

management in the first stage because, at this time, the farmers are incapable and have no capital of their own. It is also important to strengthen farmers' participation in the project by forming small organizations in every village.

3-4-2 Increase Plan for rice Production

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

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

(1) Paddy seed supply plan

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

(2) Organic fertilizer production plan

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

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

3-4-3 Upland Crops and Fruit Development Plan

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

Approximately 2,000 ha of land will be reclaimed to expand the upland fields to 3,893 ha and another 10,000 ha will be irrigated for upland crops during the dry season. The area for the orchards will be 3,600 ha, indicating an increase of 3,000 ha. In order to achieve these, it is necessary to carry out the supply of the seeds and the saplings smoothly.

The establishment of a farm aid system or financial system is important, as fruit production takes several years. The farmers with small lands are not usually granted loans by the existing financial system.

Considering the future market structure, citrus trees are positively recommendable. As varieties have different growing years, mixed planting will be carried out in the first stage, and economically effective trees will be gradually increased. Companion planting of chestnut trees and jujube trees which are early growing but less profitable, and citrus trees, which are late growing but highly profitable will be implemented. The farmers will determine maintenance cost from the former and will wait for the growth of the latter. After the complete growth of the latter, the former will be felled and will be made into a citrus orchard.

(1) Upland crops seed production plan

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

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

3-4-4 Livestock Development Plan

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

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

3-4-5 Fishery Development Plan

Fish is an important source of protein and cash. However, according to the following reasons, it is still under-developed. They are ① under-developed fishing tools, methods and supporting organizations, ② natural breeding is impeded by flood and ③ expensive production cost of fries.

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

The incubatory is composed of a propagation pond and a breeding pond. Adult fish are bred in the propagation pond. The fishes will be changed every 2 years to maintain high fertility rate. As natural fries have a high death rate (more than 80%), they will have to be protected in the breeding pond for about 3 weeks after incubation in order to decrease the death rate.

3-5 Irrigation and Drainage

3-5-1 Provincial Development Policy

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

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

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

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

Irrigation development policy of Savannakhet Province is based above.

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

- (i) domestic use in dry season

(ii) irrigation use in dry season

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

This policy stems from the following reasons.

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

3-5-2 Water Resources Potential

Research for the water resources in Savannakhet province had been done by UNDP/FAO Group in January 1990. The values of the water resources were roughly estimated by district as shown below and rainfall contour lines are shown in Fig. 3-3.

Water Resources in Savannakhet Province

District	Area (km ²)	Average (mm)	Flow (ℓ/s/km ²)
Saybouly	1109.9	600	19
Atsaphangthong	2992.9	1050	33
Outhoumphone	942.6	700	22
Khanthabouly	1033.4	600	19
Champhone	786.9	700	22
Songkhone	1372.9	600	19
Songbouly	1527.1	850	27
Thapangthong	2930.8	700	22
Nanhom	1141.4	1500	47
Phine	2699.4	1050	33
Xepone	3254.7	1650	52
Nong	1928.3	1150	36

These values may be useful for roughly understanding the water resources potential in view of the rainfall depth, based on the following findings.

- * Average annual rainfall at the stations in Savannakhet province varies from 1400 mm to 2200 mm.
- * Annual loss of the evapo-transpiration is about 800 mm.

3-5-3 Development Strategy

(1) Selection of potential area

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

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

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

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

- ① Examination of suitability based on the results of soil survey and analysis
- ② Examination of suitable sites through topographical maps with scale of 1/100,000, 1/50,000
- ③ Estimation of usable water capacity through hydrological analysis and field survey
- ④ Field reconnaissance to check the present conditions

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

- (a) Existing rainfed paddy fields
- (b) Sizable plain areas
- (c) Topographically suitable areas for irrigation

(2) Development scale

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

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

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

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

(3) Irrigation system

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

- Reservoir
- Weir
- Pump
- Flood gate

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

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

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

(4) Water requirement

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

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

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

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

Puddling water : 180 mm

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

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

Efficiency : 60 %

Evapotranspiration : Modified Penman Method

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

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

Representative crop : Groundnut

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

Efficiency : 47 %

3-5-4 Flood Control Plan

(1) Xe Bangfai basin

As mentioned above, besides 7 existing flood gates, there are 15 planned projects, 4 flood gates of which are under construction. According to the survey results by the Institute of Irrigation and Hydropower, about 7,000 ha of paddy field will be protected by dikes about 50 km in length, 1 ~ 2 m in height and 1 ~ 2 m in width. A floodway at the downstream area of B. Xay Soung will also be effective to decrease the water level of the Xe Bangfai river.

(2) Xe Banghiang basin

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

① Floodway

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

② Improvement of Xe Champhon river

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

③ Regulating reservoir

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

3-5-5 Irrigation Development Program

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

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

Development Project by Type

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

(2) Reservoir

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

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

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

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

The design of Nhyod H. Bak was completed in 1982 with the technical assistance of Vietnam. However, its implementation has not been started for 10 years because of no financial resource. The feasibility study should

be required for the project before its implementation. As for H. Khambou project, the design work was finished by the provincial irrigation division but the budget has not been realized. The design works for other projects will be done according to the materialization of the plans. Out of these 38 reservoir projects, only H. Cheao reservoir is in a floody area for cultivation during the dry season with small pump irrigations. The total irrigable areas by the above 38 reservoirs are shown below according to scale.

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

(3) Weir

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

(4) Pump

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

during the dry season will be irrigated. However, actual dry season irrigable area may be reduced considering the present results of the other pump irrigation projects.

(5) Flood gate

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

(6) Long term large scale projects

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

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

Irrigable areas of each large scale project are as follows.

Long Term Large Scale Projects

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

3-5-6 Irrigation Development Area

The list and location of the 83 small to medium scale and 8 large scale development projects are shown in Table 3-2 and Fig. 3-4.

Total irrigable area is:

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

They are summarized below by irrigation type.

Irrigation Development Area

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

3-5-7 Rehabilitation Program

As mentioned in section 3-5-1, Provincial Development Policy, 'Rehabilitation in preference to new schemes' are one of the important policies. It is proposed that many effective rehabilitation works should be promoted as much as possible. Out of 83 projects, the following 3 projects are rehabilitation or improvement projects.

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

The above 2 pump projects aim at the expansion of the utilization of existing reservoir water by pumps and canals.

