Zone

(i) Rural road improvement plan

Route No. 13 and No. 9 intersects in Xeno Zone, and the main roads in this zone are fixed.

The roads to be improved are:

–	B. Sanamxai ~ B. Ahong	: 14 km
	Bridge improvement	: 3 places
–	Xeno ~ B. Phondua	: –
	Bridge improvement	: 3 places

(ii) Village water supply

Xeno has a simple water supply system, but the rural area gets their water supply from shallow wells and ponds. Thirty new wells with a depth of 60~80 m will be constructed.

(3) Savannakhet Zone

(i) Rural road improvement plan

Route No. 13, route No. 9 and route No. 11 in Savannakhet Zone are in good condition. The villagers farm along route No. 9 and No. 11, but there are no rural roads connected to these routes. This matter will be considered and a plan will be made.

The improvement and construction works of the roads are as follows.

–	B. Phonsim ~ B. Samsaai ~ Route No. 11	: 10 km
	New bridge construction	: 1 place
–	B. That ~ B. Gnang song	: 8 km
	New bridge construction	: 1 place
–	B. Thassno ~ B. Lak 7 ~ Savannakhet	: 15 km
	Bridge improvement	: 4 places
–	B. Maibuangthale ~ B. Nateuy	: 10 km
	New bridge construction	: 2 places

(ii) Village water supply

The rural area of Savannakhet zone, like other zones, has insufficient domestic water supply.

Therefore, 40 wells will be established in the areas experiencing severe water shortage.

(4) B. Lak 35 Zone

(i) Rural road improvement plan

The center will be established at the intersection of route No. 13 and route No. 11. This center will be used as a base for promoting zone development. The road that leads to this center will be, therefore, improved.

The rural roads to be improved are as follows:

–	B. Mai ~ B. Vatthna	: 11 km
	New bridge construction	: 1 place
–	B. Phonkho ~ B. Dongphosi ~ Route No. 13	: 14 km
	Bridge improvement	: 4 places
–	B. Phonkho ~ B. Nakham ~ Route No. 13	: 14 km
	Bridge improvement	: 7 places
–	B. Nakhow ~ B. Laosouligna ~ Route No. 9	: 26 km
	Bridge improvement	: 6 places
–	B. Kengkok ~ B. Lahanamthong	: –
	New bridge construction	: 1 place
	Bridge improvement	: 5 places

(ii) Village water supply

B. lak 35 Zone has the largest population in the study area and 70 new wells will be constructed in the area.

(5) Pakxong Zone

(i) Rural road improvement plan

The villagers of Pakxong zone reside along route No. 13, Xe Champhone and Mekong.

The rural roads in this zone are damaged by storms and rain and the road conditions indicate broken road surface and culverts.

The rural roads to be improved are as follows:

- B. Nongnokkhian ~ B. Huanhin : 13 km
  Road crossing culvert : 5 places
- B. Huanhin ~ B. Nong in ~ : 22 km
  Route No. 13
  Bridge improvement : 6 places
- Pakxong ~ B. Napak soud : 26 km
  Bridge improvement : 7 places

(ii) Village water supply

Pakxong has a simple water supply system, but the rural areas are still dependent on shallow wells, ponds and rivers. Forty new wells will be constructed in villages suffering from severe water shortage during the dry season.

(6) Donghen Zone

(i) Rural road improvement plan

The roads in the mountainous district of Donghen Zone are under-developed. The road improvement plan will be formulated so as not to isolate the area during the rainy season.

The rural road to be improved are as follows:

–	B. Senkeo ~ B. Nachan ~ Donghen	: 9 km
	Bridge improvement	: 2 places
	New bridge construction	: 3 places
–	B. Nachan ~ B. Naphek	: 5 km
	New bridge construction	: 5 places
–	Pongna ~ Route No. 9	: 12 km
	Bridge improvement	: 5 places
–	B. Phondok ~ B. Khokhinkeo	: 7 km
	New bridge construction	: 2 places
–	B. Xakhun nua ~ B. Taleo nua	: 13 km
	New bridge construction	: 5 places
–	B. Chelamong tai ~ Route No. 9	: 6 km
	New Bridge improvement	: 2 places

(ii) Village water supply Plan

Donghen city has a simple water supply system, but the rural area is still dependent on shallow wells, ponds and rivers. Forty new wells will be constructed in villages suffering from severe water shortage during the dry season.

3-3-6 Construction Cost Estimation

The estimated construction cost by zones, excluding costs for reclamation, tertiary canals and farm facilities are as follows.

(unit: 1,000US$)

Zone/Project Type	Small, Medium	Large	Roads	Center	Well	Total
Xe Bangfai	11,827	28,920	5,480	1,046	800	48,073
Xeno	6,120	—	1,750	475	600	8,945
Savannakhet	1,843	4,020	3,840	225	600	10,528
B. Lak	19,284	7,260	7,520	550	1,400	36,014
Pakxong	1,843	—	6,050	445	880	9,138
Donghen	7,681	15,170	6,950	460	800	31,061
Total	48,958	55,370	31,590	321	5,000	143,759

3-4 Evaluation of the Masterplan

3-4-1 Outline

The masterplan aims to carry out an agricultural development in a large area extending over 12,000 km^2.

In order to hasten the implementation of the plan and to achieve the objectives by the target year, the study area will be divided into six zones and an agricultural integrated development plan will be proposed.

The implementation of this plan will greatly contribute to the achievement of self-sufficiency in cereal production, the improvement of the agricultural structure and the realization of successive diminution and fundamental cessation of slash-and-burn cultivation, the principal targets of the state's agricultural development project. Various impacts and benefits such as increase in agricultural production and farmers' living environment, etc. can be expected too from the implementation of the plan.

In this chapter, the plan's desirability will be ascertained through the effects gained from the implementation of the plan on selected development goals by trying to extract quantitative factors and comparing them with the present situation.

3-4-2 Impacts of Agricultural Production

A. Impacts of Irrigation Area

(1) Expansion of Irrigation Area

About 1,821 ha or only 2% of all acreage under cultivation (90,244 ha) is presently irrigated. After the development plan implementation, the total irrigation area will be extended, 36 times more than the present area, to about 62% or 66,853 ha of the total agricultural land. Irrigation will be conducted all year round on 43,388 ha (65%) and the cropping intensity will sharply increase in the dry season.

(2) Production and Yield Increase

Due to the expansion of paddy fields and irrigation area, the annual rice product is anticipated to increase to 250%, indicating an increase of 452,500 t/year from 181,164 t/year.

The total production and unit yield of rice at present and for the target year is shown in the Table below:

Item	Present			Target Year		
	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
Rainfed paddy	87,751	2.0	175,500	33,948	2.5	84,900
Irrigated paddy						
Rainy season	0	2.5	0	66,853	3.5	234,000
Dry season	1,821	3.0	5,500	33,388	4.0	133,600
Upland paddy	143	1.8	300	0		0
Total			181,300			452,500

Another 10,000 ha will be irrigated for vegetables and other upland crops in the dry season.

(3) Increase in upland field area

The upland field area is anticipated to increase to 630%, indicating an increase of 17,493 ha from 2,777 ha. The irrigated upland fields will be

increased to 2,340% (from 427 ha to 10,000 ha), and the area for the orchards will be increased to 6000% (600 ha to 3,600 ha).

B. Impact of Livestock Promotion

Due to the reinforcement of the prevention of epidemic, forest pasturage, securement of feed in the dry season and natural increase, the number of livestock will increase to 250% and to 400% for poultries.

C. Promotion of Fishery

Hatching ponds will be constructed for fishery, and freshwater fishes will be bred in these ponds.

D. Increase in Agricultural Production

The present agricultural production is 363685US$, and as shown in Table 4-2, an increase of 3318%, 116,726US$, is estimated for the agricultural production of the target year after the implementation of the development plan.

3-4-3 Promotion of Seed Production and Dispersion of Superior Varieties

In order to cope with the increase in the demand for high-yielding varieties due to the expansion of irrigated fields, seed and sapling farms will be established, and their production will be increased. Based on these conditions, new varieties will be introduced, dispersion will be hastened, and rice production will be stabilized both in quality and quantity.

Due to the impact of the demonstration of cash crops such as vegetables, fruits, etc., and the production of superior seeds, expensive crops of good quality will be dispersed in the area, and the productivity of the land and labor in the area will be greatly improved.

3-4-4 Impact of the Improvement of Agricultural Support and Living Environment

A. Impact of Agricultural Supporting Centers

(1) Protection from deterioration of rice quality

Due to smooth collection, storage and adequate treatment of the surplus paddy, deterioration of rice quality and decrease in price of rice will be prevented.

(2) Stabilization of producers' price

To cope with the farmers' demand for cash, the center will buy the surplus paddy and sell it when market prices are high. The profit gained from the paddy will be used for the improvement of the farmers' level and for rural development.

(3) Promotion of the improvement of agricultural structure

The improvement of the agricultural structure will be promoted through the collection and analysis of the information on marketing, cropping patterns, growing term and agricultural inputs, planning and training on planting, harvest, and shipping, and repayment of profits.

(4) Self-supply of Fertilizer

The self-supply of organic fertilizer will cause production increase and will curtail the expenses for chemical fertilizers and the use of foreign currencies.

(5) Increase in Employment Opportunities

In order to systematically and effectively manage the centers, a lot of technicians for the various levels and laborers will be employed. Temporary workers will be also employed during the harvest season. Thus, employment opportunities will increase.

(6) Improvement of Women's Status

Due to the construction of rice-polishing mills and storehouses, rural women will be released from the post-harvest treatment works. The

training and employment opportunities for women will increase and their status will be improved.

(7) Other impacts

- Improvement of farmers' communication
- Increase in training opportunities
- Promotion of local talent, rural development

B. Impact of the Improvement of Rural Roads

About 265 km of rural roads will be improved in order to make passage possible. The following impacts will, therefore, appear.

- Promotion of communication among the farmers by conducting visits among the villages, exchange of technology and agricultural information
- Promotion of supply of inputs, production and marketing activities
- Economization of working time
- Promotion of machines and smooth O/M

C. Impact of the Improvement of Living Environment

(1) Impact of improvement of water supply

Due to the construction of 250 wells

- Water intake labor will be annihilated and the farmers will have lots of spare time.
- The supply of fresh water will eliminate infectious diseases and reduce the death rate.
- The supply of water to the animals will be easy and their breeding will be furthered.

(2) Impact of preservation of pasture and forest

This will be effective not only for the development of livestock and fruit production, but also for preservation of living environment, protection from erosion, and preservation of water resources.

3-4-5 Priority of the Zones

Each zone is evaluated by its impacts, and they are as follows:

Items/Zone	Xe Bangfai	Xeno	Savanna khet	B. Lak 35	Pakxong	Donghen
Existing Irrigation	○	×	×	○	×	×
Water Resources	○	×	○	○	×	○
Marketing	△	○	○	○	×	×
Diversification	×	×	○	△	○	×
Scale and Easiness of Construction	○	△	△	△	×	×
Productivity	○	×	△	△	×	○
Flood Damage	×	○	×	△	△	○
Marks (○=3, △=2, ×=1)	16	12	15	17	10	13
Priority	2	5	3	1	6	4

3-5 Project Implementation Plan

3-5-1 Basic Policy of Project Implementation

For agricultural development, needless to say, the increase of land productivity is important. Development of economy, marketing and society have to be carried out on the same level to ensure that the two biggest targets; self-sufficiency in food and improvement of the agricultural structure, can be achieved. The project implementation plan has to be formulated from such point.

The establishment of agricultural supporting centers plays an extremely important role in agricultural improvement. These centers are the key stations in the development of markets, farmers' organization, input supplies and farmers' living conditions. Only with equal implementation in developing these sectors, will the agriculture be improved.

The first implementation project should be to combine the establishment of a center, on an adequate scale, with irrigation projects, including rural improvement projects near the center. Other irrigation projects, road improvement and expansion of the center on a corresponding scale will follow.

The center has to collect sufficient amount of paddy to obtain profits and Smooth management. This point has to be considered at the selection of the irrigation projects. Maneuverability of O/M and introduction of upland crops are also important factors. Gravity irrigation with reservoir system, with a possibility of double cropping, is recommendable.

3-5-2 Project Implementation Plan

The project implementation plan will be carried out according to the zone priority mentioned above. It is, however, undesirable to concentrate on a few zones. Each zone will be developed together step by step.

(1) Implementation Plan by Zones

(i) B. Lak 35 Zone

This zone is the most important agricultural area.

The center will be constructed at B. Lak 35 where the most important point of transportation is located.

H. Kalang (1), Thongxakun and Thongbak irrigation projects are on schedule in 1991. H. Louang, H. Xiangxoum, H. Takiang, H. Taleo, Namphu, Phummachedy and Nhyod H. Bak irrigation projects are at a good location. The last 2 projects are medium scale, F/S is necessary.

(ii) Xe Bangfai Zone

H. Xay (1), Namphou, Hatxiandi, H. Phiphut, H. Sadu, H. Bangkak and H. Sokbo irrigation projects are scheduled for 1991.

The Xe Bangfai irrigation project seems to be an effective one. After implementation of Nam Theune Project, which is under F/S, plenty of water will flow from the Nam Theune all through the year. The Xe Bangfai Project would improve irrigation on the lower Xe Bangfai plain. However, the project is of a large scale and the urgent implementation of F/S is recommendable. If the project is carried out, the dam site will be suitable for the location of the center as it is located along Route No. 13, and on the boundary of 2 provinces.