Furthermore, there are additional intake facilities under construction at the following existing weir projects.

Project	District
(1) H. Mong	Songkhone
(2) H. Xom	Sonbouly
(3) H. Bong	Outhomphone
(4) H. Houaxang	Khanthabouly

Canal construction following an intake is the responsibility of the farmers and by this additional works, gravity irrigation will become possible. This can be considered as a kind of rehabilitation or improvement project. There will also be a possibility to raise the height of existing weirs if topographical conditions are suitable, creating more irrigation capacity.

3-5-8 Provincial Development Budget and Implementation

Out of the 83 development projects listed in Table 3-2, survey works were completed for 65 projects and design works for 24 projects. The survey for small weirs or reservoirs is only cross leveling of the rivers, taking one day for weirs and 3 to 4 days for reservoirs.

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

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

The 83 projects are classified by construction methods below.

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

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

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

Note: * Excluding pump cost, using existing pump

** Excluding pump cost, pumps from FAO

3-5-9 Operation and Maintenance

Success of irrigation project depends on a well-organized operation and maintenance system. This will ultimately depend on the farmers' understanding and cooperation. Without the farmers' cooperation, all efforts by the Government will be in vain. At present, a farmers' group for small weir or pump project is composed of one member per village and their activities are successful. According to the expansion of the project scale, the organization of farmers' groups will extend over more than 2 villages. The

key point of the farmers' organization is to start from a smaller unit. To unite the farmers' group in the village, for example, a total of 50 farmers will be divided into 5 groups of 10 farmers each and 5 leaders of each group will be trained first. The success of the unification will lead to cooperation among villages for the second stage. The operation and maintenance of irrigation facilities are finally the responsibilities of the benefiting farmers, though, considering that "water management cooperation" in Lao has not yet been established completely, the provincial technicians should also be trained to level up their technique and knowledge of management.

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

The concept of "Water Charge" or "O/M cost has to be covered by water charge" would be acceptable to the farmers as these payments will ultimately bring about more income than the water charge itself. In addition, to realize the technically important net water consumption, water measurement facilities will have to be set up in each field.

3-6 Agro-infrastructure Development Plan

3-6-1 Basic Approach

As previously stated in 3-1, the project is mainly focused on zone development taking into consideration the site conditions, district administration, infrastructure, population, agricultural production and farming. An agricultural supporting center shall be established in each zone, and these centers will promote development by implementing the bottom-up method. The role of the centers is to support the improvement of the agricultural techniques, production increase, improvement of transportation, expansion of the market, stabilization of prices, the safe procurement of provisions and the development of the living conditions in the rural area.

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

3-6-2 Rural Road Improvement

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

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

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

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

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

The improvement schemes are as follows:

(1) 5 Year Road Improvement plan

The simultaneous improvement of all roads is difficult because of shortage of funds, engineering and construction equipment. Therefore, the improvement of the routes considered to be very important to agricultural development will be given priority. (See Fig. 3-5)

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

The development of agro-infrastructures will support and further the Project. The improvement of the roads, especially those in need of immediate repair, will take precedence of other rural development works.

The main O/M executive agency is DCTPC. However, due to limited O/M budget and superannuated equipment, operation and maintenance has not been conducted efficiently. It is important, therefore, to consolidate the

executive agency (DCTPC). Consolidation can be achieved according to the following measures.

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

(3) To Establish the Farmers' Supporting System

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

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

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

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

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

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

The following methods should be considered.

- Surface course grading methods,
- The intensity of road crossing conduit and banking depth,

- Road embankment materials, embankment intensity (California bearing ratio), road cross grade,
- Road width, longitudinal slope, traffic drainage,
- Road bridge grade and design load,
- Road pavement method and others.

(5) Road surface improvement scheme

Improvement will be carried out on roads with completely damaged road body by erosion during the rainy season. Consequently, the improvement of the roads becomes very hard and complicated because it will entail big volumes of road body embankment, replacement of drainage facilities and the upper course of the laterite soil embankment. Therefore, it is necessary to conduct road surface grading and side ditch cleaning twice a year (after and before the rainy season). The conditions of the surface course should be maintained to avoid serious damages and in order to limit the construction cost to 1/3~1/10 of the heavy improvement works.

3-6-3 Post-harvest

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

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

The plan aims to collect 10~20% (400~800 tons) of paddy from the whole zone, and the estimated amount of paddy to be reserved in the future is 40% of the total amount of production, due to the consolidation of the farmers organization.

3-6-4 Stabilization of Rural Life

(1) Domestic water supply

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

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

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

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

- Groundwater resources

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

- Rainwater use

Rain water is considered as a safe source of water supply. It can also be used as drinking water. Water tanks and jars can be easily and economically produced and they are popular especially in the northeast of Thailand. For example, the construction of a big water tank (φ1.5 m×2.5 m) made of bamboo instead of reinforced bars, would cost only about 90,000 Kip (130 US\$). The production of water jars can possibly develop into a domestic industry in the rural area.

- Construction of Small Reservoirs

The farmers will construct small reservoirs near small rivers or the farming area. The bed embankment of the small reservoirs will be made of clay and dikes will be constructed to ward off coarse water. The reservoirs filled with rain water will become clear after 2~3 years. By then, it can be used for drinking.

The effective domestic water supply system will be studied together with the wells, water tanks, jars, and reservoirs.

(2) Electricity

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

The electrification plan of the Electric Company is stated below.

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

Electrification is possible in villages with electric wirings, but impossible in villages without electric wires.

At present, the State Enterprise of Building Construction No. 2 produces 200 electric posts every month.

(3) Rural Medical Care

There are 14 hospitals, 57 doctors, 897 nurses and 37 pharmacists in Savannakhet Province. Moreover, the total number of hospital beds in the province is 856.

The hospitals are established in the Provincial capital and district capitals. Medical treatment, however, is not sufficiently implemented in the rural areas.

The main diseases in the study area are malaria, skin disease, parasitemia, diarrhea, bronchitis, stomatitis, and endemic diseases. The death rate of individuals from 18~55 years of age is high.

There is, therefore, a need to establish a clinic (complete with water works, electricity and about 10 beds) within the center of the zones for emergency measures and periodical health examination, in order to improve the medical conditions in the rural area.

CHAPTER 4 AGRICULTURAL DEVELOPMENT (MASTER PLAN)

4-1 Organization Development Plan

4-1-1 Agricultural Supporting Center

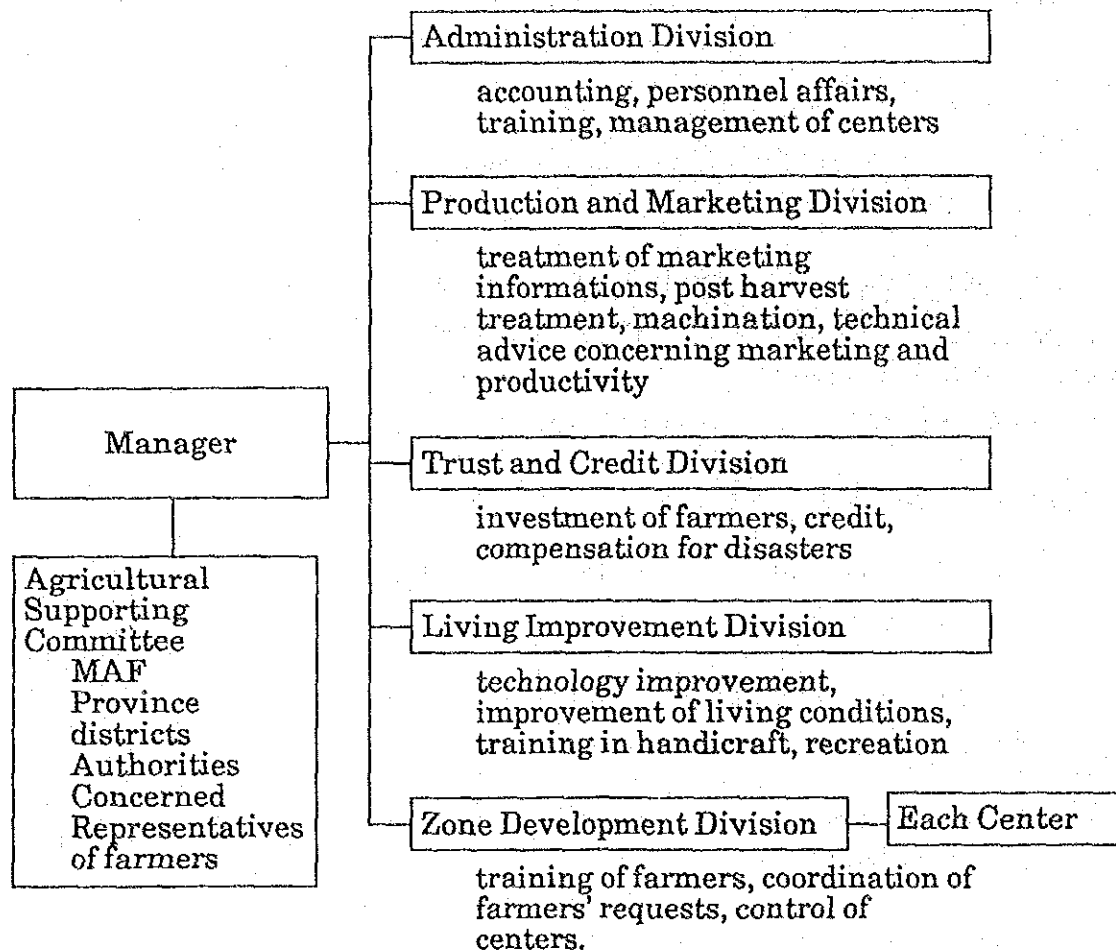
Agricultural supporting centers are built in each zone to mainly support software development. The centers will be controlled by MAF, Savannakhet Province and Khammouane Province with the cooperation of the district government and authorities concerned.

The functions of the center are as follows:

- Post-harvest functions (collection of paddy, rice mill, storage, rice bank, etc.)
- Collection, analysis and transmission of informations concerning marketing and marketing development.
- Formulation of production planning, supply of inputs and training of farmers.
- Operation and maintenance of constructed facilities.
- To promote the development of the agricultural structure.
- Promotion of rural industries
- Improvement of the farmers' living conditions

As previously mentioned in Chapter 3, the center will be initially managed by the government. The organization of the Savannakhet Head Center is shown below.

Savannakhet Head Center



4-1-2 Zone Division

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

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

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

(a) Xe Bangfai Zone

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

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

(b) Xeno Zone

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

(c) Savannakhet Zone

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

(d) B. Lak 35 Zone

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

(e) Pakxong Zone

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

(f) Donghen Zone

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

4-1-3 The Characteristics of Each Zone

(1) Xe Bangfai Zone

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

The road conditions of the area, however, are very poor. Except for the road connecting Thakhek City and Nongbok Town, traffic is impossible during the rainy season. There are no roads connecting the area to route No. 13. The only bridge across the Xe Bangfai river is the one in route No. 13. The construction of roads that would connect the area to route No. 13, therefore, is important.

(2) Zeno Zone

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

(3) Savannakhet Zone

This zone includes Savannakhet City, the second largest city in Lao PDR. This city is the political and commercial center of the area, and has

the highest population density. The main agricultural land spreads along the Sompoy River. In spite of a comparatively small catchment area, the course of this river is unstable, and drought and flood often occur. The other cultivated lands are located along the Mekong river. Pumping irrigation is conducted in some parts of the area.

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

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

(4) B. Lak 35 Zone

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

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

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

(5) Pakxong Zone

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

(6) Donghen Zone

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

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

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

4-2 Proposed Land Use

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

(1) Paddy field:

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

(2) Upland field:

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

There are plenty of suitable areas for orchards. However, considering

the demand and supply of fruits and other tree crops, and the shortage of labor, the area for the orchard was limited.

- Normal upland field:

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

The proposed land use is summarized below and the proposed land use for each zone is shown in Table 4-1 and Fig. 4-1.

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

4-3 Agricultural Development Plan

4-3-1 Rice Production Plan

(1) Rice Production

As shown in Table 4-1, the irrigated area will be expanded to 66,853 ha, 40 times more than the present area, in the rainy season and 33,388 ha during the dry season. The paddy fields will be increased to 100,801 ha, 15% more than the present area.

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

(2) Paddy seed production plan

The necessary volume of paddy seed is 50 kg/ha. It is necessary to have 130 ha of irrigated paddy fields if 10% of the paddy seeds will be renewed. The Thasano Seed Farm will be expanded up to 50 ha. Although the drying facilities have enough capacity, it is necessary to install additional pumps and farm machines.