(iii) Savannakhet Zone

Savannakhet center will be the head office of all centers. Phakkha and Thapho irrigation projects are scheduled for 1991. H. Nambo, and H. Kasen irrigation projects are located at good sites. The H. Sompoy irrigation project covers a large part of this zone, though much sedimentation is expected after dam construction. F/S including hydrology, topography and geology is necessary.

(iv) Donghen Zone

This area has many water resources, and its development will have a favourable effect on the lower stream of the Champhon river.

H. Kasine irrigation project is on schedule for 1991. H. Tabonghak, H. Ngut, H. Nalai and Vang Khonh irrigation projects are ideally located. There are 2 large scale projects, Xe Champhon (1) and (2). Their F/S is necessary at the same time.

(v) Xeno Zone

H. Thahao (2) irrigation project is on schedule for 1991. H. Xeno, H. Hinelat and H. Kipma irrigation projects are effective.

(vi) Pakxong Zone

The water resources are poor in this zone, but upland crops such as tobacco and sesame are widely planted. Establishment of a center and a seed farm is effective.

3-6 Top Priority Project

The top priority project should be ① project with a harmonized integrated development ② a project with a suitable scale and one in need of high technology ③easy construction of accessible roads ④ a project in which diversification of farming is highly possible ⑤ highly marketable (near consumptive cities and has good road conditions) ⑥ immediately effective (possibility of double cropping, less flood damages and easiness of O/M) and ⑦effective for demonstration (traffic conditions, type of irrigation).

Many irrigation projects of weirs, pumps and gates have been carried out on local budget, and some projects are on the schedule for 1991. Consideration of possible irrigation during dry season, O/M and technology necessary for the study area, a gravity irrigation project with reservoirs and possible double cropping, is preferential. Considering the above-mentioned necessary factors for a top priority project altogether, the project should comprise a center and development projects for hardware, such as irrigation, roads and rural infrastructure. The top Priority Project is selected from the top priority zone, B. Lak 35 Zone. Irrigation projects are selected near the center and form the two important plains for agricultural development.

CHAPTER 4 OUTLINE OF THE TOP PRIORITY PROJECT AREA

4-1 Location

B. Lak 35 is located at the cross point of Route 11 and Route 13, 30 km west-south-west of savannakhet.

B. Mai is located at the entrance of the Nhyod H. Bak project area. It is 5 km eastwards from B. Lak 35 along route 11. B. Dongkhankhou, which is 5 km north of B. Mai, is located at the center of the areas that will benefit from this project. The water resources of this project are the Bak river.

B. Namphou is located at the center of the areas that will benefit from Namphou project. In order to reach B. Dongphosi, go 5 km to the west after moving 5 km southwards from B. Lak 35. B. Namphou is located 3 km south of B. Dongphosi. This area occupies the northern part of Phoummachedy basin. The Xai, Phou and Somhon rivers and their tributaries flow into the basin, joining all together at B. Phonsomhong at the southern end of the basin. These rivers are connected to the Chan river and flow into the Mekong river located 7 km downstream. Some of the water of these rivers become underground water.

4-2 Hydrology

4-2-1 Discharge Observation

Current measurements were done at 7 sites during the 24th-25th of December 1990. The discharge measurements are as follows:

H. Bak at the dam site:	200 ℓ/sec
H. Bak at B. Khamthao:	30 ℓ/sec
H. Xay at the bridge:	no flow
H. Namphou at the bridge;	90 ℓ/sec
H. Namphou + H. Xay	92 ℓ/sec
H. Pangha at B. Dontoum:	42 ℓ/sec
H. Pangha + H. Phou:	172 ℓ/sec

Though no surface flow was measured in H. Xay, the surface flow in H. Namphou was stable in the drought season.

4-2-2 Discharge for Water Balance Calculation

Nhyod H. Bak dam and H. Xay dam are proposed for the agricultural development project. For the required reservoir capacity checking, water balance calculation for the irrigation scheme should be based on the discharge at the water intake and dam sites.

With the consideration of the discharge observation and annual run-off due to rainfall, the discharge at the sites were derived under the following conditions:

* the drought year 1985 as the hydrological standard year for irrigation scheme

* direct run-off coefficient due to rainfall is about 0.35

Following table shows the discharge at the dam and water intake sites for the water balance calculation (based on 6 year probable rainfall at Xeno)

unit 10^3m^3

Site	Nhyod H. Bak	No.1	No.2	No.3+No.4	No.5	No.6
JAN	546	96	26	220	452	144
FAB	424	84	13	167	295	98
MAR	519	80	22	207	407	131
APR	853	274	75	361	966	291
MAY	1,521	640	174	666	2,043	599
JUN	3,580	1,797	489	1,609	5,416	1,564
JUL	2,402	1,132	308	1,069	3,479	950
AUG	3,379	1,678	457	1,516	5,073	1,466
SEP	1,595	556	151	592	1,790	527
OCT	1,511	635	173	662	2,027	595
NOV	363	33	9	164	264	90
DEC	375	0	0	142	172	64
TOTAL	17,068	7,005	1,897	7,375	22,384	6,519

4-3 Topography. Soil. Land Use

4-3-1 Topography

The project area is geologically composed of ancient alluvial deposits and dilluvial soils mainly consisting of sandstone shale and siltstone.

The elevation of the project area ranges from an EL 142 m to 166 m, with gentle slopes and undulations from the north-west to the south-east.

The area is categorized into two relieves and the vegetation of each category is as follows:

(1) Upper Pediment (EL: higher than 150 m, Topography: Erosion surface)
This area is a mosaic of woodland, wasteland, small pond, spring and rainfed paddy fields.

(2) Lower Pediment (EL: lower than 150 m, Topography: Alluvial valleys)
It occupies the central pat of the Project area, and has flat to micro reliefs. Most of the area is covered by rainfed paddy field. A part of the area was covered by water for only a short period at the time of flooding.

4-3-2 Soil Classification

According to the soil classification made in conformity with the system of "The soil amp of the world" compiled by FAO and UNESCO in 1974, the soils in the project area were classified into four groups. 38% of the soils belong to Acrisols.

(1) Acrisols

The acrisols extend broadly over the Project area. Acrisols are typical soils in the humid tropical area and are characterized by a base saturation of less than 50% in the B horizon at less than 120 cm deep where clay has illuviated. Acrisols develop on flats of ancient alluvial deposits which are broadly distributed at the monsoon zone. The mother rock is delicate and weathered, and is leached to elluviated layer clay. They are acidic and

podsolized in the surface horizon and ferric and alluminum illuviates in the lower layer.

The top soils are slightly acidic (pH 5.5 - 6.0) and has the texture of sandy loams or clay loam. The subsoils are more acidic than the top soils and the texture ranges form silty clay to clay. Soil profile shows a remarkably poor soil structure with ferric characteristic (mottles of ferric oxides and oxidic concretion or hardened plinthite at least 25 cm thick) within 100 cm from the surface.

Clay mineral of Acrisols is mainly of Kaolinite which is characterized as having low cation exchange capacity (CEC), low base saturation degree, and high acidity, which are obvious in the data obtained from the laboratory analysis, and especially low phosphorus content.

Generally, the soils with an elevation lower than 150 m have a depth of more than one meter. This difference is considered to be caused by the soil conservation effect of covering vegetation.

(2) Fluvisols

The soils classified under Fluvisols are located at the southwest boundary of the H. Bak district. The area is 226 ha in measurement and is mainly made up of waste lands, small ponds and rainfed paddy fields.

The soils are primarily made from recent alluvium deposists on a hardpan depression.

The profile has no particular diagnostic features except for very few weak mottling formation in the shallow depth. The typical horizon sequence is A/B/C. The A horizon is brownish black (5 YR 2/2) in matrix color, clay loam to clay, medium and weak sub-angular blocky structures, friable when wet and slightly hard when dry, and has gradual and smooth boundaries with the B horizon.

The B horizon is brownish black (7.5 YR 3.2) in matrix color, clayey in texture, and is diffused and smoothly bounded to the C horizon.

The C horizon is dull to dark brown (7.5 YR 3/4) in matrix color, gravelly and clayey in texture.

(3) Gleysols (Humid Gleysols)

The soils of this unit develop rather widely over the depression along the H. Bak and H. Phou River in the flat portion of the Project area. The area is 559 ha and cultivated with rainfed paddy.

The land covered by this soil develops on the recent alluvial deposits. It gets inundated during the rainy season and has high ground water table even in the dry season. Typical soil horizon sequence is A/C and the effective soil depth is shallow and limited by the groundwater which only exists 30 - 40 cm from the ground surface even in the rainy season.

The A horizon has high moisture content, grayish black in color, very fine clay, massive structure, firm, and is clearly and smoothly bounded to the C horizon.

The C horizon is grayish in color, clay to silty clay, and contains low organic carbon.

With regard to physical properties, the soils have relatively high moisture holding capacity with very low permeability coefficient. This soil area is suitable for paddy cultivation but not for the corps.

(4) Cambisols

Cambisols extend over the upper pediment of the project area.

The top-soil and subsoil are slightly acidic (pH 5.5 - 6.0) with the texture of sandy loam to clay loam. Soil profile shows remarkably poor structure with ferric characteristics (mottles of ferric oxides and lateritic gravels) below to 150 cm from the surface.

Clay mineral of Cambisols has low cation exchange capacity (CEC) and low base saturation degree, which are obvious in the data obtained from the laboratory analysis, and especially low phosphorus content, too.

Generally, the Area with an elevation higher than 150 m (upper pediment), has a Cambisol thickness of more than one meter, however, some area are shallow.

Areas by soil types are as follows:

unit ha

Soil Type	Namphou	Nhyod H. Bak	Total
Gleysols	252	307	559
Acrisols	489	470	959
Cambisols	220	569	789
Gluvisols	-	236	236
Total	961	1,582	2,543

4-3-3 Land Classification

Land Classification of the project area is made in accordance with the land classification system formulated by the National Institute of Agricultural Science, Japan.

In the Japanese system, lands are classified into 4 capability classes, i.e., Ⅰ, Ⅱ, Ⅲ and Ⅳ. Each class is defined as follows:

Class Ⅰ; Land has almost no limitation for crop production and/or no risk of soil conservation. It is naturally fertile and has a great potential for crop production without applying any soil improvement practices.

Class Ⅱ; Land has some limitations for crop production and/or some risks of soil conservation, and requires some soil improvement practices for normal crop production.

Class Ⅲ; Land is widely limited for crop production and/or is likely to be subject to risks of soil conservation, and fairly intensive improvement practices are required.

Class Ⅳ; Land has great natural limitations than those in Class Ⅲ, but can be utilized for cultivation of some specific crops under very careful management.

Land is classified under the above four classes in each factor and finally determined at the lowest class among all classes of the factors. The 13 factors are thickness of top soil (t), effective depth of soil (d), gravel content

in top soil (g), easiness of plowing (P), permeability under submerged condition (ℓ), stage of redox potential (r), wetness of land (w), inherent fertility (f), content of available nutrients (n), degree of hazard (i), frequency of hazard (a), slope (s) and erosion (e).

The area extent of each capability class is as follows:

Class		Nhyod H. Bak	Namphou	Total
Paddy	Upland			
III	IV	1,183	834	2,017
IV	IV	399	127	526
Total		1,582	961	2,543
Village, Stream, Pond		43	39	82

From the results of the land classification, 2,017 ha has been evaluated as suitable for paddy cultivation. For cultivation of upland crops, all of the lands are unsuitable under the present condition. As the main evaluated factors are w and e, there are no problems on cultivation after irrigation development.

4-3-4 Land Use

The project area has been developed and used as paddy fields for a long time. The paddy fields are almost rainfed with single cropping of rice during the rainy season, and double cropping fields are for spring water or manual irrigation. Early maturing varieties, medium maturing varieties and late maturing varieties are planted, respectively. These varieties are closely concerned with water resources and flood conditions. Farmers prefer to plant these three types of paddy varieties together.

The upland crop fields are classified into normal upland fields and burnt fields, however there are only few burnt fields. Home gardens are cultivated in some parts of the residential areas and paddy fields and fruits trees, vegetable spices, and fiber crops are planted in a small scale.

Paddy field during the dry season, and a part of the forest area are used as pasture for buffaloes and cattles.

4-4 Rural Society

4-4-1 Beneficiary Villages in the Development Area

The beneficiary villages are 14 villages in Champhone District for Nhyod H. Bak Project and 9 villages in Kanthabouly District for Namphou Project.

As of 1990, the population of each village is as follows;

Nhyod H. Bak Area

Village	B. Xianban	B. Nonghong	B. Sithong	B. Kho	B. Nongven
Population	532	457	560	712	392
	B. Dongdokmai	B. Vatthama	B. Phailom	B. Phonthan	
	515	650	317	225	
	B. Nanokkhian	B. Dongkhankhou	B. Nongkalong		
	455	650	640		
	B. Gnangsoung	B. Dongkhamkhenm	Total		
	479	426	7,049		

Namphou Area

Village	B. Mouangkahi-Nua	B. Mouangkhai-Tai	B. Dongtoum	B. Dongmakfai
Population	457	560	712	392
	B. Donghouakham	B. Namphou-Nua	B. Namphou-Tai	
	227	630	568	
	B. Dongphosi	B. Phoxai	Total	
	740	267	6,480	

The average population increase rate for the past 5 years is 3.2%.

4-4-2 Rural Life

(1) Administrative structures of farm villages

The village organization are most closely involved with the farmers' daily living, and it is the only farmers organization existing at present.

The general structure of the village is centered on the village chief who is assisted by 2 or 3 persons.

The village is divided into collective units called "Chu" which is composed of a group of 5~10 households, 2 or 3 ≪Chu's≫ gathered together will form a "nouy", and several "nouys" will compose a "kum", indicating a subtle communication network.

The women's association, the senior association, Youth Association and the garrison of the village are mobilized in different occasions, varying from ceremonial occasions to restoration works of damaged caused by calamities. In case there are important works to be made, such as repair of roads or reservoirs, they collaborate with other villages.

(2) Farm size and average yield

Farm size per household is 1.21 ha of paddy field, 1.22 ha including upland in Nhyod H. Bak Area, and 0.96 ha and 1.10 ha respectively in Namphou Area.

According to interviews conducted at the districts, the average paddy yield were 1.97 t/ha in Nhyod H. Bak Area and 1.28 t/ha in Namphou Area.

On the other hand, according to the interview survey at 4 villages, the average yield were 0.81 t/ha and 1.32 t/ha respectively.

The modified values based on the interview survey, are 1.47 t/ha and 1.40 t/ha respectively.

Main data of each area are as follows:

	Nhyod H. Bak Area	Namphou Area	Total
Number of family	1,325	1,179	2,504
Total paddy fields (ha)	1,589.25	1,138.03	2,727.28
Farm size of paddy field (ha/family)	1.21	0.96	1.09
Total farm lands (ha)	1,603.75	1,295.51	2,899.26
Farm size of farm lands (ha/family)	1.22	1.10	1.16
Paddy production (t)	3,054.47	1,561.78	4,516.26
yield (t/ha)	1.87	1.28	1.66

Demand and supply of paddy in the project area are shown at the following table. In 1990, there was an overproduction of 669 t of paddy in the Nhyod H. Bak Area, but a shortage of 764 t in the Namphou Area. There was a total shortage, therefore, of 95 t of paddy.

	Nhyod H. Bak Area	Namphou Area	Total
Population	7,049	6,480	13,529
Paddy production (t)			
Paddy	3,054	1,462	4,516
upland rice	96	32	128
Rice Consumed in the area (t)	2,326	2,138	4,464
Tax (t)	155	120	275
Balance (t)	669	-764	-95

(3) Farmers' household economy

Approximately 57% of the total income and 51% of the total expenditures are covered by self consumptive paddy production/consumption. The most part of cash income is contributed by livestock at approximately 22%, followed by wage income. Medical expenses surpass the production cost in Namphou Area, while production cost is only second to paddy consumption in Nhyod H. Bak Area.

The results of the interview of the 4 villages are shown at the following table.

(unit %)

	Nhyod H. Bak Area	Namphou Area	Total
Income	100	100	100
Crops	57.6	56.6	57.0
Paddy	53.3	53.9	53.6
others	4.3	2.7	3.4
Livestock	22.9	21.3	22.0
Buffalo and cattle	11.1	14.5	13.0
Pig	7.8	3.4	5.4
Poultry	4.0	3.4	3.6
Wage, salary	6.3	15.6	11.5
Handicraft	5.1	1.0	2.8
Remittance, others	8.1	5.5	6.7
Expenditure	100	100	100
Production cost	14.7	6.7	9.6
Fertilizer, chemicals	12.1	3.8	6.8
Labor cost, others	2.6	2.9	2.8
Consumptive paddy	50.7	36.3	41.5
Medical cost	9.9	15.0	13.1
Educational cost	4.9	5.4	5.2
Special expenses	3.5	4.9	4.4
Daily cost, others	16.3	31.7	26.2

(4) Medical care and education

The medical care condition in the project area is extremely poor, and only 3 villages have medical clinics at without permanent doctor. Out of the clinics, only one has a permanent nurse. The average medical expenses cover 13% of the total expenditure of the farmers' household economy. The number of elementary and junior high schools is 18 in the Nhyod H. Bak Area and 9 schools in the Namphou Area. The school attendance is estimated to be more than 75%. Each village has an elementary school. The educational system, however, faces problems such as lack of teaching materials, teaching staff and well qualified teachers.

(5) Domestic water

The area's source of domestic water is mostly well water. The number of families commanded by one well ranges from 13 to 115 families, 52 families with 289 persons in average. Only one village has no well and depends on a stream.

The number of villages where one well commands more than 60 families is 9 in the Nhyod H. Bak Area and 1 village in the Namphou Area. According to the field survey, the shuttle frequency is 6 ~ 7 times/day, and a total volume of water consumption per day per capita is estimated to be between 20 and 30 liters.

4-5 Agriculture

4-5-1 Cropping Situation

The area mainly cultivates paddy fields. According to the last 5 years statistics, the paddy fields in Khanthabouly and Champhou District are decreasing, but production is increasing. Aside from paddy, upland rice, vegetables, peanuts, cotton, hemps, etc. are also cultivated in the area. The cropping percentage is estimated at 80% for paddy rice, 15% for upland rice, 5% of vegetables, peanuts, etc., while cultivation ratio corresponds to 100% for the rainy season cropping, and 2% for dry season cropping.

4-5-2 Rice Cultivation

98% of the paddy rice are glutinous rice of which 20% are early maturing species, 30% are medium maturing species and 50% late maturing species. Paddy cultivation and rice planting starts in the downstream area where water circulation is good. Late maturing species are then planted in this area. It then proceeds to paddy fields with good water circulation.

The rainy season paddy planting begins in May to June, the transplanting is carried out in June to July, and harvesting is carried out from October to December.

There are few damages by flood in the project area, and they are mostly caused by drought.

4-5-3 Field Crops

Cultivation is carried out by burning and conducting direct seeding before the rainy season in the hilly area. The different crops cultivated during the rainy season are peanuts with a ratio of 65%, 25% for industrial crops such as cotton, sesame and hemps, and vegetables are planted at the places where water is easily gained during the dry season. Peanut production (fresh seeds with shells) during the harvest season amounts to about 500 kg/ha, and water melon in the dry season amounts to 4,500 kg/ha.

4-5-4 Fruit Trees

There are no large scale orchards in the Study Area and only several trees are planted in the village surroundings. The impediments in orchard development in this Area are the following: 1) cultivation knowledge of the farmers are poor; 2) transmission of market information are inadequate, and 3) short supply of fruit trees.

4-5-5 Livestock and Poultry

Livestocks usually gain weight during the rainy season, but lose weight during the dry season. The average birth rate of piglets is 5 heads, but a small number of baby pigs die within a year (about 2 heads); as for poultry the brooding average is twice a year and each brooding consists of about 5 eggs, but a lot of chicks die soon.

According to the data of the last 5 years in the Study Area, cattle and poultry are making gross progress.

4-5-6 Fish Farming

Aside from the inflow of cash, cheap protein resources can also be developed. The Savannakhet Bureau of Agriculture made a study on farming in paddy fields, however, the Project wasn't realized due to lack of funds. The government-run farm of Phukubou, which was the base for the supply of fries, had to stop producing young fishes because of poor management. Therefore, the supply of fries is only provided by small scale private water culture traders.

4-5-7 Agricultural Support

An information counter has been established within the Savannakhet Agricultural Bureau to investigate the financing of farming funds intended for small farmers. However, in order to obtain a loan with low interest rate, it is necessary to draw up one's personal assets and method of repayment and to obtain the approval of the Bureau of Agriculture. Further, those who have never written documents shall have to design a plant and small scale farmers have never been granted loans with low interest rates as the formulation of these documents are difficult.

Although the area is afforded with technical assistance, there is also a shortage in the absolute amount of extension workers and agricultural inputs such as fertilizers, seeds and agricultural chemicals. According to the survey conducted on farmers, the need for agricultural input materials are growing gut the supply is short.

4-5-8 Labor Force

Draught animals used as labor force hold 10% of the total volume of work; the majority of the work is executed by man power. Labor is most particularly required during the rice planting and harvest season. To ensure the labor force in this period, mutual assistance is practiced and priority is given to relatives.

Rice planting and harvest periods involve the most intensive work in paddy field cultivation. The labor of a male adult is 45 ma·day/ha in rice transplanting and 17 man·day/ha in harvesting.

4-5-9 Diffusion of Agricultural Machinery and Implements

The public enterprises under the control of the Bureau of Agriculture rent out agricultural machineries and implements like tractors and trucks and promotes the mechanization of agricultural works. However, mechanization is obstructed by the following: 1) farmers can't afford the rental fees due to scanty farming capital, 2) the lagging improvement of cultivated lands and rural roads makes the delivery of machines difficult; 3) shortage of me experienced in the operation of the machines.

The diffusion of agricultural machinery will take a long time, because it needs much funds.

4-5-10 Use of Agricultural chemicals and Fertilizers

Compound fertilizers are remarkably effective and easy to transport, and therefore, are being widely used in the area. The transportation cost of the supply coming from Vientiane is expensive that it is a lot cheaper to purchase the fertilizers directly from Thailand. Restrictions imposed on the exportation of fertilizers in Thailand, however, obliged the farmers in this area to use enough volume.

Compound fertilizer is used as a basal fertilizer during the cultivation period. It is rarely used as a additional fertilizer, the most effective use of compound fertilizers, because, 1) shortage in fertilizer application techniques causes uneven sprinkling of fertilizer which damages the growth and development of the crop, 2) lack of capital to purchase them used for additional fertilizer.

According to the field survey, the supplied volume was 10 kg/ha in Urea, 25 kg/ha in Ammopho, 50 kg/ha in composts and they are extremely few.

The agricultural chemicals used are mainly insecticides, whereas bactericides and herbicides are scarcely used at all.

4-5-11 Existing Irrigation System

There are two irrigation systems around the project area. One is the H. Bak reservoir project in Champhon, and the other is the Kouthapho reservoir in Khanthabouly. The former was constructed in 1989 in B. Dong Nongkhoumk, 15 km downstream of the Bak river from B. Dongkhankhou. The latter was constructed in 1988 southeast of the Phoummachedy plain. H. Bak reservoir is inundated during the rainy season making the irrigation of 200 ha of land in and around the reservoir in the dry season, by manpower or small pumps using water from 400 ha of reservoir in the dry season possible. As for the Kouthapho reservoir, 10 to 30 ha of paddy fields are irrigated in the dry season by gravity with the water from 50 ha of reservoir area. Also, some 50 ha of paddy fields are irrigated in the rainy season when the rainy season starts belatedly.

Besides the two projects mentioned above, irrigation for dry season paddy cultivation was also conducted several times in B. Namphou by using a little of the annual flow of the H. Phou Noy river where a small earth dike and reservoir is constructed. The irrigated areas varied from 3 to 5 ha depending on the flow of the river. All these reservoirs have almost no irrigation facilities such as canals and diversion structures, except for the small canal of Kouthaphou reservoir. Plot to plot irrigation system is used with temporary canals which are constructed annually or installed with small pumps.

CHAPTER 5 BASIC DEVELOPMENT APPROACH

5-1 Factors That Impede Agricultural Development

General factors are mentioned in the master plan formulation, the factors which are specially given emphasis are as follows:

(1) Shortage of irrigation facilities

There is not irrigation systems in the project area excepting a few small scale and elementary irrigation at places where much water can be easily used. As the chemical fertilizers are not effective without irrigation, the shortage of irrigation facilities impedes increase of productivity and diversification of crops.

(2) Shortage of fertilizer

According to the survey, approximately 90% of farmers in the project are use chemical fertilizers, almost of all farmers, however, supply less than 100 kg/ha, it does not reach to an effective volume.

(3) Poor road conditions

Farmers can not select suitable timing for supply of agricultural inputs and transportation of products due to poor road conditions. Middlemen also do not visit the area during rainy season.

(4) Insufficient marketing system

Due to the past self-consumpting agricultural system, the marketing system is poor. It impedes from farmers' volition to increase the production, to plant diversified crops, and it makes middlemen easy to beat down the price of the products.

5-2 Approach to Development

The purpose of the Project is to increase the production and farmers' income, and to raise the farmers' living level by introduction of irrigation and modern agricultural technology. In order to achieve it improvement of

farming based on irrigation development, marketing system development, roads development and water supply development is studied.

5-2-1 Land use

Land use plan is formulated based on the land classification in consideration with topography, farming conditions and irrigation method.

5-2-2 Irrigation

The purpose of irrigation is to stabilize the raining paddy production to increase land productivity and to make agricultural diversification possible. The rivers, which are water resources in the project area, have small catchment areas and base flow is few. Therefore, in order to keep irrigation water for dry season, a construction of reservoir is necessary. Considering insufficient experience of pumping irrigation systems, technology, funds, supply of part and underdeveloped electrification in the project area, a gravity irrigation system with reservoir is recommendable for the first pilot project.

5-2-3 Agriculture

Considering traditional cropping pattern and water resources, all irrigable areas are proposed to plant paddy during rainy season. During dry season, half of the irrigable fields will be planted by paddy and other half by upland crops.