Other seed farms measuring 80 ha will be established at Donghen zone and Xe Bangfai Zone where plenty of water resources can be found.

(3) Organic fertilizer production plan

① Production

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

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

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

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

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

② Fertilization standard

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

4-3-2 Upland Crops and Fruit Production Plan

(1) Expansion of upland fields and irrigable areas

The upland fields will be 7,493 ha and 10,000 ha for the second crops of irrigated paddy fields, while the present area is 2,493 ha and 427 ha respectively. The upland rice fields included in the present area will be annihilated. The upland areas in each zone are shown in Table 4-1. These areas are largely distributed in Pakxong Zone, where lots of upland crops are planted at present, and in Donghen Zone, a mountainous area. Moreover, the irrigable paddy fields which will be used for upland crop cultivation during the dry season, are largely distributed in Donghen Zone, B. Lak 35 Zone and Xe Bangfai Zone, the areas rich in water resources.

(2) Formation of Chief Producing Area

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

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

(3) Sapling farms

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

4-3-3 Livestock Development Plan

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

(1) Pastureland

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

Calves born during the dry season suffer from malnutrition. The death rate of young animals is high due to feed shortage. This plan, therefore, will construct a special place where pregnant cows will be transferred

whenever feed shortage occurs. In this place, these cows will be fed with rice straws, and through careful management, accidental deaths can be prevented.

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

a) Construction of Fences

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

b) Water Resources Securement Plan

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

c) Breeding Plan

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

d) Management System

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

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

(2) Hatchery Plan

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

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

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

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

b) Production Scale

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

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

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

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

c) Feed Production Scale

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

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

d) Rough Estimate of Management Cost

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

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

e) Development Foothold

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

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

(3) Facility plan

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

Facility Scale

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

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

4-3-4 Fishery Development Plan

(1) Incubatory pond

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

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

(2) Fishing plan

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

(3) Breeding capacity of reservoirs

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

4-3-5 Agricultural Gross Earnings

The estimated agricultural gross earnings for the target year will be 116,726 US\$, 3.2 times more than the present earning of 36,685 US\$. The data are shown in Table 4-2.

4-4 Irrigation and Development Plan

4-4-1 Xe Bangfai Zone

(1) Target plan and background

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

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

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

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

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

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

(2) Project

(a) Reservoir

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

Reservoir Project

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

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

(b) Weir

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

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

(c) Pump

Main irrigation development on the medium term is a series of pump stations along the Xe Bangfai river. These pump stations have 2 to 4 inclined type pumps with a capacity of 33 m³/min., 500 mm diameter and 130 kW of motor each, according to irrigation areas. There are 3 pump stations under construction in Bungxe, Kengphosi in Saybouly

district and Namphou in Nonbok district. The pump irrigation projects, including the above 3 stations, are shown in the following table with a total irrigation area of 8,000 ha in both rainy and dry season.

Pump Project

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

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

(d) Gate

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

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

(3) Planned Irrigable Area

The location of irrigation projects in Xe Bangfai zone is shown in Fig. 4-2, 3 and planned irrigable areas by irrigation type are as follows.

Planned Irrigable Area (Xe Bangfai Zone)

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

(4) Long term large scale project

(a) Background

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

On the other hand, Nam Theun No. 2 Dam project has just finished the feasibility study and is on the way to its implementation stage in the years 1994 to 1997. After the completion of the dam, it is possible to generate electricity of 300 to 600 MW and an average flow of 200 m³/sec is planned to be discharged to the Xe Bangfai river through out the year. The feasibility study on the multipurpose utilization of the water resources from Nam Theun No. 2 Dam, compared with a series of pump stations and flood protection projects, is proposed for the future long term plan.

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

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

(b) Xe Bangfai weir

[Planning policy]

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

[Intake facilities]

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

[Generating electricity facilities]

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

[Irrigation facilities]

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

Dimension of Xe Bangfai Weir

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

(c) H. Sikhai reservoir

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

H. Sikhai Project

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

4-4-2 Xeno Zone

(1) Target plan and background

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

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

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

(2) Project

(a) Reservoir

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

Reservoir Project

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

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

(b) Weir

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

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

(3) Planned Irrigable Area

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

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

4-4-3 Savannakhet Zone

(1) Target plan and background

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

(2) Project

(a) Reservoir

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

Reservoir Project

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

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

(b) Weir

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

Weir Project

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

(c) Pump

There are 2 pump irrigation projects under construction with the water resource from the Mekong river. The type of pumps is an inclined type with a capacity of 33 m³/min., a diameter of 500 mm and a

motor capacity of 130 kW. Total irrigable areas are 450 ha in both rainy and dry season shown as follows.

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

(3) Planned irrigable area

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

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

(4) Large scale long term project

[H. Sompoy Reservoir]

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

General information of H. Sompoy reservoir is as follows.

H. Sompoy Reservoir

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

4-4-4 B. Lak 35 Zone

(1) Target plan and background

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

(2) Project

(a) Reservoir

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

Reservoir Project

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

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

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	

(3) 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

(4) 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

4-4-5 Paksong Zone

(1) 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 ranges 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 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.

(2) 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	Irrigable Area (ha)		
Height (m)	Length (m)	Volume (10 ³ m ³)	Length (km)	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

(3) 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

4-4-6 Donghen Zone

(1) 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 km² at Kengkok with a total annual flow of 1,600 million m³. However, this flow concentrates in rainy season and the average flow in dry season (January to April) is 0.3 m³/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.

(2) 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	Irrigable Area (ha)		
Height (m)	Length (m)	Volume (10 ³ m ³)	Length (km)	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 rainy season and 30 ha in 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 a water resource of the Xe Champhone river.

Pump Project

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

(3) 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

(4) Long term large scale project

(a) Xe Champhone (No. 1) Reservoir

This reservoir will enable irrigation of 4,780 ha paddy fields of 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 of 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 described 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

4-5 Agro-infrastructure Development Plan

4-5-1 Xe Bangfai Zone

(1) 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 $\phi 40\sim 60$ 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 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 |

(2) Agricultural supporting center

Three centers will be established in Xe Bangfai zone, and these centers will propagate agricultural services, promote marketing improvement of agricultural products, rice mill and storage, and improvement of rural life.

The centers are equipped with the following.

- Administration office, rice mill and storage
- Market

- Facilities for organic fertilizers
- Fodder mill (use for rice bran and maize)
- Water supply facilities
- Telephone, electricity
- Vehicles, etc.

(3) 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 are 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 $\phi 15\sim 20$ cm, and the wells will be manual in type.
The construction methods of the well will be the same in each zone.

4-5-2 Xeno Zone

(1) 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

(2) Agricultural supporting center

The facilities of the center are as follows:

- Administration office, rice mill and storage,
- Market
- Vehicles
- Telephone and others

(3) 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.

4-5-3 Savannakhet Zone

(1) 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 ~ : 10 km
 Route No. 11
 New bridge construction : 1 place
- B. That ~ B. Gnang song : 8 km
 New bridge construction : 1 place
- B. Thassno ~ B. Lak 7 ~ : 15 km
 Savannakhet

Bridge improvement	: 4 places
- B. Maibuangthale ~ B. Nateuy	: 10 km
New bridge construction	: 2 places

(2) Agricultural supporting center

There are many rice mill factories in Savannakhet City, and the social infrastructures such as rice institutes, the Government offices, minibuses terminals, workshops, electricity, hospital and schools are in good condition. Therefore, a center that will generalize and promote Agricultural Development will be established in this zone.

The center will propagate agricultural services, promote marketing of agricultural products, administration of MAF and DAF, rice storage plan, fertilizer distribution and strengthening of agricultural cooperatives.

The center is equipped with the following.

- General Affairs Office (with management equipments, meeting room)
- Vehicles
- Telephones, etc.

(3) 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.

4-5-4 B. Lak 35 Zone

(1) 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 ~ : 14 km
Route No. 13
Bridge improvement : 4 places
- B. Phonkho ~ B. Nakham ~ : 14 km
Route No. 13
Bridge improvement : 7 places
- B. Nakhov ~ B. Laosouligna ~ : 26 km
Route No. 9
Bridge improvement : 6 places
- B. Kengkok ~ B. Lahanamthong : -
New bridge construction : 1 place
Bridge improvement : 5 places

(2) Agricultural supporting center

The center is equipped with the following.

- Administration office, rice mill and storage
- Market
- Vehicles
- Telephone and others

(3) 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.

4-5-5 Pakxong Zone

(1) 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. Nongnokkhan ~ 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

(2) Agricultural supporting center

Pakxong city is an important trading city located between Savannakhet and Champasak province. The functions of Pakxong Center are to develop trading relations outside, as well as to support zone development. The center is equipped with the following.

- Administration office, rice mill and storage
- Market, workshop
- Fodder mill
- Water supply, telephone
- Vehicles, etc.

(3) 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.

4-5-6 Donghen Zone

(1) Rural road improvement plan

The roads in the mountainous district of Donghen Zone are underdeveloped. 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

(2) Agricultural supporting center

Donghen city is the intermediate trading place of Savannakhet city, the eastern part of the Province and Vietnam. One of the functions of the center is to propagate agricultural services. The center is equipped with the following.

- Administration office, rice mill and storage
- Market
- Fodder mill
- Water supply, telephone
- Vehicles, etc.

(3) Village water supply Plan

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

4-6 Construction Cost Estimation

The estimated construction cost of the 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

CHAPTER 5 EVALUATION OF THE MASTERPLAN

5-1 Outline

The masterplan aims to carry out an agricultural development in a large area extending over 12,000 km².

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 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.

5-2 Impacts of Agricultural Production

5-2-1 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).

5-2-2 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.

5-2-3 Promotion of Fishery

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

5-2-4 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.

5-3 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.

5-4 Impact of the Improvement of Agricultural Support and Living Environment

5-4-1 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

5-4-2 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

5-4-3 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.

5-5 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

CHAPTER 6 PROJECT IMPLEMENTATION PLAN

6-1 Basic Policy of Project Implementation

For the 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 of foods 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 roads improvement and expansion of the center on a corresponding scale will follow.

The center has to collect sufficient amount of paddy to obtain profits. This point has to be considered at the selection of the irrigation projects. Maneuverability of O/M is also an important factor. Gravity irrigation system, with a possibility of double cropping, is recommendable.

6-2 Project Implementation Plan

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

6-2-1 Implementation Plan by Zones

(1) 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.

(2) Xe Bangfai Zone

H. Xay (1), Namphou, Hatxiandi, H. Phiphut, H. Sadu, H. Bangkok 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 a large scale, 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.

(3) Savannakhet Zone

Savannakhet center will be a 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.

(4) 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.

(5) Xeno Zone

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

(6) 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.

6-2-2 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 ③ easy construction of accessible roads ④ a project in which diversification of farming if 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 ⑦ effective 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 7 PRIOR PROJECT (B.LAK 35 AGRICULTURAL DEVELOPMENT)

7-1 Nhyod H. Bak Irrigation Project

(1) Location

B. Mai is located at the entrance of the 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 and the existing reservoir (H. Bak reservoir) constructed in B. Dong Nongkhoun, 15 km downstream of the Bak river from B. Dongkhoun in January 1989. The proposed project is named Nhyod H. Bak reservoir, meaning the upper reservoir of the H. Bak river.

(2) Background

The survey and basic design work of this project has been completed in 1982 with the technical assistance of Vietnam. However, it has not been implemented yet because of financial reasons. Furthermore, with the exception of some drawings, the basic data and reports are not available at present. In the first phase of this study, the Nhyod H. Bak project was taken up as a priority project and the feasibility study on this project will be done by using all of the existing data on the changes of social and natural conditions after Vietnam's first survey.

(3) General information of the project

The detailed plan of this project is specified through the feasibility study. The tentative general plan, however, is shown below, and the general layout and irrigation plan are shown in Fig. 7-1 to 7-7.

Nhyod H. Bak Irrigation Project

Catchment Area (km ²)	31.0	Main Canal Length (km)	13.0
Annual Flow (10 ⁶ m ³)	13.0	Irrigable Area (ha)	
Gross Storage (10 ⁶ m ³)	20.7	Rainy Season	1,000
Net Storage (10 ⁶ m ³)	13.4	Dry Season	500
Reservoir Area (ha)	570	Total	1,500
High Water Level (m)	168.0	Main Villages that will benefit from the project:	B. Dongkhankhou
Low Water Level (m)	163.0		B. Nonghong
Earth Dam Height (m)	16.5		B. Nanokkhian
Length (m)	1,200		B. Dongmakyang
Volume (10 ³ m ³)	515		B. Nongkalong

7-2 Namphou Irrigation Project

(1) Location

B. Dongphosi and B. Namphou are located at the center of the areas that will benefit from this 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.