As the modern farming is the first experience for farmers, a demonstration farm will be constructed to make easy agricultural extension work.

5-2-4 Agricultural Supporting Center

The production and the kinds of products will be increased by the implementation of the Project, and it causes the necessity of a marketing system. On the other hand, the Government tries to establish agriculture managed by farmers-selves. An agricultural supporting center will be established so that smooth marketing will be promoted, and that the benefits will be returned back to the farmers and other agricultural development.

5-2-5 Rural Infrastructure Development

In order to make effective agricultural development, agricultural supporting center and farmers' communication, rural roads and water supply will be improved.

CHAPTER 6 AGRICULTURAL DEVELOPMENT PLAN

6-1 Proposed Land Use

As a result of land capability classification, an area of 2.017 ha is classified into class Ⅰ, Ⅱ and Ⅲ for crop cultivation.

Further, the land use plan is determined, taking the present land use and topographic conditions for irrigation into consideration in addition to the result of land classification. Some of the areas classified as unsuitable, but presently cultivated as paddy field included in the irrigation area. Infrastructures including irrigation facilities will occupy 263 ha, consisting of 195 ha of present rainfed paddy field, 37 ha of grass land, 15 ha of forest, 14 ha of waste land and 2 ha of pond and stream.

For the area where the soil is composed of gleysols, acrisols and cambisols, rotational cropping of rice and upland crops are proposed considering the suitability of soils, soil improvement and necessity of crop diversification.

The proposed land use is summarized as follows:

	Present Land Use						Proposed Land Use					
	H. Bak		Namphou		Total		H. Bak		Namphou		Total	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Rainfed Paddy Field	1,170	72	835	83	2,005	76	110	7	45	5	155	6
Irrigated Paddy Field	-	-	-	-	-	-	-	-	45	4	45	2
Paddy/Upland Crop Field	-	-	-	-	-	-	950	58	660	66	1,610	61
Upland Crop Field	12	1	3	-	15	1	12	1	3	-	15	1
Grassland	230	14	59	6	289	11	200	12	52	5	252	9
Forest	102	6	18	2	120	5	89	5	16	2	105	4
Waste land	68	4	46	5	114	4	59	4	41	4	100	4
Pond and Stream	35	2	37	4	72	3	34	2	36	4	70	3
Village	8	1	2	-	10	-	8	1	2	-	10	-
Infra - Structure	-	-	-	-	-	-	163	10	100	10	263	10
Total	1,625	100	1,000	100	2,625	100	1,625	100	1,000	100	2,625	100

6-2 Rural Society, Farmers' Organization Plan

6-2-1 Plan for Medical Care

The conditions of medical care are extremely poor. Medical care requires heavy expenses and as such will increasingly give impetus to a needy existence. This is why a full consideration must be given to construction of clinic facilities, permanent doctors are required, and qualified nurses, too, are to be employed. However, training of doctors and nurses should be taken as a nation wide problem.

The plan, if feasible, is to build a clinic with 10 beds in B. Lak 35, and to employ and station doctors and 3 nurses permanently.

6-2-2 Plan for Education

The problem of education doesn't concern only this Area. Therefore, headway has been made on the basis of a national priority policy.

Even now, every village has an elementary school, and it is desirable to include junior high school classes in the existing elementary schools. It is also desirable to increase teaching staff corresponding to the number of classes in order to avoid a double teaching system. more important problem is to raise the quality of teaching staff, an improvement of pay condition is one way to solve the problem.

6-2-3 Plan for Domestic Water

The average number of well in the Project Area is Planned as 1 well for less then 60 families, that is to say, 1 well for a population of about 290.

A total of 10 wells must be built, 9 wells in Nhyod H. Bak Area and 1 in the Namphu Area.

6-2-4 Agricultural supporting Center

(1) Purpose

The purposes of the establishment of the agricultural supporting center are to increase productivity (land productivity, labor productivity

and investment productivity), to improve the economic condition and to elevate farmers' social status by their efforts.

In order to achieve these purposes, a farmers' organization will be created, and it will carry out the collection, processing, storage, and marketing of the farmers' products and fishery using newly constructed reservoir at the first stage. And it will carry out expansion of the center's function such as supply of production inputs, promotion of agricultural machinerization, credit, improvement of farmers' living conditions, expansion of modernized agricultural lands, processing, etc., after accumulation of the center's funds.

(2) Functions

It's fundamental functions will be as follows:

- Collection of surplus rice and other agricultural products, storage, rice polishing, Selling
- Providing informations related to farming and marketing,
- Instruction concerning operation and maintenance of water supply facilities,
- Technical training concerning the demonstration farms and cultivation, and
- Fish farm management and sale of handicraft work

(3) Organization

The ultimate objective of the project is for armers to manage the Center by themselves. However, there are obviously a lack of staff able to conduct instructions about many techniques, and a lack of funds. To solve these problems it is essential to receive assistance (funds, qualified persons) from the provincial government.

The organization of the Center will consist of Board of Directors and the following Divisions.

Board of Directors : 11 persons (MAF 1, province 3, O/M office 1, Districts 2, Village 4)

Chief of the Center : 1 person

General Affairs Division : 1 person, finance, human affairs, members' list, building and repairs.

Production and Marketing Division : 4 persons, informations of marketing, sale, storage and processing of products.

Life Improvement Division : 2 persons, information related to living improvement practice technical training for handicraft work

Credit and Loan Division : 1 person, credit, fertilizers, compensation of damages due to drought, etc.

Technical Division : 3 persons, training of farmers, machinalization, fish breeding

(4) Location of the Center

The Agricultural Supporting Center will be established at B. Lak 35 which is located at the intersection of route No. 13 and route No. 11. Furthermore, this area is the central zone of the beneficiary villages.

(5) Center management plan

(i) Income

(a) Income by rice marketing

- Income by collection, storage and selling of the excess paddy, 5,362 t. (10 % of selling price) 56,301,000 kip
- Income by rice cleaning (3,000 t/year) 45,000,000 kip

(b) Income by upland crops marketing (860 t, 10 % of selling price) 12,470,000 kip

(c) Income by fish breeding (10 t/year and fries selling) 4,990,000 kip

Annual income 118,761,000 kip

(ii) Expenditure

(a) Personnel expenses

Staff (12 persons)	15,120,000 kip
Staff (10 persons)	43500,000 kip
Temporary employee (60 M/M)	1,950,000 kip

(b) Fuel

Generators	7,100,000 kip
Vehicles	10,248,000 kip

(c) Maintenance (generators, rice mill, pump, vehicles, buildings) 25,474,000 kip

(d) O/M costs for fishery 850,000 kip

(e) Replacement costs 25,490,000 kip

Annual expenditure	90,732,000 kip
Annual balance	28,029,000 kip

(iii) Management Plan

Agricultural production will increase year by year for the first 5 years. The benefit of the center will appear from 3rd year and full benefit will appear from 8th year as follows:

(unit : 10^6 kip)

	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year
Income	55.99	84.83	98.84	103.47	118.62	118.71	118.74	118.76
Rice								
Rice Production	5363	6435	7508	7753	8825	8825	8825	8825
Cosumptive rice in the Area	1316	1316	1316	1316	1316	1316	1316	1316
Excess rice	1900	2972	4045	4290	5362	5362	5362	5632
Selling income	19.95	31.21	42.47	45.05	56.30	56.30	56.30	56.30
Rice cleaning income	28.50	44.58	45.00	45.00	45.00	45.00	45.00	45.00
Upland crops								
Selling volume (t)	520	623	693	762	860	860	860	860
Selling income	7.54	9.04	10.05	11.05	12.47	12.47	12.47	12.47
Fishery	0	0	1.32	2.37	4.85	4.94	4.97	4.99
Expenditure	55.99	84.83	98.84	100.25	90.73	90.73	90.73	90.73
Personnel expenses								
Staff (person)	4	8	12	12	12	12	12	12
Salary	5.04	10.08	15.12	15.12	15.12	15.12	15.12	15.12
Staff (person)	6	10	10	10	10	10	10	10
Salary	2.70	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Tempolary employee (M/M)	30	40	60	60	60	60	60	60
Labor cost	0.98	1.30	1.95	1.95	1.95	1.95	1.95	1.95
Fuel	12.31	17.35	17.35	17.35	17.35	17.35	17.35	17.35
Maintenance cost	9.47	25.99	26.00	26.00	27.89	27.89	27.89	27.89
Fishery cost	0	0.12	3.00	0.85	0.85	0.85	0.85	0.85
Replacement cost	25.49	25.49	25.49	25.49	25.49	25.49	25.49	25.49
Blance	0	0	5.43	12.21	25.47	25.56	25.59	25.61

In this management plan, taxes are not considered, tax reduction system would be necessary until the center's management will reach to normal one.

6-2-5 Operation and Maintenance of Facilities

(1) Construction Office

The main agency in charge of the execution of the Project is the Laos Ministry of Agriculture an Forestry (MAF). The MAF will create the Office of Construction, and will appoint an Office manager, which will make the work proceed, and will manage the office too.

In order to control the Project construction, a Steering Committee including provincial staff will be formed under the Minister's authority. They will deliberate on the important items concerning the conduct of the work. The office manager will be in close touch with the Steering Committee.

The construction office will supervise not only the construction work but also other works, such as detailed planning ahead of the construction work, draft of Tender Documents, prior investigation on the requirements for Tender, examination of Tender, and securement of the building sites.

The construction office will be probably built in the Department of Agriculture and Forestry of Savannakhet.

(2) Operation and Maintenance Office

After the construction work is completed, all the work facilities will be turned over to the Savannakhet Province for operation and maintenance.

The manager appointed by the Governor shall be in charge of the operation and maintenance work and the management of the office.

The Steering Committee will be placed under the Governor's jurisdiction, and will deliberate on the important items concerning the execution of O/M work. Even after the completion of the construction work, the Ministry of Agriculture and Forestry, acting as the important Member of the Steering Committee, will give appropriate advice and support to the O/M Office to help smoothen the execution of the O/M work.

As the project is a medium scale one, the Office will be managed by 2 engineers, 1 agricultural extension worker and 2 operators for the first stage. The Office is installed with radio phone equipments for smooth communication to the center and the project areas.

The Office will be installed with O/M machines such as 1 backhoe (0.5 m^3), 1 motor grader (135 HP), 1 dump truck (8 t) and 1 pick-up.

The contents of the business that must be carried out by the O/M Office will be as follows.

(i) Draft of Water use Plan

The Plan for irrigation water distribution will be based on the storage capacity of water in the reservoirs, the weather conditions, The cropping varieties, the planted area, and the field conditions.

(ii) Hydrologic observations (amount of rainfall, water level), re-adjustment of the observation record, and analysis.

Observations will be carried out on the water level and the storage capacity of the reservoirs, meteorological data to formulate the water use and cropping plan.

(iii) Control of Irrigation Water

Farmers will be igformed how to correctly hold and control a reasonable amount of water in accordance with the growth of the crops.

(iv) Maintenance and Repair of irrigation Facilities

Maintenance and repair of the dams, the storage reservoirs, and main canals must be conducted usually in order to avoid the facilities malfunction. The water users' organization will be responsible for the operation and maintenance of canals.

(v) O/M and Repair of Machines and implements

O/M and repair of machines for O/M will be carried out.

(vi) Training of Water Management Techniques

Training of techniques related to the efficient use of water will be carried out at the demonstration farm, to improve the farmers cultivation and irrigation techniques.

(vii)Extension of Improved Farming Methods

Agricultural mechanization, selection of varieties, fertilizer application techniques (proper use of chemical and organic fertilizer), knowledge of chemical effects, safe spraying methods, etc. will be introduced at the demonstration farm.

(viii) Guidance on Demonstration Farm Management

Regarding the Management of the demonstration farm, each household shall cultivate its unit independently.

Office shall guide farmers concentratedly so as to raise demonstration effect and agricultural level in the province.

(ix) Guidance on Agricultural Supporting Center

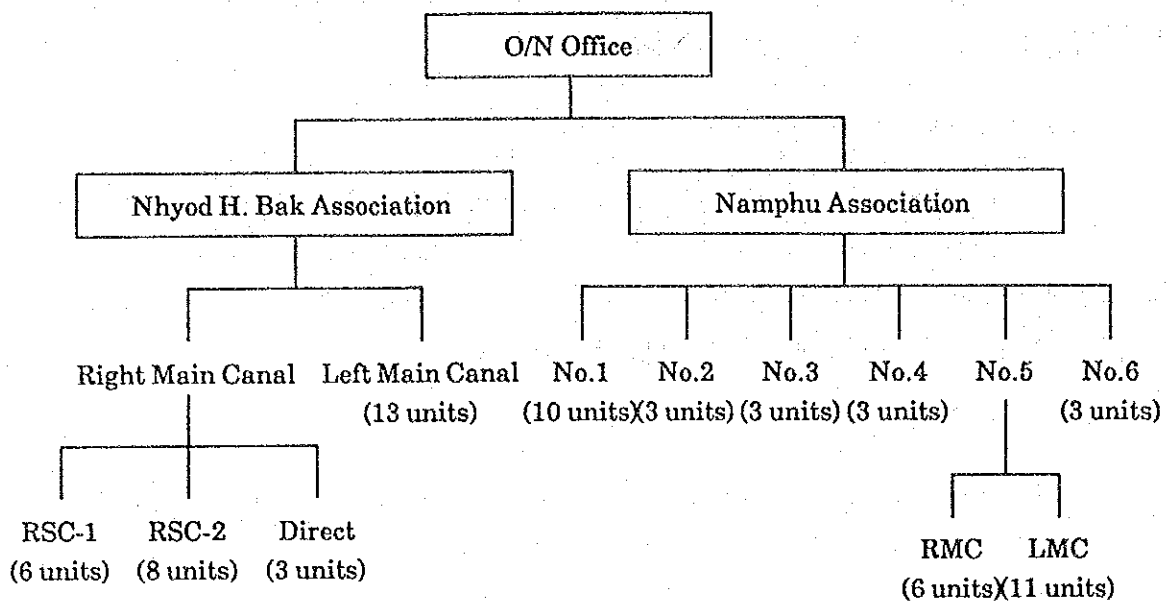
The Office shall guide the center's management for its smooth development.

(3) Water users association

Though the water management plan, cropping pattern for every year, O/M plan for the irrigatoin and drainage facilities will be formulated by the O/M Office, an water users association will be established for complete execution of the plans and for raising farmers' intension to participate to the project.

The water users association will be organized with a unit organization of each field turn-out. It will be organizaed by 20 ~ 50 families. The unit organization will be grouped to each secondary canals group, and to each main canals, and finally to each irrigation system. Each association will select operators of turn-out, and he will operate the system under the guidance of the Office.

Organization chart is shown bellow.



6-3 Agricultural Development Plan

6-3-1 Selection of crops.

After completion of the project construction, 1,655 ha of the existing rainfed paddy fields will be irrigated and 985 ha out of the 1,655 ha will be upgraded to year-round irrigation.

All irrigated paddy fields will be planted by paddy during rainy season, and 490 ha will be planted by paddy and another 495 ha will be planted by upland crops during dry season.

As for upland crops, a formulation of chief producing district is desirable from a viewpoint of extension work of the farming technology and marketing. considering the past farming, marketing, soil conditions, meteorological conditions, expensive fertilizers, saving water and easiness of processing and storage, a formulation of chief producing district of peanuts is proposed.

Though other crops such as vegetables, spices, etc. might be planted, they are considered to be for self-consumptive use in small scale. Peanuts are, therefore, proposed as a main crops.

6-3-2 Planting Method

(1) Paddy

(i) Nursary bed

The area of the nursary bed is 500 m^2 per ha of paddy field, and the nursary period is 25 days.

Photo-sensitive varieties such as RD6, RD8 and Sampatong, during rainy season, and low photo-sensitive varieties, such as RD10 and IR789, during dry season will be applied. The volume of seeds will be 40 kg/ha with seed selection using solution. the seeds will be supplied by the Tasano seed farm. Seeds will be replaced every 3 years.

(ii) Land preparaion and transplanting

Land preparation will take 10 days, and harrowing and puddling of soil will be carried out by animal power.

Transplanting will be made with a spacing of 30 cm × 15 cm.

(iii) Fertilization

Amount of fertilizers to supply will be 150 kg/ha of Ammophos, 1,000 kg/ha of composts and 100 kg/ha of Urea for the rainy season paddy. Considering the difficulty of production and resolution of composts during dry season, the volume will be 200 kg/ha, 500 kg/ha and 100 kg/ha respectively for the dry season paddy. Urea is easy to resolve, all amount of Urea and 60 % of Ammophos will be used for additional fertilizer, and 40 % of Ammophos and all amount of composts will be used for basal fertilizer.

(iv) Weeding and plant protection

Weeding will be carried out 2 - 3 times in accordance with the weed growth. It is effective to carry out the insect protection systematically, not individually.

The applied volume of chemicals is 10 kg/ha for rainy season and 5 kg/ha for dry season

(v) Harvesting

Harvesting will be carried out by hand as present. The proposed yield is 4,0 t/ha for the rainy season paddy and 4.5 t/ha for the dry season paddy.

(2) Upland crops.

In peanut cultivation, watering is required from the sowing period upto the flowering period. It is better to leave the soil dry during fructification, in order to prevent the seeds from getting spoiled.

Furrow irrigation shall be adopted and the cultivation of early maturing and high-yielding native varieties shall be popularized.

The planting method is as follows:

- a sowing volume average of 60 kg/ha;
- an interhill space of 20 cm, and an interrow space of 30 cm;
- approximately 16,000 hills/ha.

To protect the seeds from birds, they shall be dipped into the waste oil of machines before they are sown.

A fertilizer application plan shall be made for manuring. This plan shall entail the use of 1000 kg/ha of composts, 150 kg/ha of compound fertilizer, and 50 kg/ha of Urea. 10 kg/ha of chemicals will be supplied for insect protection. The proposed yield is 2.5 t/ha.

(3) Fishery

A reservoir which is suitable scale for fish breeding will be constructed, fishery plan is formulated using it.

(i) Fry production

After duly considering on ① high propagating powers and fast growth, and ② high marketability, Tilapia Nilofica and Common Carp are selected for fish breeding.

In order to protect weak fries from natural enemies and to improve the life rate of stocked fries, they shall be stocked for approximately 3

weeks in a hatchery constructed in the center, and then transferred to the reservoir after they are fully grown.

Fries shall be purchased for breeding, and those to be made as parent fishes shall be selected and then stocked in a small pond.

It is necessary to guarantee a minimum water depth of the hatchery averaging 45 cm all throughout the year.

Parent fishes for reproduction must be renewed, otherwise their propagating power will deteriorate, especially Tilapias which can only be used for 2 years.

The male and female ratio of parent fishes in fish ponds is 3:7 for Tilapia and 2:8 for Carps, respectively. Although these ratios have been standardized, the male ratio is raised when fertilization rate decreases.

Fry production plan is as follows:

Fish Species	Incubated Eggs Quantity	Male and Female Comparative Rate	Hatching Rate	Stopped Eggs Rate	Spawn Quantity	Hatching Frequency	Fry Production
Tilapia	3,500	8:19	95%	10%	56,858	3	127,931
Carp	1,000	4:16	90%	10%	12,960	2	19,440

(ii) Fry Selling

10% of produced fries will be sold 14 days after hatching and another 90% will be transported to the reservoir after one month's growth.

According to the existing prices, a fry costs 20 kip/piece.

(iii) Fish production

90% of produced fries will be stocked in the reservoir.

The growth rate is 60%, natural increase rate is 65% and catching rate is 25% are assumed. The price of fish is 450 kg/kg, and average weight of fish is 270g. Accordingly, annual production is as follows:

(unit number)

	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year
Fry production	0	147,371	147,371	147,371	147,371	147,371	147,371
Stocked Fry (90%)	0	132,634	132,634	132,634	132,634	132,634	132,634
Grown Fish	0	79,580	79,580	79,580	79,580	79,580	79,580
Naturally Increased Fish	0	46,554	65,590	70,509	73,168	74,465	75,097
Catched fish	0	8,413	17,034	37,522	38,187	38,511	38,669
Fishing Volume (kg)	0	2,272	4,599	10,131	10,310	10,398	10,441
Fishing Production (10^3 kip)	0	1,022	2,070	4,559	4,640	4,679	4,698
Fry selling (10^3 kip)	0	295	295	295	295	295	295

Considering the scale of the reservoir, the volume of fishing would be limited at 10 t/year.

Eight hatching facilities shall be made from concrete partitions.

(iv) Fish Feed

Fry feed consists of 40% rice bran and 60% assorted chicken feed. The unit price for 1 kg is 142 Kips. On the other hand the feed of adult fishes contains 60% rice bran and 40% assorted chicken feed, with a unit price of 93 Kips/kg.

The distribution standard of feed is once very 3 days, 20% of the feed is rationed for the 1st 9 months, and then subsequently decreased to 10% for another 3 months.

Once every 2 days 600 g of feed is supplied to a fry for one month.

6-3-3 Production Cost

(1) Farm Inputs and Labor

Production inputs and labor are planned as follows:

Item	Present Rainy Season Paddy	Upland Rice	Peanuts	Proposed Rainy Season Paddy	Dry Season Paddy	Peanuts
Farm Inputs						
Seed (kg/ha)	55	80	75	40	40	60
Fertilizer (kg ha)						
Urea	5	-		100	100	50
Ammophos	25	-	25	150	200	150
Compost	5	-	-	1,000	500	1,000
Insecticide (kg/ha)						
Diaginon 13%	-	-	-	10	5	10
Seven	5	-	5	-	-	-
Labor (man-day/ha)						
Land Preparation	25	25	22	25	30	22
Nursery	7	-	-	3	5	-
Transplanting or Sowing	45	25	12	50	47	12
Irrigation	-	-	-	5	10	5
Fertilization and Others	16	5	13	5	5	15
Harvesting	35	30	35	50	40	40
Threshing	17	17	12	15	20	10
Total	145	102	94	153	157	104

Proposed labor is 8 man day for the rainy season paddy and 10 man. day for peanuts are increased per hector comparing to the present one.

Monthly labor plan with project is shown below, and it can be employed within the project area.

Item	Growing Area (ha)	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Rainfed Paddy irrigated	155	0	0	0	0	4,340	5,425	2,325	620	775	2,015	4,650	2,325
Irrigated Paddy	1,625	0	0	0	0	41,375	57,925	33,100	6,620	6,620	33,100	49,650	24,825
Dry Season Paddy Irrigated	490	4,900	25,480	4,900	17,150	12,250	0	0	0	0	0	0	12,250
Rainfed Upland	15	0	0	0	0	375	135	75	75	375	375	0	0
Dry Season Crop irrigated	495	11,880	6,435	4,950	2,475	2,970	12,375	0	0	0	0	0	10,890
Sub-Total	1,810	16,780	31,915	9,850	19,625	61,310	75,860	35,500	7,315	7,770	35,490	54,300	50,290
Available Labor	4,426	137,206	128,354	137,206	132,780	137,206	132,780	137,206	132,780	132,780	137,206	132,780	137,206
Excess Labor		120,426	96,439	127,356	113,155	75,896	56,920	101,706	125,465	125,010	101,716	78,480	86,916

(2) Production cost

The production cost per hector applying the price in October, 1991 is estimated at 252,700 kip for rainy season paddy, 239,400 kip for dry season paddy and 193,200 kip for peanuts, they are more expensive than present production cost, 168% in rainy season paddy and 186% in peanuts.

6-3-4 Proposed Production

Considering the informations of internal research stations, other similar projects an the yield of other similar areas, the following yield is proposed.

Rainy season paddy	4.0 t/ha
Dry season paddy	4.5 t/ha
Peanuts	2.5 t/ha

Future annual agricultural production is expected as follows:

Crops	Without Project			With Project		
	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
Rainfed Paddy	2,005	1.5	3,007.5	155	1.5	232.5
Irrigated Rainy Paddy	-		-	1,655	4.0	6,620
Irrigated Dry Paddy	-		-	490	4.5	2,205
Total Paddy	2,005		3,007.5	2,300		9,057.5
Rainfed Upland Crop	15	0.5	7.5	15	0.5	7.5
Irrigated Upland Crop	-		-	495	2.5	1,237.5
Total upland Crop	15		7.5	510		1,245

6-3-5 Demand and Production of Rice in the Villages Concerned

Demand and production of rice in the villages concerned in case of with Project are as follows:

	Nhyod H. Bak Area	Namphou Area	Total
Population	7,049	6,480	13,529
Paddy Production			
Rainfed Paddy Are (ha)	529	348	877
Production (t)	794	522	1,316
Irrigated Rainy Paddy (ha)	950	705	1,655
Production (t)	3,800	2,820	6,620
Irrigated Dry paddy (ha)	400	90	490
Production (t)	1,800	405	2,205
Consumption of Paddy (t)	2,326	2,138	4,464
Tax	181	134	315
Excess of Paddy (t)	3,887	1,475	5,362

6-4 Irrigation and Drainage Development Plan

6-4-1 Irrigation Water Requirements

The crops proposed to be grown in the area are paddy rice and such field crops as groundnut, watermelon and other vegetables. The irrigation water requirement for them is separately estimated based on the proposed typical cropping pattern for rainy season paddy, dry season paddy and dry season peanut cultivation.

The irrigation water requirement for the crops is estimated on a monthly basis by the following procedure.

(i) Paddy Rice :

- Estimate of paddy rice water consumption (CU) from potential evapotranspiration calculated by using the climatic data and crop coefficients (Kc) varying with growth stages
- Estimate of percolation rate (P)
- Estimate of effective rainfall (ER)
- Estimate of nursery water (NW) and puddling water requirement (PW)
- Estimate of net irrigation water requirement (NR)
  NR=(CU+P-ER+NW+PW)/IE
- Estimate of gross irrigation water requirement (GR) based on (NR) divided by irrigation efficiency (IE)

(ii) Field Crops :

- Estimate of crop water consumption (CU)
- Estimate of effective rainfall (ER)
- Estimate of net irrigation water requirement (NR)
- Estimate of gross irrigation water requirement (GR) based on (NR) divided by irrigation efficiency (IE)
  GR=(CU-ER)/IE

Crops water consumption is estimated as a product of potential evapotranspiration (ETo) and crop coefficient (Kc), which varies according to the crop growth stage. The potential evapotranspiration is calculated by the modified Penman method recommended in "Crop Water Requirements, FAO Irrigation and Drainage Paper No. 24, 1977 (FAO Paper)".