(2) Background and basic principles

The first provincial plan was the construction of a weir in Namphou river. This plan aims at fully utilize of Namphou river, the only river which does not dry up even during the dry season, showing a flow of 90 l/sec according to the survey conducted on 25th, Dec. 1990. On the other hand, the provincial government is very interested with the intensive irrigation development of Phoummachedy basin which has about 3,000 ha of cultivated area. However, there are no adequate water resources in the basin enough to cover the whole area. A future plan concerning the use of

Kangnong river which is located 12 km southwards from the basin will be, therefore, constructed. The proposed reserved water of the Kangnong river (Phoummachedy Reservoir project) will be able to irrigate the southern half of the basin area which is about 1,000 to 1,500 ha. Because of poor water resources, this project aims to fully utilize the small rivers flowing in the basin prior to the future plan. The northern part of the basin outside of Phoummachedy will be the project area. The project has a reservoir in the upper reaches of the Xai river and five (5) weirs downstream of Xai river and its tributaries. The project aims to reuse and store water in the river channel in the dry season.

(3) General information of the project

– H. Xai Reservoir

The proposed dam site is near B. Phoxaimai which is located at the uppermost area of the Xai river. The dimensions of the dam and the irrigation area are shown below. Some of the stored water (about 400 mil. m³) will be discharged in the river channel of Xai river in the dry season and will be used for the downstream weir, too.

Namphou Irrigation Project

Catchment Area (km ²)	15.8	Earth Dam	Height (m)	9.0
Annual Flow (10 ⁶ m ³)	6.6		Length (m)	500
Gross Storage (10 ⁶ m ³)	1.9		Volume (10 ³ m ³)	72
Net Storage (10 ⁶ m ³)	0.8	Main Canal	Length (km)	6.5
Reservoir Area (ha)	100	Irrigable Area (ha)		
High Water Level (m)	170		Rainy Season	160
Low Water Level (m)	168		Dry Season	60
			Total	160

– No. 1 to No. 5 Weir

The sites of the 5 weirs will be specified after the implementation of the Phase II survey and feasibility study. The tentative sites are shown below.

Weir	Site of Weir
No. 1 Weir	Intersection of Xai river and Provincial road 100 to 200 m upstream of Xai bridge
No. 2 Weir	Tributary of Xai river, 2 km upwards from the junction of Xai river
No. 3 Weir	1 km upwards from Namphou bridge (intersection of Namphou river and Provincial road)
No. 4 Weir	300 m downstream from the junction of Xai river and Namphou river
No. 5 Weir	Phou river, 2 km upstream from B.Dontoum

The weirs will be in the form of a stoplog or a gate, since they can both easily control the water level in the rainy season, and can conduct supplementary gravity irrigation.

Among the five (5) weirs, No. 1, having some discharge from H. Xai reservoir, and No. 3 having continuous annual flow (30 to 60 lit/sec in dry season), can conduct gravity irrigation in the dry season. The remaining No. 2, 4 and 5 weirs are utilized in such a manner that the gates are closed at the end of the rainy season in order to store water in the river channels. The stored water is used for small scale irrigation along the upper reaches of the weirs by using small pumps or hand pumps.

The irrigation area of the five (5) weirs is shown below.

Irrigation Area of 5 Weirs (ha)

Weir	Rainy Season	Dry Season	Total
No. 1	110	25	135
No. 2	50	10	65
No. 3	90	30	120
No. 4	110	10	120
No. 5	80	10	90
Total	440	85	525

The Main Villages that will benefit from the Namphou Irrigation Project are B. Phoxaimai, B. Dongphosi, B. Namphou-Nua, B. Namphou-Tai, B. Namphou-Noy, B. Donghouakham and B. Dongmakfai.

The general layout and irrigation plan of Namphou Irrigation Project are shown in Fig. 7-8 to 13.

7-3 Rural Infrastructure

The necessary facilities for the improvement of transportation, farmers' living conditions and farmers' organization which were recommended as priority projects are summarized below.

- Road improvement : about 39 km
- Well : 70 sites
- Agricultural supporting center :
 - Building (Wooden house) with meeting room, training room, office, etc.
 - Rice mill, Store house, etc.

CHAPTER 8 WORK PLAN HEREAFTER

The work hereafter will be carried out from Phase II, and the Interim Report will be submitted to the Government of Lao PDR.

8-1 Field Work II

(1) At the start of the Field work II, the Interim report will be submitted to the Government of Lao PDR. The master plan will be presented and the Government's agreement will be necessary.

(2) Field work II

A F/S for the top priority project, B. Lak 35 Agricultural Development Project will be carried out. The project is composed of 2 fields, an agricultural center which will promote marketing and organization, and 2 projects which will construct irrigation systems and rural infrastructure.

i) Study area

a) Agricultural supporting center : B. Lak 35

b) Irrigation and rural infrastructure development projects :

Nhyod H. Bak irrigation project and Namphu irrigation project

ii) Meteorology and hydrology

In order to raise the accuracy of the data collected at Phase I, a supplementary survey will be carried out. The current measurement of the water resources for the 2 irrigation projects, will be conducted, and basic data will be prepared.

iii) Soil and land use

Survey points will be settled in the study area based on prepared maps of 1/5000. Sampling, reconnaissance survey, topographic survey and hearing will be carried out. Sampling will be carried out per 200 ha, and additional one will be done, if necessary. The analysis of Particle Size Distribution, PH, EC, Cation Exchange Capacity, total N, Moisture Capacity, etc. will be carried out. In order to raise the productivity of the project area, a

reasonable land use plan will be formulated in consideration of the results of the studies on irrigation, drainage, agriculture, agro-economy, and organization.

iv) Agro-society and farmers' organization

The benefiting areas in the center is Nhyod H. Bak area and Namphu area. However, the future target of the organization will be all of the zones, keeping it in mind that the field survey will be conducted. Conducting a contract for sample survey on farmhouses, structure of agro-society, farmers' living, population and its component, the income, living environment existing farmers' organization, farmers' intention, etc. will be studied. Clearing the position of the project in the zone, an organization plan will be formulated.

v) Agro-economy and marketing

Agricultural production, crops, prices, transportation, consumption, markets, agricultural facilities, production costs, farmers' income, credit, land ownership, etc. will be studied. The present conditions of marketing and agro-economy in the study area will be obtained, and the scale of the center, marketing and agro-economic plan will be formulated.