The calculated potential evaporations are as follows:

Potential Evapotranspiration (ETo)

(Unit : mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
4.7	5.1	6.1	6.4	5.5	4.6	4.6	4.2	4.5	4.9	4.9	4.5

The estimated crop coefficients vary from 0.95 to 1.1 for the rainy season paddy, 1.0 to 1.25 for the dry season paddy and 0.5 to 1.05 for the dry season peanut.

The field observation results show that (CU) + (P) (Evapotranspiration + Percolation) varies from 5 to 7 mm/day in the rainy season, and 7 to 9 mm/day in the dry season. The soil in the project area is mostly loamy-sand. Considering the observation results, soil type and the available information obtained from the existing irrigation projects, the percolation rate is determined at 1.5 mm/day for the rainy season and 3 mm/day for the dry season.

The puddling water requirement consists of water equivalent in soil moisture before and after puddling, standing water required in soil surface, and evaporation and percolation losses from paddy field, etc. Taking these factors into consideration, the puddling water requirement is estimated as 180 mm.

The nursery water requirement refers to water needed for preparation of nursery bed, and evapotranspiration and percolation during nursery period. The nursery water requirement is estimated at 420 mm.

Design rainfall to estimate water requirement is probable minimum rainfall with a 6-year return period, corresponding to 1.252 mm in a year. The effective rainfall is estimated on a monthly basis, using "monthly

effective rainfall curve" developed by the Mekong Committee. the estimated annual effective rainfall is 958 mm for paddy rice and 729 mm for upland crops.

The irrigation loss refers to farm application loss, operation loss and conveyance loss. Taking into account the soil characteristics, topography, climate, irrigation practices and experience, etc., the application efficiency is assumed to be 85 % for paddy rice irrigation and 65 % for field crop irrigation.

According to the actual results measured in the irrigated paddy field of South Asian countries, a total operation loss is 50 to 100 % of the net irrigation water requirement. Even after the canal operation practices and water management are improved through appropriate guidance, a certain amount of irrigation water requirement will be wasted. considering these factors, the operation efficiency is assumed to be 80 %.

The canal conveyance loss is caused by seepage through the wetted perimeter of the canal and evaporation from the canals water surface. As a result, of the field measurement an average conveyance loss of 0.11 % (the flow reduced from 0.495 m^3/s to 0.4945 m^3/s with a 1000 m of canal length) was measured. From this results, the conveyance efficiency is assumed to be 90 %.

Overall irrigation efficiency is estimated at 61 % for paddy rice irrigation and 47 % for field crop irrigation.

Diversion water requirements are estimated based on the above-mentioned procedure, and they are as follows, showing the maximum diversion water requirement to be 1.3 m^3/sec for Nhyod H. Bak and 0.8 m^3/sec for Namphou area, respectively.

Diversion Water Requirement (m³/sec)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Nhyod H. Bak Irrigation Area												
Paddy (900ha)	-	-	-	-	-	0.3	1.0	0.0	0.6	0.5	0.07	-
Paddy (400ha)	0.7	0.7	0.7	0.2	-	-	-	-	-	-	-	0.1
Field (400ha)	0.3	0.5	0.6	0.2	0.02	-	-	-	-	-	-	0.01
Total	1.0	1.2	1.3	0.4	0.02	0.3	1.0	0.0	0.6	0.5	0.07	0.11
Namphou Irrigation Area Irrigation Area												
Paddy (705ha)	-	-	-	-	-	0.2	0.8	0.0	0.5	0.4	0.05	-
Paddy (90ha)	0.2	0.2	0.2	0.03	-	-	-	-	-	-	-	0.02
Field (95ha)	0.08	0.1	0.2	0.05	0.0	-	-	-	-	-	-	0.0
Total	0.28	0.3	0.4	0.08	0	0.2	0.8	0.0	0.5	0.4	0.05	0.02

6-4-2 Design Discharge

Based on the proposed cropping pattern, the maximum diversion requirements per ha are 1.1 lit/sec/ha for rainy season paddy, 1.87 lit/sec/ha for dry season paddy and 1.53 lit/sec/ha for dry season field crop.

Considering the proposed cropping plan and aiming to avoid overdesign, the design discharges for both areas are determined as follows:

Nhyod H. Bak
- Main canal : 1.43 lit/sec/ha
  $(1.87+1.53)/2\times800/950=1.43)$
- Secondary, Turnout : 1.87 lit/sec/ha
  (Requirement for dry season paddy)

Namphou
- Main canal : 1.1 lit/sec/ha
  (Requirement for rainy season paddy, more area than limited dry season cultivation are)
- Secondary, Turnout : 1.87 lit/sec/ha
  (Requirement for dry season paddy)

6-4-3 Irrigation Schedule

The available moisture in the soil is expressed as moisture amount held by the soil between field capacity and wilting point. The soil in the proposed field crop area is identified as loamy sand. the main crop is peanut. The available moisture is estimated at 130 mm/m from the relationship among soil type, kind of crop and the available moisture. the readily available moisture is calculated at 39 mm.

Since evapotranspiration is 4.9 mm/day, the irrigation interval is 3914.9=8 days.

6-4-4 Drainage Plan

(1) Design rainfall

The daily maximum rainfall with a 10-year return period is adopted as design rainfall (185 mm).

(2) Drainage Water Requirement for Paddy Field

The drainage water requirement is estimated at 6.1 lit/sec/ha as shown below.

i) Design rainfall is 185 mm/day
ii) Effective water depth in the paddy field is 110 mm
iii) Standing water depth in the paddy field is 30 mm
iv) Excess rainfall to be drained from the paddy field within 48 hours is 105 mm

Q	= q × A
q	= RE24 × 10 m^2/(3,600 sec × 48 hours)
	= 105×10/(3,600×48)=6.1 lit/sec/ha
RE24	= R24-(D1-D2)=185-(110-30)=105 mm

Where :

Q	= Design drainage water requirement (m^3/sec)
q	= Unit drainage water requirement per ha
A	= Drainage area
R24	= Design rainfall, 185 mm/day
D1	= Effective water depth in the paddy field, 110 mm

D2 = Standing water depth in the paddy field, 30 mm
RE24 = Excess rainfall to be drained, 105 mm

(3) Drainage Water Requirement for Upland Field

Rainfall water runs off from the upland field immediately after rainfall. There is no storage function in the upland field. In order to estimate the peak runoff, the upland field including the outer drainage area of the project, is divided into 26 sub-areas for Nhyod H. Bak area and 17 sub-areas for Namphou area, considering the topography and future layout of the drains. The peak runoffs from these areas are individually estimated by the Rational formula.

6-4-5 Irrigation and Drainage Facilities

(1) Irrigable area

(a) Nhyod H. Bak irrigation Plan

(i) Basic concept

Basic concept of irrigation and drainage plan for this area are ① maximum utilization of the water resource, ② maximum storage of available water for both supplementary irrigation and dry season irrigation, and ③ gravi irrigation for existing paddy fields.

(ii) Irrigable area

The amount of available water is estimated at about 17.1 million m^3 per annum. Based on the result of the simulation of water balance and considering cropping patterns, proposed irrigation plan is as below.

Crop	Irrigable Area (ha)
Rainy season paddy	950
Dry season paddy	400
Dry season field crops	400

(b) Namphu Irrigation Plan

i) Basic concept

The basic concept of this irrigation project are ① maximum utilization of the water resource, ② effective water storage for both supplementary irrigation and dry season irrigation, ③ gravity irrigation for existing paddy fields, and ④ effective utilization of return flow and base flow.

ii) Irrigable area

The selected irrigation area amounts to 705 ha considering the topographical conditions is as follows;

Crop	Irrigable Area (ha)
Rainy season paddy	705
Dry season paddy	90
Dry season field crops	95

(2) Water resources development facilities

(a) Nhyod H. Bak Irrigation Facilities

(i) Irrigation System

The irrigation facilities to supply the water to fields will consist of Nhyod H. Bak reservoir, and main, secondary, tertiary and field canals with related structures.

The intake facilities of the reservoir is located on the right bank of the H. Bak river. The right bank main canal (RMC) branches off at just after the outlet to the Left Bank Main Canal (LMC).

The LMC covering the direct irrigable area, 139 ha, connects with the left bank secondary canal (LSC) which covers 218 ha. The RMC covering the direct irrigable areas, 51 ha, connects with the right bank secondary canal-1, (RSC-1), which covers 242 ha, and the right bank secondary canal-2 (RSC-2) which covers 174 ha.

(ii) Nhyod H. Bak Reservoir

Dam site selection

In order to select the suitable dam site, considerations about capacity, irrigation efficiency, difficulty for construction, construction cost, eviction, submerged area (existing paddy field, forest area), climate, meteorology, catchment area, topography, geology, safety for flooding, etc. are made and three (3) alternatives comparison shows that the proposed site is the most suitable one.

Type of Dam

Dam type should be determined based on the consideration of such information as availability of materials, purpose of dam, volume of dam, similar projects, topographical, economical and technical conditions, etc. Taking into account the information above, homogeneous type dam is proposed for this project.

Height of Dam

The height of dam is determined by topography, irrigable areas, hydrology and sedimentation, as below.

Dam Crest Elevation	:	EL 171.00 m
Design Flood Level	:	EL 169.10 m
Normal Full Water Level	:	EL 167.10 m
Lowest Water Level	:	EL 161.00 m

Geology

The dominant soils of the dam site are sandy loam and loamy sand, showing more than 70 of N-value with depths of between 4.8 m and 10.2 m. Type of material soils is mostly sandy clay loam with gravel of laterite.

Design of Dam

Considering the condition of surface soil depth, in the center of both rivers about 3.0 to 4.0 m depth of surface soil should be replace with

embankment materials.

The dimensions of Nhyod H. Bak Dam are summarized below.

Catchment Area	31.0 km^2
Total Capacity	11.9×10^6 m^3
Effective Capacity	8.9×10^6 m^3
Reservoir Area	430 ha
Dam height	21 m
Dam Crest Length	965 m
Dam Crest Width	6 m
Slope Upperstream Side	1:3.0
Slope Downstream Side	1:2.5
Dam Volume	320×10^3 m^3

(b) Namphu Irrigation Facilities

(i) Irrigation System

The irrigation facilities to supply the water to fields will consist of six (6) diversion facilities. Each irrigable area of those six (6) diversion facilities above is summarized below:

Diversion Facilities	No.1	No.2	No.3	No.4	No.5	No.6
River	H. Xay	H. Banhang	H. PhouNoy	H. Phou	H. Xay	H. Pangha
Irrigable Area (ha)						
Rainy season paddy	140	45	35	25	410	50
Dry season paddy	30	0	10	10	40	0
Dry season field crops	30	0	10	5	40	10

① H. Xay Reservoir

Dam site selection

Only one (1) site is determined through a 1/5000 scale map and site investigation considering the most effective capacity and minimum dam volume.

Type of Dam

As the case of Nhyod H. Bak Dam, based on the local conditions, homogeneous type is also proposed.

Height of Dam

The height of dam was determined to maximize a total capacity of dam considering the topographical condition. Dimensions of elevation are determined as below.

Dam Crest	EL 172.5 m
Design Flood Level	EL 170.8 m
Normal Full Water Level	EL 169.3 m
Lowest Water Level	EL 167.0 m

Geology

Dominant soils are sandy loam to sand stone, showing more than 70 of N-Value with depth of between 1.8 m and 2.3 m. The type of material is sandy clay gravel and laterite.

Design of Dam

Considering the condition of surface soil depth, in the center of both rivers about 1.5 m depth of the surface soil should be replaced with embankment materials.

The dimensions of H. Xay Dam are summarized below.

Catchment Area	15.8 km^2
Total Capacity	1.6×10^6 m^3
Effective Capacity	0.98×10^6 m^3
Reservoir Area	95 ha
Dam Height	10.5 m
Crest Length	730 m
Crest Width	5.0 m
Slope (Upper stream side)	1:2.5
Slope (Down stream side)	1:2.5
Dam Volume	83×103 m^3
Design flood discharge	88 m^3/s
	Spillway Overflow type

	Maximum outlet	0.154 m^3/s
		Outlet works Gate type

② H. Banhang Weir

Because of no suitable sites for reservoir and small catchment are (4.3 km^3), only supplementary irrigation by weir is recommended for this area.

Weir;	Design flood discharge	15 m^3/s
	Height of Weir	3.5 m
	Length of Weir	9.4 m
	Type	Gate type slide gate
		1.5m(L)×1.0m(H)×2
		stop log gate 1.5m(L)×1

③ H. Phou Noy Reservoir

A regular flow is expectable in H. Phou Noy river and an existing small reservoir (1.0 ha) is observed. The proposed plan is mostly to use a regular flow for both rainy and dry season irrigations by rehabilitating and raising the existing dike and installation of intake facilities. By raising the dike, the effective capacity of reservoir will be increased and which will be an insurance for dry season irrigation when a regular flow decreases.

The raising height of existing dam crest is 1.0 m on average with EL 162.5 m of the raising dam crest level and 142 m of the dam crest length. The type of spillway is an overflow type with 10 m wide and in the both sides of the spillway stoplog type of intakes are installed with 1.0 m wide each.