The basic data for the project evaluation will be prepared.

vi) Agriculture

The farming conditions and agricultural expansion in the study area through the villages will be surveyed, and a plan for the centers with an adequate scale will be formulated.

As for the 2 irrigation projects, by carrying out the survey of cropping pattern, cultivated area, production, present conditions of agricultural inputs, marketing, farming systems, livestock, fishery, processing, etc., a diversified agricultural plan, which will raise farmers' income and improve farming, will be formulated.

vii) Irrigation and drainage

An irrigation and drainage plan, based on the development policy for the 2 proposed irrigation projects, will be formulated. The formulation will be carried out considering cropping pattern, O/M costs, organization, water

management. The design of irrigation facilities will be studied in consideration of the scale of water resources which is based on the water requirement estimated by irrigable area, cropping pattern and hydrological analysis. The benefiting areas, the canals and facilities of the water resources will be designed using maps on a scale of 1/5000. The basic topographical and geological data will be surveyed for designing important structures, such as dams and canals. The implementation of the following survey will be commissioned.

a) Boring, field permeability test and standard penetration test on the dam axis

- Nhyod H. Bak Dam : 20m 1 hole, 10m 2 holes
- Namphu Dam : 15m 1 hole, 5m 2 holes

b) Soil mechanic test for dam materials (specific gravity, grading, moisture ratio, liquidity index, damping test, permeability test, unconfined compression test)

- Nhyod H. Bak Dam : 4 samples
- Namphu Dam : 2 samples

c) Longitudinal and cross leveling for dam axis

- Nhyod H. Bak Dam : longitudinal leveling 0.8 km
cross leveling about 30 points
(150m width)
- Namphu Dam : longitudinal leveling 0.7 km
cross leveling about 25 points
(100m width)

d) Longitudinal and cross leveling for weir axis
longitudinal leveling 0.8 km (160m×5 places)
cross leveling 1.0 km (50m width 4 points×5)

e) Route survey for main canals

- Nhyod H. Bak Dam : about 17 km
- Namphu Dam : about 10 km

Based on the results of the above-mentioned survey, the design and preliminary cost estimation of irrigation facilities will be carried out.

viii) Rural infrastructure

The present conditions of the rural infrastructure in the study area will be surveyed. Based on the master plan formulated in Phase I, a development plan for agro-infrastructure (rural roads, water supply, public facilities, electrification and O/M plan) will be formulated, and a preliminary cost estimation will be carried out.

ix) Progress report

Based on the results of the above-mentioned studies, a progress report will be prepared and presented.

8-2 Home Work II

(1) Supplementary Study for the Master Plan

Based on the results of the Field Work II, a supplementary study will be carried out, if necessary.

(2) Formulation of B. Lak 35 Agricultural Development Project

Based on the results of the F/S, the B. Lak 35 Agricultural Development Project will be formulated, and the draft final report, including the master plan, will be prepared.

8-3 Presentation of the Draft Final Report

This report will be submitted immediately after the completion of the home work. It will cover the results of all the analysis and studies. The Government of Lao PDR may provide JICA with comments, should there be any, through the Embassy of Japan within one month after the acceptance of the report.

8-4 Final Report

This report will be prepared within two months after the acceptance of the comments from the Government of Lao PDR on the Draft final report.

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Table 2 -1 Present Land Use

(Unit : ha, %)

Kind of land	Study area	D. Nong- DOK	D. Say- bouly	D. Outho- mpone	D. Khan- thaouly	D. Cham- phone	D. Son- bouly	D. Song- khone	D. Atsa- phanthong
(1) Rainfed paddy field	86,072	11,392	8,143	9,300	10,854	16,774	5,485	11,320	12,804
(2) Paddy, duple cropping	1,679	480	193	0	131	638	51	140	46
(3) Total paddy field	87,751	11,872	8,336	9,300	10,985	17,412	5,536	11,460	12,850
(4) Upland field	2,493	118	251	128	545	241	89	869	252
(5) Cultivated land	90,244	11,990	8,587	9,428	11,530	17,653	5,625	12,329	13,102
(6) Forest and other lands	1,109,856	126,110	92,913	101,972	116,270	107,447	118,375	152,371	294,298
(7) Total	1,200,100	138,100	101,600	111,400	127,800	125,100	124,000	164,700	307,400
(8) Ratio (5)/(7) (%)	7.5	8.7	8.5	8.5	9.0	14.1	4.5	7.5	4.3
(9) do (3)/(5) (%)	97.2	99.0	97.1	98.6	95.3	98.6	98.4	93.0	98.1
(10) do (2)/(3) (%)	1.9	4.0	2.3	0	1.2	3.7	0.9	1.2	0.4

Table 2 - 2

Monthly Meteorological Statistics at SAVANNAHET

Elevation : 155m above MSL

Latitude : 16 33'N

Longitude : 104 45'E

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	ANNUAL
Mean Temperature (°C)	21.6	25.1	27.6	29.5	29.1	28.2	28.4	27.7	27.5	26.4	23.9	20.9	26.3
Mean Daily Maximum (°C)	28.9	31.7	33.9	34.9	33.6	31.7	32.0	31.2	31.3	30.9	29.0	27.7	31.4
Mean Daily Minimum (°C)	14.4	18.6	21.2	24.1	24.6	24.6	24.8	24.3	23.6	22.0	18.8	14.4	21.3
Extreme (°C)	5.1	9.8	6.3	16.0	19.0	20.0	20.4	20.1	20.0	14.5	9.0	5.2	5.1
Mean Relative Humidity (%)	67	68	64	67	74	79	79	82	78	75	71	68	73
Mean Daily Maximum (%)	96	94	88	89	93	93	93	94	94	93	92	93	93
Mean Daily Minimum (%)	39	41	40	45	55	64	69	62	58	50	42	52	52
Evaporation (mm)	3.3	4.0	4.7	5.0	4.7	4.1	3.9	3.8	3.7	3.8	3.6	3.0	3.8
Wind (m/s)	2.5	1.8	1.9	1.8	1.3	1.5	1.4	1.4	1.4	2.0	2.6	2.7	2.7
Sunshine (hrs)	8.9	8.8	8.1	8.1	7.3	5.4	5.6	4.6	5.7	7.3	8.6	8.7	7.3
Rainy days	0	1	2	6	13	16	14	19	13	7	2	0	8
Rainfall	2	9	33	62	148	266	212	310	229	88	4	1	1,384