④ H. Phou Reservoir

The proposed plan is mostly to use the regular flow, which is also expectable in H. Phou river, for both rainy and dry season irrigation. Besides, for both an insurance for dry season irrigation and domesticity or livestock, a dam construction is proposed.

Considering the condition of surface soil depth, in the center of the river about 1.0 m depth of the surface soil should be replaced with embankment materials.

Dimensions of H. Phou Dam are as below

Reservoir Area	2.0 ha
Dam Crest Level	EL 163.5 m
Design Flood Level	EL 162.5 m
Normal Full Water Level	EL 161.5 m
Lowest Water Level	EL 161.0 m
Dam Type	Homogeneous Type
Dam Height	5.8 m
Crest Length	307 m
Crest Width	4.0 m
Slope	1:2.0
Dam Volume	9.3×10^3 m^3

⑤ H. Xay Weir

The value of 135 m^3/s is taken as a design flood discharge. The design policy is the more easy operation and maintenance the better, same as all the structures in this project. Twelve (12) slide gates of 1.5 m long and 1.5 m wide each and total width of 24.6 m are required though, two (2) each of the gates near the both banks will be possible to be replaced with stop log to minimize the construction cost. On the both sides of the gated weir, fixed weirs are proposed with 4.0 m wide each, leading to 32.6 m of total width of the weir. The height of gated weir (from the apron to the top of the operation deck) is 4.8 m.

⑥ H. Pangha Weir

Because of no suitable site for reservoir, mostly supplementary irrigation by weir is proposed and only 10 ha for field crops irrigation in the dry season is expectable with a small regular flow.

The value of 53.6 m^3/s is taken as a design flood discharge. Six (6) slide gates of 1.5 m long and 1.0 m wide each and total width of 9.0 m are required though, two (2) gates near the left bank will be possible to be replaced with stop log to minimize the construction cost. On the both sides of the gated weir, concrete weirs are proposed with 2 m wide

on the left bank side and 30 m wide on the right bank side. In addition to the concrete fixed weirs on the left side, 11 m wide of fixed weir composed of gabion is required, leading to 52 m of total width of the weir. The height of gated weir is 5.4 m.

(3) Irrigation Canals

Command areas and canal length of each canal are as follows;

Canals	Nhyod H. Bak		Canals Namphu	
	Command Area (ha)	Length (m)	Command Area (ha)	Length (m)
Main Canals	350 to 950	10,690	25 to 245	14,440
Secondary Canals	220 to 300	10,920	50	660
Tertiary Canals	10 to 100	31,830	2 to 70	20,930
Field Canals	< 15	76,000	<5	43,510

Design criteria

Design discharge

Nhyod H. Bak

- Main canal and related structures=1.43 lit/s/ha
- Secondary canal/turnout=1.87 lit/s/ha

Namphu

- Main canal and related structures=1.1 lit/s/ha
- Secondary canal/turnout=1.87 lit/s/ha

Hydraulic formula : Manning's formula

Allowable velocity

	Max.	Min.
- Canal	0.6 m/s	0.3 m/s
- Concrete structure	2 m/s	0.3 m/s

Roughness coefficient

- Concrete structure : 0.015
- Unlined canal : 0.025

Freeboard
Minimum freeboard for

- Main and secondary canals : 0.3 m
- Tertiary and field canals : 0.15 m

Cross section of canals

Canal base width (B) - water depth (H) ratio and crest width of bank (W) are determined empirically. Internal and external side slopes of canals are determined on the basis of soil mechanical test. Factors necessary for determination of cross section of canal are as follows :

Canals	B/H	Internal Side Slope (I:Z)	Crest width of Bank (W) (m)	Freeboard (m)
Main/Secondary	Around 0.6	1.5 - 1.0	4.5 - 3.0	0.3
Tertiary	Less than 1	1.0	0.6 - 0.8	0.2
Field	Less than 1	1.0	0.3	0.15

Filling Height or Cutting Depth D (m)	External Side Slope for Filling Portion of Canal	Internal Side Slope for Cutting Portion
D<1.5	1 : 1.5	1 : 1.5
2.5<D<4	1 : 2	1 : 2

Note : In case of D> 4m, a berm of 1.5 m of 1.5 m wide will be provided to internal side slope of canals.

(4) Drainage facilities

(a) Drainage system

The Project area is not likely in the habit of inundation and has a lot of natural drains (streams or rivers), therefore minimum drainage

facilities are proposed for the sooner drain of excess water aiming at the better growing of crops and soil conservation. The drainage facilities of the Project will consist of tertiary and field drains and related structures. Only one (1) secondary drain is required for the Nhyod H. Bak Area though, no main drains are proposed for both areas.

(b) Design criteria

The basic design criteria for drains and drainage structures are as follows:

i) Design discharge

- For paddy field : 6.1 lit/s/ha
- For upland field : by Rational formula

ii) Hydraulic formula : manning's formula

iii) Allowable velocity

	Max.	Min.
- Drain	0.9 m/s	0.3 m/s
- Concrete Structure	2.5 m/s	0.8 m/s

iv) Roughness coefficient

- Drain : 0.03
- Concrete structure : 0.015

v) Side slope of drain : 1:1.5

(c) Total length of drainage canals

Drainage canal	Nhyod H. Bak	Namphu
Secondary	2,110 m	-
Tertiary	15,760 m	4,350 m
Field	62,000 m	33,350 m
Culvert	16 places	31 places

(5) Farm Road

Village roads connecting the national road Route 13 or route 11 run through the both Project areas though, roads in the Project area are considerably poor in both density and quality. In order to strengthen the road network in the Project area with the purpose of ① efficient transportation of agricultural input and output to and/or from village and market, and ② smooth operation and maintenance work of canals and structures, farm roads will be provided alongside the main canals, secondary canals, tertiary canals and field canals. The farm road will be earthen road with a width of 3.0 to 4.5 m for main and secondary canals, and 0.6 to 0.8 m for tertiary canals, and 0.3 m for field canals. The surface will be paved with laterite of 3.5 m wide and 0.15 m thick only for some farm roads to be provided alongside the main and secondary canals with a width of 4.5 m according to the importance of the roads.

(6) Demonstration Farm

Introduction and extension of the improved farming practice and water management practice are indispensably necessary for the optimum agricultural production in the Project area. In addition, such practices have to be improved through field trials to meet the local requirement in the area. In order to promote such extension and execute such field trials, construction of demonstration farm (58 ha in net) is proposed under the Project. The proposed site is located near B. Dongkhankhou almost center of the Nhyod H. Bak Irrigation Area. This location is very effective for demonstration and is very convenient to carry out technical guidance of the Project office.

- Land consolidation is proposed.
- Use of small farm tractors is proposed
- 3 ha of farm plot size is proposed
- The demonstration farm will consist of one tertiary block.
- Farming will be carried out by farmers who own the land under the provincial guidance.

- A meteorological station will be installed.

6-5 Rural Infrastructure

6-5-1 Rural Road Improvement Plan

(a) Routes of Rural Road to be Improved

The Agricultural Supporting Center will be established at B. Lak 35, located at the intersection of route No. 13 and route No. 11. The objective of the rural road improvement Plan will be formulated for the existing lateral roads which connect the Nyhod H. Bak irrigation area (950 ha), the Namphou irrigation area (705 ha) and the Agricultural Supporting Center.

The distance of road improvement are as follows:

Road Section	Distance	Distance of road Improvement
- B. Mai ~ B. kokleng (Wilhin the Nyhod H. Bak irrigation area)	11 km	Route-A 10.4 km
- B. Phonkho ~ National Road No. 13 intersection (west side of the Namphou Irrigation Area)	14 km	Route-B 14.2 km
- B. Phonkho ~ Namphou intersection National road No. 13 (Southside of the Namphou Irrigation Area)	14 km	Route-C 5.0 km
Total	39 km	29.6 km

(b) Improvement Routes and Beneficiary Villages

About 29.6 km of rural roads will be improved in order to make traffic possible. The improvement of rural roads will greatly contribute, not only to support irrigation development, but also to the prosperity of the villages.

The beneficiary villages will be as follows:

Improvement Route	Bridge Improvement	Village		Population
Route - A 10,426m	1 place	B.Mai	B.Nongboua	5,894
		B. Khamnoy	B. Nonghong	
		B. Donggne	B. Dongkhakhou	
		B. Nanokkhian	B. Dongmakyang	
		B. Nongkalong	B. Kokleng	
		Phailom	B.Dongkhamkhen	
Route - B 14,164m	3 places (improvement)	B. Phoxai Mai	B. Dongphosi	6,480
		B. Namphou Nua	B. Namphou Tai	
		B. Donghouakham	B. Dongmakfai	
		B. Dontoum	B. Mouangkhai	
Route - C 5,018m	5 places (2:improvement) (3:new construction)	B. Phonkho	B. Natai	5,630
		B. Tan	B . Phonthat	
		B. Deng	B. Namakka	
		B. Takdet	B. Phosomhong	
		B. Nakhum		
Total 29,608 m	9 places	29 villages		18,004

(c) Rural Road Improvement Standards

The most suitable standards for rural road improvement will be formulated giving full consideration to the range of other areas, to the future management of maintenance and to economically feasible construction.

The rural roads which are not seriously damaged will be improved by stripping (10 cm), subbase grading and laterite soil pavement.

Moreover, the roads where surface damages are progressing and where even roadbeds are seriously damaged, thus making traffic difficult, will be improved by substantial strengthening of roadbeds, by subbase course stabilization, and laterite soil pavement.

The design plan for the improvement of rural roads is shown below.

- Road surface width : 6m
- Road surface stripping : 10cm thick
- Laterite pavement : 15cm thick
- road height : 30~50cm height from adjoining land

- road cross fall : 3% transverse slope
- Road cross drain : ϕ600mm concrete pipe × lines
- Shoulder slope gradient : 1:2 embankment
- California bearing ratio (CBR) : More than 6

The design plan for bridge improvement is shown below.

- Superstructure : Floor slab type, RC. bridge
  Floor width 3.6m
- Substructure : RC. abutment and pier,
  Single column footing direct
  Foundation
- Design load : T-10t

6-5-2 Agricultural Supporting Center Plan

(a) Rice Processing and Storage Facilities

In consideration of the rural conditions, the facilities will be designed under the rural standards in force in Lao. The design of facilities will be carried out in consideration of capacity of equipment, durability, cost and economical efficiency in operation and maintenance, easy checking of preservation and method of construction. The scale of facilities, based on rice mill and storage in the Project Area, will be determined in due consideration of rural conditions and customs as well as the Project Area's paddy production and rice processing capacity. Storage facilities are as follows:

- Storage floor area : 475m^2 single story, wooden building
- Rice storing volume : Paddy storing 40m^3 × 7 places = 150t, and bag storing 200t, total capacity is about 350t.
- Ventilation : Natural louver ventilation (prevention from dusty draining, humidity, hear)

Rice mill facilities are as follows:

- Floor area : 100m2, Wooden building
- rice processing capacity : 1,000 kg/hr in paddy

(b) Multi-purpose Building

The multi-purpose building is planed for a market, a drying yard, a workshop, a meeting place, etc.

(c) Description of the Center Facilities

- Total area : 2.25 ha (150×150m)
- Office : 250m wooden building
- Garage : 150m2 wooden building
- Storage : 475m2 wooden building, Ventilation
- Market : 875m2 slate roof only
- Rice mill : 100m2 wooden building, ventilation
- Fish farm : 120m2 wooden building, water pipe and drain
- Water supply : Well, water supply facilities
- Truck terminal and drying space : 4,000m2 concrete pavement t=10cm
- Truck : 8t - 3 Units
- O/M cars : pick up - 1 Unit, Motor bike - 2 cars
- Generator : 45 KVA -1 Unit, 15 KVA - 1 Unit

6-5-3 Village Water Supply Plan

Optimum scale and sizing of the facilities are as follows:

- Well type : Shallow well; excavation surface will be protected by a 1.0 diameter concrete pipe; depth 10~15m. The well will be constructed by manual excavation; shall be 1.6m in diameter.
- Pumping : Line shaft hand pump (manual type)
- Wells siting : Facilities for villages with dense population and serious water shortage in the dry season. A total of 10 wells shall be planned.

<Namphou area>
B. Dongmakfai,

<Nyhod H. Bak area>
B. Xianban, B. Nonghong, B, Kho,
B, Nongveng, B. Vatthana, B. Phailom
B. Phonthan, B. Nanokkhian, B. Nongkalong

6-5-4 Equipments for O/M Office

The following O/M equipments will be required for the O/M of the constructed and/or improved facilitie.

Backhoe	0.4m^3	1 Unit
Motor grader	135 HP	1 Unit
Dump truck	8 t	1 Unit
radio station		4 stations (O/M Office, Center, Nhyod H. Bak Area, Namphou Area)
Vehicle		1 pickup
Wrokshop car		1 Unit
Training equipments		1 Set

6-5-5 Rural Road O/M Equipment

The following O/M equipment will be required for the operation and maintenance of the rural roads.