Table 2-3 Meteorologic Stations

METEOROLOGIC STATIONS

CODE NUMBER	STATION	OPERATION	LOCATION	
			LATITUDE	LONGITUDE
170404	THAKHEK	LAO PDR	17 25'	104 48'
160504	DONG HENE	LAO PDR	16 00'	105 48'
160505	KENG KOK	LAO PDR	16 26'	105 12'
160502	SENO	LAO PDR	16 40'	105 00'
160405	SAYANNAKHET	LAO PDR	16 33'	104 45'
	H. PHINE	LAO PDR		
	SEPONE	LAO PDR		
	SONBOURY	LAO PDR		
	PAKSONG	LAO PDR		
	SEBANG NOUANE	LAO PDR		
	HUONG NONG	LAO PDR		
	BAN VEUNE	LAO PDR		
170403	NAKHON PHANOM	THAILAND		
160503	KHEHARAT	THAILAND		
160401	MURDAHAN	THAILAND		

HYDROLOGIC STATION

RIVER	STATION	LOCATION		DATUM
		LATITUDE	LONGITUDE	
MEKONG	KHEHARAT	16 04.0'	105 12.0'	108.38 /H.S.L
MEKONG	SAYANNAKHET	16 33.7'	104 44.8'	125.41 /H.S.L
MEKONG	NAKHON PHANOM	16 57.0'	104 44.0'	120.0 /T.B.M
SE BANG FAI	SE BANG FAI	17 04.3'	104 59.1'	125.0 /H.S.L
SE BANG FAI	BAN THA KHAN	16 54'	104 47'	15.507/T.B.M
SE BANG FAI	BAN PAK SE	16 57'	104 47'	14.903/T.B.M
SE BANG FAI	BAN TON HEN	17 03'	104 54'	17.00 /T.B.M
SE BANG FAI	BAN XAYSOUNG	17 05'	104 50'	15.00 /T.B.M
SE BANG FAI	BAN PHAK	16 59'	104 59'	16.344/T.B.M
SE CHAPHONE	KENGKOK	16 27.0'	105 12'	129.98 /H.S.L
SE CHAPHONE	DONHENG	16 02'	105 17'	
SE PON	BAN HUANG	16 40'	106 18'	14.313/T.B.M
SE XANGXOY	BAN PHALANE	16 39'	105 34'	10.05 /T.B.M
SE LANGONG	HUANG NONG	16 22'	106 31'	10.967/T.B.M
SE BANG NOUAN	BAN SE BANG	16 01'	105 29'	
SE THAHOUAK	NOUAN HIGHWAY	16 35'	105 55'	
SE BANG HIENG	BAN KENG DONE	16 35'	105 19.0'	121.9 /H.S.L
SE BANG HIENG	TCHAPON	16 11.1'	106 14.5'	19.149/T.B.M
SE BANG HIENG	KENG TANGANE	16 40.5'	105 23'	115.38 /T.B.M
SE BANG HIENG	THAKONG	16 06'		

Table 2- 4 Flow Regime of Xe Banghiang and Xe Bangfai

Xe Banghiang							(cu.m/sec)	
Year	Max.	High	Medium	Low	Drought	Min.	Average	
1960			(Lack of some data)					
1961	6,360.00	1,130.00	176.00	53.00	4.00	0.00	964.18	
1962	4,950.00	666.00	146.00	66.10	3.70	1.00	572.83	
1963	5,440.00	911.00	107.00	47.20	3.70	0.20	647.72	
1964	7,070.00	538.00	167.00	41.80	4.00	0.00	666.91	
1965	2,250.00	466.00	111.00	65.20	3.70	0.20	333.88	
1966	3,970.00	376.00	148.00	42.70	2.70	0.00	448.52	
1967	4,100.00	375.00	116.00	48.10	4.00	1.00	417.98	
1968	7,540.00	277.00	89.20	39.10	2.30	1.00	418.24	
1969	4,930.00	117.00	451.00	40.90	1.60	0.20	476.54	
1970	4,220.00	185.00	619.00	44.00	1.00	0.20	490.85	
1971	5,760.00	170.00	840.00	55.30	3.60	0.00	624.69	
1972			(Lack of some data)					
1973	2,790.00	107.00	550.00	47.20	5.40	0.00	435.48	
1974			(Lack of some data)					
1975	4,710.00	192.00	476.00	52.60	2.80	0.00	546.56	
1976	4,020.00	131.00	371.00	31.90	4.80	0.00	337.49	
1977	3,150.00	62.20	190.00	31.90	4.60	1.00	268.92	
1978			(Lack of some data)					
1979			(Lack of some data)					
1980			(Lack of some data)					

Xe Bangfai							(cu.m/sec)	
Year	Max.	High	Medium	Low	Drought	Min.	Average	
1973	2,990.00	653.00	104.00	39.80	25.70	22.80	441.41	
1974	3,220.00	556.00	94.60	30.20	26.90	25.70	497.04	
1975	3,320.00	522.00	97.30	31.80	26.90	25.40	515.34	
1976	3,190.00	569.00	89.40	34.60	30.00	29.20	446.55	
1977	2,870.00	265.00	42.00	32.20	27.50	26.60	246.74	
1978			(Lack of some data)					
1979	2,780.00	300.00	68.20	30.80	17.00	15.00	380.97	
1980	2,760.00	273.00	50.30	25.10	19.10	17.90	243.87	
1981	3,000.00	589.00	111.00	26.60	19.90	17.60	420.82	
1982	1,850.00	393.00	53.20	31.40	17.70	16.70	278.22	
1983	1,190.00	263.00	39.10	24.60	19.30	17.20	151.35	
1984	3,140.00	411.00	116.00	28.00	18.60	16.70	427.44	
1985			(Lack of some data)					
Average	2,755.45	435.82	78.65	30.45	22.60	20.98	368.16	