-	Bulldozer	D6 type	130 HP	1 Unit
-	Wheel loader		110 HP	1 Unit
-	Backhoe	0.4m^3		1 Unit
-	Motor grader		135 HP	1 Unit
-	Road roller	Vibrating type	70 HP	1 Unit
-	Dump truck	8t		2 Unit
-	Water tank	Sprinkler truck 10t		1 Unit
-	Spare parts			1 Sum

These supplementary O/M equipment will be used for the rural improvement routes (Route A, B, C total distance : about 30 km) as well as the reparation of the rural roads required for the Savannkhet Province Agriculture Development (total distance : about 520 km) and will be supervised by DCTPC. Therefore, all rural road improvement and road O/M works will be conducted according to the local budget and the improvement plan of the executive agency (DCTPC).

CHAPTER 7 CONSTRUCTION PLAN AND COST ESTIMATION

7-1 Construction Plan

7-1-1 Construction Work

The construction works under the Project are broadly divided into three (3) categories, namely irrigation and drainage facilities, rural infrastructures and agricultural supporting center. Main work for each category are as follows:

(1) Irrigation and drainage facilities

a. Nyod H. Bak
- N.H. Bak reservoir
- Main, secondary, tertiary and field canals
- Secondary, tertiary and field drains
- Demonstration farm

b. Namphou
- 3 reservoirs
- 3 weirs
- Main, secondary, tertiary and field canals
- Tertiary and field drains

(2) Rural infrastructures
- Rehabilitation of rural road
- Rural water supply

(3) Agricultural supporting center
- Buildings
- Fish pond

7-1-2 Construction Schedule

The construction schedule of the Project is prepared as the following conditions:

i) All the construction works will be executed by qualified international contractor(s) selected through international competitive tendering.

ii) Since the construction work includes a large volume of earth work, the mechanized construction method will be employed.

iii) Major construction equipment and machinery needed for the work such as bulldozers (21t, 15t), backhoes (0.6m^3, 0.3m^3), wheel loaders (1.3m^3, 1.0m^3), tire rollers (8t), road rollers (10t), motor graders (3.1m), dump trucks (11t, 8t), truck cranes (20t), water tankers (5m^3), etc. are mostly available in Lao PDR.

iv) Earth work for main irrigation and drainage facilities will be concentrated in the dry season.

v) Competent foreign consultant(s) will be engaged in detailed design, preparation of tender documents, technical guidance for prequalification and tendering works, and supervision of the construction works.

vi) Acquisition of lands necessary for the construction work will be made by the Project office.

vii) Annual workable days for construction works are estimated at 272 days.

After the pre-construction work, such as detailed design and tendering are completed in the first year, the construction work will commence in February of the second year and end in February of the 4th year, taking a period of two (2) years. Consequently, the irrigation of the entire Project area will commence from the rainy season of the 4th year.

7-2 Cost Estimation

7-2-1 Basic conditions for cost estimation

The costs for the implementation of the Project are estimated on the following assumptions:

i) The exchange rate as of November 1991 used in the estimate was US$1.0=Kip 700=Yen 130.

ii) All the construction works will be carried out by contractor(s) selected through international tendering. Most of the construction machinery and equipment needed for the construction works will be available in Lao PDR.

iii) Taxes on construction materials, machinery and equipment to be imported from abroad are exempted.

iv) Unit costs of respective works are estimated at price and wage levels prevailing in Savannakhet. The unit costs are divided into the foreign currency portion and local currency portion based on the following classification:

Local currency portion
- Labor force
- Wooden materials
- Sand and gravel
- Inland transportation
- Administration expenses

Foreign currency portion
- Reinforcing bar
- Depreciation of construction and machinery
- Steel gates
- Structural steel
- Cement
- Fuel
- International transportation
- General expenses and profits for foreign contractor(s)

- Expenses and fees of engineering services by foreign consultant(s)

v) Physical contingency is taken as 10% of direct construction cost

vi) Price contingency is estimated based on a price escalation rate of 1% for the foreign currency equivalent.

7-2-2 Cost Estimate

(1) Construction cost and annual disbursement schedule

The total construction cost for the Project is estimated to be equivalent to US$15.0 million, (US$12.4 million of foreign currency portion and local currency portion equivalent to US$2.6 million). The annual disbursement schedule is worked out based on the construction schedule shown in Table.

(2) Annual O/M cost

Personal expenses	Annual salary 504,000 kip×3 =	1,512,000 kip
	Annual salary 450,000 kip×2 =	900,000 kip
		2,412,000 kip

Annual fuel expenses for backhoes, motor graders, dump truck and car are estimated at 4,460,000 kip.

Annual maintenance costs for machineries are estimated at 16,800,000 kip. Therefore, O/M costs at the full operation stage of the project is estimated to be 23,672,000 kip = 33,818 US$.

(3) Replacement cost of the project failities

O/M equipments (345,000 US$) will be replaced every 10 years, and steel gates, turnouts (243,080 US$) will be replaced every 25 years.

(4) Annual O/M cost

Annual O/M cost is as follows;

Item	1~3 year	4~6 year	7~9 year	After 10 year
Personal expense	1,962,000	2,412,000	2,412,000	2,412,000
Fuel	940,800	1,540,112	3,209,136	4,460,904
Maintenance	1,190,000	16,800,000	16,800,000	16,800,000
Total	4,092,800	20,752,112	22,421,136	23,672,904
Total in US$	5,847	29,646	32,030	33,818

CHAPTER 8 PROJECT EVALUATION

8-1 General

The Project aims to enhance the living standards of beneficiaries and to contribute to the rural development.

To achieve the above objectives, the Project emphasizes the irrigation development plan, accompanied by three other plans; agricultural supporting center, rural road, rural water supply plan.

8-1-1 Evaluation Methology

Project evaluation was carried out through the economic and financial analysis of project cost, operation and maintenance costs, and benefits.

The economic analysis will be made to ascertain Project desirability in terms of its contribution to the economic and social welfare of the country as a whole.

1) Economic evaluation is made by estimating the Economic Internal Rate of Return (EIRR) with the cost-benefit analysis of the Project. The cost-benefit analysis of projects were made according to the following steps:

   - Identification of Project costs and benefits :
   - Valuation of costs and benefits in terms of economic prices; and
   - Present value comparisons of costs and benefits, sensitivity analysis and selection of projects based on derived economic feasibility indicators.

2) The financial analyses dealt with :

   - Farm income analysis including the analysis of farm enterprise income and net farm income; and

   - Farm budgets for financial resources.

Furthermore, the impact of the Project on farm budget and their capacity to pay for irrigation water charges are analyzed in the farm budget assessment.

3) In addition to the direct benefits, intangible socio-economic impacts resulting from Project implementation are briefly studied to evaluate social feasibility, at the same time, the existence of any social constraints concerning the implementation of the project were studied, too.

8-1-2 Basic Assumption

Project evaluation was carried out on the following assumptions :

1) The Project implementation period is about three years.

2) The economic span of the Project is 50 years after construction.

3) The current prices are expressed in constant prices as of October of 1991.

4) The exchange rate of Lao Kip to US. Dollar is 700 kips which is equivalent to US$ 1. (700k=1 US$)

5) The construction cost for the agricultural supporting center, rural roads, rural water supply facilities, and purchase cost of the farm machinery for the proposed demonstration field are excluded from the initial capital cost for the project evaluation, because they can be regarded as social investments that are not directly related to the increment of agricultural productivity.

6) The operation/maintenance costs of the agricultural supporting center are excluded from the O/M cost of the Project, that is, the objective cost of the economic/financial analysis to evaluate the Project, because it is proposed to be managed separately by the farmers' association which is organized individually from the irrigation beneficiaries association.

7) Furthermore, O/M costs for the rural road and rural water supply facilities are excluded from the O/M costs of the Project, because they shall be entrusted to the users union.

8-2 Economic Evaluation

8-2-1 General

Economic prices for inputs and outputs of the Project were valuated based on the following criteria :

(1) Direct transfer of payments such as taxes and subsidies, were eliminated wherever they could be isolated, since the transfer of payments are payment that merely represent the transfer of claims to real resources from a farmer or organization to another.

(2) Shadow price of foreign exchange was derived at 720 kips, equivalent to US$ 1, based on the latest foreign exchange rate at the official and black market.

(3) Economic prices of traded goods and services are to be based on border prices. Border prices of farm inputs and outputs were estimated based on the World Bank's projections of international market prices for the year 2,000. The World Bank forecasted prices and the 1985 constant prices were adjusted to the 1991 constant prices by multiplying the factor of 1.4869 derived from the MUV index. Additional domestic charge at the border is added to the price, and the savable cost by import substitution and additional cost for export expansion are deducted in order to estimate the import and export parity price at the farm gate in the Project area.

(4) Domestic currency values were converted to the economic price by the Standard Conversion Factors (SCF) in order to adjust the distortion on domestic prices as a result of national trade policies such as tariff and subsidy. A standard conversion factor of 0.970 was used, it was estimated based on the official foreign exchange rate as of October 1991, that is, US$1=k700. The shadow exchange rate is US$1=k720.

(5) Economic value of unskilled labor wage was valuated by the shadow wage. The shadow price rate of labor was estimated at 0.36, which is derived from the ratio of weighted average of farm labor cost.

8-2-2 Economic Cost

The Financial Project cost was converted into the Economic Project cost in accordance with the following procedures :

- The cost for rural road and water supply developments, and purchase of farm machinery for the demonstration field block were excluded from the capital cost;
- Contingency for price escalation was deduced from the financial cost;
- All the costs were divided into the foreign currency portion and local currency portion;
- Unskilled labor cost was converted into opportunity cost;
- Whole local currency portion was converted into economic price by multiplying SCF of 0.97.

Consequently, the derived economic project construction cost is US$ 11,763 thousand the proposed operation and maintenance cost per year reaches US$33.8 thousand on the financial base and US$33.4 thousand on the economic base, and replacement of O/M equipments are US$1,625 thousand on the financial base, and US$ 1,623 thousand on the economic base.

8-2-3 Economic Benefit

(1) Identification of Benefit

When the project was evaluated, only agricultural benefits to be acquired from the irrigation development were analysed and valuated.

The benefit will come out immediately after the implementation of the Project. The benefit is expected to increase and fully attain its target level after 5 years.

The increase in agricultural production mainly results from introduction of irrigation farming for the wet season crops and irrigation water supply for the dry season crops.

Increase of yield is planned as follows;

Year	4th	5th	6th	7th	8th
Rainy season paddy	2.5	3.0	3.5	3.8	4.3
Dry season paddy	2.5	3.0	3.5	4.0	4.5
Peanuts	1.5	1.8	2.0	2.2	2.5

(2) Economic price for agricultural outputs and inputs

The production of rice and peanut through irrigation farming is proposed in the project. From this, rice shall be produced for importation and peanut for exportation. Therefore, the economic price of rice was based on import parity prices and that of peanut, on export parity prices.

Farm inputs such as fertilizer and agricultural chemicals are wholly imported from abroad and their prices are, therefore, based on import parity prices.

(3) Net agricultural production value

The benefits were estimated as the difference of annual net crop production value with and without project conditions.

Net agricultural production values were estimated by deducting production costs from gross production values. The result is summarized as follows :

(Unit : US$.000)

Crop	Without Project	With Project	Increment
Paddy	361.31	1,406.65	1,044.9
Peanut	0.04	150.98	151.0
Total	361.35	1,557.63	1,195.90

8-3-4 Result of Economic Evaluation (Economic Internal Rate of Return)

(1) The economic internal rate of return is calculated at 8.05%. The net present value is 1,622,172 US$.

(2) Sensitivity Analysis

In order to evaluate the soundness of the Project to the possible changes in the economic condition in future, the sensitivity analyses were made for the following case in terms of EIRR.

Case I The Project costs increase by 10% due to unforeseen geological and topographical conditions, and increase in material costs.

Case II The project benefits decrease by 10% due to unexpected decrease in the world price of the crop, or decrease in crop yields.

The effects of these changes on EIRR and NPU are summarized below :

Case	EIRR (%)	NPV (US$)
Case I	7.45	699,335
Case II	7.38	533,117

8-3 Financial Analysis

8-3-1 Farm Income Analyses

Farm income analysis were made to determine the incremental returns that the farm households may be expected.

The analyses were made according to the following procedure :

- profitability of individual farm enterprise
- farm enterprise gross value of production
- farm enterprise cost of production

Net farm income is the difference between gross value of production and cost of production.

The farm budget analyses were made according to 3 different farming scales (1.0 ha, 1.5 ha, 2.0 ha) and the results show that the farm income and farmer's disposable income are expected to increase significantly under the Project.

The future annual disposable income is estimated to be 29 to 1000 times larger than the present one. Thus, the standard of living of the farmers in the Project area will be evidently changed by the implementation of the Project.

8-3-2 Payability of Irrigation Water Charges

Generally, the irrigation water charge is imposed to the water users it is spent for the payment of O/M expenditures and for the repayment of the capital cost of the Project.

If the farmers could not pay the water charge, all the costs of the Project will have to be shouldered by the government, and such expenditures will become a heavy burden to the Government.

Therefore, the farmer's capacity to pay the irrigation water charges was examined in connection with the amount of their incremental disposable income.

The annual O/M cost required for the Project is estimated at US$33.819, which is equivalent to about US$12.81 per hectare, about 2.2% of the gross agricultural production value. This corresponds to about 3.5% of the payability of 1.5 ha scale farmers.

In consideration of the above and with regard to similar projects at home and abroad, water charge for the Project is proposed to be about 8% of the incremental disposable income of 1.5 ha scale farmers. The following table presents the estimated incremental disposable income.